Cardiovascular Emergencies

Objectives

Cognitive

- **4-3.1** Describe the structure and function of the cardiovascular system. (p 402)
- **4-3.2** Describe the emergency medical care of the patient experiencing chest pain/discomfort. (p 415)
- **4-3.3** List the indications for automated external defibrillation (AED). (p 419)
- **4-3.4** List the contraindications for automated external defibrillation. (p 421)
- **4-3.5** Define the role of EMT-B in the emergency cardiac care system. (p 402)
- **4-3.6** Explain the impact of age and weight on defibrillation. (p 420)
- **4-3.7** Discuss the position of comfort for patients with various cardiac emergencies. (p 411)
- **4-3.8** Establish the relationship between airway management and the patient with cardiovascular compromise. (p 411)
- **4-3.9** Predict the relationship between the patient experiencing cardiovascular compromise and basic life support. (p 410)
- **4-3.10** Discuss the fundamentals of early defibrillation. (p 422)
- **4-3.11** Explain the rationale for early defibrillation. (p 422)
- **4-3.12** Explain that not all chest pain patients result in cardiac arrest and do not need to be attached to an automated external defibrillator. (p 421)
- **4-3.13** Explain the importance of prehospital ACLS intervention if it is available. (p 430)
- **4-3.14** Explain the importance of urgent transport to a facility with Advanced Cardiac Life Support if it is not available in the prehospital setting. (p 430)
- **4-3.15** Discuss the various types of automated external defibrillators. (p 420)
- **4-3.16** Differentiate between the fully automated and the semiautomated defibrillator. (p 421)
- **4-3.17** Discuss the procedures that must be taken into consideration for standard operations of the various types of automated external defibrillators. (p 421)
- **4-3.18** State the reasons for assuring that the patient is pulseless and apneic when using the automated external defibrillator. (p 421)
- **4-3.19** Discuss the circumstances which may result in inappropriate shocks. (p 421)
- **4-3.20** Explain the considerations for interruption of CPR when using the automated external defibrillator. (p 430)
- **4-3.21** Discuss the advantages and disadvantages of automated external defibrillators. (p 421)
- **4-3.22** Summarize the speed of operation of automated external defibrillation. (p 421)
- **4-3.23** Discuss the use of remote defibrillation through adhesive pads. (p 421)
- **4-3.24** Discuss the special considerations for rhythm monitoring. (p 421)
- **4-3.25** List the steps in the operation of the automated external defibrillator. (p 426)
- **4-3.26** Discuss the standard of care that should be used to provide care to a patient with persistent ventricular fibrillation and no available ACLS. (p 427)
- **4-3.27** Discuss the standard of care that should be used to provide care to a patient with recurrent ventricular fibrillation and no available ACLS. (p 427)
- **4-3.28** Differentiate between the single rescuer and multi-rescuer care with an automated external defibrillator. (p 426)
- **4-3.29** Explain the reason for pulses not being checked between shocks with an automated external defibrillator. (p 423)
- **4-3.30** Discuss the importance of coordinating ACLS trained providers with personnel using automated external defibrillators. (p 427)
- **4-3.31** Discuss the importance of postresuscitation care. (p 427)
- **4-3.32** List the components of postresuscitation care. (p 427)
- **4-3.33** Explain the importance of frequent practice with the automated external defibrillator. (p 424)
- **4-3.34** Discuss the need to complete the Automated Defibrillator: Operator's Shift Checklist. (p 425)
- **4-3.35** Discuss the role of the American Heart Association (AHA) in the use of automated external defibrillation. (p 402)
- **4-3.36** Explain the role medical direction plays in the use of automated external defibrillation. (p 424)
- **4-3.37** State the reasons why a case review should be completed following the use of the automated external defibrillator. (p 424)
- **4-3.38** Discuss the components that should be included in a case review. (p 424)
- **4-3.39** Discuss the goal of quality improvement in automated external defibrillation. (p 424)
- **4-3.40** Recognize the need for medical direction of protocols to assist in the emergency medical care of the patient with chest pain. (p 415)
- **4-3.41** List the indications for the use of nitroglycerin. (p 415)
- **4-3.42** State the contraindications and side effects for the use of nitroglycerin. (p 415)
- **4-3.43** Define the function of all controls on an automated external defibrillator, and describe event documentation and battery defibrillator maintenance. (p 420)

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Affective

4-3.44 Defend the reasons for obtaining initial training in automated external defibrillation and the importance of continuing education. (p 424)

4-3.45 Defend the reason for maintenance of automated external defibrillators. (p 423)

4-3.46 Explain the rationale for administering nitroglycerin to a patient with chest pain or discomfort. (p 416)

Psychomotor

4-3.47 Demonstrate the assessment and emergency medical care of a patient experiencing chest pain/discomfort. (p 413)

4-3.48 Demonstrate the application and operation of the automated external defibrillator. (p 426)

4-3.49 Demonstrate the maintenance of an automated external defibrillator. (p 423)

4-3.50 Demonstrate the assessment and documentation of patient response to the automated external defibrillator. (p 426)

4-3.51 Demonstrate the skills necessary to complete the Automated Defibrillator: Operator's Shift Checklist. (p 425)

4-3.52 Perform the steps in facilitating the use of nitroglycerin for chest pain or discomfort. (p 416)

4-3.53 Demonstrate the assessment and documentation of patient response to nitroglycerin. (p 416)

4-3.54 Practice completing a prehospital care report for patients with cardiac emergencies. (p 418)

Cardiovascular Emergencies

12

Cardiovascular Emergencies

You are the Provider

You are a volunteer firefighter EMT-B who lives in a rural area. You are at your full-time job when your pager is activated. The dispatcher requests your fire department to respond to 403 McKay Rd for a 65-year-old man complaining of severe chest pain. The address is two blocks from your location, and you respond directly to the scene with your personal jump kit. Advanced life support has been simultaneously dispatched from a location that is 10 to 15 minutes away.

You arrive at the private residence to find an older man in his living room, sitting in a chair clutching his chest. As you introduce yourself the patient says, "This is the worst pain I've ever had in my life!" He tells you that he has had a previous heart attack a couple of years ago, and that he thinks his nitroglycerin is in his bedroom but didn't feel well enough to get it. A fellow EMT-B arrives with your fire department's EMS equipment, including an AED. You ask him to look for the patient's nitroglycerin while you apply high-flow oxygen and take vital signs.

1. What other signs and symptoms might be found in a patient who is having a heart attack?
2. As an EMT-B, you can assist a patient with his or her own prescribed nitroglycerin. What must you know before administering any medications, and what must you specifically know before assisting a patient with nitroglycerin?

Cardiovascular Emergencies

The American Heart Association reports that cardiovascular disease (CVD) claimed 910,614 lives in the United States in 2003. This is 37.3% of all deaths, or 1 of every 2.7 deaths. Heart disease has been the leading killer of Americans since 1900. This statistic is still true today.

It is important for EMS providers to understand that many deaths caused by CVD occur from problems that may have been avoided by people living more prudent lifestyles and by access to improved medical technology. We can help to reduce these numbers of deaths with better public awareness, early access, increased numbers of laypeople trained in CPR, and with public access defibrillation and the recognition of the need for advanced life support services.

This chapter begins with a brief description of the heart and how it works. It then discusses the relationship between chest pain and ischemic heart disease. It explains how to recognize and treat acute myocardial infarction (classic heart attack) and the complications of sudden death, cardiogenic shock, and congestive heart failure. The use of nitroglycerin is described. The last part of the chapter is devoted to the use and maintenance of the automated external defibrillator (AED).

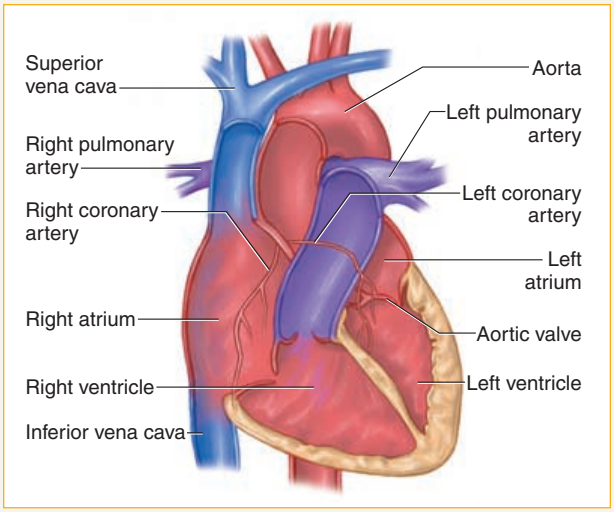

Figure 12-1 The heart is a four-chambered muscle that pumps blood to all parts of the body.

Cardiac Structure and Function

The heart is a relatively simple organ with a simple job. It has to pump blood to supply oxygen-enriched red blood cells to the tissues of the body. The heart is divided down the middle into two sides (left and right) by a wall called the septum. Each side of the heart has an atrium, or upper chamber, to receive incoming blood and a ventricle, or lower chamber, to pump outgoing blood (Figure 12-1 ▲). Blood leaves each of the four chambers of the heart through a one-way valve. These valves keep the blood moving through the circulatory system in the proper direction. The aorta, the body's main artery, receives the blood ejected from the left ventricle and delivers it to all the other arteries so that they can carry blood to the tissues of the body.

The right side of the heart receives oxygen-poor (deoxygenated) blood from the veins of the body (Figure 12-2A ▶). Blood enters into the right atrium from the vena cava, which then fills the right ventricle. After contraction of the right ventricle, blood flows into the pulmonary artery and the pulmonary circulation, where the blood is oxygenated. The left side of the heart receives oxygen-rich (oxygenated) blood from the lungs through the pulmonary veins (Figure 12-2B ▶). Blood enters into the left atrium and then passes into the left ventricle. This side of the heart is more muscular than the other because it must pump blood into the aorta and all the other arteries of the body.

Technology

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- Vocabulary Explorer
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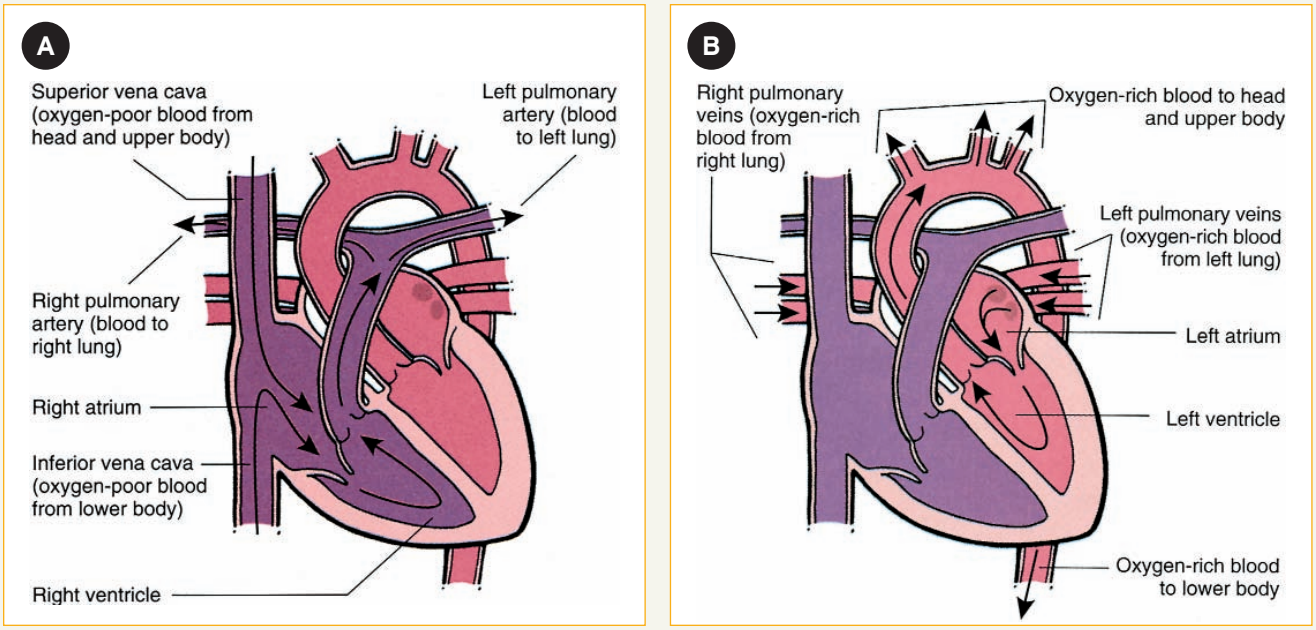

Figure 12-2 **A.** The right side of the heart receives oxygen-poor blood from the veins. **B.** The left side of the heart receives oxygen-rich blood from the lungs through the pulmonary veins.

The heart contains more than muscle tissue. The heart's electrical system, which is distributed throughout the entire heart, controls heart rate and enables the atria and ventricles to work together (Figure 12-3 ▶). Normal electrical impulses begin in the sinus node, just above the atria. The impulses travel across both atria, causing them to contract. Between the atria and the ventricles, the impulses cross over a bridge of special electrical tissue called the atrioventricular (AV) node. Here the signal is slowed down for about one tenth to two tenths of a second to allow blood time to pass from the atria to the ventricles. Then the impulses exit the AV node and spread throughout both ventricles, causing the ventricular muscle cells to contract.

Circulation

To carry out its function of pumping blood, the myocardium, or heart muscle, must have a continuous supply of oxygen and nutrients. During periods of physical exertion or stress, the myocardium requires more oxygen, so the heart must increase its output of blood flow. In the normal heart, the increased need for blood is easily supplied by dilation, or widening, of the coronary arteries, which increases blood flow. The coronary arteries are the blood vessels that supply blood to the heart muscle (Figure 12-4 ▶). They start at the first part of the aorta, just above the aortic valve. The right coronary artery supplies blood to the right ventricle and, in most people, the bottom part, or inferior wall, of the left ventricle. The left coronary artery divides into two major branches, both of which supply the left ventricle.

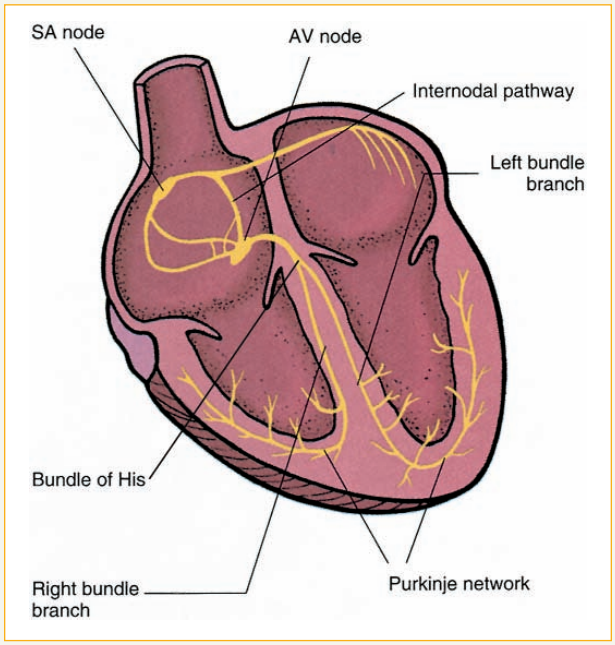

Figure 12-3 The electrical conduction system of the heart controls most aspects of heart rate and enables the four chambers to work together.

