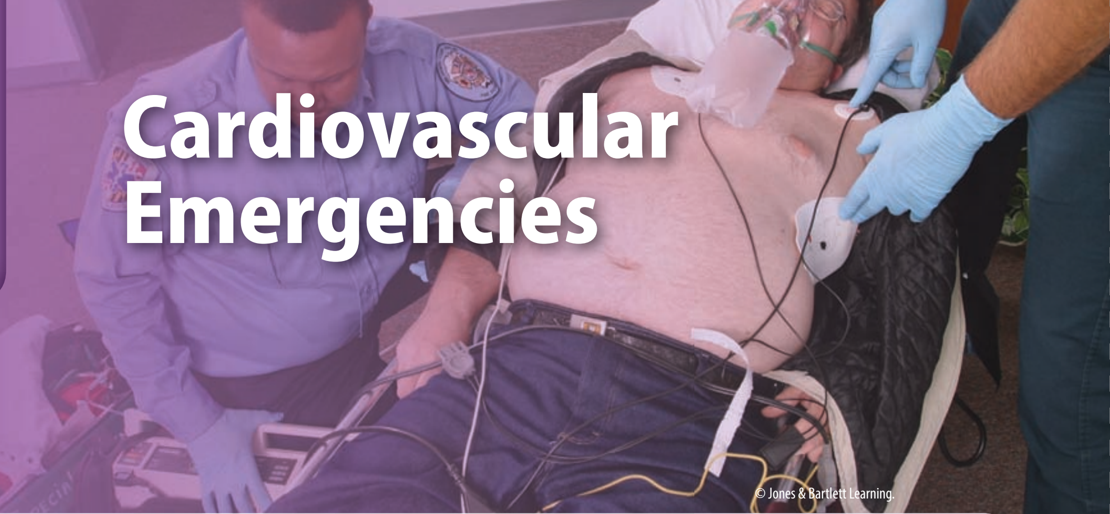
CHAPTER

16

Cardiovascular Emergencies



© Jones & Bartlett Learning.

National EMS Education Standard Competencies

Pathophysiology

Applies fundamental knowledge of the pathophysiology of respiration and perfusion to patient assessment and management.

Medicine

Applies fundamental knowledge to provide basic emergency care and transportation based on assessment findings for an acutely ill patient.

Cardiovascular

Anatomy, signs, symptoms, and management of

- Chest pain (pp 629–665)
- Cardiac arrest (pp 629–639, 654–665)

Anatomy, physiology, pathophysiology, assessment, and management of

- Acute coronary syndrome (pp 629–639, 642–652)
  - Angina pectoris (pp 629–638, 642–652)
  - Myocardial infarction (pp 629–639, 654–665)
- Aortic aneurysm/dissection (pp 629–636, 642–652)
- Thromboembolism (pp 629–637, 642–652)
- Heart failure (pp 629–636, 640–652)
- Hypertensive emergencies (pp 629–636, 642–652)

Knowledge Objectives

1. Discuss the basic anatomy and physiology of the cardiovascular system. (pp 629–636)
2. Discuss the pathophysiology of the cardiovascular system. (pp 636–642)
3. Describe the anatomy, physiology, pathophysiology, assessment, and management of thromboembolism. (pp 636–639)
4. Describe the anatomy, physiology, pathophysiology, assessment, and management of angina pectoris. (pp 637–638)
5. Describe the anatomy, physiology, pathophysiology, assessment, and management of myocardial infarction. (pp 638–639)
6. Describe the anatomy, signs and symptoms, and management of hypertensive emergencies. (p 642)
7. Describe the anatomy, physiology, pathophysiology, assessment, and management of aortic aneurysm/dissection. (p 642)
8. Explain the assessment for patients with cardiovascular problems. (pp 642–647)
9. Explain the relationship between airway management and the patient with cardiac compromise. (pp 643–644)
10. Give the indications and contraindications for the use of aspirin and nitroglycerin. (p 648)
11. Recognize that many patients will have had cardiac surgery and may have implanted pacemakers or defibrillators. (pp 653–654)
12. Define cardiac arrest. (p 654)
13. Compare the difference between the fully automated and the semiautomated defibrillator. (pp 654–655)
14. Describe the different types of AEDs. (p 655)
15. Explain the use of remote adhesive defibrillator pads. (p 656)
16. Recognize that not all patients in cardiac arrest require an electric shock. (p 656)
17. List the indications and contraindications for use of an automated external defibrillator (AED). (pp 656–657)
18. Discuss the reasons for early defibrillation. (pp 656–657)
19. Explain the circumstances that may result in inappropriate shocks from an AED. (p 657)
20. Explain the reason not to touch the patient, such as by delivering CPR, while the AED is analyzing the heart rhythm and delivering shocks. (p 657)
21. Describe AED maintenance procedures. (pp 657–659)
22. Explain the relationship of age to energy delivery. (p 659)
23. Explain the role of medical direction in the use of AEDs. (p 659)
24. Discuss the importance of practice and continuing education with the AED. (p 659)
25. Explain the need for a case review of each incident in which an AED is used. (p 659)
26. List quality improvement goals relating to AEDs. (p 659)
27. Discuss the procedures to follow for standard operation of the various types of AEDs. (pp 659–661)
28. Describe the emergency medical care for the patient with cardiac arrest. (pp 659–665)
29. Describe the components of patient care following AED shocks. (pp 661–663, 665)
30. Explain criteria for transport of the patient for advanced life support (ALS) following CPR and defibrillation. (pp 663–664)

31. Discuss the importance of coordinating with ALS personnel. (pp 664–665)

Skills Objectives

1. Describe the steps to take in the assessment of a patient with chest pain or discomfort. (pp 642–647)
2. Demonstrate how to provide emergency medical care for a patient with chest pain or discomfort. (pp 647–649)
3. Demonstrate the administration of nitroglycerin. (pp 648–649, Skill Drill 16-1)
4. Demonstrate how to attach a cardiac monitor to obtain an ECG. (pp 651–652, Skill Drill 16-2)
5. Demonstrate how to perform maintenance of an AED. (pp 657–659)
6. Demonstrate how to perform CPR. (pp 660–663, Skill Drill 16-3)
7. Demonstrate the use of an AED. (pp 660–663, Skill Drill 16-3)

Introduction

The American Heart Association reports that cardiovascular disease claimed 786,641 lives in the United States in 2011. This is 31.3% of all deaths, or approximately 1 of every 3 deaths. Although this is a decline from previous years, heart disease has been the leading killer of Americans since 1900.

It is important for EMS providers to understand that many deaths caused by cardiovascular disease occur because of problems that may have been avoided by people living more healthful lifestyles and by access to improved medical technology. We can help to reduce the number of deaths with better public awareness, early access to medical care, increased numbers of laypeople trained in cardiopulmonary resuscitation (CPR), increased use of evolving technology in dispatch and cardiac arrest response, public access to defibrillation devices, the recognition of the need for advanced life support (ALS) services and use of cardiac specialty centers when they are available.

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

Anatomy and Physiology

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 16-1**. 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 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

YOU are the Provider PART 1

You and your partner are returning to your station after completing a call when you are dispatched to 1152 Blanco Road for a 60-year-old woman with chest pain. Dispatch advises you that the patient's son, who called 9-1-1, stated that she has a history of heart problems. You proceed to the scene, which is approximately 5 minutes away. The time is 0942 hours, traffic is light, the weather is clear, and the temperature is 80°F (27°C).

1. What is the function of the heart?
2. What does the heart require to function effectively?
3. What should you include in your primary assessment of a patient with cardiac problems?

Figure 16-2A. Blood from the vena cava enters the right atrium, which then fills the right ventricle. After contraction of the right ventricle, blood flows into the pulmonary artery and the pulmonary circulation in the lungs, where the blood is oxygenated. As the blood reaches the lungs, it receives fresh oxygen from the alveoli and carbon dioxide waste is removed from the blood and moved into the alveoli. The blood then returns to the heart through the pulmonary veins. The left side of the heart receives oxygen-rich (oxygenated) blood from the lungs through the pulmonary veins **Figure 16-2B**. Blood enters the left atrium and then passes into the left ventricle. The left ventricle is more muscular than the right ventricle because it must pump blood into the aorta to supply all the other arteries of the body.

The heart contains more than muscle tissue. The heart's electrical system controls heart rate and enables the atria and ventricles to work together **Figure 16-3**.

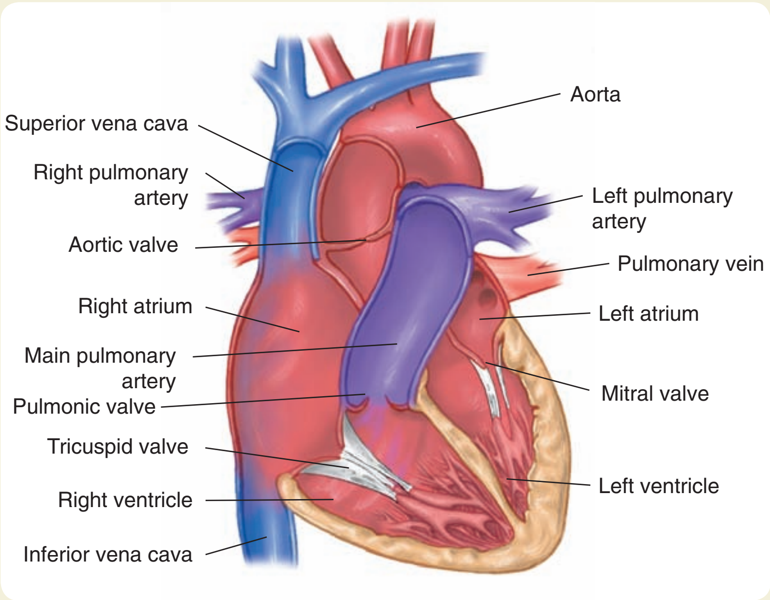


Figure 16-1 The heart is a four-chambered muscle that pumps blood to all parts of the body.

© Jones & Bartlett Learning.

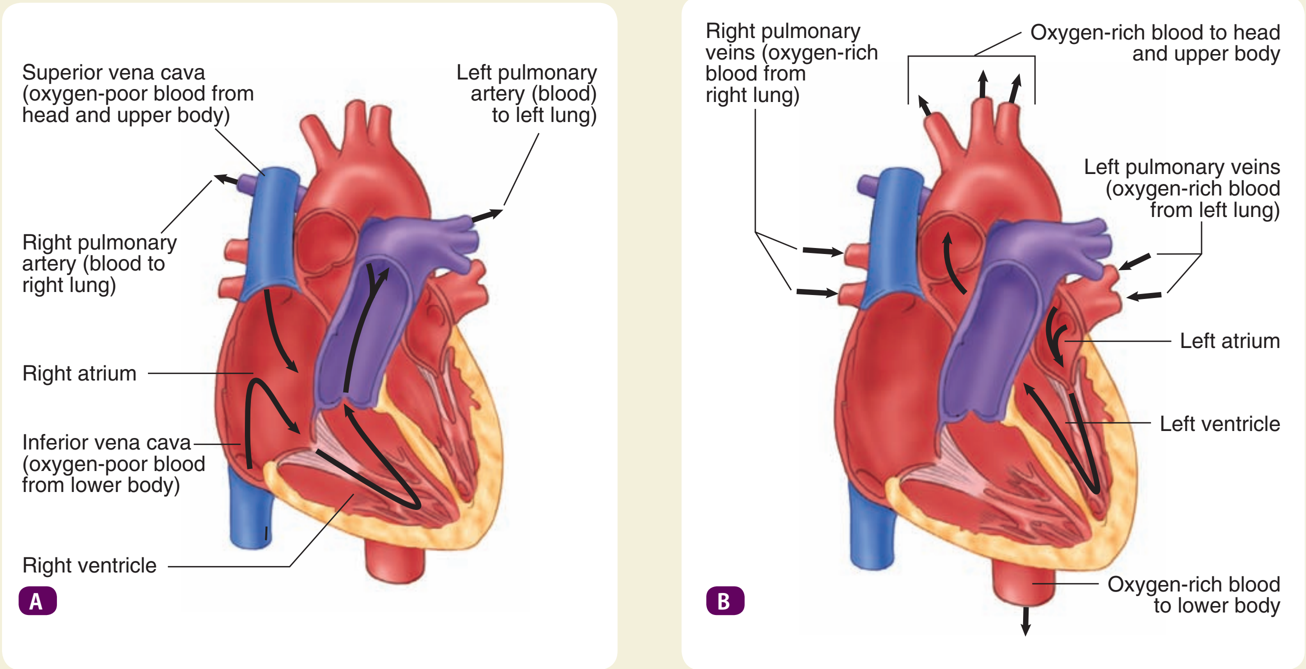


Figure 16-2 **A.** The right side of the heart receives oxygen-poor blood from the venous circulation. **B.** The left side of the heart receives oxygen-rich blood from the lungs through the pulmonary veins.

A, B: © Jones & Bartlett Learning.

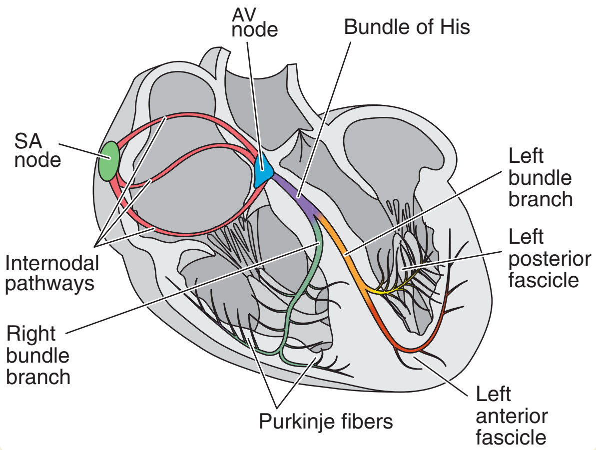


Figure 16-3 The electrical conduction system of the heart controls most aspects of heart rate and enables the four chambers to work together.

© Jones & Bartlett Learning.

Normal electrical impulses begin in the sinus node, which is in the upper part of the right atrium and is also known as the sinoatrial (SA) node. The impulses travel across both atria, stimulating them to contract. Between the atria and the ventricles, the impulses cross a bridge of special electrical tissue called the atrioventricular (AV) node. Here, the signal is slowed for about one- to two-tenths of a second to allow blood time to pass from the atria to the ventricles. The impulses then exit the atrioventricular node and spread throughout both ventricles via the bundle of His, the right and left bundle branches, and the Purkinje fibers, causing the ventricular muscle cells to contract.

