

Chapter 14

Cardiovascular Emergencies

Unit Summary

After students complete this chapter and the related course work, they will understand the significance and characteristics of the anatomy and physiology of the cardiovascular system; cardiovascular emergencies; the pathophysiology of respiration and perfusion; signs and symptoms of the most common cardiac conditions; the indications, contraindications, and use of automated external defibrillators (AEDs); and the general care of a patient experiencing a cardiac emergency. The student should also be able to apply this fundamental knowledge to patient assessment and management during in-classroom scenarios.

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:

ÉChest pain (pp 5256555)

ÉCardiac arrest (pp 5256530, 5456555)

Anatomy, physiology, pathophysiology, assessment, and management of:

ÉAcute coronary syndrome (pp 5256534)

 Angina pectoris (pp 5256532)

 Myocardial infarction (pp 5256534)

ÉAortic aneurysm/dissection (pp 5256530, 5376538)

ÉThromboembolism (pp 5256532)

ÉHeart failure (pp 5256530, 5356537)

ÉHypertensive emergencies (pp 5256530, 5376538)

Knowledge Objectives

1. Understand the basic anatomy and physiology of the cardiovascular system. (pp 5256530)
2. Describe the anatomy, physiology, pathophysiology, assessment, and management of angina pectoris. (pp 5256532)
3. Describe the anatomy, physiology, pathophysiology, assessment, and management of thromboembolism. (pp 5256532)

4. Describe the anatomy, physiology, pathophysiology, assessment, and management of myocardial infarction. (pp 5256534)
5. Understand the anatomy, signs and symptoms, and management of hypertensive emergencies. (pp 5256530, 5376538)
6. Describe the anatomy, physiology, pathophysiology, assessment, and management of aortic aneurysm/dissection. (pp 5256530, 5376538)
7. Discuss the pathophysiology of the cardiovascular system. (pp 5316538)
8. Understand the relationship between airway management and the patient with cardiac compromise. (p 538)
9. Explain patient assessment procedures for cardiovascular problems. (pp 5386543)
10. Give the indications and contraindications for the use of nitroglycerin. (pp 5426544)
11. Recognize that many patients will have had cardiac surgery and may have implanted pacemakers. (pp 5446545)
12. Define cardiac arrest. (p 545)
13. Give the indications and contraindications for use of an automated external defibrillator (AED). (pp 5456547)
14. Explain the relationship of age and weight to defibrillation. (p 546)
15. Discuss the different types of AEDs. (pp 5466547)
16. Give the advantages of using AEDs. (pp 5466547)
17. Describe the difference between the fully automated and the semiautomated defibrillator. (pp 5466547)
18. Explain the use of remote, adhesive defibrillator pads. (pp 5466547)
19. Recognize that not all patients in cardiac arrest require an electric shock. (pp 5466547)
20. Explain the circumstances that may result in inappropriate shocks from an AED. (pp 5466547)
21. 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 547)
22. Understand the reasons for early defibrillation. (p 548)
23. Describe AED maintenance procedures. (pp 5486550)
24. Explain the role played by medical direction in the use of AEDs. (p 550)
25. Understand the importance of practice and continuing education with the AED. (p 550)
26. Explain the need for a case review of each incident in which an AED is used. (p 550)
27. Understand quality improvement goals relating to AEDs. (p 550)
28. Discuss the procedures to follow for standard operation of the various types of AEDs. (pp 5506554)
29. Describe the emergency medical care for the patient with cardiac arrest. (pp 5506555)
30. Describe the components of care following AED shocks. (pp 5536554)
31. Explain criteria for transport of the patient for advanced life support (ALS) following CPR and defibrillation. (p 555)
32. Discuss the importance of coordinating with ALS personnel. (p 555)