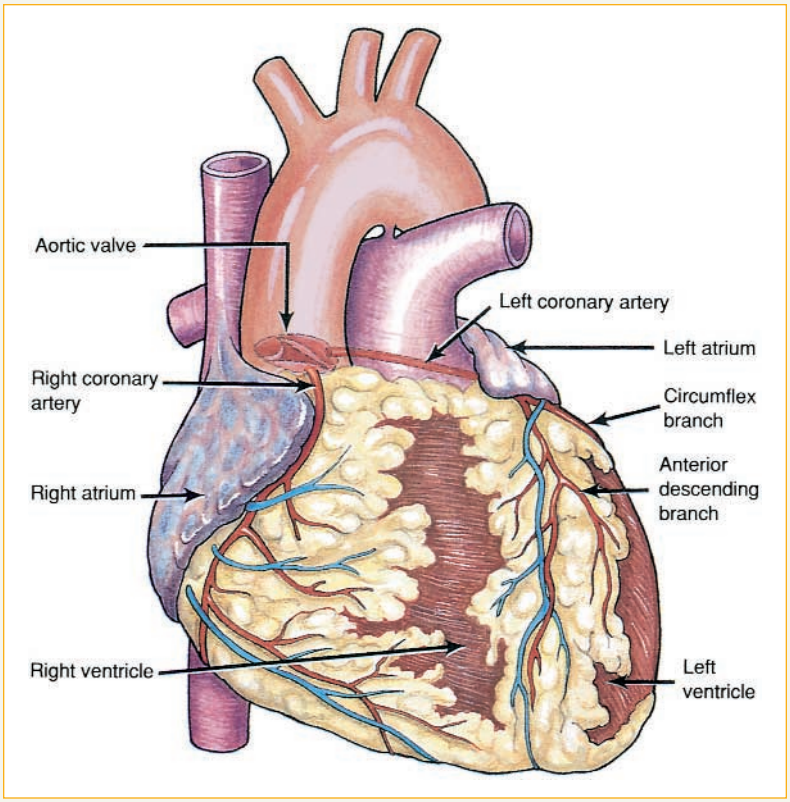

Figure 12-4 The coronary arteries carry the blood supply to the heart.

Two major arteries branching from the upper aorta supply blood to the head and arms (Figure 12-5 ▶). The right and left carotid arteries supply the head and brain with blood. The subclavian arteries (under the clavicles) supply blood to the upper extremities. As the subclavian artery enters each arm, it becomes the brachial artery, the major vessel that supplies blood to each arm. Just below the elbow, the brachial artery divides into two major branches: the radial and ulnar arteries, supplying blood to the hands.

At the level of the navel, the descending aorta divides into two main branches called the right and left iliac arteries, which supply blood to the groin, pelvis, and legs. As the iliac arteries enter the legs through the groin, they become the right and left femoral arteries. At the level of the knee, the femoral artery divides into the anterior (front) and posterior (back) tibial artery and the peroneal artery, supplying blood to the feet.

After blood travels through the arteries, it enters smaller and smaller vessels called arterioles and capillaries. The capillaries are tiny blood vessels about one cell thick that connect arterioles to venules. Capillaries, which are found in all parts of the body, allow the exchange of nutrients and waste at the cellular level.

Venules are the smallest branches of veins. After traveling through the capillaries, blood enters the system of veins, starting with the venules, on its way back to the heart. The veins become larger and larger and eventually form the two large venae cavae: the upper vena cava and the lower vena cava. The superior (upper) vena cava carries blood from the head and arms back to the right atrium. The inferior (lower) vena cava carries blood from the abdomen, kidneys, and legs back to the right atrium. The superior and inferior venae cavae join at the right atrium of the heart, where blood is eventually returned into the pulmonary circulation for oxygenation (Figure 12-6 ▶).

Blood consists of several types of cells and fluid (Figure 12-7 ▶). Red blood cells are the most numerous and give the blood its color. Red blood cells carry oxygen to the body's tissues and then remove carbon dioxide. Larger white blood cells help to fight infection. Platelets, which help the blood to clot, are much smaller than either red or white blood cells. Plasma is the fluid that the cells float in. It is a mixture of water, salts, nutrients, and proteins.

Blood pressure is the pressure of circulating blood against the walls of the arteries. Systolic blood pressure is the maximum pressure exerted by the left ventricle as it contracts. As the left ventricle relaxes, the arterial pressure falls. When the aortic valve closes, blood flow stops. The diastolic blood pressure is the pressure exerted against the walls of the arteries while the left ventricle is at rest. Remember that the top number in a blood pressure reading is the systolic pressure, and the bottom number is the diastolic or resting pressure.

Cardiac Compromise

Chest pain or discomfort that is related to the heart usually stems from a condition called ischemia, or insufficient oxygen. Because of a partial or complete blockage of blood flow through the coronary arteries, heart tissue fails to get enough oxygen and nutrients.

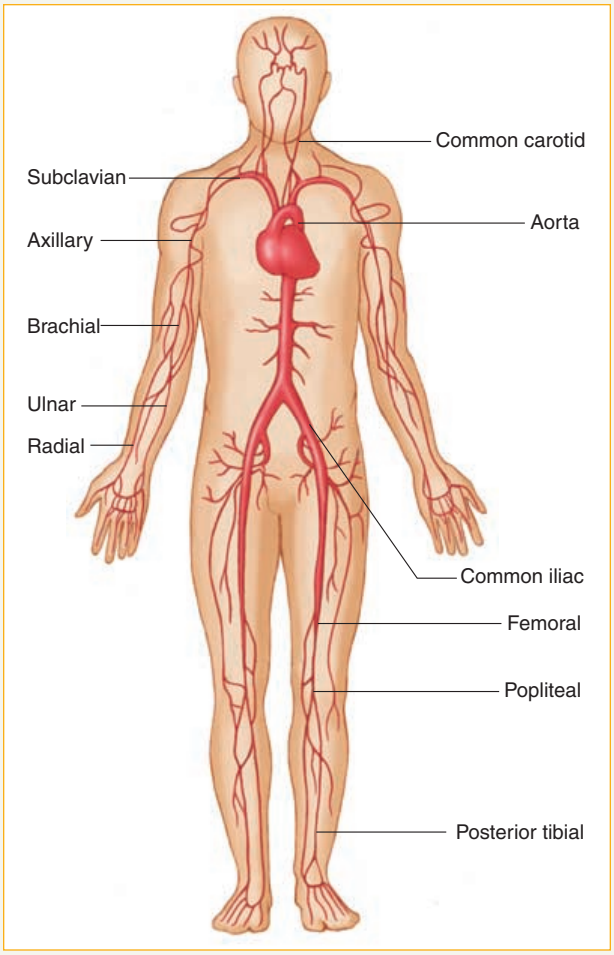

Figure 12-5 The major arteries of the body carry oxygen-rich blood to all parts of the body.

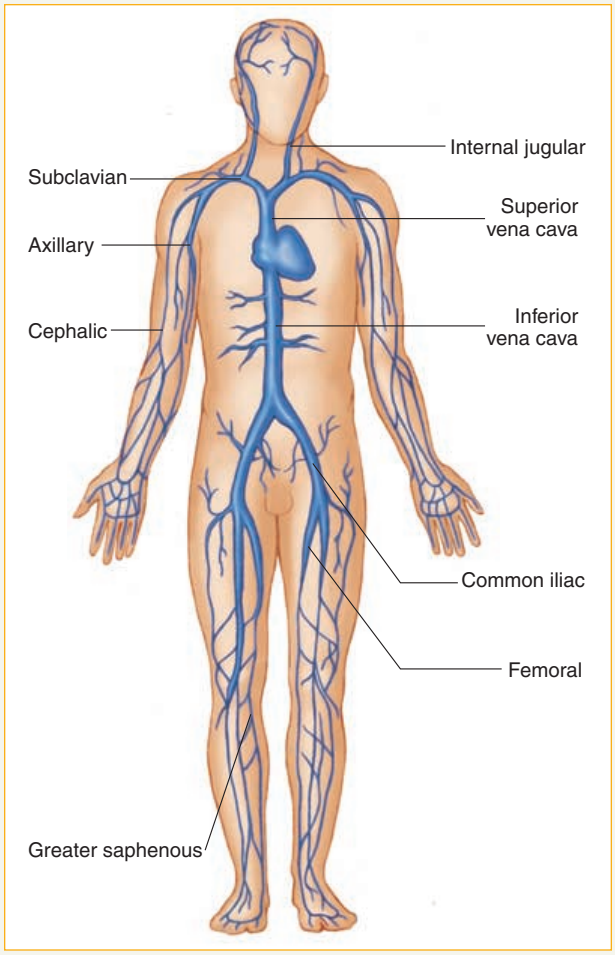

Figure 12-6 The veins carry blood from the body back to the heart, which pumps it through the lungs for oxygenation.

The tissue soon begins to starve and, if blood flow is not restored, eventually dies. Ischemic heart disease, then, is disease involving a decrease in blood flow to one or more portions of the heart muscle.

Atherosclerosis

Most often, the low blood flow to heart tissue is caused by coronary artery atherosclerosis. Atherosclerosis is a disorder in which calcium and a fatty material called cholesterol build up and form a plaque inside the walls of blood vessels, obstructing flow and interfering with their ability to dilate or contract Figure 12-9 ▶. Eventually, atherosclerosis can even cause complete occlusion, or blockage, of a coronary artery. Atherosclerosis usually involves other arteries of the body as well.

The problem begins when the first deposit of cholesterol is laid down on the inside of an artery. This may happen during the teenage years. As a person ages, more

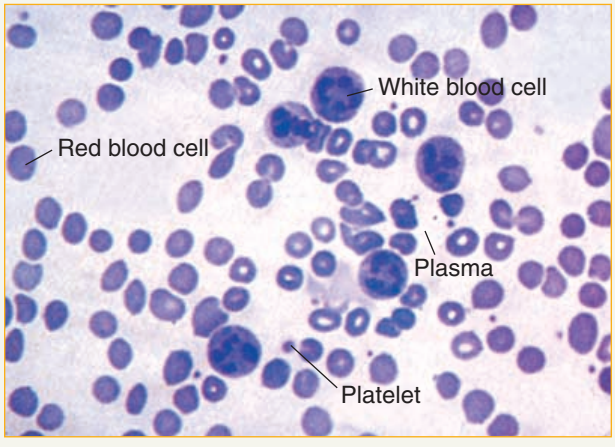

Figure 12-7 Blood consists of several types of cells and fluids, including red blood cells, white blood cells, and platelets.

EMT-B Tips

Pulsation

As the left ventricle contracts, it ejects a forceful wave of blood through the arteries. You can feel that wave in areas where the artery lies over a bone and is near the surface of the skin. This wave of blood is called the pulse. Common places to feel for a pulse include the following Figure 12-8 ▶:

- The carotid pulse can be felt in the neck, two fingerbreadths on either side of the Adam's apple (thyroid cartilage), and should be taken on the side closest to the EMT-B.
- The femoral pulse can be felt in the groin, right at the crease dividing the lower abdomen from the leg.
- The brachial pulse can be felt on the medial aspect of the elbow, right at the level of the crease. This is the pulse that you listen to when you take blood pressure. Pulsations also can be palpated on the medial side of the arm between the elbow and armpit.
- The radial pulse can be felt on the thumb side of the wrist, about one finger width above the wrist crease.
- The posterior tibial pulse can be felt on the inside of the ankle, just posterior to the medial malleolus. The medial malleolus is the bony bump at the end of the tibia.
- The dorsalis pedis pulse can be felt at the top of the foot. This artery is not in the exact same place in all people. To find its pulse, place your hand across the top of the foot just below the ankle crease. Once you feel something that might be a pulse, use your fingertips to confirm that finding.

Practice feeling for these pulses on yourself and on friends and family members.

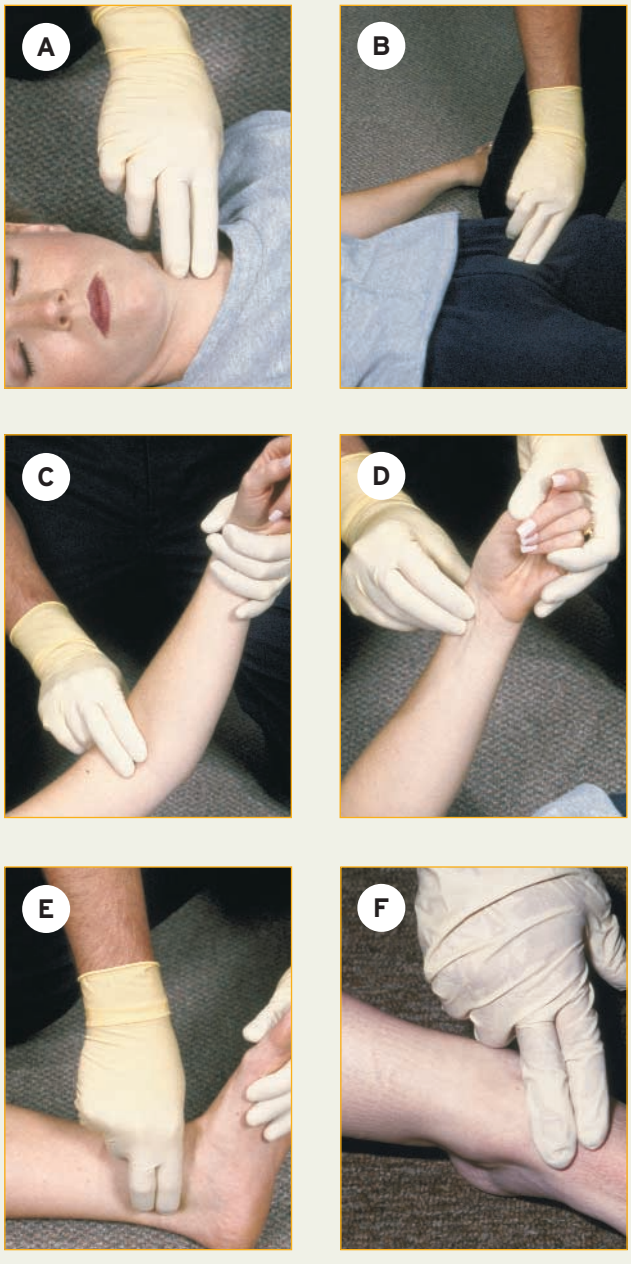

Figure 12-8 Common pulse points.
A. The carotid pulse is taken at the neck.
B. The femoral pulse is felt in the groin area.
C. The brachial pulse can be felt on the inside of the upper arm.
D. The radial pulse can be felt on the thumb side of the wrist.
E. The posterior tibial pulse can be felt on the inside of the ankle.
F. The dorsalis pedis pulse can be felt at the top of the foot.

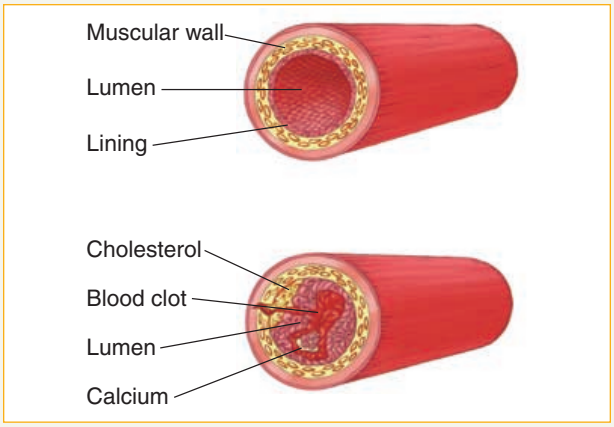

Figure 12-9 In atherosclerosis, calcium and cholesterol build up inside the walls of the blood vessels, causing an obstruction in blood flow to the heart.