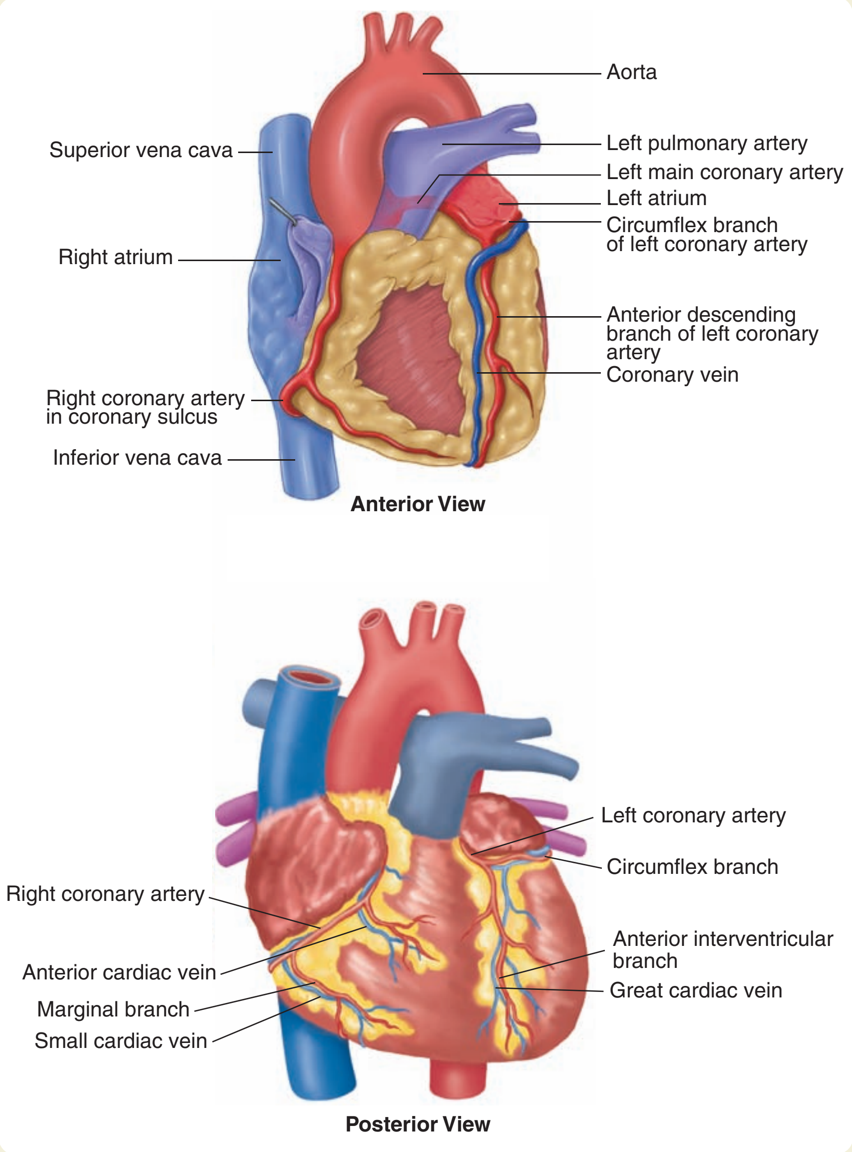
Cardiac muscle cells have a special characteristic called **automaticity** that is not found in any other type of muscle cells. Automaticity allows a cardiac muscle cell to contract spontaneously without a stimulus from a nerve source. Normal impulses in the heart start at the sinoatrial node. As long as impulses come from the sinoatrial node, the other myocardial cells will contract when the impulse reaches them. If no impulse arrives, however, the other myocardial cells are capable of creating their own impulses and stimulating a contraction of the heart, although at a generally slower rate.

The stimulus that originates in the sinoatrial node is controlled by impulses from the brain, which arrive by way of the **autonomic nervous system**. The autonomic nervous system is the part of the brain that controls the functions of the body that do not require conscious thought, such as the heartbeat, respirations, dilation and constriction of blood vessels, and digestion of food. The autonomic nervous system has two parts, the **sympathetic nervous system** and the **parasympathetic nervous system**. The sympathetic nervous system is also known as the "fight-or-flight" system and makes adjustments to the body to compensate for increased physical activity. The sympathetic nervous system speeds up the heart rate, increases respiratory rate and depth, dilates blood vessels in the muscles, and constricts blood vessels in the digestive system. The parasympathetic nervous system directly opposes the sympathetic nervous system. The parasympathetic nervous system slows the heart and respiratory rates, constricts blood vessels in the muscles, and dilates blood vessels in the digestive system. Normally, these two systems balance each other, but in times of stress, the sympathetic nervous system gains primary control, whereas in times of relaxation, the parasympathetic system takes control.

▶ 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. The heart must increase cardiac output to meet the increased metabolic requirements of the body. Cardiac output is increased by increasing the heart rate or stroke volume. The **stroke volume** is the volume of blood ejected with each ventricular contraction. In the normal heart, increased oxygen demand of the myocardium itself is 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 16-4**. They start at the first part of the aorta, just above the **aortic valve**. The right coronary artery supplies blood to the right atrium and right ventricle and, in most people, the bottom part, or inferior wall, of the left ventricle. The left coronary artery supplies blood to the left atrium and left ventricle and divides into two major branches, just a short distance from the aorta.

Two major arteries branching from the upper aorta supply blood to the head and arms **Figure 16-5**. The right and left carotid arteries supply the head and brain with blood. The right and left 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



Anterior View

Posterior View

Figure 16-4 The coronary arteries carry the blood supply to the heart.

© Jones & Bartlett Learning.

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 lower arms and hands.

At the level of the umbilicus, 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 arteries and the peroneal artery, supplying blood to the lower legs and feet.

After blood travels through the arteries, it enters smaller and smaller vessels called arterioles and eventually enters the capillaries. 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. As the blood passes through the capillaries, it gives up oxygen to the tissues and picks up carbon dioxide and other waste products to be removed from the body.

Venules are the smallest branches of veins. After traveling through the capillaries, oxygen-poor 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 superior vena cava and the inferior 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.

Blood consists of fluid and several types of cells **Figure 16-6**. Red blood cells are the most numerous and give the blood its color. Red blood cells carry oxygen to the body's tissues and 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 force of circulating blood against the walls of the arteries. Systolic blood pressure is the maximum pressure generated in the arms and legs during the contraction of the left ventricle, during the time period known as systole. As the left ventricle relaxes in the stage known as

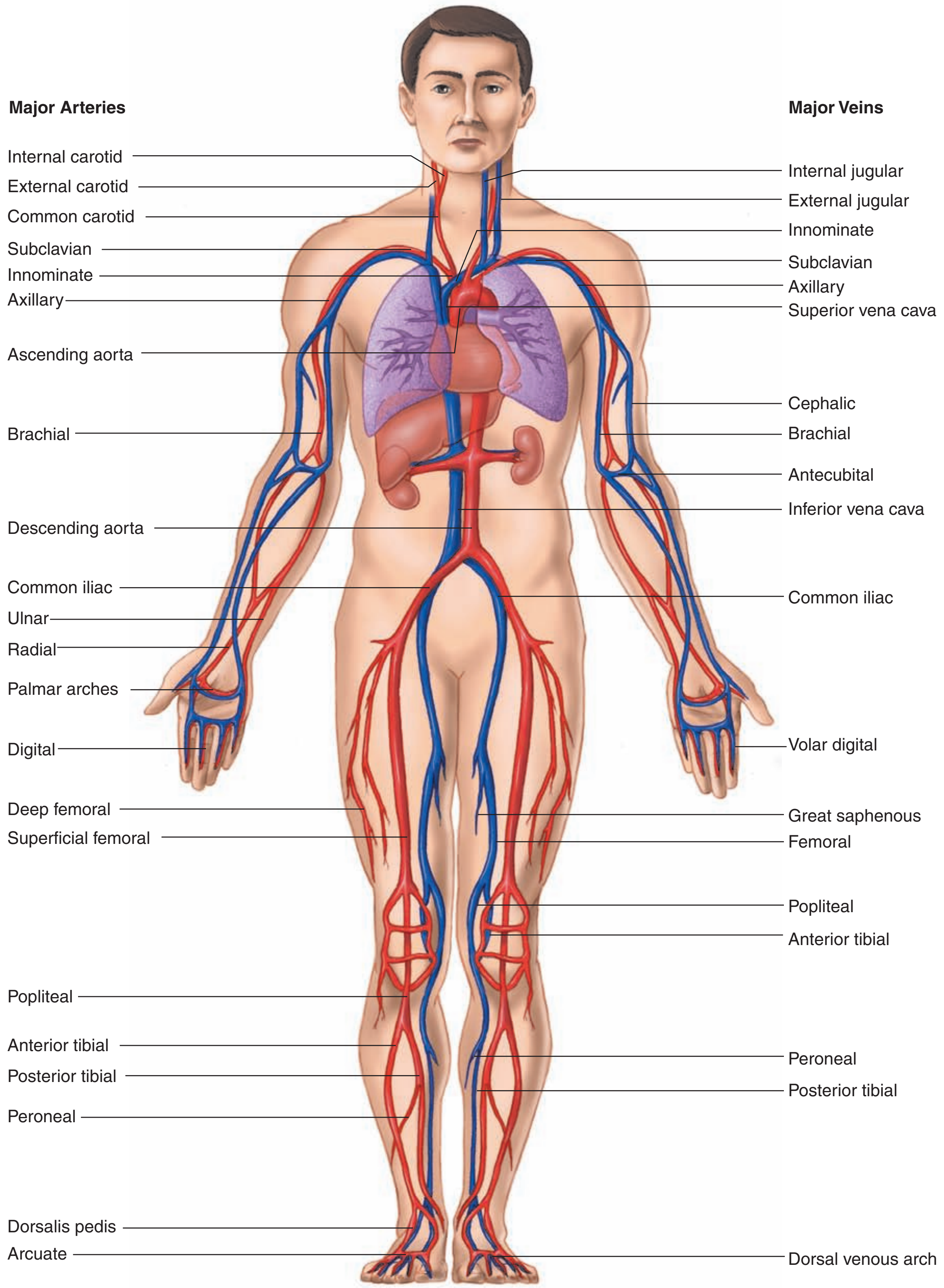


Figure 16-5 The major arteries of the body carry oxygen-rich blood to all parts of the body. The major veins of the body carry deoxygenated blood back to the heart.

© Jones & Bartlett Learning.

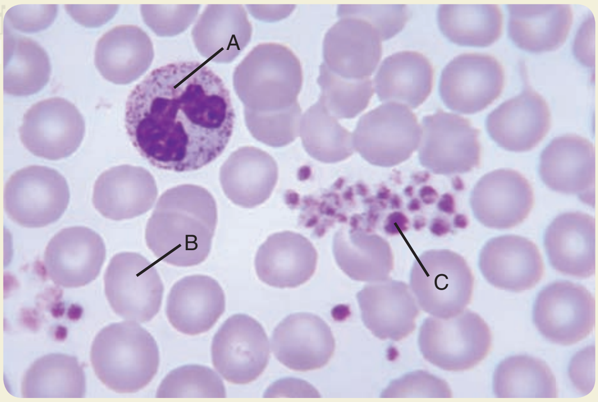


Figure 16-6 Blood consists of fluid and several types of cells, including red blood cells (B), white blood cells (A), and platelets (C).

© Carolina Biological Supply, Co/Visuals Unlimited.

diastole, the arterial pressure falls. When the left ventricle relaxes, the aortic valve closes and blood flow between the left ventricle and the aorta 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. The cardiac cycle consists of one systolic and one diastolic time period.

As the blood passes through an artery during systole, a pulse is generated. This pulse can be felt by placing a finger on the skin over the artery at a point where the artery lies near the skin surface and gently compressing. Pulses felt in the extremities, such as the radial and the posterior tibial, are called peripheral pulses, whereas pulses near the trunk of the body, such as the femoral and carotid pulses, are known as central pulses.

The rate of cardiac contractions can be increased or decreased by the autonomic nervous system. The heart also has the ability to increase or decrease the volume of blood it pumps with each contraction based on the autonomic nervous system response. To obtain an accurate measure of the efficiency of the heart, we have to measure the volume of blood pumped and the heart rate. This is determined by calculating the cardiac output. The **cardiac output** is calculated by multiplying the heart rate by the volume of blood ejected with each contraction, or the stroke volume. This is the volume of blood that passes through the heart in 1 minute and is the best measure of the output of the heart. In the field, we have no way of directly measuring the volume of blood being pumped; therefore, we must rely on the heart rate and the strength of the pulse to estimate the cardiac output.

The constant flow of oxygenated blood to the tissues is known as **perfusion**. Good perfusion requires three primary components. The first is a well-functioning heart, or "pump." The heart must operate

Words of Wisdom

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 near the surface of the skin. This wave of blood is called the pulse. The evaluation of a patient's pulse is important in the assessment and treatment of cardiovascular emergencies. EMTs should be skilled at finding multiple pulse points and should compare proximal and distal pulses bilaterally, when applicable, to determine any differences in quality or strength that could indicate the patient's condition is progressing to decompensated shock.

Common places to feel for a pulse include the following **Figure 16-7**:

- The carotid pulse can be felt in the neck by placing two fingertips in the center of the throat on the windpipe, and then sliding them towards you into the groove between the trachea and the neck muscle. Do not assess both carotid pulses at the same time as this could greatly reduce blood flow to the brain.
- The femoral pulse can be felt in the groin at the crease dividing the lower abdomen from the leg.
- The brachial pulse can be felt on the medial aspect of the elbow at the level of the crease. This is the pulse that you listen for when you take blood pressure. Pulsations also can be palpated on the medial side of the arm midway between the elbow and armpit.
- The radial pulse can be felt on the thumb side of the wrist, about one fingerbreadth above the wrist crease.
- The posterior tibial pulse can be felt on the inside of the ankle, just behind the medial malleolus. The medial malleolus is the bony bump at the bottom end of the tibia.
- The dorsalis pedis pulse can be felt at the top of the foot. This artery is not in the same place in all people. To find the 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 16-7 Common pulse points. **A.** The carotid pulse is felt in the neck. **B.** The femoral pulse is felt in the groin area. **C.** The brachial pulse is felt on the inside of the upper arm. **D.** The radial pulse is felt on the thumb side of the wrist. **E.** The posterior tibial pulse is felt on the inside of the ankle. **F.** The dorsalis pedis pulse is felt on the top of the foot.

A, B, C, D, E, F: © Jones & Bartlett Learning.

at an appropriate rate because a rate that is too slow or too fast will reduce the volume of blood circulated and, thus, reduce the cardiac output. When the heart beats too rapidly, there is not enough time between contractions for the heart to refill completely, and when the heart beats too slowly, the volume of blood circulated per minute decreases due to the slow pulse rate. The second component of good perfusion is an adequate volume of "fluid," or blood. If there is blood loss through hemorrhage, the reduced volume will limit the amount of tissue that can be perfused. Third, the blood must be carried in a properly sized "container." This means that the blood vessels must be appropriately constricted to match the volume of blood available so that circulation can occur without problems. If the blood vessels dilate, thereby increasing the size of the

Words of Wisdom

Cardiac Output = Heart Rate × Stroke Volume

Cardiac output is the amount of blood pumped out of the left ventricle in 1 minute.

Heart rate is the number of times the heart contracts in 1 minute.

Stroke volume is the volume of blood pumped out by the left ventricle in one contraction.

Stroke volume is affected by preload, afterload, and contractility. Preload is related to the venous return to the right atrium. Afterload is associated with systemic vascular resistance, which is a function of the constriction of the systemic blood vessels. As the blood vessels constrict, it is harder for the ventricle to push the blood into them. Contractility refers to how forcefully the heart contracts.

container, and the volume of fluid remains the same, there will not be enough blood to fill the blood vessels and perfusion will be reduced. If there is a problem with the functioning of the heart, the functioning of the blood vessels, or the volume of blood, perfusion will fall, which will lead to cellular death and, eventually, death of the patient.

Pathophysiology

Chest pain or discomfort that is related to the heart usually stems from a condition called **ischemia**, which is decreased blood flow, in this case, to the heart. Because of a partial or complete blockage of blood flow through the coronary arteries, heart tissue fails to get enough oxygen and nutrients. 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 16-8**. 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 trace of cholesterol is deposited on the inside of an artery. This may happen as early as the teenage years. As a person ages, more 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 during times of maximum need.