Skills Objectives

1. Demonstrate how to assess and provide emergency medical care for a patient with chest pain or discomfort. (pp 5386543)
2. Demonstrate the administration of nitroglycerin. (pp 5426544, Skill Drill 14-1)
3. Demonstrate how to perform maintenance of an AED. (pp 5486550)
4. Demonstrate how to perform AED and CPR. (pp 5516553, Skill Drill 14-2)

Lecture

I. Introduction

- A. Cardiovascular disease has been the leading killer of Americans since 1900, accounting for about 1 of every 2.8 deaths.**
- B. EMS can help reduce deaths by providing the following services:**
1. Encouragement of people to follow a healthy lifestyle
 2. Early access
 3. More CPR training of laypeople
 4. Public access to defibrillation devices
 5. Recognition of the need for ALS

II. Anatomy and Physiology

- A. It is important for EMTs to understand cardiovascular structure and function.**
1. The heart's job is to pump blood to supply oxygen-enriched red blood cells to the tissues of the body.
 2. The heart is divided down the middle into left and right sides, each with an upper chamber (atrium) to receive incoming blood and a lower chamber (ventricle) to pump outgoing blood.
 - a. Right side of the heart pumps oxygenated blood to the lungs.
 - b. Left side of the heart pumps oxygenated blood to the body and is more muscular than the right.
 3. Blood leaves each of the four chambers of the heart through one-way valves, which keep the blood moving through the circulatory system in the proper direction.
 4. The aorta, the body's main artery, receives blood ejected from the left ventricle and delivers it to all other arteries that supply the body's tissues.
- B. The heart's electrical system controls heart rate and coordinates the work of the atria and ventricles.**
1. The heart generates its own electrical impulse, starting at the sinus node.
 2. The impulse passes from the atria to the ventricles.
- C. The cardiac muscle is known as the myocardium.**

1. Automaticity allows spontaneous contraction without a stimulus from a nerve source.
 - a. As long as impulses come from the sinoatrial node, the other myocardial cells will contract when the impulse reaches them.
 - b. If no impulse arrives, however, the other cells are capable of creating their own impulses and stimulating a contraction.

D. The autonomic nervous system (ANS) controls involuntary activities of the body.

1. The ANS has two parts, which normally balance one another.
 - a. Sympathetic nervous system
 - i. The "fight-or-flight" system
 - ii. Speeds up heart rate; increases respiratory rate and depth; dilates blood vessels in the muscles; and constricts blood vessels in the digestive system
 - iii. In times of stress, this system gains primary control.
 - b. Parasympathetic nervous system
 - i. Slows various bodily functions down
 - ii. Slows heart and respiratory rates; constricts blood vessels in the muscles; and dilates blood vessels in the digestive system
 - iii. In times of relaxation, this system gains primary control.

E. The myocardium must have a continuous supply of oxygen and nutrients to pump blood.

1. Increased oxygen demand during periods of physical exertion is supplied by the dilation (widening) of the coronary arteries.

F. Stroke volume describes the volume of blood ejected with each ventricular contraction.

1. Increased stroke volume results in increased cardiac output.

G. The coronary arteries are blood vessels that supply blood to heart muscle.

1. They start at the first part of the aorta, just above the aortic valve.
2. The right coronary artery supplies blood to the right ventricle and, usually, the inferior wall of the left ventricle.
3. The left coronary artery divides into two major branches, which both supply the left ventricle.

H. The arteries supply oxygenated blood to different parts of the body.

1. The right and left carotid arteries supply the head and brain.
2. The subclavian arteries supply the upper extremities.
3. The brachial artery supplies the arms.
4. The radial and ulnar arteries supply the hands.
5. The right and left iliac arteries supply the groin and pelvis.
6. The right and left femoral arteries supply the legs.
7. The anterior and posterior tibial and peroneal arteries supply the feet.