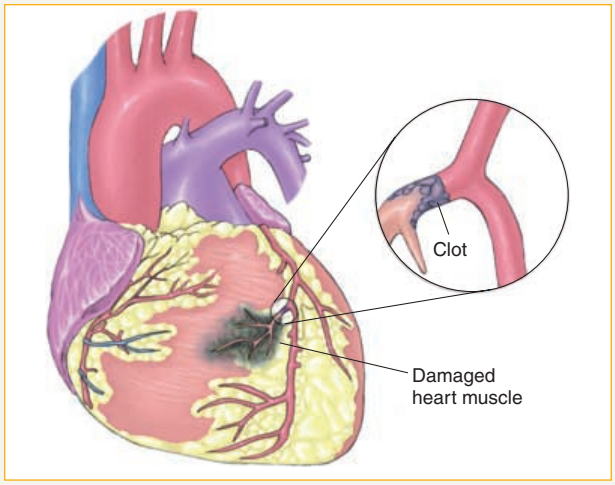

Figure 12-10 An acute myocardial infarction (heart attack) occurs when a blood clot prevents blood flow to an area of the heart muscle. If left untreated, this can result in death of heart tissue.

of this fatty material is deposited; the lumen, or the inside diameter of the artery, narrows. As the cholesterol deposits grow, calcium deposits can form as well. The inner wall of the artery, which is normally smooth and elastic, becomes rough and brittle with these atherosclerotic plaques. Damage to the coronary arteries may become so extensive that they cannot accommodate increased blood flow at times of maximum need.

For reasons that are still not completely understood, a brittle plaque will sometimes develop a crack, exposing the inside of the atherosclerotic wall. Acting like a torn blood vessel, the ragged edge of the crack activates the blood-clotting system, just as it does when an injury has caused bleeding. In this situation, however, the resulting blood clot will partially or completely block the lumen of the artery. Tissues downstream from the blood clot will suffer from lack of oxygen (ischemia). If blood flow is resumed in a short time, the ischemic tissues will recover. However, if too much time goes by before blood flow is resumed, the tissues will die. This sequence of events is known as an acute myocardial infarction (AMI), a classic heart attack (Figure 12-10 ▲). Infarction means the death of tissue. The same sequence may also cause the death of

You are the Provider — Part 2

You begin your focused history and physical exam by questioning the patient using the OPQRST mnemonic. You learn that:

- The patient was sitting, watching TV when the chest pain began (Onset)
- Nothing makes the chest pain better or worse, including breathing or body position (Provokes)
- The patient describes the pain as heavy and crushing (Quality)
- The pain radiates from the left side of his chest to his left arm and into his jaw (Radiates)
- 10/10 (Severity)
- The pain started just before he called 9-1-1 and has been constant (Time)

You look for the presence of medication patches or scars indicating previous heart surgeries or the presence of a cardiac pacemaker or defibrillator. None are found. The patient's vital signs are a blood pressure of 160/98 mm Hg, a pulse of 110 beats/min and regular, respirations of 24 breaths/min, and an oximetry reading of 99% (94% originally on room air).

3. What other mnemonic is helpful in obtaining the rest of the information needed and not addressed through OPQRST?

cells in other organs, such as the brain. The death of heart muscle can lead to severe diminishment of the heart's ability to pump, or **cardiac arrest**.

In the United States, coronary artery disease is the number one cause of death for both men and women. The peak incidence of heart disease occurs between ages 40 and 70 years, but it can also strike teens or individuals in their 90s. You must be alert to the possibility that, although less likely, a 26-year-old person with chest pain could actually be having a heart attack, especially if he or she has a higher than usual risk.

Factors that place a person at higher risk for a myocardial infarction are called risk factors. The major controllable factors are cigarette smoking, high blood pressure, elevated cholesterol levels, elevated blood glucose levels (diabetes), lack of exercise, and stress. The major risk factors that cannot be controlled are older age, family history of atherosclerotic coronary artery disease, and male gender.

Angina Pectoris

Chest pain does not always mean that a person is having an AMI. When, for a brief period of time, heart tissues are not getting enough oxygen, the pain is called **angina pectoris**, or angina. Although angina can result from a spasm of the artery, it is most often a symptom of atherosclerotic coronary artery disease. Angina occurs when the heart's need for oxygen exceeds its supply, usually during periods of physical or emotional stress when the heart is working hard. A large meal or sudden fear may also trigger an attack. When the increased oxygen demand goes away (eg, the person stops exercising), the pain typically goes away.

Angina pain is typically described as crushing, squeezing, or "like somebody standing on my chest." It is usually felt in the midchest, under the sternum. However, it can radiate to the jaw, the arms (frequently the left arm), the midback, or the epigastrium (the upper-middle region of the abdomen). The pain usually lasts from 3 to 8 minutes, rarely longer than 15 minutes. It may be associated with shortness of breath, nausea, or sweating. It disappears promptly with rest, supplemental oxygen, or nitroglycerin, all of which increase the supply of oxygen to the heart. Although angina pectoris is frightening, it does not mean that heart cells are dying, nor does it usually lead to death or permanent heart damage. It is, however, a warning that you and the patient should both take seriously. Even with angina, because oxygen supply to the heart is diminished, the electrical system can be compromised and the person is at risk for significant cardiac rhythm problems.

Angina can be further differentiated into "stable" and "unstable" angina. Unstable angina is characterized by pain in the chest of coronary origin that occurs in response to progressively less exercise or fewer other stimuli than those ordinarily required to produce angina. If untreated, it can often lead to myocardial infarction. Stable angina is characterized by pain in the chest of coronary origin that is relieved by the things that normally relieve it in a given patient, such as resting or taking nitroglycerin. EMS usually becomes involved when stable angina becomes unstable, such as when a patient whose pain is normally relieved by sitting down and taking one nitroglycerin tablet has taken three tablets with no relief. Keep in mind that it can be very difficult even for physicians in hospitals to distinguish between the pain of angina and the pain of a myocardial infarction. Patients experiencing chest pain therefore should always be treated as if they are having a myocardial infarction.

Heart Attack

As we have seen, the pain of AMI signals the actual death of cells in the area of the heart where blood flow is obstructed. Once dead, the cells cannot be revived. Instead, they will eventually turn to scar tissue and become a burden to the beating heart. This is why fast action is so critical in treating a heart attack. The sooner the blockage can be cleared, the fewer the cells that may die. About 30 minutes after blood flow is cut off, some heart muscle cells begin to die. After about 2 hours, as many as half of the cells in the area can be dead; in most cases, after 4 to 6 hours, more than 90% will be dead. In many cases, however, opening the coronary artery with either "clot-busting" (thrombolytic) medications or angioplasty (mechanical clearing of the artery) can prevent damage to the heart muscle if done within the first hour after the onset of symptoms. Therefore, immediate treatment and transport to the emergency department are essential.

An AMI is more likely to occur in the larger, thick-walled left ventricle, which needs more blood and oxygen, than in the right ventricle.

Signs and Symptoms of Heart Attack

A patient with a heart attack may show any of the following signs and symptoms:

- Sudden onset of weakness, nausea, and sweating without an obvious cause

- Chest pain/discomfort/pressure that is often crushing or squeezing and that does not change with each breath
- Pain/discomfort/pressure in the lower jaw, arms, back, abdomen, or neck
- Sudden arrhythmia with syncope (fainting)
- Shortness of breath or dyspnea
- Pulmonary edema
- Sudden death

The Pain of Heart Attack

The pain of an AMI differs from the pain of angina in three ways:

- **It may or may not be caused by exertion** but can occur at any time, sometimes when a person is sitting quietly or even sleeping.
- **It does not resolve in a few minutes**; rather, it can last between 30 minutes and several hours.
- **It may or may not be relieved** by rest or nitroglycerin.

Note that not all patients who are having an AMI experience pain or recognize it when it does occur. In fact, about a third of patients never seek medical attention. This can be attributed, in part, to the fact that people are afraid of dying and do not wish to face the possibility that their symptoms may be serious (cardiac denial). Middle-aged men, in particular, are likely to minimize their symptoms. However, a few patients, particularly older individuals, women, or those with diabetes do not experience any pain during an AMI but will have other common complaints associated with ischemia discussed earlier. Others may feel only mild discomfort and call it "indigestion." It is not uncommon for the only complaint, especially in older women, to be fatigue.

Therefore, when you are called to a scene where the chief complaint is chest pain, complete a thorough assessment, no matter what the patient says. Any complaint of chest discomfort is a serious matter. In fact, the best thing you can do is to assume the worst.

Physical Findings of AMI and Cardiac Compromise

The physical findings of AMI vary, depending on the extent and severity of heart muscle damage. The following are common:

- **Pulse.** Generally, the pulse rate increases as a normal response to pain, stress, fear, or actual injury to the myocardium. Because arrhythmias are common in AMI, you may feel an irregularity of the pulse.

Documentation Tips

Documenting exactly how a patient describes chest discomfort, in the patient's own words, is a valuable source of information for hospital staff. Remember OPQRST.

- **Blood pressure.** Blood pressure may fall as a result of diminished cardiac output and diminished capability of the left ventricle to pump. However, most patients with AMI will have a normal or, most likely, elevated blood pressure.
- **Respiration.** Respirations are usually normal unless the patient has congestive heart failure. In that case, respirations may become rapid and labored.
- **General appearance.** The patient often appears frightened. There may be nausea, vomiting, and a cold sweat. The skin is often ashen gray because of poor cardiac output and the loss of perfusion, or blood flow through the tissue. Occasionally, the skin will have a bluish tint, called cyanosis; this is the result of poor oxygenation of the circulating blood.
- **Mental status.** Patients with AMI sometimes experience an almost overwhelming feeling of impending doom. If a patient tells you, "I think I am going to die," pay attention.

Consequences of Heart Attack

Heart attack can have three serious consequences:

- Sudden death
- Cardiogenic shock
- Congestive heart failure

Sudden Death

Approximately 40% of all patients with AMI never reach the hospital. Sudden death is usually the result of cardiac arrest, in which the heart fails to generate an effective blood flow. Although you cannot feel a pulse in someone experiencing cardiac arrest, the heart may still be twitching, though erratically. The heart is using up energy without pumping. Such an abnormality of heart rhythm is a ventricular arrhythmia, known as ventricular fibrillation.

A variety of other lethal and nonlethal arrhythmias may follow AMI, usually within the first hour. In most

cases, premature ventricular contractions (PVCs), or extra beats in the damaged ventricle, occur. PVCs by themselves may be harmless and are common among healthy, as well as sick, individuals. Other arrhythmias can be much more dangerous. These include the following (Figure 12-11 ▼):

- Tachycardia. Rapid beating of the heart, 100 beats/min or more.
- Bradycardia. Unusually slow beating of the heart, 60 beats/min or less.
- Ventricular tachycardia (VT). Rapid heart rhythm, usually at a rate of 150 to 200 beats/min. The electrical activity starts in the ventricle instead of the atrium. This rhythm usually does not allow adequate time between each beat for the left ventricle to fill with blood. Therefore, the patient's blood pressure may fall, and he or she may lose a pulse altogether. The patient may also feel weak or lightheaded or may even become unresponsive. In some cases, existing chest pain may worsen or chest pain that was not there before onset of the arrhythmia may develop. Most cases of VT will be sustained and may deteriorate into ventricular fibrillation.
- Ventricular fibrillation. Disorganized, ineffective quivering of the ventricles. No blood is pumped through the body, and the patient usually becomes unconscious within seconds. The only way to treat this arrhythmia is to defibrillate the heart. To defibrillate means to shock the heart with a specialized electrical current in an attempt to stop the chaotic, disorganized contraction of the myocardial cells and allow them to start again in a synchronized fashion to restore a normal rhythmic beat. Defibrillation is highly successful in terms of saving a life if delivered within the first few minutes of sudden death. If a defibrillator is not immediately available, CPR must be initiated until the defibrillator arrives. Even if CPR is begun right at the time of collapse, chances of survival diminish 10% each minute until defibrillation is accomplished.

If uncorrected, unstable ventricular tachycardia or ventricular fibrillation will eventually lead to asystole, the absence of all heart electrical activity. Without CPR, this may occur within minutes. Because it reflects a long period of ischemia, nearly all patients you find in asystole will die.

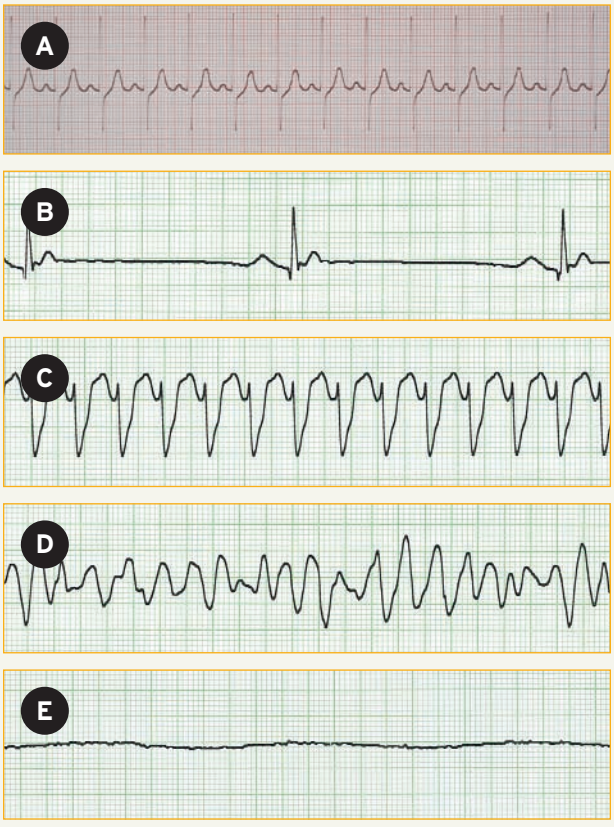

Figure 12-11 Common heart arrhythmias. **A.** Sinus tachycardia. **B.** Bradycardia. **C.** Ventricular tachycardia (VT). **D.** Ventricular fibrillation (VF). **E.** Asystole.

Cardiogenic Shock

Shock is a simple concept but one that few people without medical training really understand. For that reason, Chapter 23 is devoted to a discussion of shock. The discussion of shock in this chapter is limited to that associated with cardiac problems; however, many other medical problems may cause shock as well.

For an EMT-B, shock is also a critical concept. Shock is present when body tissues do not get enough oxygen, causing body organs to malfunction. In cardiogenic shock, often caused by a heart attack, the problem is that the heart lacks enough power to force the proper volume of blood through the circulatory system. Cardiogenic shock can occur immediately or as late as 24 hours after the onset of the AMI. The various signs and symptoms of cardiogenic shock are produced by the improper functioning of the body's organs. The challenge for you is to recognize shock in its early stages, when treatment is much more successful.