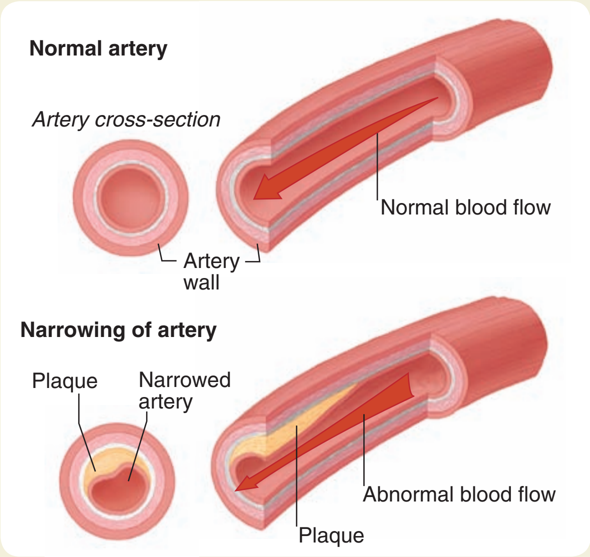


Figure 16-8 In atherosclerosis, calcium and cholesterol build up inside the walls of the coronary blood vessels, causing an obstruction in blood flow to the heart.

© Jones & Bartlett Learning.

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 when an injury has caused bleeding. In this situation, however, the resulting blood clot will partially or completely block the lumen of the artery. If it does not occlude the artery at that location, the blood clot may break loose and begin floating in the blood, becoming what is known as a thromboembolism. A **thromboembolism** is a blood clot that is floating through blood vessels until it reaches an area too narrow for it to pass, causing it to stop and block the blood flow at that point. Tissues downstream from the blood clot will have a lack of oxygen (hypoxia). If blood flow is resumed in a short time, the hypoxic tissues will recover. However, if too much time goes by before blood flow is resumed, the hypoxic tissues will die. If a blockage occurs in a coronary artery, the condition is known as an **acute myocardial infarction (AMI)**,

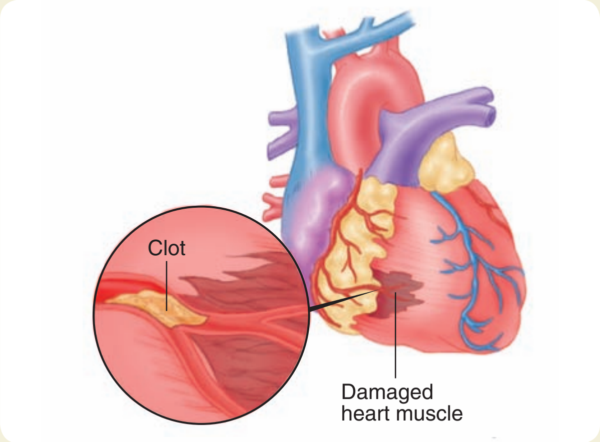


Figure 16-9 An acute myocardial infarction (heart attack) occurs when a blood clot prevents blood flow to an area of the heart muscle. If left untreated, death of heart tissue can result.

© Jones & Bartlett Learning.

a classic heart attack **Figure 16-9**. **Infarction** means the death of tissue. The same sequence may also cause the death of 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 cause it to stop completely (**cardiac arrest**).

In the United States, coronary artery disease is the number one cause of death for men and women. The peak incidence of heart disease occurs between ages 45 and 64 years, but it can also strike teens and people in their 90s. You must be alert to the possibility that, although less likely, a 26-year-old with chest pain could actually be having an AMI, especially if he or she has a higher than usual risk.

Factors that place a person at higher risk for an AMI are called risk factors. The major controllable factors are cigarette smoking, high blood pressure, elevated cholesterol level, elevated blood glucose level (diabetes), lack of exercise, and obesity. The major risk factors that cannot be controlled are older age, family history of atherosclerotic coronary artery disease, race, ethnicity, and male sex. Lesser factors that play a role in heart disease are stress, excessive alcohol, and poor diet.

▶ Acute Coronary Syndrome

Many patients who call for EMS assistance because of chest pain have acute coronary syndrome. **Acute coronary syndrome**, also called ACS, is a term used to describe a group of symptoms caused by myocardial ischemia. As discussed earlier, myocardial ischemia is a decrease in blood flow to the heart, which leads to chest pain through reduction of oxygen and nutrients to the tissues of the heart. This can be a temporary situation known as angina pectoris, or a more serious condition, an AMI. Because the signs and symptoms of these two conditions are very similar, they are treated basically the same under the designation of acute coronary syndrome. To understand them better, we will look at each one separately.

Angina Pectoris

Chest pain does not always mean that a person is having an AMI. When, for a brief time, heart tissues are not getting enough oxygen, the pain is called **angina pectoris**, or angina. Although angina can result from a spasm of an 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.

Anginal pain is commonly described as crushing, squeezing, or "like somebody standing on my chest." It is usually felt in the mid portion of the chest, under the sternum. However, it can radiate to the jaw, the arms (frequently the left arm), the midportion of the back 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 usually disappears promptly with rest, supplemental oxygen, or nitroglycerin (NTG), all of which decrease the need or 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 take seriously. Even with angina, because the 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 or discomfort in the chest of coronary origin that occurs in response to progressively less exercise or fewer stimuli than ordinarily required to produce angina. If untreated, it can lead to AMI. 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 difficult, even for physicians in hospitals, to distinguish between the pain of angina and the pain of an AMI. Patients experiencing chest pain or discomfort, therefore, should always be treated as if they are having an AMI.

Acute Myocardial Infarction

The pain of an AMI signals the actual death of cells in the area of the heart muscle 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 arterial 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 "clot-busting" (thrombolytic) medications or angioplasty (mechanical clearing of the artery) can prevent permanent damage to the heart muscle if done within the first few hours after the onset of symptoms. Therefore, immediate prehospital treatment and transport to the emergency department (ED) are essential.

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

Signs and Symptoms of Acute Myocardial Infarction. A patient with an AMI may show any of the following signs and symptoms:

- Sudden onset of weakness, nausea, and sweating without an obvious cause
- Chest pain, discomfort, or pressure that is often crushing or squeezing and that does not change with each breath
- Pain, discomfort, or pressure in the lower jaw, arms, back, abdomen, or neck
- Irregular heartbeat and syncope (fainting)
- Shortness of breath, or dyspnea
- Nausea/vomiting
- Pink, frothy sputum (indicating possible pulmonary edema)
- Sudden death

The Pain of Acute Myocardial Infarction. 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 occurs. 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 want to face the possibility that their symptoms may be serious (cardiac denial). Middle-aged men, in particular, are likely to minimize their symptoms. However, some patients, particularly older people, women, and people with diabetes, do not experience any pain during an AMI but 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 patients and women, to be fatigue. AMI without the classic chest pain is often referred to as a silent MI. Heart disease is the number one killer of women in the United States, and EMTs should consider AMI even when the classic symptom of chest pain is not present. This is also true for older people and people with diabetes.

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. Patients with cardiac risk factors should also be carefully assessed if they have any of the associated symptoms, even if no chest pain is present. 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 Acute Myocardial Infarction and Cardiac Compromise. The physical findings of AMI vary, depending on the extent and severity of heart muscle damage. The following are common:

- **General appearance.** The patient often appears frightened. There may be nausea, vomiting, and a cold sweat. The skin is often pale or 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.
- **Pulse.** Generally, the pulse rate increases as a normal response to pain, stress, fear, or actual injury to the myocardium. Because dysrhythmias are common in an AMI, you may feel an irregularity or even a slowing of the pulse. The pulse may also be dependent on the area of the heart that has been affected by the AMI. Damage to the inferior area of the heart often presents with bradycardia.

Words of Wisdom

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 (Onset, Provocation/Palliation, Quality, Radiation, Severity, Time of onset).

- **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 an AMI will have a normal or, possibly, elevated blood pressure.
- **Respiration.** The respiratory rate is usually normal unless the patient has CHF. In that case, respirations may become rapid and labored with a higher likelihood of cyanosis and possibly frothy sputum. A complaint of difficulty breathing is common with cardiac compromise, so even if the rate seems normal, look at the work of breathing, and treat the patient as if respiratory compromise were present.
- **Mental status.** Patients with AMIs often experience confusion or agitation and 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 Acute Myocardial Infarction. An AMI can have three serious consequences:

- Sudden death
- Cardiogenic shock
- Congestive heart failure

Sudden Death. Approximately 40% of all patients with an AMI do not reach the hospital alive. Sudden death is usually the result of cardiac arrest, in which the heart fails to generate 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 any blood. Such an abnormality of heart rhythm is a ventricular **dysrhythmia**, known as ventricular fibrillation.

A variety of other lethal and nonlethal dysrhythmias may follow an AMI, usually within the first hour. In most cases, premature ventricular contractions, or extra beats in the damaged ventricle, occur. Premature ventricular contractions by themselves may be harmless and are common among healthy people, as well as sick people. Other dysrhythmias can be much more dangerous. These include the following

- **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**. 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 beats for the left ventricle to fill with blood. Therefore, the patient's blood pressure may fall, and the pulse may be lost altogether. The patient may also feel weak or light-headed or may even become unresponsive. In some cases, existing chest pain may worsen or chest pain that was not there before onset of the dysrhythmia may develop. Most cases of ventricular tachycardia will be sustained and may deteriorate into ventricular fibrillation.
- **Ventricular fibrillation** (V fib). 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 convert this dysrhythmia is to defibrillate the heart. To **defibrillate** means to shock the heart with a specialized electric current in an attempt to stop the chaotic, disorganized contraction of the myocardial cells and allow them to start again in a synchronized manner 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 at the time of collapse, chances of survival diminish approximately 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, asystole may occur within minutes. Asystole usually reflects a long period of ischemia, and nearly all patients you find in asystole will die.

▶ Cardiogenic Shock

Shock is a simple concept but one that few people without medical training really understand. For that reason, Chapter 12 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.

Shock is 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 is more commonly found in an AMI that affects the inferior and posterior regions of the left ventricle of the heart because this provides circulation to the majority of the body. 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 likely to be successful.

▶ Congestive Heart Failure

Failure of the heart occurs when the ventricular heart muscle is so permanently 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, in the setting of heart valve damage, or as a consequence of long-standing high blood pressure. Any condition that weakens the pumping strength of the heart may cause CHF and this often 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, CHF eventually develops. It is called "congestive" heart failure because the lungs become congested with fluid once the left side of 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

YOU are the Provider PART 2

You arrive at the scene and are escorted by the patient's son to her bedroom. She is sitting up in bed with her fist clutched against her chest. She is conscious and alert, but is notably anxious. Her skin is pale and diaphoretic. Your partner opens the jump kit as you assess the patient.

Recording Time: 0 Minutes	
Appearance	Anxious; notably diaphoretic
Level of consciousness	Conscious and alert
Airway	Open; clear of secretions and foreign bodies
Breathing	Increased respiratory rate; adequate depth
Circulation	Radial pulse, rapid and irregular; skin, pale and diaphoretic

After confirming that she has not taken any medication and that she is not allergic to any medications, you give the patient four 81-mg aspirins to chew and swallow according to your protocols. As you continue your assessment and further inquire about her medical history, your partner applies the pulse oximeter, which shows that the patient's oxygen saturation is 91%. Based on this he applies oxygen via nasal cannula at 4 L/min and prepares to take her vital signs. She tells you that she had a heart attack 3 years ago; has high blood pressure; and takes enalapril (Vasotec), nitroglycerin, and one aspirin per day.

4. Why is aspirin given to patients with an acute cardiac event?
5. What type of medication is nitroglycerin? How may it help relieve chest pain, pressure, or discomfort?
6. When is nitroglycerin indicated for a patient? What is the typical dose?

Words of Wisdom

Cardiogenic 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 report "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, cool, 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. As the shock progresses, the pulses may become irregular and weak.
- Shock can also present with 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. It is very important though not to assume that shock is not present just because the blood pressure is normal (compensated shock).

Treatment of Cardiogenic Shock

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

1. Position the patient comfortably. Some patients will be more comfortable in a semi-Fowler position (head and knees slightly elevated); however, patients with low blood pressure may not tolerate a semi-upright position but may be more comfortable and more alert in a supine position.
2. Administer high-flow oxygen.
3. Assist ventilations as necessary.
4. Cover the patient with sheets or blankets as necessary to preserve body heat. Be sure to cover the top of the patient's head in very cold weather, as this is where much heat is lost.
5. Provide prompt transport to the ED.

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 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 (backup of fluid).
- The patient generally will have high blood pressure, a 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.
- Skin is usually pale or cyanotic and sweaty.
- 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 CHF, these soft sounds can be heard even at the top of the lung.

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

Treatment of Congestive Heart Failure

Treat a patient with CHF the same way as a patient with chest pain:

1. Take the vital signs, and give oxygen by nonrebreathing mask with an oxygen flow of 10 to 15 L/min. Medical control may, either by protocol or in response to your request, order the use of continuous positive airway pressure (CPAP) to move some of the fluid out of the lungs to provide better oxygenation.
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 feel as if 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 in reducing pulmonary edema if the patient's systolic blood pressure is more than 100 mm Hg. 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 ED is essential.

the walls of the capillary vessels and into the alveoli. This condition is called pulmonary edema. It may occur suddenly, as in an AMI, or slowly over months, as in chronic CHF. Sometimes, in patients with an acute onset of CHF, severe pulmonary edema will develop, 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 up as swelling 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. Since the right side of the heart supplies the preload for the left side of the heart, right heart failure can result in an inadequate supply of blood to the left ventricle resulting in a drop in the systemic blood pressure. It is important to realize that some patients may present with signs of both left-sided and right-sided heart failure because left-sided failure often leads to right-sided failure.

Hypertensive Emergencies

Hypertension is defined as any systolic blood pressure greater than 140 mm Hg or a diastolic blood pressure greater than 90 mm Hg. Another cardiac-related condition is a hypertensive emergency. A **hypertensive emergency** usually occurs only with a systolic pressure greater than 180 mm Hg or a rapid rise in the systolic pressure. Because patients do not feel their blood pressure, the signs and symptoms of hypertensive emergency are related to the effects of the hypertension. Some patients with chronic hypertension may not experience signs or symptoms until their systolic pressure is significantly higher than this value. One of the most common signs is a sudden severe headache. If described as "the worst headache I have ever felt," this may also be a sign of cerebral hemorrhage. Other signs and symptoms include strong bounding pulse, ringing in the ears, nausea and vomiting, dizziness, warm skin (dry or moist), nosebleed, altered mental status, and even the sudden development of pulmonary edema. Untreated hypertensive emergencies can lead to a stroke or a dissecting aortic aneurysm.

If you suspect your patient is experiencing a hypertensive emergency, attempt to make him or her comfortable and monitor the blood pressure regularly. Position the patient with the head elevated, and transport rapidly to the ED. Depending on the distance and time involved in transport, you should consider ALS assistance for the patient. Paramedics may be able to administer medications to lower the blood pressure to a safer level. If ALS personnel can be on the scene quickly, contact them early and allow them to transport the patient from the scene. If the transport distance is long, consider asking for an ALS unit to meet you along the way and take over patient care and transportation from that point. Remember that getting the patient with a hypertensive emergency to the hospital as quickly and safely as possible is the best prehospital treatment you can provide.