I. The arterioles and capillaries are smaller vessels that receive blood from the arteries.

1. Capillaries are one-cell thick.
 - a. Exchange nutrients and oxygen for waste at the cellular level
 - b. Connect arterioles to venules

J. The venules and veins receive blood from the capillaries.

1. Venules are the smallest branches of the veins.
2. Vena cavae return oxygen-poor blood to the heart.
 - a. Superior (upper) vena cava carries blood from the head to the arms back to the right atrium.
 - b. Inferior (lower) vena cava carries blood from the abdomen, kidneys, and legs back to the right atrium.

K. Blood consists of several types of cells and fluid.

1. Red blood cells carry oxygen and remove carbon dioxide.
2. White blood cells fight infection.
3. Platelets help blood to clot.
4. Plasma is the fluid that cells float in.

L. Blood pressure is defined as the pressure of circulating blood against artery walls.

1. Systolic blood pressure is the maximum pressure generated by the left ventricle as it contracts.
 - a. The top number in a blood pressure reading
2. Diastolic blood pressure is the pressure against artery walls while the left ventricle is at rest.
 - a. The bottom number in a blood pressure reading

M. A pulse is felt when blood passes through an artery during systole.

1. Peripheral pulses are felt in the extremities (eg, radial and posterior tibial).
2. Central pulses are felt near the trunk of the body (eg, femoral and carotid).

N. Cardiac output is defined as the volume of blood that passes through the heart in 1 minute.

1. Calculated by multiplying the heart rate by the volume of blood ejected with each contraction (stroke volume)
 - a. In the field, stroke volume can be roughly determined by the strength of a patient's pulse.

O. Perfusion describes the constant flow of oxygenated blood to the tissues.

1. Good perfusion requires the following:
 - a. A well-functioning heart
 - i. Appropriate heart rate allows the proper volume of blood to be circulated
 - b. An adequate volume of blood
 - i. Reduced volume (eg, through hemorrhage) limits the amount of tissue that can be perfused.
 - c. Blood vessels must be appropriately constricted to match the volume of blood available.
 - i. Dilated blood vessels mean reduced perfusion.
2. If perfusion fails, cellular death occurs, and, eventually, the patient will die.

III. Pathophysiology

A. Heart-related chest pain usually stems from ischemia, which is decreased blood flow to the heart or inefficient supply of oxygen and nutrients.

1. Ischemic heart disease involves a decrease in blood flow to one or more portions of the heart muscle.
2. If the blood flow is not restored, the tissue dies.

B. Atherosclerosis is a disorder in which calcium and cholesterol build up and form a plaque inside the walls of blood vessels.

1. It can cause complete occlusion or blockage of a coronary artery and other arteries of the body.
2. Fatty material accumulates as a person ages, resulting in the narrowing of the lumen (inside diameter of the artery).
 - a. The inner wall of the artery becomes rough and brittle.
 - b. If a brittle plaque develops a crack (for unknown reasons), the ragged edge of the crack activates the blood-clotting system, resulting in a blood clot that will partially or completely block the lumen of the artery.
3. A thromboembolism is a blood clot that floats through the blood vessels.
 - a. If it reaches an area too narrow for it to pass, it stops and blocks blood flow at that point.
 - b. Tissues downstream from the blood clot will suffer from ischemia.
 - c. If too much time passes before blood flow is resumed, the tissues will die.
 - d. This sequence of events is known as acute myocardial infarction (AMI), a classic heart attack.
 - i. "Infarction" means the death of tissue.
 - e. The death of heart muscle can severely diminish the heart's ability to pump, called cardiac arrest.
4. In the United States, coronary artery disease is the number one cause of death for men and women.
 - a. The peak incidence of heart disease is between 40 and 70 years, but it can strike in individuals ranging from their teens to their 90s.
5. Risk factors place a person at higher risk for an AMI.
 - a. Major controllable risk factors:
 - i. Cigarette smoking
 - ii. High blood pressure
 - iii. Elevated cholesterol level
 - iv. Elevated blood glucose level (diabetes)
 - v. Lack of exercise
 - vi. Stress
 - b. Major uncontrollable risk factors:
 - i. Older age
 - ii. Family history
 - iii. Male sex

C. Acute coronary syndrome (ACS) describes a group of symptoms caused by myocardial ischemia.

1. This includes temporary myocardial ischemia, resulting in angina pectoris or a more serious condition, an AMI.

D. Angina pectoris occurs when the heart's need for oxygen exceeds the available supply, usually during physical or emotional stress.