EMT-B Tips

Shock

Signs and symptoms

- One of the first signs of shock is anxiety or restlessness as the brain becomes relatively starved for oxygen. The patient may complain of "air hunger." Think of the possibility of shock when the patient is saying that he or she cannot breathe. Obviously, the patient can breathe, because he or she can talk. However, the patient's brain is sensing that it is not getting enough oxygen.
- As the shock continues, the body tries to send blood to the most important organs, such as the brain and heart, and away from less important organs, such as the skin. Therefore, you may see pale, clammy skin in patients with shock.
- As the shock gets worse, the body will attempt to compensate by increasing the amount of blood pumped through the heart. Therefore, the pulse rate will be higher than normal. In severe shock the heart rate usually, but not always, is greater than 120 beats/min.
- Shock can also be characterized by rapid and shallow breathing, nausea and vomiting, and a decrease in body temperature.
- Finally, as the heart and other organs begin to malfunction, the blood pressure will fall below normal. A systolic blood pressure less than 90 mm Hg is easy to recognize, but it is a late finding that indicates decompensated shock. Do not assume that shock is not present just because the blood pressure is normal (compensated shock).

Treatment of Patients With Cardiogenic Shock

Take the following steps when treating patients with signs and symptoms of shock:

1. Position the patient comfortably. Most patients with heart failure will be more comfortable in semi-Fowler's position; however, those with low blood pressure may not tolerate a semi-upright position. These patients may be more comfortable and be more alert in a supine position.
2. Administer high-flow oxygen.
3. Assist ventilations as necessary.
4. Cover patient with sheets/blankets as indicated to preserve body heat. Be sure to cover head in cold weather.
5. Provide prompt transport to the emergency department.

Congestive Heart Failure

Signs and symptoms

- The patient finds it easier to breathe when sitting up. When the patient is lying down, more blood is returned to the right ventricle and lungs, causing further pulmonary congestion.
- Often, the patient is mildly or severely agitated.
- Chest pain may or may not be present.
- The patient often has distended neck veins that do not collapse even when the patient is sitting.
- The patient may have swollen ankles from dependent edema (back-up of fluid).
- The patient generally will have a high blood pressure, rapid heart rate, and rapid respirations.
- The patient will usually be using accessory breathing muscles of the neck and ribs, reflecting the additional hard work of breathing.
- The fluid surrounding small airways may produce rales (crackles), best heard by listening to either side of the patient's chest, about midway down the back. In severe congestive heart failure, these soft sounds can be heard even at the top of the lung.

Once congestive heart failure develops, it can be treated but not cured. Regular use of medications may alleviate the symptoms. However, these patients often become ill again and are frequently hospitalized. Approximately half will be dead within 5 years of the onset of symptoms.

Treatment of CHF

Treat the patient with congestive heart failure the same way as the patient with chest pain:

1. Take the vital signs, monitor heart rhythm, and give oxygen by nonrebreathing mask with an oxygen flow of 10 to 15 L/min.
2. Allow the patient to remain sitting in an upright position with the legs down.
3. Be reassuring; many patients with CHF are quite anxious because they cannot breathe.
4. Patients who have had problems with CHF before will usually have specific medications for its treatment. Gather these medications and take them along to the hospital.
5. Nitroglycerin may be of value if the patient's blood pressure is above 100 mm Hg systolic. If the patient has been prescribed nitroglycerin, and medical control or standing orders advise you to do so, you can administer it sublingually.
6. Prompt transport to the emergency department is essential.

Congestive Heart Failure

Failure of the heart occurs when the ventricular heart muscle is so damaged that it can no longer keep up with the return flow of blood from the atria. Congestive heart failure (CHF) can occur any time after a myocardial infarction, heart valve damage, or long-standing high blood pressure, but it usually happens between the first few hours and the first few days after a heart attack.

Just as the pumping function of the left ventricle can be damaged by coronary artery disease, it can also be damaged by diseased heart valves or chronic hypertension. In any of these cases, when the muscle can no longer contract effectively, the heart tries other ways to maintain an adequate cardiac output. Two specific changes in heart function occur: The heart rate increases, and the left ventricle enlarges in an effort to increase the amount of blood pumped each minute.

When these adaptations can no longer make up for the decreased heart function, congestive heart failure eventually develops. It is called "congestive" heart failure because the lungs become congested with fluid once the heart fails to pump the blood effectively. Blood tends to back up in the pulmonary veins, increasing the pressure in the capillaries of the lungs. When the pressure in the capillaries exceeds a certain level, fluid (mostly water) passes through the walls of the capillary vessels and into the alveoli. This condition is called pulmonary edema. It may occur suddenly, as in AMI, or slowly over months, as in chronic congestive heart failure. Sometimes, patients with an acute onset of CHF will develop severe pulmonary edema, in which the patient has pink, frothy sputum, and severe dyspnea.

If the right side of the heart is damaged, fluid collects in the body, often showing in the feet and legs. The collection of fluid in the part of the body that is closest to the ground is called dependent edema. The swelling causes relatively few symptoms other than discomfort. However, chronic dependent edema may indicate underlying heart disease even in the absence of pain or other symptoms.

Assessment of the Patient With Chest Pain

While en route, consider the minimum and maximum BSI precautions that will be needed. BSI can be as simple as gloves for the chest pain patient or full BSI precautions for the patient in cardiac arrest. Remember, the patient's condition can change rapidly from the time you are dispatched.

Scene Size-up

Do not let your guard down on medical calls. Always ensure that the scene is safe for you, your partner, your patient, and bystanders. As you approach the scene, determine the nature of illness and how many patients there are. This information can be obtained from

You are the Provider — Part 3

Your partner enters the room with a bottle of nitroglycerin. It is important to know the 5 Rs prior to administering any drug—right drug, right dose, right time, right route, right patient—and you must specifically know that a patient's systolic blood pressure is more than 100 mm Hg prior to administering nitroglycerin. You must also know indications, contraindications, and side effects of medications you assist with or administer.

He examines the nitroglycerin, obtains permission from medical control, and then assists the patient with its administration.

4. What other tactics can you employ to assist this patient?

bystanders, first responders, or the patient. From the nature of the call and first glance at your patient, determine whether you will need additional resources to assist in moving the patient. If you are in a tiered-response system, request that the paramedics be dispatched to your location. You will need to quickly assess the scene to determine if spinal stabilization is needed.

Initial Assessment

General Impression

All patient assessments begin by determining whether or not the patient is responsive. If the patient is not responsive, evaluate the ABCs and assess for use of the automated external defibrillator (AED), which is discussed in the section on cardiac arrest later in this chapter. Generally, the AED should be applied if the patient is pulseless, not breathing (apneic), and unresponsive.

If the patient is responsive, begin by asking the chief complaint. Remember that many patients present differently when experiencing an AMI. A chief complaint of chest pain or discomfort, shortness of breath, or dizziness should be taken seriously. Many patients who suspect that something is wrong appear anxious and perhaps sense an impending doom. Act professionally; be calm. Speak to the patient in a normal voice that is neither too loud nor too soft. Let the patient know that trained individuals, including you, are present to provide care and that he or she will soon be taken to the hospital. Remember, some patients may act carefree, while others may be demanding. Most patients, however, are still frightened. Your professional attitude may be the single most important factor in winning the patient's cooperation and helping the patient through this event. Patients often have a good idea about what is happening, so do not lie and offer false reassurance. If asked, "Am I having a heart attack?" you can say, "I do not know for sure, but in case you are, we are taking care of you. We are going to help you now by giving oxygen, and we will be taking you to the hospital. You are in good hands."

Airway and Breathing

Unless the patient is unresponsive, the airway will most likely be patent. Responsive individuals should be able to maintain their own airway. But some episodes of cardiac compromise may produce dizziness or even fainting spells. If either of these have occurred, be suspicious of spinal injuries from a fall. Assess and treat the patient as appropriate.

Assess the patient's breathing to determine if it is adequate to provide enough oxygen to an ailing heart. Some patients feel short of breath even though there are no obvious signs of respiratory distress. In either situation, apply oxygen with a nonrebreathing mask at 10 to 15 L/min. If the patient is not breathing or has inadequate breathing, ensure adequate ventilations with a BVM device and 100% oxygen.

Circulation

Assess the patient's circulation. Determine the rate and quality of the patient's pulse. Is the pulse rhythm regular or irregular? Is it too fast or too slow? If you find abnormalities in the pulse, you should be more suspicious. Assess the patient's skin condition, color, and temperature as well as capillary refill time. Changes in perfusion may indicate more serious cardiac compromise. Begin treatment for cardiogenic shock early to reduce the workload of the heart. Place the patient in a comfortable position, usually sitting up and well supported. Provide reassurance that appropriate treatment is being given for the condition to reduce the patient's anxiety. Is there any major bleeding that needs to be controlled? If so, utilize direct pressure to control the bleeding and bandage appropriately.

Transport Decision

Make a transport decision. Does the patient need to be transported rapidly? Is the patient's condition life-threatening, or is it stable enough to allow for performing a focused history and physical exam on scene? Generally speaking, most patients with chest pain should be transported immediately. Whether to transport using the lights and siren is determined with each patient and estimated transport time. As a general rule, however, cardiac patients should be transported in the most gentle, stress-relieving manner possible. Very little time is saved by the using the lights and siren, but you can do a lot to calm your patient and reduce the release of heart-damaging adrenaline through your reassurance and by creating a ride to the hospital that is as pleasant as possible. Try not to allow the patient to exert himself or herself, strain, or walk. If necessary, lift the patient, using care.

Your decision of where to transport the patient will depend on your local protocol. Patients are generally

transported to the closest appropriate facility. If your service is served by one hospital, the transport decision is an easy one. In larger urban areas, there may be several hospitals within the service areas. Some medical directors have written protocols requiring patients with suspected cardiac emergencies to be transported to medical centers with certain capabilities, such as emergency angioplasty. Others require the patient to be transported to the nearest facility for stabilization prior to transporting to a specialty hospital. Be sure you know your local protocol.

Focused History and Physical Exam

SAMPLE History

For a conscious medical patient, begin with taking a brief history from the patient. Friends or family members who are present often have helpful information. Ask them the following questions:

- Has the patient ever had a heart attack before?
- Has the patient been told about having heart problems?
- Are there any risk factors for coronary artery disease, such as smoking, high blood pressure, or high-stress lifestyle?

The SAMPLE history provides basic information on the patient's overall medical history. You will want to determine as many signs and symptoms as you can. For example, you may determine that the patient has chest pain at rest, or absence of chest pain with respirations or movement. The more signs and symptoms a patient has, the easier it is to identify a particular problem. In addition, ask whether the patient has had the same pain before. If so, ask "Do you take any medications for the pain?" and "Do you have any of the medication with you?" If the patient has had a heart attack or angina before, ask whether the pain is similar.

Be sure to include the OPQRST questions when you are obtaining the symptoms as part of the SAMPLE history. Using OPQRST helps you to understand the details of specific complaints, such as chest pain Table 12-1 ▶. Even when a patient may not be able to articulate his or her exact medical condition, knowing the patient's medications may give you important clues. For example, a patient may say he has "heart problems." You see that he is taking furosemide (Lasix), digoxin, and amiodarone. Furosemide is a diuretic, digoxin increases the strength of heart contractions, and amiodarone controls certain types of arrhythmias. These drugs are most often prescribed together for patients with congestive heart failure and may alert you to carefully evaluate lung sounds for pulmonary congestion and increase the amount of oxygen being delivered.

Focused Physical Exam

Pay particular attention to the cardiovascular system, but also check the respiratory system. How well is the heart working? Assess skin color, temperature, and condition. Is it cool, moist? How do the mucous membranes look? Are they pink, ashen, or cyanotic? Are the lung sounds clear? Are the neck veins distended?

Baseline Vital Signs

Measure and record the patient's vital signs. As you obtain the SAMPLE history, have your partner take the patient's baseline vital signs, including pulse, blood

You are the Provider — Part 4

You relay the patient's mental status, age, chief complaint, history of heart attack, vital signs, and your treatment to the incoming ALS unit. Their estimated time of arrival at the hospital is approximately 10 minutes. Because he is not in cardiac arrest, you keep the AED nearby but do not apply it.

You confirm that the patient is not allergic to aspirin and dispense two 81-mg tablets of baby aspirin, noting that the medication has not expired. You instruct the patient to chew and swallow them.

7. What can you do to prepare for the paramedics' arrival?

TABLE 12-1 OPQRST Mnemonic for Assessing Pain

- **Onset.** Determine what time the discomfort that motivated the call for help began.
- **Provocation.** Ask what makes the pain or discomfort worse. Is it positional? Does a deep breath or palpation of the chest make it worse?
- **Quality.** Ask what type of pain it is. Let the patient use his or her own words to describe what is happening. Try to avoid supplying the patient with only one option. Do not ask "Does it feel like an elephant is sitting on your chest?" Instead, say "Tell me what the pain feels like." If the patient cannot answer an open-ended question, then provide a list of alternatives. "There are lots of different kinds of pain. Is your pain more like heaviness, pressure, burning, tearing, dull ache, stabbing, or needlelike?"
- **Radiation.** Ask whether the pain travels to another part of the body.
- **Severity.** Ask the patient to rate the pain on a simple scale. Often, a scale ranging from 0 to 10 is used, in which 0 represents no pain at all and 10 represents the worst pain imaginable. Do not use the patient's answer to determine whether the pain has a serious cause. Instead, use it to check whether the pain is getting better or worse. After a few minutes of oxygen or administration of a nitroglycerin pill, ask the patient to rate the pain again.
- **Time.** Find out how long the pain lasts when it is present and whether it has been intermittent or continuous.

pressure, and respirations. You must obtain readings for both systolic and diastolic blood pressures. If available, use pulse oximetry. Note the time that vital signs are taken.

Communication

Alert the emergency department about the status of your patient's condition and your estimated time of arrival. Report to medical control. Report to the hospital by radio or cellular telephone while en route. Include information about the patient's history, vital signs, repeat vital signs, medications being taken, and any treatment you are giving. Follow the instructions of medical control. Describe the patient's condition to the emergency department staff on arrival.

Interventions

Depending on local protocol, prepare to administer baby aspirin and assist with prescribed nitroglycerin. Check the condition of the medication and its expiration date. Be sure to put on gloves before handling nitroglycerin tablets or spray.

Administer baby aspirin according to local protocol. Baby aspirin comes in 81-mg chewable tablets. Recommended dosage is often 162 mg (two tablets) or 324 mg (four tablets). Aspirin (acetylsalicylic acid) prevents clots from forming or getting bigger.

After obtaining permission from medical control, help the patient administer prescribed nitroglycerin. Nitroglycerin works in most patients within 5 minutes to relieve the pain of angina. Most patients who have been prescribed nitroglycerin carry a supply with them. Nitrostat is one trade name for nitroglycerin. Patients take one dose of nitroglycerin under the tongue whenever they have an episode of angina that does not immediately go away with rest. If the pain is still present after 5 minutes, patients are typically instructed by their physicians to take a second dose. If the second dose does not work, most patients are told to take a third dose and then call for EMS. If the patient has not taken all three doses, you can help to administer the medication, if you are allowed to do so by local protocol.