An **aortic aneurysm** is a weakness in the wall of the aorta. The aorta dilates at the weakened area, which makes it susceptible to rupture. A **dissecting aneurysm** occurs when the inner layers of the aorta become separated, allowing blood (at high pressures) to flow between the layers. Uncontrolled hypertension is the primary cause of dissecting aortic aneurysms. This separation of layers weakens the wall of the aorta significantly, making it more likely to be ruptured under conditions of continued high blood pressure. If the aorta ruptures, the amount of internal blood loss will be so large that the patient will die almost immediately. The signs and symptoms of a dissecting aortic aneurysm include very sudden chest pain located in the anterior part of the chest or in the back between the shoulder blades. It may be difficult to differentiate the chest pain of a dissecting aortic aneurysm from that of an AMI, but a number of distinctive features may help. The pain from an AMI is often preceded by other symptoms—nausea, indigestion, weakness, and sweating—and tends to come on gradually, getting more severe with time and often described as "pressure" rather than "stabbing." By contrast, the pain of a dissecting aortic aneurysm usually comes on full force from one minute to the next Table 16-1. A patient with a dissecting aortic aneurysm also may exhibit a difference in blood pressure between arms or diminished pulses in the lower extremities. Aortic aneurysms are almost impossible to diagnose in the prehospital setting, but you must consider them a possibility in any patient with significant hypertension. Transport the patient without delay.

Patient Assessment

While en route to the scene, consider the standard precautions that will be needed. The precautions can be as simple as gloves for a patient with chest pain or full precautions for a patient in cardiac arrest. Remember, the patient's condition can change rapidly between the time you are dispatched and your arrival.

Table 16-1 AMI Versus Dissecting Aortic Aneurysm

	AMI	Dissecting Aneurysm
Onset of pain	Gradual, with additional symptoms	Abrupt, without additional symptoms
Quality of pain	Tightness or pressure	Sharp or tearing
Severity of pain	Increases with time	Maximal from onset
Timing of pain	May wax and wane	Does not abate once it has started
Region/radiation	Substernal; back is rarely involved	Back possibly involved, between the shoulder blades
Clinical signs	Peripheral pulses equal	Blood pressure discrepancy between arms or decrease in a femoral or carotid pulse

© Jones & Bartlett Learning.

Scene Size-up

Do not let your guard down on medical calls. Always ensure that the scene is safe for all. As you approach the scene, look for and address any hazards. Determine the necessary standard precautions and whether you will need additional resources.

Identification of the nature of illness is important to start your patient assessment in the right direction. Use the information you get from the dispatcher, clues at the scene, and comments of bystanders or family members to begin to develop an idea about the type of problem your patient might be experiencing. For patients with cardiac problems, the clues often include a report of chest pain, difficulty breathing, or sudden loss of consciousness. Once you establish a preliminary nature of illness, you will be able to guide your assessment to find the important information much more effectively. Just remember not to become fixated on a specific condition at this early point in the assessment; sometimes the situation turns out to be very different from how it initially appeared.

Primary Assessment

As you approach the patient, form a general impression of his or her condition to recognize and address life threats. You will likely begin by determining whether the patient is responsive. Perform a primary assessment of the patient. If the patient is unresponsive and is not breathing, begin CPR, starting with chest compressions, and call for an AED. Use of the AED is discussed in the section on cardiac arrest later in this chapter. Generally, an AED should be applied if the patient is pulseless, not breathing (apneic), and unresponsive. Consider calling for ALS backup if possible.

Once you have formed a general impression, the next step in the primary assessment is to assess airway and breathing. Unless the patient is unresponsive, the airway will most likely be patent. Responsive patients should be able to maintain their own airway. Some episodes of cardiac compromise may produce dizziness or even fainting spells (syncope). If dizziness or fainting has occurred, consider the possibility of a spinal injury 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. If the rate is too fast or too slow, the depth of respiration seems to be too shallow, or the patient is struggling to breathe, respirations are inadequate. Listen for abnormal breath sounds at this time because these can also be important indicators of respiratory distress. Some patients feel shortness of breath even though there are no obvious signs of respiratory distress. Pulse oximetry is a valuable tool in treatment of respiratory distress and should be applied at this time. If the patient is having chest pain and their oxygen saturation is less than 95%, administer oxygen at 4 L/min via a nasal cannula. If they do not improve quickly, increase the oxygen concentration. Apply a nonrebreathing mask at 15 L/min. In general, the goal is to maintain the oxygen saturation level between 95% and 99%. If the patient is not breathing or has inadequate breathing, ensure adequate ventilations with a bag-valve mask (BVM) and 100% oxygen.

Patients experiencing pulmonary edema may require positive-pressure ventilation with a BVM or

CPAP. CPAP is the most effective way to assist a person with CHF to breathe effectively and prevent an invasive airway management technique. Be aware of the indications and contraindications of CPAP and be competent in utilizing this equipment.

After assessing airway and breathing, assess the patient's circulation. Determine the rate and quality of the patient's pulse. Is the pulse rhythm regular or irregular? Is the pulse too fast or too slow? If you find abnormalities in the pulse, you should be more suspicious. Assess the patient's skin condition, color, moisture, and temperature, as well as the capillary refill time. Changes in perfusion may indicate more serious cardiac compromise. Consider 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.

Make a transport decision based on whether you were able to stabilize life threats during the primary assessment. The remainder of the assessment can be performed en route, if time allows. Generally speaking, most patients with chest pain should be transported immediately. Whether to transport using the lights and siren is determined for each specific patient and may be partially based on the estimated transport time. As a general rule, however, patients with cardiac problems should be transported in the most gentle, stress-relieving manner possible. You will save very little time 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 easy. 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 cardiac specialty centers with certain capabilities, such as cardiac catheterization or targeted temperature management after resuscitation from cardiac arrest. Others require the patient to be transported to the nearest facility for stabilization before transporting to a specialty hospital. Be sure you know your local protocol.

Words of Wisdom

Athletes may have a slower (bradycardic or <60 beats/min) heart rate as a result of normal physiologic changes related to physical conditioning. Tachycardia (>100 beats/min) is a normal physiologic response to exercise to ensure adequate tissue perfusion. Pain, fear, and excitement may also cause a person to be tachycardic. It is important that you assess the patient to determine whether a bradycardic or tachycardic heart rate is appropriate for the patient.

History Taking

Once you have stabilized life threats, you will want to determine and investigate the chief complaint and know more about the history of the present illness. For a conscious medical patient, begin with taking a brief past history, identifying associated signs and symptoms, and identifying pertinent negatives. Friends or family members who are present often have helpful information.

Remember that not all patients experiencing an AMI have the same signs and symptoms. 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 experience restlessness, appear anxious, and perhaps have a sense of 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 responders, 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 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."

Begin by asking questions about the current situation. Determine whether the patient is experiencing chest pain or discomfort and whether there are any other signs and symptoms. Determine whether the patient is having respiratory difficulty because this is common among patients with chest pain.

If the patient is experiencing dyspnea, find out whether it is related to exertion and whether it is related to the patient's position. Often patients with chest pain experience worse difficulty breathing when they are lying down. Also determine whether the dyspnea is continuous or if it changes, especially with deep breathing. Note whether the patient has a cough and whether the cough produces sputum. Ask about other signs and symptoms that are commonly found such as nausea and vomiting, fatigue, headache, and palpitations (a feeling of the heart skipping a beat or racing). Make sure to ask about any trauma the patient might have experienced during the last few days. Be sure to record your findings, including those that are negative (known as pertinent negatives).

If the patient is responsive, obtain the SAMPLE history and ask the following questions specific to a cardiovascular emergency:

- Have you ever had a heart attack?
- Have you been told that you have heart problems?
  - Have you ever been diagnosed with angina, heart failure, or heart valve disease?
  - Have you ever had high blood pressure?
  - Have you ever been diagnosed with an aneurysm?
  - Do you have any respiratory diseases such as emphysema or chronic bronchitis?
  - Do you have diabetes or have you ever had any problems with your blood sugar?
  - Have you ever had kidney disease?
- Do you have any risk factors for coronary artery disease, such as smoking, high blood pressure, or high-stress lifestyle?
  - Is there a family history of heart disease?
  - Do you currently take any medications?

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.

Make sure to ask about allergies because the patient will very likely be given medication in the hospital. If the patient is taking medications, determine whether they are prescribed, over the counter, and/or recreational drugs. 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 metoprolol (Toprol). Furosemide is a diuretic, digoxin increases the strength of heart contractions, and metoprolol lowers blood pressure. These medications are often prescribed together for patients with CHF and may alert you to carefully evaluate the lungs for the presence of

YOU are the Provider PART 3

The patient took two of her prescribed nitroglycerin tablets before her son called 9-1-1; however, she is still experiencing chest pain, which she rates as a 7 on a scale of 0 to 10. Your partner takes her vital signs as you perform a more focused examination, inquire about her past medical history, and prepare for further treatment.

Recording Time: 2 Minutes	
Respirations	20 breaths/min; adequate depth
Pulse	118 beats/min; strong and irregular
Skin	Pale, cool, and diaphoretic
Blood pressure	150/90 mm Hg
Oxygen saturation (Spo_2)	98% (on oxygen)

7. What is significant about the patient's vital signs?
8. Should you give her additional nitroglycerin? Why or why not?

crackles (rales), which indicate fluid in the lungs and a need to increase the amount of oxygen being delivered. When you ask about medical conditions next, be sure to ask whether the patient takes medications for any other condition he or she identifies. Also, if the patient tells you that he or she takes prescription medications, ask what condition these are taken for. Asking about the last oral intake may seem unnecessary, but this information can be very important; it is always better to have too much information rather than not enough. Also remember to ask about any home remedies the patient might have used because this information can be important too.

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 16-2**.

Secondary Assessment

Circumstances will dictate which aspects of the physical examination will be used. The secondary assessment of a conscious patient with chest pain or discomfort would likely focus on the patient's cardiac and respiratory systems.

The physical examination of a patient with chest pain begins with the cardiovascular system. Evaluate the patient's circulation by assessing pulses at various locations, and assess skin color, temperature, and condition. Is the skin cool or moist? How do the mucous membranes look? Are they pink, ashen, or cyanotic? Are the pulses of equal strength bilaterally? Does the patient have any edema in the extremities, especially the lower extremities? All of these physical findings can help identify poor circulation, which may be caused by a failure of the cardiovascular system.

In addition to the cardiovascular system, examine the respiratory system for signs of inadequate ventilation. These two systems are closely related, and cardiovascular issues can cause problems with the respiratory system. Are the lung sounds clear? Wet-sounding lungs indicate fluid is being moved into the lungs from the circulatory system, possibly because of a problem with the heart. Are the breath sounds equal? Are the neck veins distended? Is the trachea deviated, or is it midline? The answers to these questions can help determine whether a problem exists with the lungs or with the heart. While the physical examination is not usually as important as the history in a patient with a possible cardiac problem, it may produce important clues to the patient's condition.

Measure and record the patient's vital signs, including pulse, respirations, and blood pressure. You must obtain readings for systolic and diastolic blood pressures. Take blood pressure on both arms

Table 16-2 OPQRST Mnemonic for Assessing Pain

Onset	When did the problem begin, and what does the patient think may have caused it?
Provocation/palliation	Ask what makes the pain or discomfort better or worse. Is it positional? Does a deep breath or palpation of the chest make it worse? Did you take anything for it (including anything nonprescribed)?
Quality	Ask the patient to describe his or her pain. Let the patient use his or her own words to describe what is happening. If the patient is unable to describe the pain, try to avoid supplying 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?"
Region/radiation	Ask where the pain is located and whether the pain has spread 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; a 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 nitroglycerin, ask the patient to rate the pain again.
Timing	Find out how long the pain lasts when it is present and whether it has been intermittent or continuous.

© Jones & Bartlett Learning.

if time allows. If available, use pulse oximetry. Pulse oximetry may not give an accurate measurement if the patient has poor circulation, has been exposed to a toxic chemical, or is in cardiac arrest, but it should be used and the readings noted for all patients with possible cardiac problems.

If you have access to continuous blood pressure monitoring, be sure to use it as well, making sure you get an accurate manual blood pressure first. Repeat the vital signs at appropriate intervals, and use the settings on the automatic blood pressure monitoring machine to remind you when it is time to recheck and record the vital signs. Be sure to note the time that each set of vital signs is taken.

In patients with chest pain, it is very valuable to have a 12-lead ECG tracing from as early as possible after the onset of the pain. EMTs may assist with placing electrodes. This is discussed later in this chapter.

Reassessment

Repeat the primary assessment by checking to see whether the patient's chief complaint and condition have improved or are deteriorating. Vital signs should be reassessed at least every 5 minutes or any time significant changes in the patient's condition occur. It is essential to monitor 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 chest compressions immediately. If an AED is immediately available, use it; if not, perform CPR until the AED is available, as discussed in the later section on cardiac arrest. Reassess your interventions to see whether they are helping and whether the patient's condition is improving. Reassessment will also determine whether further interventions are indicated or contraindicated.

Transport the patient. Early, prompt transport to the ED or specialty center 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 and you do not have permission from medical control to administer nitroglycerin, complete your patient 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.

Alert the ED staff about the status of your patient's condition and your estimated time of arrival. Follow the instructions of medical control. Describe the patient's condition to the ED staff on arrival.

It is important to document your assessment and treatment of the patient. All interventions should be initiated according to protocol. If the intervention required an order from medical control, document the intervention and/or medication requested and that prior approval was granted. 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. On completing your documentation, obtain the medical control physician's signature (if required by local protocol) showing approval of medication administration.

Emergency Medical Care for Chest Pain or Discomfort

Your treatment of the patient begins with proper positioning. As mentioned before, some patients will not tolerate being positioned supine, so they should be allowed to sit up (leaning back on the stretcher). Also loosen tight clothing, trying to make the patient as comfortable as possible.

If it is indicated, you should be giving the patient oxygen by this time, but continually reassess the oxygen saturation and patient's respiratory status. For patients with mild dyspnea, a nasal cannula may be all that is needed, whereas patients with more serious respiratory difficulty may require a nonrebreathing mask. Remember to titrate the oxygen to obtain an oxygen saturation between 95% and 99%. A patient who is unconscious or in obvious respiratory distress may need assistance with breathing. Use a BVM or another positive-pressure ventilation device if available and if you have been approved to use it in your service. Alternatively, consider CPAP depending on local protocol. Be aware that ALS may be required to support the use of positive end-expiratory pressure, CPAP, bilevel positive airway pressure, and transport ventilators.

Depending on local protocol, prepare to administer low-dose (sometimes called baby or children's) aspirin and assist with prescribed nitroglycerin. Aspirin (acetylsalicylic acid) prevents clots from forming or getting bigger. Administer low-dose aspirin according to local protocol. Low-dose aspirin comes in 81-mg chewable tablets. The recommended dose is 162 mg (two tablets) to 324 mg (four tablets). Be sure you have verified that the patient is not allergic to aspirin before you give it, because many people are. Also, ask the patient if he or she has any history of internal bleeding such as stomach ulcers, and, if so, contact medical control before giving the patient aspirin.

Nitroglycerin may help to relieve the pain of angina. Nitroglycerin comes in several forms—as a small white tablet, placed sublingually (under the tongue); as a spray, also taken sublingually; and as a skin patch applied to the chest. 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 or bradycardia. You should therefore 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, use of erectile dysfunction drugs within the previous 24 to 48 hours, and the maximum prescribed dose of nitroglycerin has already been given (usually three doses). Drugs used for erectile dysfunction include sildenafil (Viagra), tadalafil (Cialis), avanafil (Stendra), and vardenafil (Levitra, Staxyn).