1. It can result from a spasm of an artery, but is most often a symptom of atherosclerotic coronary artery disease.
 - a. May be triggered by large meal or sudden fear
 - b. When increased oxygen demand goes away, the pain typically goes away
2. Angina pain is typically described as crushing, squeezing, or "like somebody is standing on my chest."

- a. Usually felt in the midportion of the chest, under the sternum
 - b. Can radiate to the jaw, arms (frequently the left arm), midback, or epigastrium (the upper-middle region of the abdomen)
 - c. Usually lasts from 3 to 8 minutes but rarely longer than 15 minutes
 - d. May be associated with shortness of breath, nausea, or sweating
 - e. Disappears promptly with rest, supplemental oxygen, or nitroglycerin
3. Although angina does not usually lead to death or permanent heart damage, it is a warning sign that should be taken seriously.
 4. Unstable angina occurs in response to fewer stimuli than ordinarily required to produce angina.
 5. Stable angina responds to rest or nitroglycerin (see *Skill Drill 14-1*).
 6. Patients experiencing chest pain should always be treated as if they are having an AMI.

E. The pain of AMI signals the actual death of cells in the area of the heart where blood flow is obstructed.

1. Once dead, the cells cannot be revived.
 - a. They will turn to scar tissue and become a burden to the beating heart.
 - b. About 30 minutes after blood flow is cut off, some heart muscles begin to die.
 - c. After about 2 hours, as many as half of the cells in the area may be dead.
 - d. After 4 to 6 hours, more than 90% of the cells will be dead.
2. Opening the coronary artery with either clot-busting (thrombolytic) drugs or angioplasty (mechanical clearing of the artery) can prevent damage if it is done within the first hour after the onset of symptoms.
3. Immediate transport is essential.
4. It is more likely to occur in the left ventricle.
 - a. More muscular than the right, so it requires more blood and oxygen
5. Signs and symptoms of AMI include the following:
 - a. Sudden onset of weakness, nausea, and sweating
 - b. Chest pain that does not change with each breath
 - c. Pain in the lower jaw, arms, back, abdomen, or neck
 - d. Irregular heartbeat and syncope (fainting)
 - e. Shortness of breath (dyspnea)
 - f. Pink, frothy sputum
 - g. Sudden death
6. The pain of AMI differs from the pain of angina in three ways:
 - a. It may or may not be caused by exertion and can occur at any time, sometimes when a person is sitting quietly or even sleeping.
 - b. It does not resolve in a few minutes; rather, it can last between 30 minutes and several hours.
 - c. It may or may not be relieved by rest or nitroglycerin.
7. Not all patients who are having an AMI experience pain or recognize when it occurs.
 - a. When called to a scene where the chief complaint is chest pain, complete a thorough assessment, no matter what the patient says.
8. Physical findings of AMI and cardiac compromise include the following:

- a. General appearance
 - i. Frightened
 - ii. Nausea, vomiting, and a cold sweat
 - iii. Pale or ashen gray skin
 - iv. Cyanosis
 - b. Pulse rate
 - i. Increases in response to pain, stress, fear, or injury to the myocardium
 - ii. Irregularity or slowing due to arrhythmias
 - iii. Bradycardia due to damage to inferior area of the heart
 - c. Blood pressure
 - i. May decrease due to diminished cardiac output and left ventricle function
 - ii. Most AMI patients will have a normal or elevated BP.
 - d. Respirations
 - i. Usually normal
 - ii. If the patient has congestive heart failure (CHF), they may be rapid and labored.
 - e. Mental status
 - i. Overwhelming feelings of impending doom: "I think I am going to die."
9. An AMI can have three serious consequences:
- a. Sudden death
 - b. Cardiogenic shock
 - c. CHF