Nitroglycerin comes in several forms—as a small white pill, placed sublingually (under the tongue); as a spray, also taken sublingually; or as a skin patch applied to the chest Figure 12-12 ▶. In any form, the effect is the same. Nitroglycerin relaxes the muscle of blood vessel walls, dilates coronary arteries, increases blood flow and the supply of oxygen to the heart muscle, and decreases the workload of the heart. Nitroglycerin also dilates blood vessels in other parts of the body and can sometimes cause low blood pressure and/or a severe headache. Other side effects include changes in the patient's pulse rate, including tachycardia and bradycardia. For this reason, you should take the patient's blood pressure within 5 minutes after each dose. If the systolic blood pressure is less than 100 mm Hg, do not give more medication. Other contraindications include the presence of a head injury, and the maximum prescribed dose has already been given (usually three doses).

Be aware that nitroglycerin will lose its potency over time, especially if exposed to light (that is why it is supplied in a brown bottle). Patients who take it only rarely may keep a bottle in their pocket for months. It may lose its potency even before its expiration date. When the nitroglycerin tablet loses its potency, patients

Figure 12-12 Nitroglycerin used to treat AMI comes in many forms, including paste, spray, tablets, and skin patches.

may not feel the fizzing sensation when the tablet is placed under their tongue, and they may not experience the normal burning sensation and headache that often accompany nitroglycerin administration. Note that the fizzing only occurs with a potent tablet, not with the spray form.

To safely assist the patient with nitroglycerin, follow the steps listed below Skill Drill 12-1 ▶:

1. **Obtain an order from medical direction**—either online or offline protocol.
2. **Take the patient's blood pressure.** Continue with administration of nitroglycerin only if the systolic blood pressure is greater than 100 mm Hg (**Step 1**).
3. Check that you have the **right medication, the right patient, and the right delivery route**. Check the expiration date.
4. **Question the patient** about the last dose he or she took and its effects. Make sure that the patient understands the route of administration. **Be prepared to have the patient lie down** to prevent fainting if the nitroglycerin substantially lowers the patient's blood pressure (the patient gets dizzy or feels faint) (**Step 2**).
5. Ask the patient to lift his or her tongue. **Place the tablet or spray the dose underneath the tongue** (while wearing gloves), or have the patient do so. Have the patient keep his or her mouth closed with the tablet under the tongue until it is dissolved and absorbed. Caution the patient against chewing or swallowing the tablet (**Step 3**).
6. **Recheck blood pressure** within 5 minutes. Record medication and the time of administration. Reevaluate the chest pain and note the response to the medication. If the chest pain persists and the patient still has a systolic blood pressure greater than 100 mm Hg, repeat the dose every 5 minutes as authorized by medical control. In general, a maximum of three doses of nitroglycerin are given for any one episode of chest pain (**Step 4**).

Reevaluate your transport decision. Transport the patient. Early, prompt transport to the emergency department is critical so that treatments such as clot-busting medications or angioplasty can be initiated. To be most effective, these treatments must be started as soon as possible after the onset of the attack. If the patient does not have prescribed nitroglycerin, move ahead with your focused assessment and prepare to transport. Be sure that this process does not consume too much time. Do not delay transport to assist with administration of nitroglycerin. The drug can be given en route.

Detailed Physical Exam

If necessary, perform a detailed physical exam to elicit further information concerning the patient's condition and necessary interventions. If you have time, you can talk with the patient about risk factors for heart disease such as cholesterol level, smoking, activity levels, and family history of heart disease. Do not gather this information unless your patient's condition is stable and everything else is done.

Ongoing Assessment

Repeat your initial assessment by checking to see if the patient's condition has improved or if the patient's condition is deteriorating. Vital signs should be reassessed at least every 5 minutes or as significant changes in the patient's condition occur. It is essential to monitor

Skill Drill 12-1

Administration of Nitroglycerin

1 Obtain an order from medical direction—either online or offline protocol.

Take the patient's blood pressure. Administer nitroglycerin only if the systolic blood pressure is greater than 100 mm Hg.

2 Check the medication and expiration date.

Question the patient about the last dose he or she took and its effects. Make sure that the patient understands the route of administration.

Prepare to have the patient lie down to prevent fainting.

3 Ask the patient to lift his or her tongue.

Place the tablet or spray the dose underneath the tongue (while wearing gloves), or have the patient do so.

Have the patient keep his or her mouth closed with the tablet under the tongue until it is dissolved and absorbed. Caution the patient against chewing or swallowing the tablet.

4 Recheck blood pressure within 5 minutes. Record each medication and the time of administration. Reevaluate the chest pain and repeat treatment if necessary.

the patient with a suspected AMI closely because sudden cardiac arrest is always a risk. If cardiac arrest occurs, you must be ready to begin automated defibrillation or CPR immediately. If an AED is immediately available, use it; if not, perform CPR until the AED is available. Reassess your interventions. It is important to continue reassessing in order to see if the interventions are helping and if the patient's condition is improving. Reassess vital signs after administering medications. Reassessment will also determine whether further interventions are indicated or contraindicated.

Communication and Documentation

It is important to document your assessment of the patient. You must record the interventions performed. All interventions should be initiated according to protocol. If the intervention required an order from medical control, document the medication requested and whether approval was granted or not. It must be clear in your documentation that the patient was reassessed appropriately following any intervention. The patient's response to the intervention and the time of each intervention must also be recorded. Upon completing your documentation, obtain the medical control physician's signature (if required by local protocol) showing approval of medication administration.

Heart Surgeries and Pacemakers

During the last 20 years, hundreds of thousands of open heart surgeries were performed to bypass damaged segments of coronary arteries in the heart. In a coronary artery bypass graft (CABG), a blood vessel from the chest or leg is sewn directly from the aorta to a coronary artery beyond the point of the obstruction. Other patients may have had a procedure called percutaneous transluminal coronary angioplasty (PTCA), which aims to dilate, rather than bypass, the coronary artery. In this procedure, usually called an angioplasty or balloon angioplasty, a tiny balloon is attached to the end of a long, thin tube. The tube is introduced through the skin into a large artery, usually in the groin, and then threaded into the narrowed coronary artery, with radiographs serving as a guide. Once the balloon is in position inside the coronary artery, it is inflated. The balloon is then deflated, and the tube is removed from the body. Sometimes, a metal mesh called a stent is placed inside the artery either instead of or after the balloon. The stent is left in place permanently to help keep the artery from narrowing again.

You are the Provider — Part 5

You hear the paramedics arrive, and you meet them at the door. You give your most recent set of vital signs, explain that a total of two nitroglycerin tablets have been administered along with the aspirin, and now his chest pain is 4/10. You help the paramedic place the patient on the cot, where a 12-lead ECG is performed while his partner prepares an IV in the ambulance.

As the machine prints out the ECG findings, you and the paramedic begin to move the patient to the ambulance. He asks if you would accompany him during transport. Your partner hands the paramedic a grocery bag containing the patient's medicine bottles. As soon as the patient is loaded into the ambulance, the paramedic instructs his partner that he is ready to go. En route, you obtain another set of vital signs, while he starts the IV.

8. Given that the patient's systolic blood pressure remains greater than 100 mm Hg, how many additional nitroglycerin tablets can you expect the paramedic to administer?
9. What other forms of the medication may be given instead of the tablet, and what problems can you encounter when examining/using a patient's nitroglycerin in the field?

A patient who has had an AMI or angina will almost certainly have had one of these procedures. Patients who have had a bypass graft will have a long surgical scar on their chest from the operation. Patients who have had an angioplasty or coronary artery stent usually will not. However, newer "keyhole" surgical techniques may not produce a large scar. You should not assume that a patient who has a small scar has not had bypass surgery. Chest pain in a patient who has had any of these procedures should be treated the same as chest pain in patients who have not had any heart surgery. In any event, chest pain in a patient who has undergone either procedure is treated exactly the same as chest pain in a patient who has not. Carry out all the described tasks, and transport the patient promptly to the emergency department of the hospital. If CPR is required, perform it in the usual way, regardless of the scar on the patient's chest. Likewise, if indicated, an AED should be used as well.

Many people with heart disease in the United States have cardiac pacemakers to maintain a regular cardiac rhythm and rate. Pacemakers are inserted when the electrical control system of the heart is so damaged that it cannot function properly. These battery-powered devices deliver an electrical impulse through wires that are in direct contact with the myocardium. The generating unit is generally placed under a heavy muscle or a fold of skin; it typically resembles a small silver dollar under the skin in the left upper chest Figure 12-13 ▶.

Normally, you do not need to be concerned about problems with pacemakers. Thanks to modern technology, an implanted unit will not require replacement or a battery charge for years. Wires are well protected and rarely broken. In the past, pacemakers sometimes malfunctioned when a patient got too close to an electrical radiation source, such as a microwave oven, but this is no longer the case. Every patient with a pacemaker should be aware of the precautions, if any, that must be taken to maintain its proper functioning.

If a pacemaker does not function properly, as when the battery wears out, the patient may experience syncope, dizziness, or weakness because of an excessively slow heart rate. The pulse ordinarily will be less than 60 beats/min because the heart is beating without the stimulus of the pacemaker and without the regulation of its own electrical system, which may be damaged. In these circumstances, the heart tends to assume a fixed slow rate that is not fast enough to allow the patient to function normally. A patient with a malfunctioning pacemaker should be promptly transported to the emergency department; repair of the problem may require surgery. When an AED is used, the patches should not be placed directly over the pacemaker. This will ensure a better flow of electricity through the patient's body.

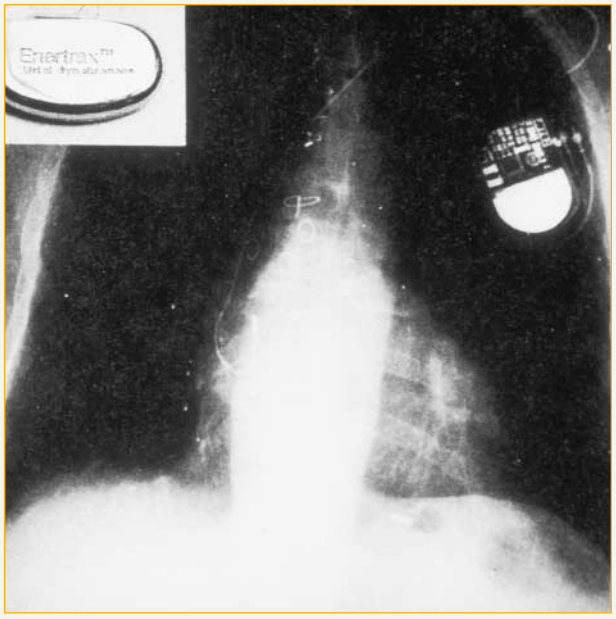

Figure 12-13 A pacemaker, which is typically inserted under the skin in the left upper chest, delivers an electrical impulse to regulate heartbeat.

Automatic Implantable Cardiac Defibrillators

More and more patients who survive ventricular fibrillation cardiac arrests have a small automatic implantable cardiac defibrillator (AICD) implanted. Some patients who are at particularly high risk for a cardiac arrest have them as well. These devices are attached directly to the heart and can prolong the lives of certain patients. They continuously monitor the heart rhythm, delivering shocks as needed. Regardless of whether a patient having an AMI has an AICD, he or she should be treated like all other patients having an AMI. Treatment should include performing CPR and using an AED if the patient goes into cardiac arrest. Generally, the electricity from an AICD is so low that it will have no effect on rescuers and therefore should not be of concern to you Figure 12-14 ▶.

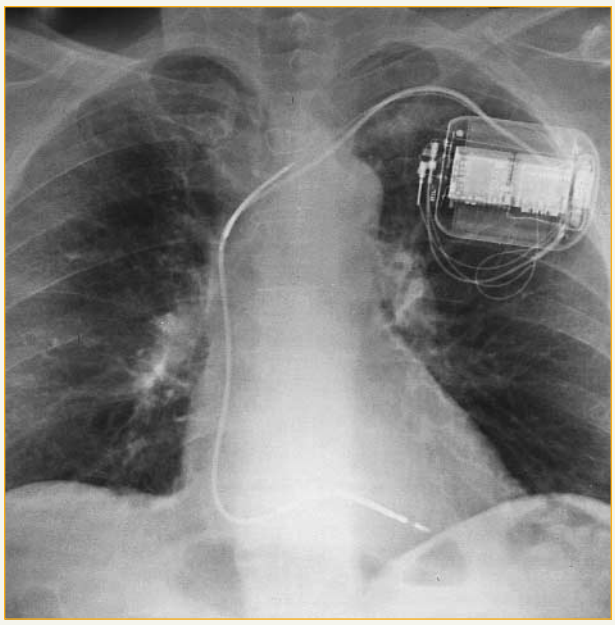

Figure 12-14 An AICD is attached directly to the heart and continuously monitors heart rhythm, delivering shocks as needed. The electricity from the AICD is so low that it has no effect on rescuers.

Pediatric Needs

Heart problems in childhood are uncommon and usually congenital, meaning that the patient was born with the problem. In general, your approach to these patients should be the same as that for an adult. You should attempt to reassure the patient. If possible, administer oxygen. If the patient will not wear a face mask, have the parent hold the oxygen in front of the child's face.

Cardiac arrest in younger children is less common than in older children and is usually caused by a breathing problem. With children from 1 to 8 years of age, an AED that has the settings to work on children is indicated. These AEDs have high specificity to recognize pediatric shockable rhythms and are able to reduce the amount of energy supplied through the pads during a shock. If a pediatric AED is not available, an adult AED and pads should be used on children between 1 and 8 years of age. Teenagers, who may occasionally have a cardiac arrest related to a heart problem, may benefit from an AED.

Cardiac Arrest

Cardiac arrest is the complete cessation of cardiac activity, either electrical, mechanical, or both. It is indicated in the field by the absence of a carotid pulse. Until the advent of CPR and external defibrillation in the 1960s, cardiac arrest was virtually always a terminal event. Now, although it is still infrequent for a patient to survive a cardiac arrest without neurologic damage, great strides have been made in resuscitation science during the last 40 years.

Automated External Defibrillation

In the late 1970s and early 1980s, scientists developed a small computer that could analyze electrical signals from the heart and determine when ventricular fibrillation was taking place. This development, along with improved battery technology, made the automated portable defibrillator possible—a device that can automatically administer an electrical shock to the heart when needed.

AED machines come in different models with different features Figure 12-15 ▶. All of them require a certain degree of operator interaction, beginning with applying the pads and turning the machine on. The operator also has to push a button to deliver an electrical shock, regardless of the model. Many AEDs use a computer voice synthesizer to advise the EMT which steps to take on the basis of the AED's analysis. Some have a button that tells the computer to analyze the heart's electrical rhythm; other models start doing this as soon as they are turned on. In the United States, the majority of the AEDs are semiautomated. Even though most defibrillators are now semiautomated, we are using the term automated external defibrillators (AED) as the general term to describe all of these machines. There are very few actual AEDs left; all manufacturers are only producing semiautomated external defibrillators.

AEDs also come equipped to give a monophasic shock or a biphasic shock. Monophasic means to send the energy in one direction, from negative to positive. Current in the biphasic waveform flows in both a positive and negative direction. This two-directional flow of current is reflected by the current going in one direction, then reversing the flow in the opposite direction. The advantage of biphasic shock is that it produces

Figure 12-15 AEDs vary in their design, features, and operation.

a more efficient defibrillation and may require a lower energy setting. The energy setting for ventricular fibrillation on a monophasic machine is 360 joules for the first shock and all shocks subsequent to that. With biphasic technology, the energy can be set at 120 joules for the first shock and all shocks subsequent to that, or can start at 120 joules for the first shock and then escalate to 200 joules with subsequent shocks. The optimum energy setting for the biphasic AED is still being studied and no recommendation for either is currently supported in the literature. The computer inside the AED is specially programmed to recognize rhythms that require defibrillation to correct, most commonly ventricular fibrillation. AEDs are extremely accurate. It would be extremely rare for the AED to recommend a shock when a shock is not required, and they rarely fail to recommend one when it would be helpful. Therefore, if the AED recommends a shock, you can believe that it is indicated.