Administering Nitroglycerin

Check the condition of the medication and its expiration date, and do not administer contaminated or expired medications. Also make sure the medication is prescribed for your patient. Occasionally, patients will try to take medications prescribed for their spouse or a friend if they think it will help them. Be sure to wear gloves when handling nitroglycerin tablets or spray because it is easily absorbed through the skin. If you handle tablets with bare fingers or get the spray on your fingers, it may be absorbed into your body, causing you to experience a very painful headache. If the patient has on a nitroglycerin patch when you arrive, be sure to carefully remove it if the patient is hypotensive or in cardiac arrest (before use of AED).

After you obtain permission from medical control, if required, help the patient administer prescribed nitroglycerin. Nitroglycerin works in most patients within 5 minutes. 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.

Be aware that nitroglycerin will lose its potency over time, especially if exposed to light. 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 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 in **Skill Drill 16-1**:

1. Obtain an order from medical control—online or through off-line protocol.
2. Take the patient's blood pressure. Administer 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. Make sure the patient has no contraindications, such as having taken medication for erectile dysfunction in the past 24 hours.
4. Ask 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 under the tongue (while wearing gloves), or have the patient do so. Have the patient lower the tongue and keep his or her mouth closed with the tablet or spray under the tongue until it is dissolved and absorbed. Caution the patient against chewing or swallowing the tablet **Step 3**.
6. Recheck the blood pressure within 5 minutes. Record the medication and the time of administration. Reevaluate the chest pain, and note the response to the

Skill Drill 16-1 Administration of Nitroglycerin

© Jones & Bartlett Learning.

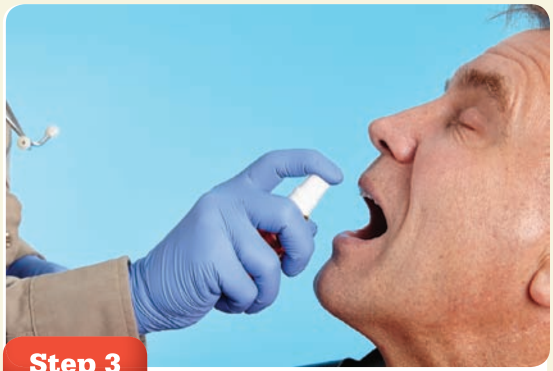
Step 1

Obtain an order from medical control. Take the patient's blood pressure. Administer nitroglycerin only if the systolic blood pressure is greater than 100 mm Hg.

© Jones & Bartlett Learning.

Step 2

Check the medication and expiration date. Ask 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.



© Jones & Bartlett Learning.

Step 3

Ask the patient to lift his or her tongue. Place the tablet or spray the dose under the tongue (while wearing gloves), or have the patient do so. Have the patient keep his or her mouth closed with the tablet or spray under the tongue until it is dissolved and absorbed. Caution the patient against chewing or swallowing the tablet.

© Jones & Bartlett Learning.

Step 4

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

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 is given for any one episode of chest pain **Step 4**.

Cardiac Monitoring

Some EMS systems will allow EMTs to place electrodes, attach the leads, and obtain an electrocardiogram (ECG) tracing prior to transport. If your service allows you to perform this skill, the following information will guide you.

For an ECG to be reliable and useful, the electrodes must be placed in consistent positions on each patient. **Figure 16-10** shows placement of limb lead electrodes, which are used to obtain a 3-lead ECG. **Figure 16-11** shows placement of limb lead electrodes and 12-lead ECG electrodes, both of which are used when obtaining a 12-lead ECG. To maintain consistency in monitoring and obtaining a useful ECG, there are predetermined locations for each electrode. Electrodes used in the prehospital setting are generally adhesive and have a gel center to aid in skin contact. Whichever type is used, certain basic principles should be followed to achieve the best skin contact and minimize **artifact** in the signal. Artifact refers to an ECG tracing that is the result of interference, such as patient movement, rather than the heart's electrical activity. Guiding principles are as follows:

- To maintain the correct lead placement, it may occasionally be necessary to shave body hair from the electrode site. Do not be fooled by a hairy chest. It may initially appear that you have good skin contact, but the electrode will rise off the skin and stick to the hair. If you must shave the site, be very careful to avoid nicking the skin. If one is available, it is best to use an electric razor to remove hair, because single-blade manual razors irritate the skin and can easily cut a patient.
- To remove oils and dead tissues from the surface of the skin, rub the electrode site briskly with an alcohol swab before application. Wait for the alcohol to dry before applying electrodes or dry it with a quick wipe of a 4-inch × 4-inch gauze pad. This step may have to be repeated if the patient is very sweaty as many cardiac patients are.
- Attach the electrodes to the ECG cables before placement. Confirm that the appropriate electrode now attached to the cable is placed at the correct location on the patient's chest or limbs (each cable is marked and color coded as to the correct location for placement).
- Once all electrodes are in place, switch on the monitor, and print a sample rhythm strip. If the strip shows any interference (artifact), verify that the electrodes are firmly applied to the skin and the monitor cable is plugged in correctly.

Artifact on the monitor can be tricky. Patient movement, including deep breathing or muscle tremor, may cause a wavy baseline or small up-and-down squiggles on the baseline. These will prevent the ECG from being usable. Make sure that the patient is

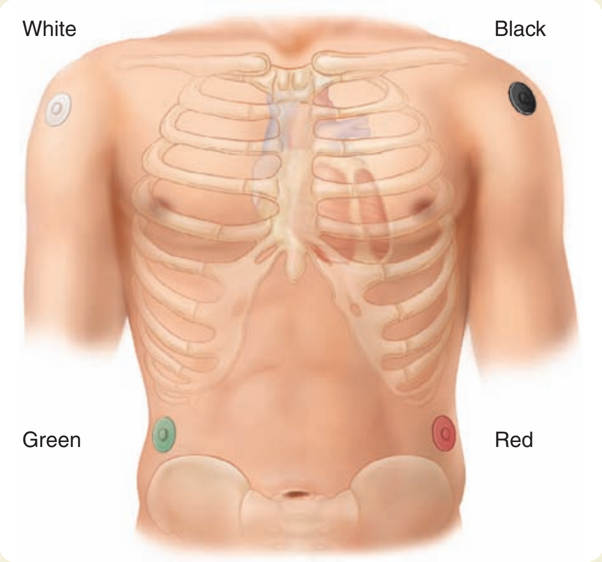
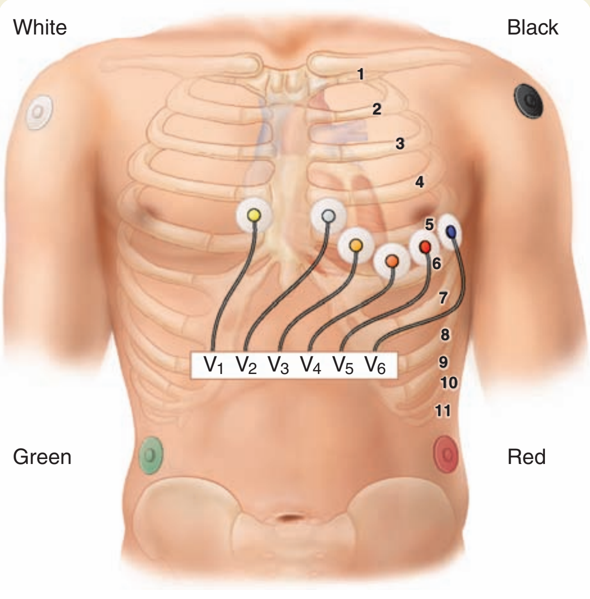


Figure 16-10 Limb electrode placement for cardiac monitoring.

© Jones & Bartlett Learning.



Lead	Location	View
V_1	4th intercostal space, right sternal border	Ventricular septum
V_2	4th intercostal space, left sternal border	Ventricular septum
V_3	Between V_2 and V_4	Anterior wall of left ventricle
V_4	5th intercostal space, midclavicular line	Anterior wall of left ventricle
V_5	Lateral to V_4 at the anterior axillary line	Lateral wall of left ventricle
V_6	Lateral to V_5 at the midaxillary line	Lateral wall of left ventricle

Figure 16-11 12-lead ECG electrode placement.

© Jones & Bartlett Learning.

supine if possible or in the semi-Fowler position if he or she is having difficulty breathing. Also make sure that the patient's arms are relaxed by his or her side and his or her feet are uncrossed.

Skill Drill 16-2 shows the steps for performing cardiac monitoring:

1. Take standard precautions **Step 1**.
2. Explain the procedure to the patient. Prepare the skin for electrode placement **Step 2**.
3. Attach the electrodes to the leads before placing them on the patient **Step 3**.
4. Position the limb electrodes on the patient, on the torso if performing continuous monitoring, on the limbs if you will be acquiring a 12-lead ECG. The RA electrode goes on the right arm distal to the shoulder or on the wrist (avoid placing it directly over a bone). The LA electrode goes on the left arm at the same location as you placed the RA electrode on the right arm. The LL electrode is placed on the left leg on the thigh or ankle, although if you do not plan to obtain a 12-lead ECG tracing, this electrode is often placed on the lower left side of the abdomen (slightly lower than an AED pad would be placed). Place the RL electrode at the same location on the right side of the body as the LL electrode on the left **Step 4**.
5. If you plan to obtain a 12-lead ECG tracing, place the chest leads on the chest as shown. The V_1 electrode is placed on the right side of the sternum between the fourth and fifth ribs. The V_2 electrode is placed on the left side of the sternum directly across from V_1. The V_4 is placed next, between the fifth and sixth ribs in a straight line down from the middle of the clavicle. The V_3 is then placed halfway between V_2 and V_4. The V_6 is placed next and is located horizontally even with V_4 in a straight line down from the middle of the armpit. Finally, V_5 is placed halfway between V_4 and V_6 **Step 5**.
6. Turn on the monitor **Step 6**.
7. Record tracings. As soon as a rhythm is visible on the screen, press the print button on the monitor and print a strip while counting slowly to six or seven. Then press the print button again to stop the printout. If the time is not printed correctly on the strip, write it on the edge of the strip. If you are obtaining a 12-lead ECG tracing, ask the patient to hold his or her breath or to take very shallow breaths. Press the 12-lead button and wait for the machine to acquire, analyze, and print or transmit the 12-lead ECG tracing. Gently tear off the tracing when the printer automatically stops **Step 7**.
8. Label each strip **Step 8**.

Skill Drill 16-2 Performing Cardiac Monitoring


© Jones & Bartlett Learning.

Step 1

Take standard precautions.


© Jones & Bartlett Learning.

Step 2

Explain the procedure to the patient. Prepare the skin for electrode placement.

Continued...

Skill Drill 16-2 Performing Cardiac Monitoring (continued)


© Jones & Bartlett Learning.

Step 3

Attach the electrodes to the leads before placing them on the patient.


© Jones & Bartlett Learning.

Step 4

Position the limb electrodes on the patient. Place the leads on the torso if performing continuous monitoring, on the limbs if you will be acquiring a 12-lead ECG.


© Jones & Bartlett Learning.

Step 5

If you plan to obtain a 12-lead ECG tracing, place the chest leads on the chest.


© Jones & Bartlett Learning.

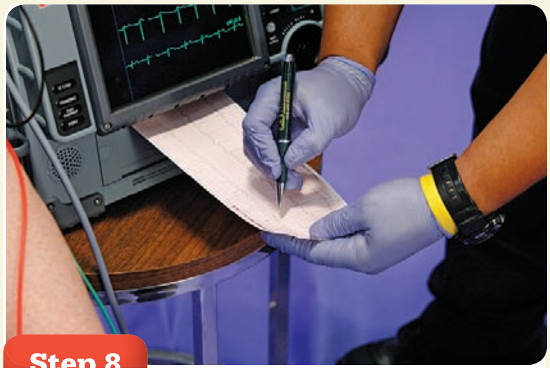
Step 6

Turn on the monitor.


© Jones & Bartlett Learning.

Step 7

Record tracings.


© Jones & Bartlett Learning.

Step 8

Label each strip.

Heart Surgeries and Cardiac Assistive Devices

During the last 30 years, hundreds of thousands of open-heart surgeries have been performed to bypass damaged segments of coronary arteries in the heart. In a coronary artery bypass graft, a blood vessel from the chest or leg is sewn directly from the aorta to a coronary artery beyond the point of the obstruction. Another procedure is the percutaneous transluminal coronary angioplasty, 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 cylinder called a stent is placed inside the artery instead of or after the balloon. The stent is left in place permanently to help keep the artery from narrowing again.

A patient who has had an AMI or angina in the past will possibly have had one of these procedures. Patients who have had a bypass graft will have a long surgical scar on the chest from the operation. Patients who have had an angioplasty or a coronary artery stent usually will not. However, newer "keyhole" surgical techniques for bypass surgery 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 in the same manner as chest pain in patients who have not had any heart surgery. Carry out all the described tasks, and transport the patient promptly to the ED 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.

In the United States many people with heart disease 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 portion of the chest **Figure 16-12**.

Figure 16-12 A pacemaker, which is typically inserted under the skin in the left upper portion of the chest, delivers an electrical impulse to regulate the heartbeat.

© Carolina K. Smith, MD/ShutterStock.

Normally, you do not need to be concerned about problems with pacemakers. Thanks to modern technology, an implanted unit will not require replacement 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. This is no longer the case; however, patients with pacemakers should avoid exposure to strong magnets. 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 ED; 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.

Automatic Implantable Cardiac Defibrillators

More and more patients who survive cardiac arrest due to ventricular fibrillation have a small automatic implantable cardiac defibrillator implanted

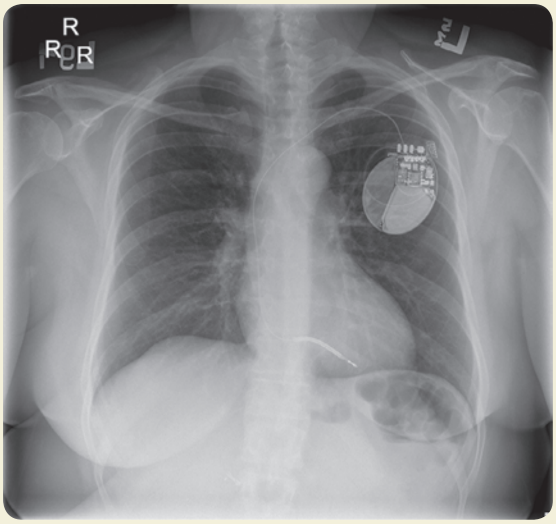


Figure 16-13 An automatic implantable cardiac defibrillator is attached directly to the heart and continuously monitors heart rhythm, delivering shocks as needed. The electricity from the defibrillator is so low that it has no effect on rescuers.

© Andrew Pollak, MD. Used with permission.

Figure 16-13. 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 automatic implantable cardiac defibrillator, 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 automatic implantable cardiac defibrillator is so low that it will not have an effect on rescuers and, therefore, should not be of concern to you.

▶ External Defibrillator Vest

An alternative to the implantable cardiac defibrillator is the external defibrillator vest. This device is a vest with built-in monitoring electrodes and defibrillation pads, which is worn by the patient under his or her clothing. The vest is attached to a monitor worn on a belt or hung from a shoulder strap. The monitor provides alerts and voice prompts when it recognizes a dangerous rhythm and before a shock is delivered. Unlike the implantable defibrillator, this device uses high-energy shocks similar to an AED, so you should avoid contact with the patient if the device warns that it is about to deliver a shock. Blue gel under the large defibrillation pads indicates that the device has already delivered at least one shock.