F. Arrhythmias describe an abnormality of the heart rhythm.

1. Premature ventricular contractions are extra beats in a damaged ventricle.
 - a. Harmless and common among healthy as well as sick people
2. Tachycardia describes rapid beating of the heart, at 100 beats/min or more.
3. Bradycardia describes unusually slow beating of the heart, at 60 beats/min or less.
4. Ventricular tachycardia describes a very rapid heart rhythm, at 150 to 200 beats/min.
 - a. May deteriorate into ventricular fibrillation
5. Ventricular fibrillation describes the disorganized, ineffective quivering of ventricles.
 - a. No blood is pumped through the body, and the patient usually becomes unconscious within seconds.
 - b. Defibrillation may convert this arrhythmia.

G. Defibrillation is the process of shocking the heart with a specialized electrical current to restore normal cardiac rhythms.

1. It can save lives if shocks are delivered within the first few minutes of sudden death.
2. CPR must be initiated until a defibrillator is available.
3. Chances of survival diminish 10% each minute until defibrillation is accomplished.

H. Asystole is the absence of all heart electrical activity.

1. It usually reflects a long period of ischemia.
2. Nearly all patients with asystole will die.

I. Cardiogenic shock occurs when body tissues do not get enough oxygen, causing body organs to malfunction.

1. It is often caused by a heart attack.
2. The heart lacks the power to force enough blood through the circulatory system.
3. It is more common in an AMI affecting the inferior and posterior regions of the left ventricle.
4. It is important to recognize shock in its early stages.

J. CHF often occurs within the first few days after a heart attack.

1. CHF develops when increased heart rate and enlargement of the left ventricle no longer make up for decreased heart function (eg, due to diseased heart valves or chronic hypertension).
2. It is called "congestive" because lungs become congested with fluid (pulmonary edema) once the heart fails to pump effectively.
 - a. Occurs suddenly or slowly over months
 - b. In acute-onset CHF, severe pulmonary edema is accompanied by pink, frothy sputum and severe dyspnea.
3. Fluid may also collect in other parts of the body (dependent edema), such as in the feet and legs.

K. Hypertensive emergencies involve any systolic blood pressure greater than 160 mm Hg or a rapid increase in the systolic pressure.

1. Sudden, severe headache is a common sign.
2. Other symptoms include the following:
 - a. Strong, bounding pulse
 - b. Ringing in the ears
 - c. Nausea and vomiting
 - d. Dizziness
 - e. Warm skin (dry or moist)
 - f. Nosebleed
 - g. Altered mental status
 - h. Sudden development of pulmonary edema
3. Untreated hypertensive emergencies can lead to stroke or dissecting aortic aneurysm.
4. Transport patients to the hospital as quickly and safely as possible.
 - a. Consider ALS assistance, depending on transport distance and time

L. Aortic aneurysm describes a weakness in the wall of the aorta.

1. It is susceptible to rupture.
 - a. If it ruptures, blood loss will cause the patient to die almost immediately.
2. A dissecting aneurysm occurs when inner layers of the aorta become separated, allowing blood to flow at high pressure between the layers.
3. Uncontrolled hypertension is the primary cause.
4. Signs and symptoms include the following:
 - a. Very sudden chest pain located in the anterior part of the chest or in the back between the shoulder blades
 - b. Pain that usually comes on full force from one minute to the next
 - c. Sometimes, a difference in blood pressure between arms or diminished pulses in the lower extremities

5. Transport patients to the hospital as quickly and safely as possible.

IV. Patient Assessment

A. Scene size-up

1. Ensure scene safety.
 - a. Ensure the scene is safe for you, your partner, your patient, and bystanders.
 - b. Determine the necessary standard precautions and whether you will need additional resources to assist in moving the patient(s).
2. Determine the mechanism of injury (MOI)/nature of illness (NOI).
 - a. Use information from the dispatcher, clues at scene, and the comments of family members and bystanders.