When an error does occur, it is usually the operator's fault. The most common error is not having a charged battery. To avoid this problem, many defibrillator companies have built smarter machines that will warn the operator that the battery is unlikely to work. However, some of the older models do not have this feature. You should check the AED daily and exercise the battery as often as the manufacturer recommends.

Another error occurs when the AED is applied to a patient who is moving. The computer may be unable to tell the difference between electrical signals from the heart and electrical signals from the arms and chest muscles that are moving. The way to avoid this error is to apply the AED only to pulseless, unresponsive patients and to stay clear of the patient (do not touch the patient) during analysis and shocking.

A third error can occur when the AED is applied to a responsive patient with a rapid heart rate. Most computers identify a regular rhythm faster than 150 or 180 beats/min as ventricular tachycardia, which should be shocked. Sometimes, though, a patient has another heart rhythm that should not be shocked but that is fast enough to confuse the computer. Again, to avoid this problem, you should apply the AED only to unresponsive patients with no pulse.

Automated external defibrillation offers the EMT-B a number of advantages. First, of course, the machine is fast, and it delivers the most important treatment for the patient in ventricular fibrillation: an electrical shock. It can be delivered within 1 minute of the EMT's arrival at the patient's side. Second, you will find that using an AED is easier than performing CPR. ALS providers do not have to be on the scene to provide this definitive care.

Current AEDs offer two other advantages. The shock can be given through remote, adhesive defibrillator pads, which are safer for you than paddles. Also, the pad area is larger than paddles, which means that the transmission of electricity is more efficient. Usually, there are pictures on the pads to remind you where they go on the patient's chest.

Not all patients in cardiac arrest require an electrical shock. Although all patients in cardiac arrest should be analyzed with an AED, some do not have shockable rhythms (eg, pulseless electrical activity and asystole). Asystole (flatline) indicates that no electrical activity remains. Pulseless electrical activity usually refers to a

state of cardiac arrest despite an organized electrical complex. In both cases, CPR should be initiated as soon as possible.

Rationale for Early Defibrillation

Few patients who experience sudden cardiac arrest outside of a hospital survive unless a rapid sequence of events takes place. The chain of survival is a way of describing the ideal sequence of events that can take place when such an arrest occurs.

The four links in the chain of survival are as follows (Figure 12-16 ▼):

- Recognition of early warning signs and immediate activation of EMS
- Immediate bystander CPR
- Early defibrillation
- Early advanced cardiac life support

If any one of the links in the chain is absent, the patient is more likely to die. For example, few patients benefit from defibrillation when more than 10 minutes elapse before administration of the first shock or if CPR is not performed in the first 2 to 3 minutes. If all links in the chain are strong, the patient has the best possible chance of survival. The link with the most determinant for survival is the third link—early defibrillation.

CPR helps patients in cardiac arrest because it prolongs the period of time during which defibrillation can be effective. Rapid defibrillation has successfully resuscitated many patients with cardiac arrest from ventricular fibrillation. However, defibrillation works best if it takes place within 2 minutes of the onset of the cardiac arrest. To try to achieve better survival rates among cardiac arrest victims, many communities are exploring the idea that nontraditional first responders should be trained to administer early defibrillation. These responders would include police officers, security personnel, lifeguards, maintenance workers, and flight attendants. As an EMT-B, you should support these efforts to shorten the time interval until defibrillation. Remember, seconds really do matter when the patient is in cardiac arrest.

EMT-B Safety

When clearing the patient before an AED shock, ensure that no one is touching the patient and that no object is touching the patient, including the stretcher or other furniture if the patient is not on the floor or ground.

Integrating the AED and CPR

Since most cardiac arrests occur in the home, a bystander at the scene may already have started CPR before you arrive. For this reason, you must know how to work the AED into the CPR sequence. Remember

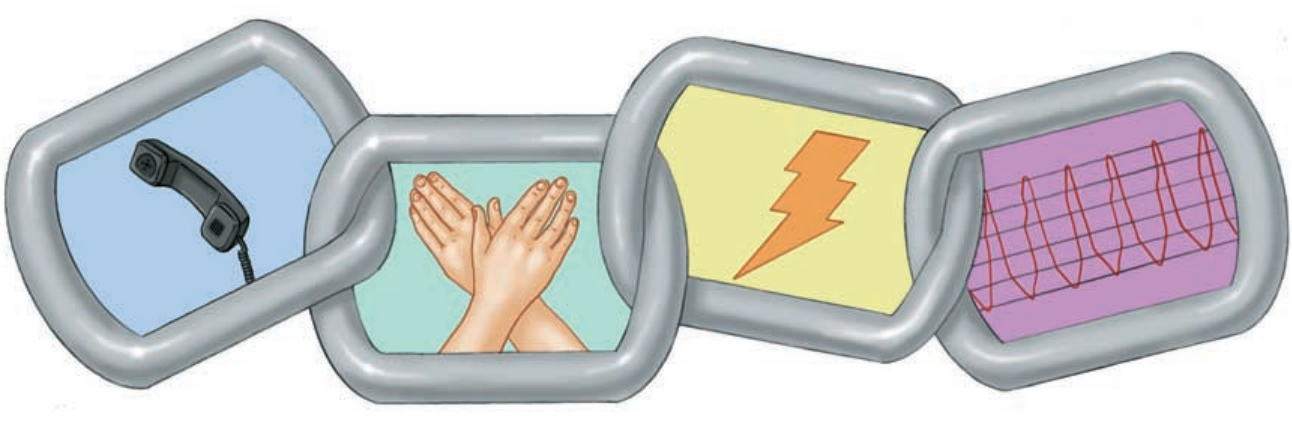

Figure 12-16 The four links of the chain of survival. *Source:* American Heart Association.

that the AED is not very complex; it may not be able to distinguish other movements from ventricular fibrillation. Therefore, do not touch the patient while the AED is analyzing the heart rhythm and delivering shocks. Stop CPR, and let the AED do its job.

AED Maintenance

One of your primary missions as an EMT-B is to deliver an electrical shock to a patient in ventricular fibrillation. To accomplish this mission, you need to have a functioning AED. You must become familiar with the maintenance procedures required for the brand of AED your service uses. Read the operator's manual. If your defibrillator does not work on the scene, someone will want to know what went wrong. That person may be your system's administrator, your medical director, the local newspaper reporter, or the family's attorney. You will be asked to show proof that you maintained the defibrillator properly and attended any mandatory in-services.

The main legal risk in using the AED is failing to deliver a shock when one was needed. The most common reason for this failure is that the battery did not work, usually because it was not properly maintained. Another problem is operator error. This means not pushing the analyze or shock buttons when the machine advises you to do so or failing to apply the AED to a patient in cardiac arrest. Of course, the AED is like any other manufactured item. It can fail, although this is rare. Ideally, you will encounter any such failure while doing routine maintenance, not while caring for a patient in cardiac arrest. Check your equipment, including your AED, at the beginning of each shift. Ask the manufacturer for a checklist of items

Geriatric Needs

Like the other body systems, the cardiovascular system undergoes changes as we get older. The heart, like other major organs, will show the effects of aging. As the heart's muscle mass and tone decrease, the amount of blood pumped out of the heart per beat is decreased. The residual (reserve) capacity of the heart is also reduced; therefore, when the vital organs of the body need additional blood flow, the heart cannot meet the need. When blood flow to the tissues is decreased, the organs suffer. If blood flow to the brain is inadequate, the patient may complain of weakness, fatigue, or dizziness and may develop syncope (fainting).

The power to the heart muscle can fail. The heart runs on electricity and has its own electrical system. Under normal conditions, electrical impulses travel throughout the heart, resulting in the contraction of the heart muscle and the pumping of blood from the heart's chambers. With aging, the electrical system can deteriorate, causing the heart's contraction to weaken or, if blood flow to the heart muscle is affected, extra beats to form. With a decreased strength of contraction, the heartbeat is weaker and blood flow to the tissues is reduced. If extra beats are produced, the patient's heart rhythm will be irregular. While some irregular heart rhythms are acceptable, others can be potentially lethal.

The arteries are also affected by aging. Arteriosclerosis (hardening of the arteries) can develop, affecting perfusion of the tissues. There is an increased chance of heart attack or stroke from decreased blood flow or plaque formation (atherosclerosis) in the narrowed arteries.

Patients with diabetes can experience reduced circulation to the hands and feet; this makes peripheral pulses harder to detect. It also puts the hands and feet at particular risk for developing infection or ulcerations.

In some older patients with angina or AMI, particularly diabetics, chest pain is absent, and the clinical picture can be confused with other, noncardiac conditions.

The cardiovascular system is affected by aging. You should be aware of the changes, seeking to determine what is normal versus what is chronic for the patient as opposed to what is an acute condition. Sometimes, the weakening of the heart muscle, the deterioration of its electrical system, and the hardening of the arteries make the task of assessing and caring for the older patient more difficult.

that should be checked daily, weekly, or less often (Figure 12-17 ▶).

If you do have an AED failure while caring for a patient, you must report that problem to the manufacturer and the US Food and Drug Administration. Be sure to follow the appropriate EMS procedures for notifying these organizations.

Medical Direction

Defibrillation of the heart is a medical procedure. While AEDs have made the process of delivering electricity much simpler, there is still a benefit in having a physician's involvement. The medical director of your service should help to teach you how to use the AED. At the very least, he or she should approve the written protocol that you will follow in caring for patients in cardiac arrest. In most states, successful completion of AED training in an EMT-B course is not permitted without approval by state laws, rules, and local medical direction authority.

There should be a review of each incident in which the AED is used. After returning from the hospital or the scene, sit down with the rest of the team and go over what happened. This discussion will help all members of the team learn from the incident. Review such events by using the written report, any voice-ECG tape recorder, and the device's solid-state memory modules and magnetic tape recordings, if applicable.

There should also be a review of the incident by your service's medical director or quality improvement officer. Quality improvement involves individuals using AEDs and the responsible EMS system managers. This review should focus on speed of defibrillation, that is, the time from call to shock. Few systems will achieve the ultimate goal: shocking 100% of patients within 1 minute of the call. However, all systems continuously work on improving patient care. Mandatory continuing education with skill competency review is generally required for EMS providers, with a continuing competency skill review every 3 to 6 months for the EMT-B.

Emergency Care for Cardiac Arrest

Preparation

En route to the scene, prepare yourself to follow BSI precautions. Upon arrival at the scene, make sure that the scene is safe for you and your partner to enter. If dispatch reports an unresponsive patient with CPR

You are the Provider — Part 6

The patient now rates his pain as 3/10. As you obtain another set of vital signs the paramedic radios the hospital and provides patient updates. You give your blood pressure reading to the paramedic who, during the radio report, administers another dose of sublingual nitroglycerin using a metered-dose spray. After the report, he asks you to complete a head-to-toe physical exam while he faxes the 12-lead ECG to the receiving hospital and prepares morphine for administration.

He checks the blood pressure again and asks the patient to rate his pain, which he says has not changed. The paramedic then confirms the patient is not allergic to morphine and administers a single dose through the IV line. By the time you reach the hospital, the patient's pain is gone.

10. As an EMT-B, why is it extremely important to obtain accurate vital signs?
11. How can an inaccurate blood pressure reading affect patient care, especially during this type of scenario?

AUTOMATED EXTERNAL DEFIBRILLATOR
Inspection Checklist

Serial # _____ **Date** _____ **Time** _____

Model # _____ **Inspected by** _____

Item	Pass	Fail
Exterior/Cables:		
Nothing stored on top of unit		
Carry case intact and clean		
Exterior/LCD screen clean and undamaged		
Cables/connectors clean and undamaged		
Cables securely attached to unit		
Batteries:		
Unit charger is plugged in and operational (if applicable)		
Fully charged battery in unit		
Fully charged spare battery		
Spare battery charger plugged in and operational (if applicable)		
Valid expiration date on both batteries		
Supplies:		
Two sets of electrodes		
Electrodes in sealed packages with valid expiration dates		
Razor		
Hand towel		
Alcohol wipes		
Memory/voice recording device—module, card, microcassette		
Manual override—module, key (if applicable)		
Printer paper (if applicable)		
Operation:		
Unit self-test per manufacturer's recommendation/instructions		
Display (if applicable)		
Visual indicators		
Verbal prompts		
Printer (if applicable)		
Attach AED to simulator/tester:		
Recognizes shockable rhythm		
Charges to correct energy level within manufacturer's specifications		
Delivers charge		
Recognizes nonshockable rhythm		
Manual override system in working order (if applicable)		

Signature:

Figure 12-17 A sample checklist for the AED.

being performed, the AED is probably one of the first pieces of equipment you will gather from the ambulance. As the operator of the AED, you are responsible for making sure that the electricity injures no one, including yourself. Remote defibrillation using pads allows you to distance yourself safely from the patient. As long as you place the pads in the correct position and make sure no one is touching the patient, you should be safe. Do not defibrillate a patient who is in pooled water. While there is some danger to you if you are also in the water, there is another problem. Electricity follows the path of least resistance; instead of traveling between the pads and through the patient's heart, it will diffuse into the water. Therefore, the heart will not receive enough electricity to cause defibrillation. You can defibrillate a soaking wet patient, but try first to dry the patient's chest. Do not defibrillate someone who is touching metal that others are touching, and carefully remove a nitroglycerin patch from a patient's chest and wipe the area with a dry towel before defibrillation to prevent ignition of the patch. It is often helpful to shave a hirsute patient's chest prior to patch placement to increase conductivity. Be sure to consult local protocols for issues such as pad placement and preparation of the pad site.

Determine the nature of illness and/or mechanism of injury. If the incident involves trauma, perform spinal stabilization as you begin the initial assessment. Is there only one patient? If you are in a tiered system and the patient is in cardiac arrest, call for ALS assistance.