If the patient is in cardiac arrest, the vest should remain in place while CPR is being performed unless it interferes with compressions. If it is necessary to remove the vest, simply remove the battery from the monitor and then remove the vest. You can then use your own AED on the patient. Any patient who is wearing a device that has already delivered a shock should be transported to the hospital for further evaluation.

▶ Left Ventricular Assist Devices

Left ventricular assist devices (LVADs) are used to enhance the pumping of the left ventricle in patients with severe heart failure or in patients who need a temporary boost due to an MI. There are several types of LVADs; the most common ones have an internal pump unit and an external battery pack. These pumps may be pulsatile, meaning they pump the blood in pulsations just like the natural heart, or they may be continuous, in which case the patient will not have any palpable pulses. If you encounter a patient with a LVAD, he or she (or his or her family members) may be able to tell you about the unit. Unless it malfunctions you should not need to deal with it. If you are unsure of what to do, contact medical control for assistance. Also, LVADs provide a number to call for assistance. Transport all LVAD supplies and battery packs to the hospital with the patient.

Cardiac Arrest

Cardiac arrest is the complete cessation of cardiac activity—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. 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 50 years.

When you arrive to find a patient who appears to be in cardiac arrest, you should automatically follow your CPR training. CPR is covered in Chapter 13, *BLS Resuscitation*.

▶ 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—a device that can automatically administer an electrical shock to the heart when needed—possible.

AED machines come in different models with different features **Figure 16-14**. All of them require a certain degree of operator interaction, beginning with turning on the machine and applying the pads. 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 operator 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. Even though most defibrillators are now semiautomated, we still use the term automated external defibrillator (AED) to describe all of these machines. There are few fully automatic AEDs (which would deliver a shock without the operator pressing a button) left. All manufacturers are now producing only semiautomated external defibrillators.

AEDs deliver electrical energy from one pad to the other (and then back to the first pad) to electrically stun the heart and allow it to resume normal function. The amount of electricity delivered by the machine varies among the manufacturers but each one has shown that the energy they deliver is adequate to defibrillate the heart. The factors involved in the defibrillation include voltage, current, and impedance. Most AEDs are set up to adjust the voltage based on the impedance (or resistance of the body to the flow of electricity) to deliver the proper amount of current, which is what actually causes the cells to defibrillate.

Figure 16-14 Automated external defibrillators vary in their design, features, and operation.

A: Photographee.eu/Shutterstock; B: Jones & Bartlett Learning.

Special Populations

A pediatric patient with chest pain is not a common call. It is usually associated with a child who has a preexisting heart condition, usually congenital (present since birth). In pediatric situations, it is vital to see family members or caregivers as a valuable source of information.

Cardiac arrest in infants and children is usually the result of respiratory failure, not a primary cardiac event. However, the American Heart Association has determined that AEDs are safe to use in infants and children. If the patient is age 8 or less, pediatric-sized pads and a dose-attenuating system (energy reducer) are preferred. However, if these are unavailable, a regular adult AED can be used. If the child is between 1 month and 1 year of age (an infant), a manual defibrillator is preferred to an AED. If a manual defibrillator is not available, an AED equipped with a pediatric dose attenuator is preferred. If neither is available, an AED without a pediatric dose attenuator may be used.

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 rare for an AED to recommend a shock when a shock is not required, and an AED rarely fails to recommend one when it would be helpful. Therefore, if the AED recommends a shock, you can believe that it is indicated.

Automated external defibrillation offers a number of advantages. First, the machine is fast, and it delivers the most important treatment for a patient in ventricular fibrillation: an electrical shock. It can be delivered within 1 minute of your arrival at the patient's side. Second, AEDs are easy to operate. 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 safe to use. Also, the pad area is larger than manual 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. As a safety measure, make sure the patient is not lying on wet ground or touching metal objects when he or she is being shocked.

Not all patients in cardiac arrest require an electrical shock. Although the cardiac rhythm of 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 refers to a state of cardiac arrest that exists despite an organized electrical complex. In both cases, CPR should be initiated as soon as possible beginning with chest compressions.

Rationale for Early Defibrillation

Few patients who experience sudden cardiac arrest outside 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 five links in the chain of survival are as follows **Figure 16-15**:

- Recognition of early warning signs and immediate activation of EMS
- Immediate CPR with emphasis on high-quality chest compressions
- Rapid defibrillation

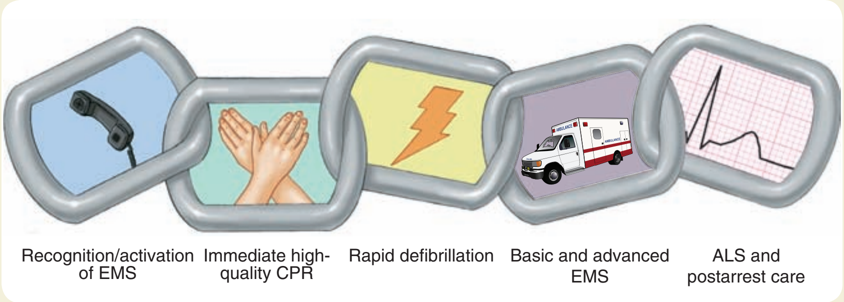


Figure 16-15 The five links of the chain of survival.

© Jones & Bartlett Learning. Data from American Heart Association.

YOU are the Provider PART 4

After completing the remainder of your assessment and initial treatment, you place the patient onto the stretcher, load her into the ambulance, and proceed to a hospital located 20 miles away. You ask your partner to notify the hospital to alert the staff as you reassess the patient.

Recording Time: 10 Minutes	
Level of consciousness	Conscious and alert; still anxious
Respirations	18 breaths/min; adequate depth
Pulse	84 beats/min; strong and irregular
Skin	Pale and cool; less diaphoretic
Blood pressure	136/84 mm Hg
Spo_2	96% (on oxygen)

9. Why is early notification of the receiving facility so important for patients with an acute coronary event?
10. Should you apply the AED to determine if she is experiencing a cardiac dysrhythmia? Why or why not?

- Basic and advanced EMS
- ALS and postarrest care

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 that is the most common determinant for survival is the third link—rapid defibrillation. This link and those for immediate high-quality CPR and basic and advanced EMS are where EMTs are most involved.

CPR helps patients in cardiac arrest because it prolongs the period during which defibrillation can be effective. Rapid defibrillation has successfully resuscitated many patients with cardiac arrest due to 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 rapid defibrillation. These responders would include police officers, security personnel, lifeguards, maintenance workers, and flight attendants. As an EMT, you should support these efforts to shorten the interval until defibrillation. Remember, seconds really matter when a patient is in cardiac arrest.

The final step in the chain of survival is ALS and postarrest care. This refers to continuing ventilation at less than 12 breaths/min to achieve an ETCO_2 of 35 to 40 mm Hg; maintaining oxygen saturation between 94% and 99%; assuring blood pressure is above 90 mm Hg; and maintaining glucose levels in the patient who is hypoglycemic. It also includes cardiopulmonary and neurologic support at the hospital as well as other advanced assessment techniques and interventions when indicated.

Integrating the Automated External Defibrillator and Cardiopulmonary Resuscitation

Because 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 that the AED is not very complex, but it may not be able to distinguish other movements from ventricular fibrillation. To avoid this problem, apply the AED only to pulseless, unresponsive patients and stay clear of the patient (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.

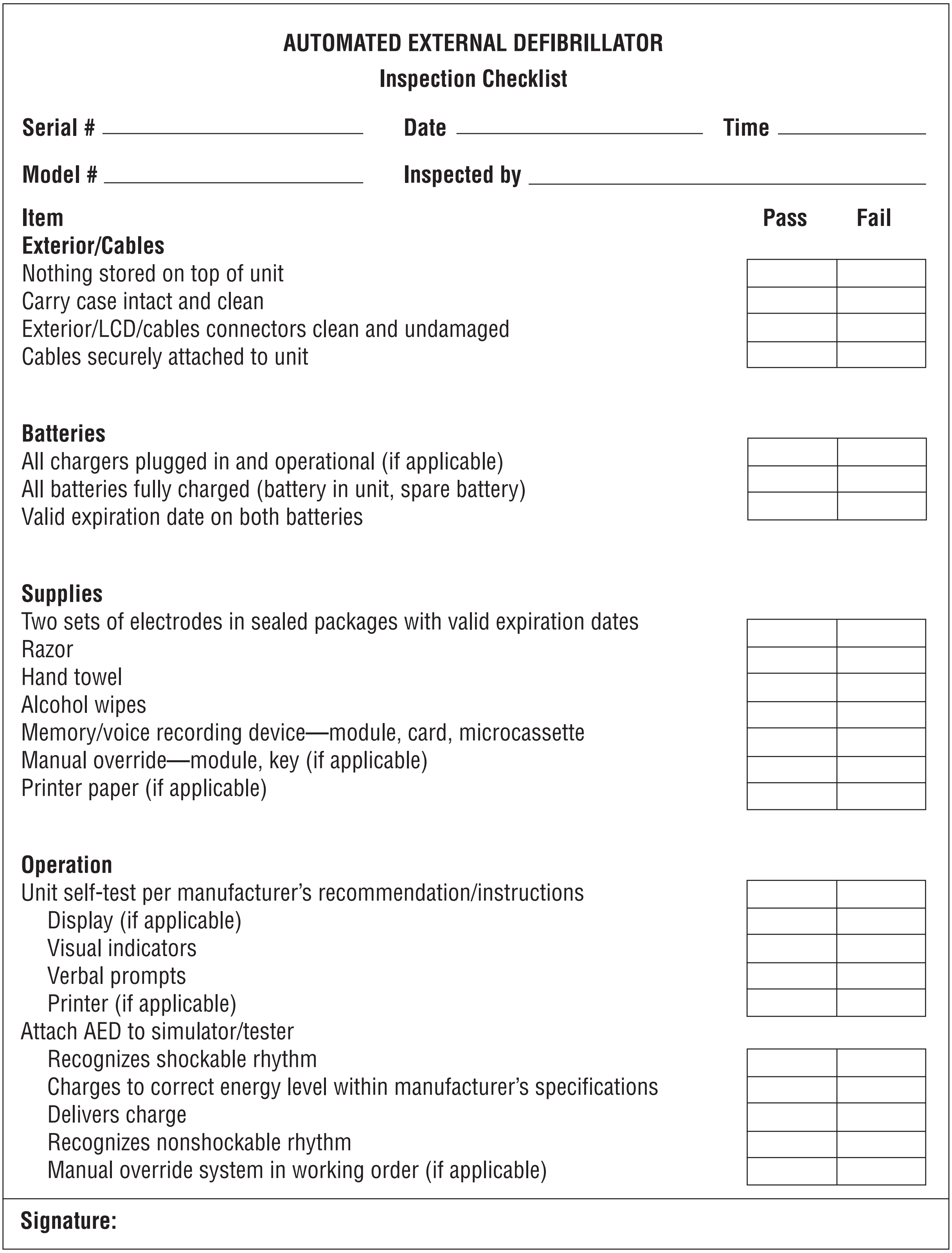
Automated External Defibrillator Maintenance

One of your primary missions as an EMT 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 system 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-service sessions.

The main legal risk in using the AED is failing to deliver a shock when one was needed. The three most common errors in using certain AEDs are failure of the machine to shock fine V fib; applying the AED to a patient who is moving, squirming, or being transported; and turning off the AED before analysis or shock is complete. Operator errors include failing to apply the AED to a patient in cardiac arrest, not pushing the analyze or shock buttons when the machine advises you to do so, or pushing the power button instead of pushing the shock button when a shock is advised. Like any other manufactured item, the AED 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.

Another reason includes failure due to a battery that did not work, usually because it was not properly maintained. To avoid a battery that is not charged, 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. Check your equipment, including your AED, daily at the beginning of each shift and exercise the battery as often as the manufacturer recommends. Ask the manufacturer for a checklist of items that should be checked daily, weekly, or less often **Figure 16-16**.

An error can also occur when the AED is applied to a responsive patient with a rapid heart rate. Most AEDs identify a regular rhythm faster than 150 or 180 beats/min as ventricular tachycardia, which should be shocked. Sometimes, however, 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 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/cables connectors clean and undamaged	☐	☐
Cables securely attached to unit	☐	☐
Batteries		
All chargers plugged in and operational (if applicable)	☐	☐
All batteries fully charged (battery in unit, spare battery)	☐	☐
Valid expiration date on both batteries	☐	☐
Supplies		
Two sets of 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 16-16 A sample checklist for the automated external defibrillator (AED).

© Jones & Bartlett Learning.

Special Populations

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 decreases. 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 report weakness, fatigue, or dizziness and may experience syncope (fainting).

The heart muscle is stimulated by 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 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. Although some irregular heart rhythms are not harmful, others can be 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 due to decreased blood flow or plaque formation (atherosclerosis) in the narrowed arteries.

Patients with diabetes can experience reduced circulation to the hands and feet, which makes peripheral pulses harder to detect. It also puts the hands and feet at particular risk for infection and ulceration.

In some older patients with angina or AMI, particularly people with diabetes, chest pain is absent, and the clinical picture can be confused with other, noncardiac conditions. These patients may present with a chief complaint of syncope (fainting), fatigue, or shortness of breath.

The cardiovascular system is affected by aging. You should be aware of the changes, seeking to determine what is normal versus what is chronic versus what is an acute condition for the individual patient. 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 older patients more difficult.

If the AED fails while you are caring for a patient, you must report the 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. Although 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 approve the written protocol that you will follow in caring for patients in cardiac arrest.

There should be a review of each incident in which the AED is used. After returning from the hospital or the scene, discuss with the rest of the team what happened. This discussion will help all members of the team learn from the incident. Review such events by using the written report and the device's 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 people using AEDs and the responsible EMS system managers. This review should focus on speed of defibrillation, that is, the time from the call to the 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.

Emergency Medical Care for Cardiac Arrest

Preparation

When dispatch reports an unresponsive patient with CPR being performed, the AED is probably one of the first pieces of equipment you will obtain from the ambulance. As the operator of the AED, you are responsible for making sure the electricity does not injure anyone, 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. Although 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 hairy patient's chest before pad 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, consider spinal immobilization as you begin the primary assessment. Is there only one patient? If you are in a tiered system and the patient is in cardiac arrest, call for ALS assistance. If you suspect that the patient may be in cardiac arrest, discuss who will perform which resuscitation responsibilities prior to arrival on the scene. Preparation tasks should be done concurrently, so that time to defibrillation is minimized. For example, one provider begins compressions while another prepares for ventilation and another prepares the AED. Working as a well-organized team will improve the chances for a successful resuscitation.