B. Primary assessment

1. Form a general impression.
 - a. If the patient is unresponsive, evaluate the ABCs and assess for AED use (apply to pulseless, apneic, and unresponsive patients).
2. Assess the patient's airway and breathing.
 - a. If dizziness or fainting has occurred due to cardiac compromise, consider the possibility of a spinal injury from a fall.
 - b. Assess breathing to determine whether the ailing heart is receiving adequate oxygen.
 - i. Shortness of breath, with no signs of respiratory distress
 - (a) Apply oxygen with a nonrebreathing mask at 10 to 15 L/min.
 - ii. Not breathing or inadequate breathing
 - (a) Apply 100% oxygen with a bag-mask device
 - iii. Pulmonary edema
 - (a) Positive-pressure ventilation with a bag-mask device or continuous positive airway pressure (CPAP)
3. Assess the patient's circulation.
 - a. Pulse rate and quality
 - b. Skin color, moisture, and temperature
 - c. Capillary refill time
 - d. Begin treatment for cardiogenic shock early to reduce the workload of the heart.
 - e. Position the patient sitting up and well supported.
 - f. Manage bleeding.
4. Make a transport decision.
 - a. Stabilize life threats, then determine if immediate transport is necessary.
 - i. Most patients with chest pain should be transported immediately.
 - ii. Follow local protocol for determining what receiving facility is most appropriate (ie, the nearest facility or a medical center with special capabilities).
 - b. Determine whether to use the lights and siren for each patient, partially based on estimated transport time.
 - c. As a general rule, patients with cardiac problems should be transported in the most gentle, stress-relieving manner possible.

C. History taking

1. Investigate the chief complaint.

- a. Because patients experiencing AMI will have different signs and symptoms, seriously consider all complaints of chest pain, shortness of breath, and dizziness.
 - b. If the patient is having respiratory difficulty:
 - i. Is it due to exertion or related to the patient's position?
 - ii. Is it continuous or does it change (eg, with deep breathing)?
 - c. If the patient has a cough:
 - i. Does it produce sputum?
 - d. Does the patient have nausea and vomiting, fatigue, headache, and/or palpitations?
 - e. Ask about recent past trauma.
2. Obtain the SAMPLE history from a conscious patient.
- a. Has the patient ever had a heart attack?
 - b. Has the patient been told that he or she has heart problems?
 - i. Angina, heart failure, or heart valve disease
 - ii. High blood pressure
 - iii. Aneurysm
 - c. Has the patient been told that he or she has other related medical problems?
 - i. Emphysema or chronic bronchitis
 - ii. Diabetes or other blood sugar problems
 - iii. Kidney disease
 - d. Does the patient have any risk factors for coronary artery disease?
 - i. Smoking
 - ii. High blood pressure
 - iii. High-stress lifestyle
 - iv. Family history of heart disease
 - v. Current medications
 - e. What are the patient's signs and symptoms?
 - f. Has the patient had the same pain before?
 - i. What medication(s) does the patient currently take?
 - (a) Does the patient have the medication(s) with him or her?
 - ii. Has the patient experienced a heart attack or angina?
 - (a) Is the pain similar?
 - g. What allergies does the patient have?
 - h. Is the patient taking medications?
 - i. Prescribed
 - (a) For what condition?
 - ii. Over the counter
 - iii. Recreational
3. Include the OPQRST mnemonic for assessing pain as part of the SAMPLE history:
- a. **O**nset
 - b. **P**rovocation/palliation
 - c. **Q**uality
 - d. **R**egion/radiation
 - e. **S**everity
 - f. **T**iming