Performing Defibrillation

If you witness a patient's cardiac arrest, begin CPR and attach the AED as soon as it is available. However, if the patient's cardiac arrest was not witnessed, especially if the call-to-arrival interval is greater than 5 minutes, you should perform 5 cycles (about 2 minutes) of CPR before applying the AED. The rationale for this is that the heart is more likely to respond to defibrillation within the first few minutes of the onset of ventricular fibrillation. If the arrest interval is prolonged, however, metabolic waste products accumulate within the heart, energy stores are rapidly depleted, and the chance of successful defibrillation is reduced. Therefore, a 2 minute period of CPR before applying the AED in patients with prolonged (> 5 minutes) cardiac arrest can "prime the pump," thus restoring oxygen to the heart, removing metabolic waste products, and increasing the chance of successful defibrillation. The steps for using the AED are listed here and shown in Skill Drill 12-2 ▶:

1. **Arrive on scene and perform your initial assessment.** Assess responsiveness. If the patient is responsive, do not apply the AED.
2. **Stop CPR** if it is in progress.
3. **Verify pulselessness and apnea.** Check for breathing and a pulse even if the patient appears to be breathing.
4. If the patient is unresponsive and not breathing or is breathing agonally (slow, gasping breaths), **give two ventilations** using a BVM device or a pocket mask (**Step 1**).
5. If there is a delay in obtaining an AED, **have your partner start or resume CPR.**
6. If an AED is close at hand, **prepare the AED pads.**
7. **Turn on the machine** (**Step 2**).
8. **Remove clothing from the patient's chest area.** Apply the pads to the chest: one just to the right of the breastbone (sternum) just below the collarbone (clavicle), the other on the left chest with the top of the pad 2″ to 3″ below the armpit. Ensure that the pads are attached to the patient cables (and that they are attached to the AED in some models).
9. **Stop CPR** (**Step 3**).
10. **State aloud**, "**Clear the patient**," and ensure that no one is touching the patient.
11. **Push the analyze button**, if there is one.
12. **Wait for the computer** in the AED to determine whether a shockable rhythm is present.
13. If a shock is not needed, go to step 17 (CPR only). If a shock is advised, make sure that no one is touching the patient. When the patient and area around the patient are clear, **push the shock button**.
14. After the shock is delivered, immediately begin **5 cycles (approximately 2 minutes) of CPR** beginning with chest compressions.
15. After 5 cycles (approximately 2 minutes) of CPR, **reanalyze the patient's rhythm**.
16. If the AED advises a shock, clear the patient and **push the shock button** (**Step 4**).
17. If no shock is advised, **check for a pulse**.
18. If the patient has a pulse, **check for breathing** (at least 5 seconds but no more than 10 seconds) (**Step 5**).
19. If the patient is breathing adequately, give the patient oxygen via a nonrebreathing mask and transport. If the patient is not breathing adequately, use the necessary airway adjuncts and proper positioning of the head and jaw to ensure an open airway. Provide artificial ventilations with a high concentration of oxygen and transport.

20. If the patient has no pulse, perform 5 cycles (approximately 2 minutes) of CPR.
21. Gather additional information about the arrest event.
22. After 2 minutes of CPR, make sure no one is touching the patient. Push the analyze button.
23. If necessary, repeat Steps 15 and 16 until ALS arrives.
24. Transport and check with medical control.
25. Continue to support the patient as needed. Ventilate until the patient is breathing normally. Continue CPR if needed (**Step 6**).

If, after any rhythm analysis, the AED advises no shock, check the patient's pulse. If the patient has a pulse, check the patient's breathing. If the patient is breathing adequately, give high-concentration oxygen via nonrebreathing mask and transport. If the patient is not breathing adequately, provide artificial ventilations with high-concentration oxygen via a BVM device and transport. Ensure that appropriate airway techniques are used at all times.

If the patient has no pulse, resume CPR for 2 minutes, then use the AED to reanalyze the heart rhythm. If the AED advises to shock, deliver one shock followed by 5 cycles (approximately 2 minutes) of CPR beginning with chest compressions. Reanalyze the rhythm. Repeat these steps if needed.

If the AED advises no shock and the patient has no pulse, resume CPR for 5 cycles (approximately 2 minutes), beginning with chest compressions. Stop and reanalyze the patient's rhythm. Shock if advised, followed by 5 cycles of CPR. If no shock is advised, continue CPR. Check with medical control and transport.

If you are the only rescuer at the scene and you have an AED, take the following steps:

1. Perform an initial assessment. Assess responsiveness. If the patient is responsive, do not apply the AED.
2. Verify that the patient has no pulse and is not breathing (or is breathing with inadequate gasping breaths).
3. If the patient is not breathing or is gasping, give two slow breaths using a BVM device or pocket mask.
4. Expose the patient's chest. Apply one pad just to the right of the breastbone (sternum), just below the collarbone (clavicle), and the other on the left side of the chest with the top of the pad 2″ to 3″ below the armpit.
5. Turn on the AED.
6. Push the analyze button, if there is one.
7. Deliver up to three shocks, if indicated.
8. Follow your local protocol. If the AED indicates no need for shocks, provide CPR.

If another person is available who knows CPR, ask for help. You will perform the steps in the same order. The only difference is that the other person can continue CPR while you are getting the AED out and applied to the patient.

After AED Shocks

The care of the patient after the AED delivers a shock depends on your location and EMS system; therefore, you should follow your local protocols. After the AED protocol is completed, the patient is likely to have had one of the following occur:

- Regained a pulse
- No pulse, and the AED indicates that no shock is advised
- No pulse, and the AED indicates that a shock is advised

Patients who fail to regain a pulse on the scene of the cardiac arrest usually do not survive. What you do with these patients will, again, depend on your EMS system. Whether you should transport the patient or wait for ALS to arrive should be in the local protocols established by medical direction. If paramedics or another advanced life support service is responding to the scene, the best option usually is to stay where you are and continue the sequence of shocks and CPR. Administering CPR while patients are being moved or transported is usually not effective. The best chance for patient survival occurs when the patient is resuscitated where found, unless the location is unsafe.

If an ALS service is not responding to the scene and your local protocols agree, you should begin transport when one of the following occurs:

- The patient regains a pulse.
- Six to nine shocks are delivered.
- The machine gives three consecutive messages (separated by 2 minutes of CPR) that no shock is advised.

If you transport a patient while performing CPR, you need a plan for managing the patient in the ambulance. Ideally, you will have two EMT-Bs in the patient compartment while a third drives. You may deliver additional shocks at the scene or en route with the approval of medical control. Keep in mind that AEDs cannot analyze rhythm while the vehicle is in motion. Nor is it as safe to defibrillate in a moving ambulance. Therefore, you should come to a complete stop if more

Skill Drill 12-2

AED and CPR

1 Stop CPR if in progress.

Assess responsiveness.

Check breathing and pulse.

If unresponsive and not breathing adequately, give two slow ventilations.

2 If pulseless, begin CPR.

Prepare the AED pads.

Turn on the AED; begin narrative if needed.

3 Apply AED pads.

Stop CPR.

4 Verbally and visually clear the patient.

Push the Analyze button if there is one.

Wait for the AED to analyze rhythm.

If no shock advised, perform CPR for 2 minutes.

If shock advised, recheck that all are clear and push the Shock button.

Immediately initiate 5 cycles (approximately 2 minutes) of CPR, beginning with chest compressions. Reanalyze rhythm.

Press Shock if advised (second shock).

Push the Analyze button, if needed, to analyze rhythm again.

Press Shock if advised (third shock).

5 Check pulse.

If pulse is present, check breathing.

Gather additional information on the arrest event.

6 If breathing adequately, give oxygen and transport. If not, open airway, ventilate, and transport.

If no pulse, perform 5 cycles of CPR (approximately 2 minutes).

Clear the patient and analyze again.

If necessary, repeat one cycle of up to three shocks.

Transport and call medical control.

Continue to support breathing or perform CPR, as needed.

shocks are needed. Be sure to memorize the protocol of your EMS service Figure 12-18 ▶.

Cardiac Arrest During Transport

If you are traveling to the hospital with an unconscious patient, check the pulse at least every 30 seconds. If a pulse is not present, take the following steps:

1. Stop the vehicle.
2. If the AED is not immediately ready, perform CPR until it is available.
3. Analyze the rhythm.
4. Deliver shock, if indicated.
5. Continue resuscitation according to your local protocol.

If you are en route with a conscious adult patient who is having chest pain and becomes unconscious, take the following steps:

1. Check for a pulse.
2. Stop the vehicle.
3. If the AED is not immediately ready, perform CPR until it is ready.
4. Analyze the rhythm.
5. Deliver one shock, if indicated.
6. Begin compressions and continue resuscitation according to your local protocol including transporting the patient.

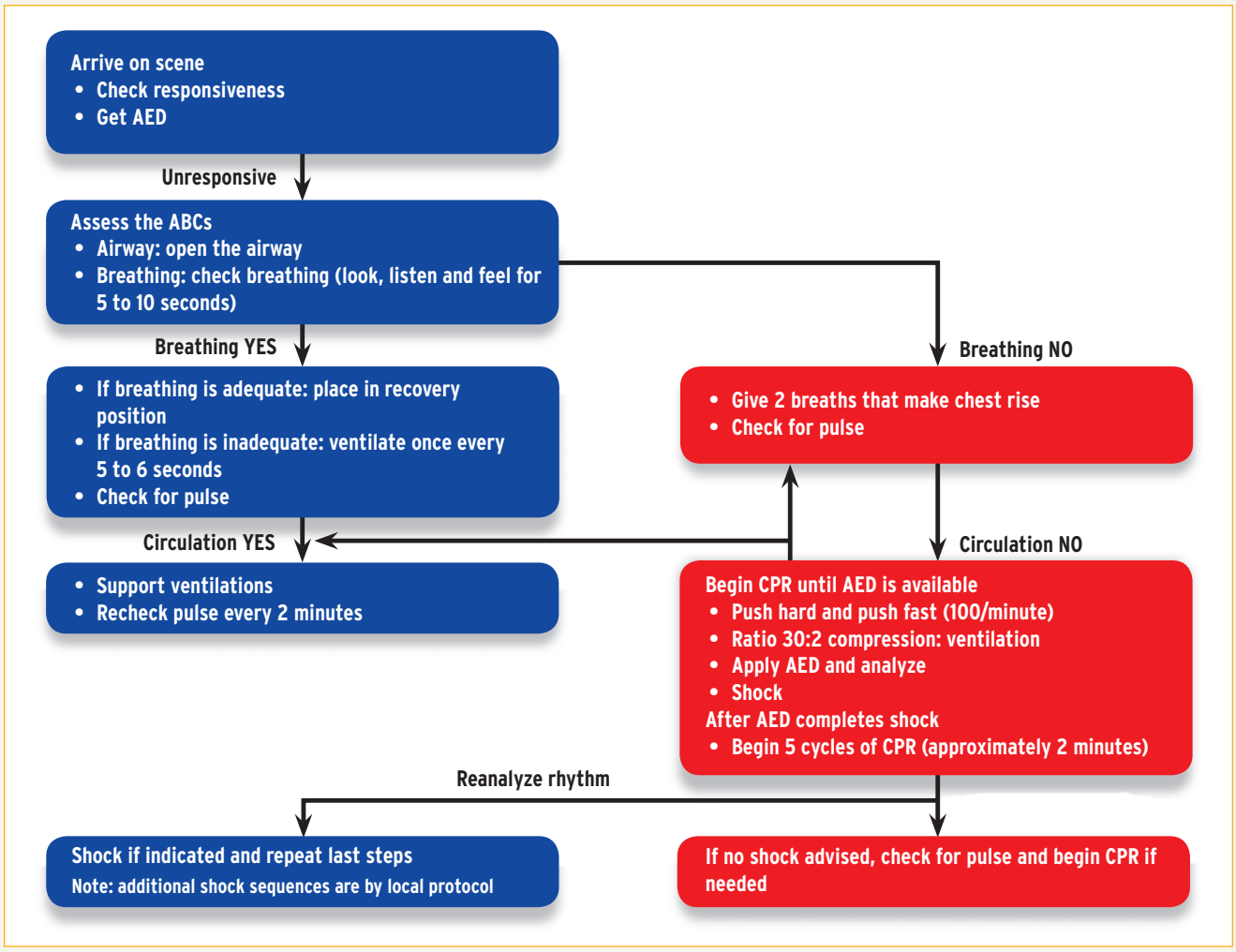

Figure 12-18 AED algorithm.

Coordination With ALS

The time to defibrillation is critical to survival after cardiac arrest. As an EMT-B equipped with an AED, you have the one tool that the dying patient in ventricular fibrillation needs most. Furthermore, it is very hard to hurt someone with an AED. Therefore, if you have an AED available, do not wait for the paramedics to arrive to administer a shock. Waiting might seem like a good idea. It is not. It is throwing away the patient's best chance for survival.

If the patient is unresponsive and does not have a pulse, apply the AED and push the analyze button (if there is one) as quickly as you can. Notify the ALS personnel as soon as possible after you recognize a cardiac arrest, but do not delay defibrillation. After the paramedics arrive at the scene, you should interact with them according to your local protocols.

EMT-B Tips

AED Operational Tips

- One EMT-B operates the defibrillator while another does CPR.
- Defibrillation comes first. Do not apply oxygen or do anything else that delays analysis of rhythm or defibrillation.
- Be familiar with the AED device used by your EMS system.
- Avoid all contact with the patient during analysis of the rhythm.
- State, "Clear the patient" before shocking. Another popular phrase is "I'm clear, you're clear, we're all clear" before delivering shocks.
- In applicable models of AEDs, check the batteries at the beginning of your shift; carry an extra charged battery with your AED.
- Only use an AED with special pediatric pads for cardiac arrest in children younger than 8 years or who weigh less than 55 lb (25 kg) and who have been assessed to be unresponsive, not breathing, and pulseless.
- Unless indicated otherwise by local protocol, you do not need to perform pulse checks during rhythm analysis; typically, there will be no pulse check between stacked shocks 1 and 2 and stacked shocks 2 and 3.
- Continued airway maintenance and artificial ventilation are of prime importance.

You are the Provider

Summary

Inaccurate blood pressure measurements can significantly affect treatment options and decisions that must be made regarding patient care. For example, if nitroglycerin is administered because of an inaccurate blood pressure reading, this could have detrimental effects on the patient or exacerbate his condition. Never estimate the reading. Ask your partner for help should it become necessary.

This scenario demonstrates the impact you have as an EMT-B in the first few minutes of a call. Your knowledge and actions can make the difference in a patient avoiding permanent disability or death as a result of a life-threatening situation such as a heart attack. Working as a team with ALS and understanding the needs of these providers can also assist in the overall quality of patient care. The transition from BLS providers to ALS providers to an emergency department physician should be seamless. With knowledge and teamwork, all levels of providers work together to provide the best patient care possible.

	Chest Pain	Cardiac Arrest
Scene Size-up	Wear BSI. Ensure scene safety. Determine NOI from patient and/or bystanders. Request additional resources if needed. Determine if spinal stabilization is needed.	Wear BSI. Ensure scene safety. Bring AED. Determine NOI/MOI. Determine if spinal stabilization is needed.
Initial Assessment		
■ General impression	Determine if patient is responsive. If so, ask about chief complaint. If not, evaluate ABCs. If patient has lost consciousness and possibly fallen, consider spinal stabilization.	Determine patient's LOC and chief complaint. If patient is unresponsive and pulseless, prepare to defibrillate.
■ Airway	Ensure that the airway is patent.	
■ Breathing	If patient is short of breath or in respiratory distress, provide oxygen via nonrebreathing mask at 10-15 L/min. If patient is not breathing, provide ventilations with a BVM device and 100% oxygen.	Check scene safety—do not defibrillate a patient in pooled water.
■ Circulation	Assess the pulse and skin. Place patient in position of comfort. Provide reassurance.	
■ Transport decision	Transport patients with chest pain immediately in gentle, stress-relieving manner.	
Focused History and Physical Exam	*NOTE: The order of the steps in the focused history and physical exam differs depending on whether the patient is conscious or unconscious. The order below is for a conscious patient. For an unconscious patient, perform a rapid physical exam, obtain vital signs, and obtain the history.*	
■ SAMPLE history	If patient is conscious, take brief SAMPLE history and ask OPQRST questions. Specifically, ask if the patient: ■ had heart attack before ■ has heart problems ■ has risk factors: smoking, high blood pressure, high stress ■ takes medications	Not applicable to a cardiac arrest patient. See emergency care table on opposite page for summary of AED procedure.
■ Focused physical exam	Perform a focused physical exam, focusing on the cardiovascular and respiratory systems. Assess skin color, temperature, and condition. Is cyanosis present? Are neck veins distended? Check mucous membranes.	
■ Baseline vital signs	Take vital signs, including systolic and diastolic blood pressures. Use pulse oximetry if available.	
■ Communication	Report to medical control and the hospital; follow instructions from medical control.	
■ Interventions	Depending on local protocol, administer baby aspirin and assist with prescribed nitroglycerin. Obtain permission from medical control before assisting with prescribed nitroglycerin.	
Detailed Physical Exam	If time permits and patient is stable, perform detailed physical exam and ask patient about risk factors for heart disease.	Not applicable to a cardiac arrest patient. See emergency care table on opposite page for summary of AED procedure.
Ongoing Assessment	Monitor patient very closely. Reassess vital signs every 5 minutes or as patient's condition changes. Reassess interventions.	After defibrillation, check pulse at least every 30 seconds. If pulse is not present, perform defibrillation and/or CPR again.
■ Communication and documentation	If cardiac arrest occurs, begin defibrillation or CPR immediately. Record all interventions. Obtain medical control physician's signature if required.	