▶ Performing Defibrillation

If you witness a patient's cardiac arrest, begin CPR starting with chest compressions and attach the AED as soon as it is available. As soon as the AED is turned on and attached, follow the instructions to analyze and deliver shocks to the patient. Make sure to minimize the time when you are not performing chest compressions; research has shown the best survival rates for patients in whom compressions were interrupted for the least amount of time. At each defibrillation, the person performing compressions should switch places with the person providing ventilations so that neither gets overtired. Immediately after each defibrillation, resume CPR with compressions first. The steps for using the AED are listed here and shown in **Skill Drill 16-3**:

1. If bystander CPR is in progress, assess the effectiveness of chest compressions by palpating for a carotid or femoral pulse. If compressions are effective, you should be able to feel a pulse. If you do, leave your fingers in that position and stop compressions. If you lose the pulse when compressions stop, immediately resume compressions. It is important to limit the amount of time compressions are interrupted. If the patient is responsive, do not apply the AED.
2. If the patient is unresponsive and CPR has not been started yet, begin providing chest compressions and rescue breaths at a ratio of 30 compressions to 2 breaths and a rate of 100 to 120 compressions per minute, continuing until an AED arrives and is ready for use **Step 1**. It is important to start chest compressions and use the AED as soon as possible. Compressions provide vital blood flow to the heart and brain, improving the patient's chance of survival. High quality compressions (ie, performed at the appropriate rate and depth, with no leaning on the chest during recoil, and interruptions minimized) provide the best cardiac output.
3. Turn on the AED **Step 2**. 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 lower chest area with the top of the pad 2 inches to 3 inches below the armpit. Do not place the pads on top of breast tissue in women. If necessary, move the breast out of the way with the back of your hand and place the pad underneath. Ensure that the pads are attached to the patient cables (and that they are attached to the AED in some models). Plug in the pads connector to the AED.
4. Stop CPR when the AED instructs you to.
5. State aloud, "Clear the patient," and ensure that no one is touching the patient.
6. Push the Analyze button, if there is one, and wait for the AED to determine whether a shockable rhythm is present. If a shock is advised, perform chest compressions while the AED is charging.
7. If a shock is not advised, perform five cycles (about 2 minutes) of CPR, beginning with chest compressions, and then reanalyze the cardiac rhythm. If a shock is advised, reconfirm that no one is touching the patient and push the Shock button. If at any time the AED advises to check the patient, quickly assess for a carotid or femoral pulse. This should not take longer than 5 to 10 seconds. If you feel a pulse, the patient has experienced **return of spontaneous circulation (ROSC)**. ROSC is defined as the return of a pulse and effective blood flow to the body in a patient who previously was in cardiac arrest. Continue to monitor the patient.
8. After the shock is delivered, immediately resume CPR, beginning with chest compressions. Remember to change to a different person for chest compressions each time CPR is paused to prevent rescuer fatigue **Step 3**.
9. After five cycles (about 2 minutes) of CPR, reanalyze the patient's cardiac

rhythm **Step 4**. Do not interrupt chest compressions for more than 10 seconds.

10. If the AED advises a shock, clear the patient, push the Shock button, and immediately resume CPR compressions. If no shock is advised, immediately resume CPR, beginning with chest compressions and remembering to change the person providing compressions.
11. Gather additional information about the arrest event.
12. After five cycles (2 minutes) of CPR, reassess the patient.
13. Repeat the cycle of 2 minutes of CPR, one shock (if indicated), and 2 minutes of CPR.
14. Transport, and contact medical control as needed **Step 5**.

If the AED advises no shock and the patient has a pulse, check the patient's breathing. If the patient is breathing adequately, give oxygen via nonrebreathing mask, adjusting the flow as soon as pulse oximetry gives a reading, and transport. If the patient is not breathing adequately, provide artificial ventilation with a BVM or pocket mask device attached to 100% oxygen and transport. Ensure that proper airway techniques are used at all times.

If the patient has no pulse, perform five cycles (approximately 2 minutes) of CPR beginning with chest compressions. After 2 minutes of CPR, reanalyze the patient's cardiac rhythm. If the AED advises to shock, deliver one shock followed immediately by CPR, beginning with chest compressions. Repeat these steps if needed.

If the patient has no pulse and the AED advises no shock, perform five cycles (approximately 2 minutes) of CPR, beginning with chest compressions. After five cycles (2 minutes) of CPR, reanalyze the patient's cardiac rhythm. If no shock is advised, continue CPR. Transport the patient, and contact medical control as needed.

After Automated External Device 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

YOU are the Provider PART 5

The patient is still conscious and alert and appears less anxious. She tells you that her chest pain has decreased in severity and is now a 3 on a 0 to 10 scale. After reassessing her, you contact the receiving facility and give the staff a patient update.

Recording Time: 17 Minutes	
Level of consciousness	Conscious and alert; less anxious
Respirations	16 breaths/min; adequate depth
Pulse	80 beats/min; strong and irregular
Skin	Pink, cool, and dry
Blood pressure	128/78 mm Hg
Spo_2	98% (on oxygen)

You deliver the patient to the emergency department (ED), where the cardiac team greets you and assumes care of the patient. The physician obtains a 12-lead electrocardiogram and determines that she is experiencing an acute myocardial infarction. Within 15 minutes, she is taken to the cardiac catheterization laboratory, where two coronary stents are successfully placed.

11. What is the difference between angina pectoris and an acute myocardial infarction?
12. As an EMT, how can you distinguish angina pectoris from an acute myocardial infarction?

Skill Drill 16-3 AED and CPR


© Jones & Bartlett Learning.

Step 1

Take standard precautions. Determine scene safety. Question bystanders. Determine responsiveness.

Assess compression effectiveness if CPR is already in progress. If the patient is unresponsive and CPR has not been started yet, begin providing chest compressions and rescue breaths at a ratio of 30 compressions to two breaths and a rate of 100 to 120 compressions per minute, continuing until an AED arrives and is ready for use.


© Jones & Bartlett Learning.

Step 2

Turn on the AED. Apply the AED pads to the chest and attach the pads to the AED. Stop CPR. If a shock is not advised, perform five cycles (about 2 minutes) of CPR, beginning with chest compressions, and then reanalyze the cardiac rhythm. If a shock is advised, reconfirm that no one is touching the patient and push the Shock button. If at any time the AED advises to check the patient, quickly assess for a carotid or femoral pulse. This should not take longer than 5 to 10 seconds. If you feel a pulse, the patient has experienced ROSC (return of spontaneous circulation). Continue to monitor the patient.


© Jones & Bartlett Learning.

Step 3

Verbally and visually clear the patient. Push the Analyze button, if there is one. Wait for the AED to analyze the cardiac rhythm. If no shock is advised, perform five cycles (2 minutes) of CPR and then reanalyze the cardiac rhythm. If a shock is advised, recheck that all are clear, and push the Shock button. After the shock is delivered, immediately resume CPR beginning with chest compressions and remember to switch rescuers.


© Jones & Bartlett Learning.

Step 4

After five cycles (2 minutes) of CPR, reanalyze the cardiac rhythm. Do not interrupt chest compressions for more than 10 seconds.

Continued...

Skill Drill 16-3 AED and CPR (continued)

© Jones & Bartlett Learning.

Step 5

If shock is advised, clear the patient, push the Shock button, and immediately resume CPR compressions. If no shock is advised, immediately resume CPR compressions and be sure to switch rescuers. After five cycles (2 minutes) of CPR, reanalyze the cardiac rhythm. Repeat the cycle of five cycles (2 minutes) of CPR, one shock (if indicated), and 2 minutes of CPR. Transport, and contact medical control as needed.

the AED protocol is completed, one of the following is likely:

- Pulse is regained (ROSC).
- No pulse, and the AED indicates that no shock is advised.
- No pulse, and the AED indicates that a shock is advised.

Patients who do not regain a pulse on the scene of the cardiac arrest usually do not survive. What you do with these patients, again, depends 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 control. If paramedics or another ALS 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 very 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 have been delivered (or as directed by local protocol).
- The machine gives three consecutive messages (separated by 2 minutes of CPR) that no shock is advised (or as directed by local protocol).

If you transport a patient while performing CPR, you need a plan for managing the patient in the ambulance. Ideally, you will have two EMTs 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 the 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 shocks are needed. Be sure to memorize the protocol of your EMS system **Figure 16-17**.

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, beginning with chest compressions, until it is available.
3. Call for help in the form of ALS support or any other available resources as appropriate based on circumstances and local protocol.

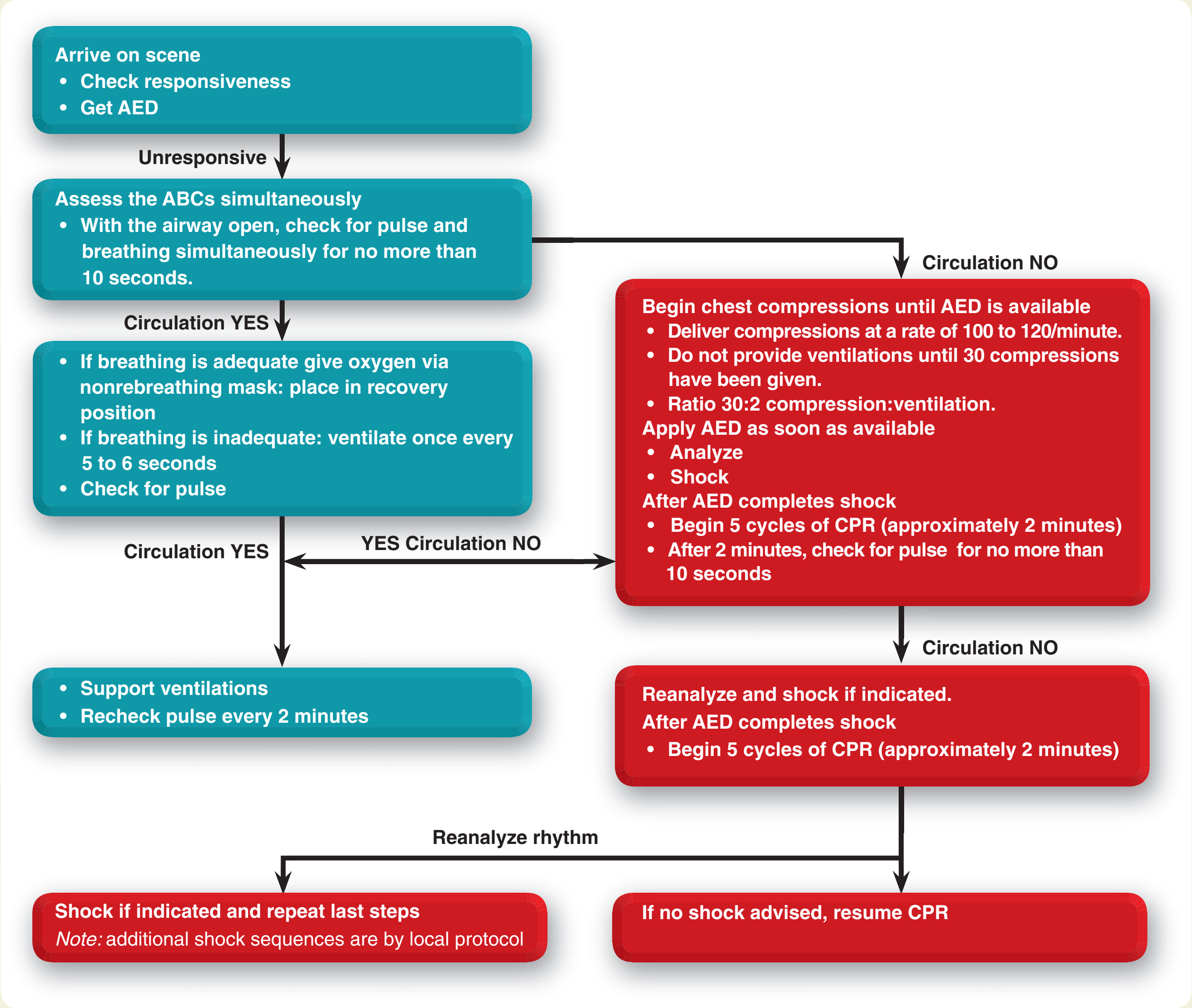


Figure 16-17 Automated external defibrillator (AED) algorithm. CPR indicates cardiopulmonary resuscitation.

© Jones & Bartlett Learning.

4. Analyze the rhythm.
5. Deliver one shock, if indicated, and immediately resume CPR.
6. 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, beginning with chest compressions, until it is ready.
4. Analyze the rhythm.
5. Deliver one shock, if indicated, and immediately resume CPR.
6. Begin compressions, and continue resuscitation according to your local protocol, including transporting the patient.

Coordination With Advanced Life Support Personnel

The time to defibrillation is critical to survival after cardiac arrest. As an EMT equipped with an AED, you have the one tool that a dying patient in ventricular fibrillation needs most. Furthermore, it is impossible to hurt someone in cardiac arrest with an AED. Therefore, if you have an AED available, do not wait for the paramedics to arrive to administer a shock to a patient in ventricular fibrillation. 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, inform them of your actions to that point and then interact with them according to your local protocols.

Management of Return of Spontaneous Circulation

If you are able to restore a heartbeat through the use of an AED (also known as ROSC), what is done next can be critical to the patient's survival. Monitor for spontaneous respirations, provide oxygen via BVM at 10 to 12 breaths/min, and maintain an oxygen saturation between 95% and 99%. Assess the patient's blood pressure and see if he or she can follow simple commands such as "Squeeze my fingers." If ALS is not on scene or en route, immediately begin transport to the closest appropriate hospital depending on local protocol.

Safety Tips

Always remember, when using an AED there are several safety items to review.

1. Be aware of the surface the patient is lying on. Wet and metal surfaces may conduct electricity, making defibrillation of the patient dangerous to EMTs.
2. What is the age of the patient? Use pediatric AED pads when appropriate.
3. Does the patient have a medication patch in the area the AED pads will be placed? If so, remove the medication patch, wipe the area clean, and then attach the AED pad.
4. Does the patient have an implanted pacemaker or internal defibrillator in the same area the AED pads will be placed? If so, place the AED pad below the pacemaker or defibrillator, or place the pads in anterior and posterior positions.

YOU are the Provider SUMMARY

1. What is the function of the heart?

The heart receives deoxygenated blood from the body, sends it to the lungs to be reoxygenated, and then pumps highly oxygenated blood throughout the body. The heart must pump effectively to ensure that the body's tissues and cells receive an uninterrupted supply of oxygen and that metabolic waste (eg, carbon dioxide) is removed from the tissues and cells and returned, through the heart, for elimination from the body by the respiratory system.

2. What does the heart require to function effectively?

Like any other critical organ or muscle, the heart requires a constant supply of oxygen, which it receives from the coronary arteries. It also relies on electricity to stimulate the contraction of the muscular layer of the heart (myocardium). Adequate blood volume is also required for effective cardiac function. As blood returns to the heart, it enters the chambers, stretches their walls, and causes them to contract with greater force. If blood volume is low, the heart will stretch less, and its contractile force will decrease.

3. What should you include in your primary assessment of a patient with cardiac problems?

Your primary assessment of a patient with cardiac problems should be no different from any other patient: to find and immediately correct problems with airway, breathing, and circulation. Look for signs of impaired cardiac function, such as an irregular heartbeat, a fast or slow heart rate, a weak (thready) pulse, and poor skin condition (eg, pallor, diaphoresis).

4. Why is aspirin given to patients with an acute cardiac event?

Aspirin has clearly been shown to reduce mortality and morbidity from acute myocardial infarction (AMI). Unless the patient is allergic to aspirin, it should be given as soon as possible if an acute cardiac event is suspected. An AMI occurs when an atherosclerotic plaque ruptures and occludes a coronary artery. When this occurs, platelets rush to the area and aggregate (clump together), which further occludes the coronary artery. Aspirin makes the platelets less "sticky," which makes them less likely to aggregate. Although aspirin will not dissolve the existing clot that is occluding the coronary artery, it may help prevent it from getting larger by reducing the amount of platelet aggregation.

5. What type of medication is nitroglycerin? How may it help relieve chest pain, pressure, or discomfort?

Nitroglycerin is a vasodilator. It works by relaxing the smooth muscle that regulates the diameter of the blood vessels, causing them to dilate (open). Nitroglycerin is used by patients with coronary artery disease who are experiencing chest pain, pressure, or discomfort. It dilates the coronary arteries and increases blood flow to the heart. As a result, the myocardial oxygen supply and demand are rebalanced, and the pain subsides or resolves completely. In some cases, however, nitroglycerin does not relieve the patient's chest pain. In a patient with a cardiac history, this should make you more suspicious that he or she is experiencing an AMI.

6. When is nitroglycerin indicated for a patient? What is the typical dose?

Nitroglycerin is indicated for patients with coronary artery disease who experience chest pain, pressure, or discomfort. Many patients with coronary artery disease have prescribed nitroglycerin, which they self-administer. If the patient has not taken any of his or her prescribed nitroglycerin, you may assist the patient in doing so after ensuring that his or her systolic blood pressure is at least 100 mm Hg and that approval from medical control has been obtained. Because nitroglycerin is a vasodilator, it can cause hypotension. Therefore, it is important to reassess the patient's blood pressure within a few minutes after administering nitroglycerin to ensure that it is at least 100 mm Hg. Nitroglycerin is contraindicated in patients with a systolic blood pressure of less than 100 mm Hg and in patients who have taken drugs for erectile dysfunction (eg, sildenafil [Viagra], tadalafil [Cialis], avanafil [Stendra], and vardenafil [Levitra, Staxyn]) within the past 24 to 36 hours. Drugs for erectile dysfunction are also vasodilators; if given together with nitroglycerin, significant hypotension may occur.

7. What is significant about the patient's vital signs?

Pale, cool, clammy (diaphoretic) skin is not exclusive to a cardiac problem. However, in the context of the patient's chief complaint and history of heart problems, it is highly suggestive that her chest pain is of a cardiac origin. An irregular heartbeat indicates a disturbance in the cardiac electrical conduction system (dysrhythmia). Again, in the context of her chief complaint and cardiac history, this should further increase your index of suspicion that she is experiencing a cardiac event. An irregular heartbeat in a patient with a cardiac problem could indicate an impending life-threatening dysrhythmia. The patient's rapid heart rate (tachycardia) and relatively elevated blood pressure (150/90 mm Hg) are also clinically significant; they indicate that her heart is working harder than normal. As the heart rate and blood pressure increase, the heart consumes and requires more oxygen. If the heart is already deprived of oxygen, the patient's condition could worsen.

8. Should you give her additional nitroglycerin? Why or why not?

Despite taking two of her prescribed nitroglycerin doses before your arrival, the patient is still experiencing significant chest pain (7 on a 0 to 10 scale). Because her systolic blood pressure is well above 100 mm Hg, you should contact medical control and request permission to assist her with one more nitroglycerin dose. Remember to reassess her blood pressure within a few minutes after administering the medication.

9. Why is early notification of the receiving facility so important for patients with an acute coronary event?

The longer it takes to reestablish blood flow distal to an occluded artery, the greater the amount of cardiac muscle damage (hence the phrase, "time is muscle"). Early reperfusion—with fibrinolytic medications (clot busters) or cardiac catheterization and stent placement—has clearly been shown to minimize the amount of cardiac damage and improve the patient's outcome. The earlier you notify the receiving facility that you are transporting a patient with a possible AMI, the more time the staff will have to allocate the resources needed to facilitate rapid cardiac reperfusion. The physician determines the reperfusion strategy. Your job is to recognize that the patient may be experiencing an AMI, provide immediate lifesaving care, promptly notify the appropriate receiving facility, and transport without delay.

10. Should you apply the AED to determine if she is experiencing a cardiac dysrhythmia? Why or why not?

No. The automated external defibrillator (AED) is applied *only* to patients who are apneic and pulseless (eg, in cardiac arrest). At present, your patient is breathing and has a pulse. Even if you did apply the AED, it would not analyze her cardiac rhythm. An AED will not analyze the cardiac rhythm if it detects patient movement. You should have the AED readily available in case she experiences cardiac arrest, but its application is not indicated at this point.

YOU are the Provider SUMMARY *continued*

11. What is the difference between angina pectoris and an acute myocardial infarction?

Angina pectoris occurs when the heart's demand for oxygen exceeds its available supply (ischemia), resulting in chest pain or discomfort. Angina is typically triggered by exertion, which increases myocardial oxygen consumption and demand. When the patient ceases exertion, oxygen supply and demand are rebalanced and the pain resolves, usually in less than 15 minutes. In more severe cases, a combination of rest and nitroglycerin are required for resolution of the patient's chest pain or discomfort.

An AMI occurs when a portion of the heart muscle is completely deprived of oxygen because of complete occlusion of one or more coronary arteries. Unlike angina, the chest pain, pressure, or discomfort associated with an AMI typically does not resolve with rest or nitroglycerin and persists for greater than 15 minutes. The patient experiencing an AMI needs prompt treatment in the hospital, which is aimed at removing the clot in the coronary artery and reestablishing distal blood flow.

12. As an EMT, how can you distinguish angina pectoris from an acute myocardial infarction?

The signs and symptoms of angina and an AMI are essentially the same and usually cannot be distinguished without advanced diagnostic procedures. In both conditions, the chest pain or discomfort may be described as a feeling of pressure or heaviness. The patient requires physician evaluation, blood analysis, and other tests to diagnose an AMI. You should assume that any patient with nontraumatic chest pain or discomfort is experiencing an AMI until ruled out by a physician.

YOU are the Provider SUMMARY *continued*

EMS Patient Care Report (PCR)

Date: 3-10-16	**Incident No.:** 130209	**Nature of Call:** Cardiac	**Location:** 1152 Blanco Road

Dispatched: 0942	**En Route:** 0942	**At Scene:** 0950	**Transport:** 1000	**At Hospital:** 1017	**In Service:** 1029

Patient Information

Age: 60 **Sex:** F **Weight (in kg [lb]):** 55 kg (121 lb)	**Allergies:** No known drug allergies **Medications:** Vasotec, aspirin (ASA), nitroglycerin (NTG) **Past Medical History:** Heart attack, hypertension **Chief Complaint:** Chest pain

Vital Signs

Time: 0952	**BP:** 150/90	**Pulse:** 118	**Respirations:** 20	**Spo$_2$:** 98%
Time: 1002	**BP:** 136/84	**Pulse:** 84	**Respirations:** 18	**Spo$_2$:** 96%
Time: 1012	**BP:** 128/78	**Pulse:** 80	**Respirations:** 16	**Spo$_2$:** 98%

EMS Treatment (circle all that apply)

Oxygen @ 4 L/min via (circle one): [✓ **NC**] **NRM** **BVM**	**Assisted Ventilation**	**Airway Adjunct**	**CPR**

Defibrillation	**Bleeding Control**	**Bandaging**	**Splinting**	**Other:** [✓ 324 mg ASA]

Narrative

Dispatched for a 60-year-old woman with chest pain. Upon arrival at the scene, found the patient sitting up in her bed with her fist clenched against her chest. She was conscious and alert, although anxious. Her airway was patent, and her breathing was adequate. She was markedly diaphoretic; had pale, cool skin; and had a rapid, irregular pulse. Patient states that she had a heart attack 3 years ago and has hypertension. She is presently taking Vasotec, NTG, and one (1) ASA per day and states that she has been compliant with her medications. Patient took two doses of her prescribed NTG before EMS arrival; however, she states that the medication had no effect; she presently describes her pain as a "7" on a scale of 0 to 10. Administered 324 mg ASA (patient stated she had no known drug allergies), applied oxygen at 4 L/min via nasal cannula to raise the oxygen saturation from 91% to just above 95%, and obtained vital signs. Contacted medical control, who authorized the administration of one more NTG dose. NTG was administered per medical control orders, the patient was placed onto the stretcher, loaded into the ambulance, and transported to the hospital. Contacted hospital shortly after departing the scene and advised that we were transporting patient with possible AMI. En route to the hospital, allowed patient to assume position of comfort and reassessed her vital signs. She was still reporting chest pain (3/10); however, her pulse rate, although still irregular, was notably slower. Reassessment of her skin revealed that it was pink, cool, and dry, and she was noted to be less anxious. Continued to monitor patient's condition throughout transport; there was no gross evidence of deterioration, and she remained conscious and alert. Delivered her to emergency department staff w/o incident. Upon arrival at the hospital, we were greeted by the cardiac team, who assumed patient care. Gave verbal report to charge nurse and returned to service.**End of report**

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 heart valve that keeps 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 to pump the blood.
- During periods of exertion or stress, the myocardium requires more oxygen. The oxygen 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 in an artery 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 condition 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 an 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 dysrhythmia; 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 dysrhythmias. 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, crackles (rales), and, sometimes, the pink sputum and dyspnea of pulmonary edema.
- Treat a patient with congestive heart failure as you would a patient with chest pain. Monitor the patient's vital signs. Give the patient oxygen via nonrebreathing face mask. Apply CPAP if it is available and you are authorized to use it. Allow the patient to remain sitting up.
- When treating patients with chest pain or discomfort, 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 semireclining 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, is not breathing, and does not have a pulse, you may perform the following, depending on the patient's age and your local protocol:
  - Unresponsive adult or child older than 8 years, perform automated external defibrillation.
  - Unresponsive child younger than 8 years, perform automated external defibrillation with pediatric pads and dose attenuator; if neither is available, an adult AED may be used.
  - Unresponsive infant between the ages of 1 month and 1 year should be manually defibrillated (an ALS skill). If ALS is not available, use an AED equipped with pediatric pads and a dose attenuator. If neither is available, adult AED pads may be used.
- The AED requires the operator to apply the pads, power on the unit, follow the AED prompts, and press the shock button as indicated.

Prep Kit *continued*

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 of the machine to shock fine V fib, applying the AED to a patient who is moving, squirming, or being transported, and turning off the AED before analysis or shock is complete.
- Do not touch the patient while the AED is analyzing the heart rhythm or delivering shocks.
- Effective CPR and early defibrillation with an AED are critical interventions to the survival of a patient in cardiac arrest. Begin CPR starting with high-quality chest compressions and apply the AED as soon as it is available.
- If an advanced life support (ALS) service is responding to the scene, stay where you are and continue CPR and defibrillation as needed. If ALS is not responding, begin transport if the patient regains a pulse, if you have delivered six to nine shocks, or if the AED gives three consecutive messages (separated by 2 minutes of CPR) that no shock is advised. Follow your local protocols regarding when it is appropriate to transport the patient.
- If an unconscious patient has no pulse during transport, stop the vehicle, reanalyze the rhythm, and 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 high-quality CPR, rapid defibrillation, basic and advanced EMS, and ALS and postarrest care. Seconds count at every stage.

Vital Vocabulary

acute coronary syndrome A group of symptoms caused by myocardial ischemia; includes angina and myocardial infarction.

acute myocardial infarction (AMI) A 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; also called *angina*.

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 aneurysm A weakness in the wall of the aorta that makes it susceptible to rupture.

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

artifact A tracing on an ECG that is the result of interference, such as patient movement, rather than the heart's electrical activity.

asystole The complete absence of all heart electrical activity.

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.

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.

automaticity The ability of cardiac muscle cells to contract without stimulation from the nervous system.

autonomic nervous system The part of the nervous system that controls the involuntary activities of the body such as the heart rate, blood pressure, and digestion of food.

bradycardia A slow heart rate, less than 60 beats/min.

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

Prep Kit *continued*

cardiac output A measure of the volume of blood circulated by the heart in 1 minute, calculated by multiplying the stroke volume by the heart rate.

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.

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 arteries The blood vessels that carry blood and nutrients to the heart muscle.

defibrillate To shock a fibrillating (chaotically beating) heart with specialized electric 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.

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

dissecting aneurysm A condition in which the inner layers of an artery, such as the aorta, become separated, allowing blood (at high pressures) to flow between the layers.

dysrhythmia An irregular or abnormal heart rhythm.

hypertensive emergency An emergency situation created by excessively high blood pressure, which can lead to serious complications such as stroke or aneurysm.

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 The heart muscle.

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

parasympathetic nervous system The part of the autonomic nervous system that controls vegetative functions such as digestion of food and relaxation.

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 anatomic position.

return of spontaneous circulation (ROSC) The return of a pulse and effective blood flow to the body in a patient who previously was in cardiac arrest.

stroke volume The volume of blood ejected with each ventricular contraction.

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

sympathetic nervous system The part of the autonomic nervous system that controls active functions such as responding to fear (also known as the "fight-or-flight" system).

syncope A fainting spell or transient loss of consciousness.

tachycardia A rapid heart rate, more than 100 beats/min.

thromboembolism A blood clot that has formed within a blood vessel and is floating within the bloodstream.

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 quivering of the ventricles, resulting in no blood flow and a state of cardiac arrest.

ventricular tachycardia A 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.

© Jones & Bartlett Learning. Courtesy of MIEMSS.

Assessment in Action

You are dispatched to a person reporting chest pain and shortness of breath. You arrive at the residence to find a 56-year-old man sitting in the kitchen. His skin is ashen, and he is diaphoretic. The patient describes the pain as substernal and crushing. On a scale of 0 to 10, he states his pain is an 8. The patient had a myocardial infarction 2 years ago, and he has angina, hypertension, and high cholesterol. His medications include nitroglycerin, furosemide, and atorvastatin. His vital signs are as follows: pulse, 140 beats/min and irregular; respiratory rate, 28 breaths/min; and blood pressure, 90/50 mm Hg. You hear crackles when listening to his breath sounds.

1. The patient's difficulty breathing and crackles are due to blood backing up in which part of the body?

   A. The heart
   B. The lungs
   C. The vessels
   D. The arteries

2. On the basis of the information given, the patient is most likely experiencing which type of shock?

   A. Neurogenic
   B. Vasogenic
   C. Cardiogenic
   D. Hypovolemic

3. Treatment of this patient includes which of the following?

   A. Oxygen, furosemide, and nitroglycerin
   B. Oxygen and transport in a position of comfort
   C. Oxygen and nitroglycerin
   D. Oxygen and transport with legs raised

4. What combination of vital signs and history gives the best clue about the patient's condition?

   A. The respiratory rate of 28 breaths/min with a history of angina
   B. The pulse of 140 beats/min with a history of high cholesterol
   C. The pulse of 140 beats/min with a history of angina
   D. The blood pressure of 90/50 mm Hg with a history of hypertension

5. What other information would be most helpful in determining the treatment of this patient?

   A. A pulse oximetry measurement and a list of medication allergies
   B. A description of his prior heart attack and how it was treated
   C. Whether or not he has an implanted pacemaker or an internal defibrillator
   D. Who is his doctor and which hospital would he prefer

6. Why would nitroglycerin be contraindicated for this patient?

   A. He may have already taken it three times.
   B. His blood pressure is too low.
   C. He may be allergic to it.
   D. He may have taken Viagra in the last 24 hours.

7. What would be your most important initial treatment of this patient?

   A. Apply the AED in case he goes into cardiac arrest.
   B. Give him nitroglycerin if he denies using Viagra.

C. Transport to the hospital because all other treatment is contraindicated.
D. Administer aspirin if he is not allergic to it.

8. The patient has a loss of consciousness on the way to the hospital. When you check, you cannot feel a pulse. What should you do?

A. Tell your partner to drive faster as you begin CPR on the patient.
B. Immediately apply the AED and wait for it to analyze the rhythm before taking any other action.
C. Have your partner pull over the ambulance and come back to help you with CPR and the AED.
D. Begin CPR and after 2 minutes stop to apply the AED while your partner continues driving to the hospital.

9. Describe the path of blood through the heart and lungs.

10. What is cardiogenic shock?