NOTE: While the steps below are widely accepted, be sure to consult and follow your local protocol.

Chest Pain

Depending on local protocol, prepare to administer baby aspirin and assist with prescribed nitroglycerin. Check condition of medication(s) and expiration date(s).

Aspirin

Administer according to protocols.

Nitroglycerin

1. Obtain permission from medical control.
2. Take patient's blood pressure. Continue only if systolic pressure greater than 100 mm Hg.
3. Check that you have the right medication, right patient, and right delivery route.
4. Question patient about last dose and effects. Ensure patient understands route of administration. Prepare to have the patient lie down to prevent fainting.
5. Ask patient to lift his or her tongue. Place tablet underneath tongue or spray under tongue if medication is in spray form. Have patient keep mouth closed until dissolved/absorbed.
6. Recheck blood pressure within 5 minutes. Record medication and time of administration. If chest pain persists and systolic blood pressure is greater than 100 mm Hg, repeat the dose every 5 minutes as authorized by medical control.

Reevaluate transport decision. Do not delay transport to assist with nitroglycerin.

Cardiac Arrest

Defibrillation

1. Perform initial assessment. If patient is unresponsive and pulseless, prepare to defibrillate. If patient is responsive, do not apply AED.
2. Stop CPR if it is in progress.
3. Verify pulselessness and apnea (no more than 10 seconds).
4. Give two ventilations using a BVM device or pocket mask.
5. If the AED is not ready, start CPR.
6. Prepare the AED pads.
7. Turn on the machine.
8. Remove clothing from patient's chest area. Apply the pads: one to the right of the breastbone just below the collarbone, one on the left chest.
9. Stop CPR.
10. State aloud, "Clear the patient." Ensure that no one is touching the patient, including yourself.
11. Push the analyze button.
12. Wait for the computer to determine if a shockable rhythm is present.
13. If a shock is not needed, go to step 17. If a shock is advised, ensure that no one is touching the patient, including yourself. Push shock button.
14. Begin 5 cycles of CPR (approximately 2 minutes).
15. Analyze rhythm.
16. Deliver shock if indicated.
17. If no shock indicated, check pulse.
18. If no pulse present, repeat from step 14.
19. If pulse is present, check breathing.
20. If breathing adequately, give patient oxygen via nonrebreathing mask and transport. If patient is not breathing adequately, open airway and ventilate.
21. Gather additional information on arrest event.
22. Transport and check with medical control.
23. Continue to support patient.

Note: If the patient's cardiac arrest was not witnessed, especially if the call-to-arrival interval is greater than 5 minutes, perform 5 cycles (about 2 minutes) of CPR and then apply the AED. Follow local protocols regarding witnessed versus unwitnessed cardiac arrest and the use of the AED.

Prep Kit

Ready for Review

- The heart is divided down the middle into two sides, right and left, each with an upper chamber called the atrium and a lower chamber called the ventricle.
- The largest of the four heart valves that keep blood moving through the circulatory system in the proper direction is the aortic valve, which lies between the left ventricle and the aorta, the body's main artery.
- The heart's electrical system controls heart rate and helps the atria and ventricles work together.
- During periods of exertion or stress, the myocardium requires more oxygen. This is supplied by dilation of the coronary arteries, which increases blood flow.
- Common places to feel for a pulse include the carotid, femoral, brachial, radial, posterior tibial, and dorsalis pedis arteries.
- Low blood flow to the heart is usually caused by coronary artery atherosclerosis, a disease in which cholesterol plaques build up inside blood vessels, eventually occluding them.
- Occasionally, a brittle plaque will crack, causing a blood clot to form. Heart tissue downstream suffers from a lack of oxygen and, within 30 minutes, will begin to die. This is called an acute myocardial infarction (AMI), or heart attack.
- Heart tissues that are not getting enough oxygen but are not yet dying can cause pain called angina. The pain of AMI is different from the pain of angina in that it can come at any time, not just with exertion; it lasts up to several hours, rather than just a few moments; and it is not relieved by rest or nitroglycerin.
- In addition to crushing chest pain, signs of AMI include sudden onset of weakness, nausea, and sweating; sudden arrhythmia; pulmonary edema; and even sudden death.
- Heart attacks can have three serious consequences. One is sudden death, usually the result of cardiac arrest caused by abnormal heart rhythms called arrhythmias. These include tachycardia, bradycardia, ventricular tachycardia, and, most commonly, ventricular fibrillation.
- The second consequence is cardiogenic shock. Symptoms include restlessness; anxiety; pale, clammy skin; pulse rate higher than normal; and blood pressure lower than normal. Patients with these symptoms should receive oxygen, assisted ventilations as needed, and immediate transport.
- The third consequence of AMI is congestive heart failure, in which damaged heart muscle can no longer contract effectively enough to pump blood through the system. The lungs become congested with fluid, breathing becomes difficult, the heart rate increases, and the left ventricle enlarges.
- Signs include swollen ankles from dependent edema, high blood pressure, rapid heart rate and respirations, rales (crackles), and sometimes the pink sputum and dyspnea of pulmonary edema.
- Treat a patient with CHF as you would a patient with chest pain. Monitor the patient's vital signs. Give the patient oxygen via nonrebreathing face mask. Allow the patient to remain sitting up.
- In treating patients with chest pain, obtain a SAMPLE history, following the OPQRST mnemonic to assess the pain; measure and record vital signs; ensure the patient is in a comfortable position, usually semi-reclining or half sitting up; administer prescribed nitroglycerin and oxygen; and transport the patient, reporting to medical control as you do.
- If a patient is not responsive, you may perform the following, depending on the patient's age, weight, and your local protocol:
  - Unresponsive adult or child older than 8 years and weighing at least 55 lb, perform automated external defibrillation

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  - Unresponsive child younger than 8 years who weighs less than 55 lb, perform automated external defibrillation with special pediatric pads if protocol allows
  - Unresponsive infant, begin CPR.
- The AED requires the operator to apply the pads, power on the unit, follow the AED prompts, and press the shock button as indicated. The computer inside the AED recognizes rhythms that require shocking and will not mislead you.
- The three most common errors in using certain AEDs are failure to keep a charged battery in the machine, applying the AED to a patient who is moving, squirming, or being transported, and applying the AED to a responsive patient with a rapid heart rate.
- Do not touch the patient while the AED is analyzing the heart rhythm or delivering shocks.
- Application of an AED, analysis of heart rhythm, and defibrillation always are a higher priority than CPR. Stop CPR as soon as an AED is available and treat the patient following the prompts from the AED. Start CPR only if shock is not advised or in 1-minute spurts between rounds of shocks.
- If advanced life support (ALS) service is responding to the scene, stay where you are and continue the sequence of shocks and CPR. Do not wait for ALS to arrive to begin defibrillation. If ALS is not responding, begin transport after six shocks or after the machine gives three consecutive messages that no shock is advised.
- If an unconscious patient has a pulse but loses it during transport, you must stop the vehicle, reanalyze the rhythm, and either defibrillate again or begin CPR as appropriate.
- The chain of survival, which is the sequence of events that must happen for a patient with cardiac arrest to have the best chance of survival, includes recognition of early warning signs and immediate activation of EMS, immediate CPR by bystanders, early defibrillation, and early advanced care. Seconds count at every stage.

Vital Vocabulary

acute myocardial infarction (AMI) Heart attack; death of heart muscle following obstruction of blood flow to it. Acute in this context means "new" or "happening right now."

angina pectoris Transient (short-lived) chest discomfort caused by partial or temporary blockage of blood flow to the heart muscle.

anterior The front surface of the body; the side facing you in the standard anatomic position.

aorta The main artery, which receives blood from the left ventricle and delivers it to all the other arteries that carry blood to the tissues of the body.

aortic valve The one-way valve that lies between the left ventricle and the aorta. It keeps blood from flowing back into the left ventricle after the left ventricle ejects its blood into the aorta. One of four heart valves.

arrhythmia An irregular or abnormal heart rhythm.

atherosclerosis A disorder in which cholesterol and calcium build up inside the walls of blood vessels, eventually leading to partial or complete blockage of blood flow.

asystole Complete absence of heart electrical activity.

atrium One of two (right and left) upper chambers of the heart. The right atrium receives blood from the vena cava and delivers it to the right ventricle. The left atrium receives blood from pulmonary veins and delivers it to the left ventricle.

bradycardia Slow heart rate, less than 60 beats/min.

cardiac arrest A state in which the heart fails to generate an effective and detectable blood flow; pulses are not palpable in cardiac arrest, even if muscular and electrical activity continues in the heart.

cardiogenic shock A state in which not enough oxygen is delivered to the tissues of the body, caused by low output of blood from the heart. It can be a severe complication of a large acute myocardial infarction, as well as other conditions.

Prep Kit continued...

congestive heart failure (CHF) A disorder in which the heart loses part of its ability to effectively pump blood, usually as a result of damage to the heart muscle and usually resulting in a backup of fluid into the lungs.

coronary artery A blood vessel that carries blood and nutrients to the heart muscle.

defibrillate To shock a fibrillating (chaotically beating) heart with specialized electrical current in an attempt to restore a normal rhythmic beat.

dependent edema Swelling in the part of the body closest to the ground, caused by collection of fluid in the tissues; a possible sign of congestive heart failure (CHF).

dilation Widening of a tubular structure such as a coronary artery.

infarction Death of a body tissue, usually caused by interruption of its blood supply.

inferior The part of the body, or any body part, nearer to the feet.

ischemia A lack of oxygen that deprives tissues of necessary nutrients, resulting from partial or complete blockage of blood flow; potentially reversible because permanent injury has not yet occurred.

lumen The inside diameter of an artery or other hollow structure.

myocardium Heart muscle.

occlusion Blockage, usually of a tubular structure such as a blood vessel.

perfusion The flow of blood through body tissues and vessels.

posterior The back surface of the body; the side away from you in the standard anatomical position.

superior The part of the body, or any body part, nearer to the head.

syncope Fainting spell or transient loss of consciousness.

tachycardia Rapid heart rhythm, more than 100 beats/min.

ventricle One of two (right and left) lower chambers of the heart. The left ventricle receives blood from the left atrium (upper chamber) and delivers blood to the aorta. The right ventricle receives blood from the right atrium and pumps it into the pulmonary artery.

ventricular fibrillation Disorganized, ineffective twitching of the ventricles, resulting in no blood flow and a state of cardiac arrest.

ventricular tachycardia (VT) Rapid heart rhythm in which the electrical impulse begins in the ventricle (instead of the atrium), which may result in inadequate blood flow and eventually deteriorate into cardiac arrest.

Points to Ponder

You have been dispatched to a report of a patient having chest pain. Upon arrival you find the patient sitting in a chair. She is pale and slightly short of breath. You complete your SAMPLE history and find the patient has a history of hypertension and CHF and had a heart attack 5 years ago. She takes nitroglycerin and hydrochlorothiazide for her blood pressure. The onset of symptoms has been over the last week. The patient has taken her nitroglycerin as prescribed and her chest pain is relieved.

You complete a detailed physical exam and find crackles in her lungs. Her ankles are very swollen. You recommend transport to the hospital for treatment. The patient refuses and wants to stay at home.

What should you say to this patient? If she refuses treatment, how should you document this?

Issues: Convincing Patients of the Need for Treatment, Right of Refusal, Advocating for the Patient, Assistance from Medical Control.

Assessment in Action

You have been dispatched to City Hall for a report of sick man. En route dispatch gives you additional information. The patient, a 67-year-old man, is at the mayor's office and is possibly having a heart attack.

As you enter the mayor's office you see an older man sitting in a chair. He is pale, sweaty, and appears to be short of breath. You introduce yourself and the patient responds, " I feel like I'm going to die." He tells you he has a "stabbing" pain in his chest that moves to his left arm. The pain started 15 minutes ago while working at his desk. The patient has a pulse of 90 beats/min and irregular, a blood pressure of 180/100 mm Hg, and respirations of 22 breaths/min. He continues to tell you he had open heart surgery two years ago and takes nitroglycerin for angina and Lopressor for high blood pressure.

1. The patient's general appearance, SAMPLE history, and vital signs lead you to believe this patient is having a(n):
   - **A.** acute myocardial infarction (AMI).
   - **B.** asthma attack.
   - **C.** cardiac arrest.
   - **D.** psychological episode.
2. Because this patient's chest pain has lasted longer than 15 minutes, you can rule out:
   - **A.** angina pectoris.
   - **B.** cardiac tamponade.
   - **C.** sudden death.
   - **D.** COPD.
3. The EMT-B can assist this patient with needed heart medication called:
   - **A.** dopamine.
   - **B.** nitroglycerin.
   - **C.** penicillin.
   - **D.** Vasotec.
4. Atherosclerosis can lead to:
   - **A.** pressure sores.
   - **B.** headaches.
   - **C.** lung disease.
   - **D.** a blockage or occlusion of the coronary artery.
5. A severe blockage of a coronary artery that depletes the heart's ability to pump is called:
   - **A.** cardiogenic stoppage.
   - **B.** heart depletion
   - **C.** reduced pump stroke.
   - **D.** cardiac arrest.
6. The poor appearance of this patient is due to lack of cardiac output and:
   - **A.** cold temperatures.
   - **B.** poor skin condition.
   - **C.** loss of perfusion (shock).
   - **D.** past medical history.
7. AMIs (heart attacks) do not always lead to sudden death. The patient can also have cardiogenic shock and:
   - **A.** mini strokes.
   - **B.** congestive heart failure (CHF).
   - **C.** neurogenic myopathy.
   - **D.** lung abscesses.
8. An abnormality in a patient's heart rhythm is called a:
   - **A.** cardiac arrhythmia.
   - **B.** cardiac malfunction.
   - **C.** cardiac seizure.
   - **D.** cardiac standstill.

Challenging Questions

9. Explain the differences in pain between an AMI and angina pectoris.
10. Trace the flow of blood through the cardiovascular system starting from the right atrium.
11. What are signs and symptoms of congestive heart failure (CHF) and the treatment?
12. What are the indications for use and the steps in using an AED?