D. Secondary assessment

1. Perform a focused physical examination.
 - a. Focus on the cardiac and respiratory systems.
 - i. Circulation
 - (a) Skin color
 - (b) Skin temperature
 - (c) Skin condition
 - ii. Respirations
 - (a) Are lung sounds clear?
 - (b) Are breath sounds equal?
 - (c) Are neck veins distended?
 - (d) Is the trachea deviated or midline?
2. Obtain a complete set of vital signs.
 - a. Airway, breathing, and circulation (ABCs)
 - b. Systolic and diastolic blood pressures
 - c. If available, use pulse oximetry.
 - d. If continuous blood pressure monitoring is available, use it as well.
 - e. Repeat at appropriate intervals and note the time that each set of vital signs is taken.

E. Reassessment

1. Reassess vital signs every 5 minutes or any time significant changes in the patient's condition occur.
2. Sudden cardiac arrest is always a risk with patients experiencing a cardiovascular emergency.
3. Provide interventions (see *Skill Drill 14-1*).
 - a. Ensure a proper position of comfort.
 - i. Allow patients to sit up if most comfortable.
 - ii. Loosen tight clothing.
 - b. Give oxygen.
 - i. Use nasal cannula for patients with mild dyspnea.
 - ii. Use nonrebreathing face mask for patients with more serious respiratory difficulty.
 - c. Assist unconscious patients with breathing as well as those with respiratory distress.
 - i. Use bag-mask device or positive-pressure ventilation device, according to local protocols.
 - d. Depending on protocol:
 - i. Administer low-dose aspirin.
 - (a) Effects:
 - (1) Prevents blood clots from forming or getting bigger
 - (b) 81-mg chewable tablets
 - (c) Recommended dose: 162 mg (two tablets) to 324 mg (four tablets)
 - ii. Assist the patient with prescribed nitroglycerin after obtaining permission from medical control.
 - (a) Mechanism of action:
 - (1) Relaxes blood vessel wall muscles
 - (2) Increases blood flow and oxygen supply to heart
 - (3) Decreases workload of heart
 - (4) Dilates blood vessels
 - (b) Side effects:
 - (1) May cause change in patient's pulse rate (eg, tachycardia or bradycardia)
 - (c) Available forms:
 - (1) Sublingual pill

- (2) Sublingual spray
- (3) Skin patch applied to chest
- (d) Indications:
 - (1) Ischemic pain
 - (2) Pulmonary edema
 - (3) Acute angina pectoris
 - (4) CHF
- (e) Contraindications:
 - (1) After administering nitroglycerin, if the patient's blood pressure is less than 100 mm Hg, do not administer more medication.
 - (2) Presence of head injury
 - (3) Use of erectile dysfunction drugs within 24 hours
 - (4) Maximum prescribed dose has already been given (usually 3 doses)
- e. Make sure medications are neither expired nor contaminated before administering them to the patient.
- f. Make sure prescription medications are prescribed for the patient.
- g. Wear gloves when administering medication.
- h. If cardiac arrest occurs:
 - i. Perform CPR immediately until an AED is available.
- 4. Reassess your interventions.
- 5. Provide rapid patient transport if not performed already.
- 6. Communication and documentation
 - a. Alert the emergency department about the patient's condition and estimated time of arrival.
 - b. Report to the hospital while en route.
 - i. SAMPLE history
 - ii. OPQRST
 - iii. Vital signs
 - iv. Reassessment of vital signs
 - v. Medications taken
 - vi. Prehospital treatment
 - c. Document your assessment and interventions.

V. Heart Surgeries and Pacemakers

- A. Over the last 20 years, hundreds of thousands of open-heart operations were performed to bypass damaged segments of coronary arteries in the heart.**
- B. In the coronary artery bypass graft (CABG) operation, a blood vessel from the chest or leg is sewn directly from the aorta to a coronary artery beyond the point of obstruction.**
- C. Percutaneous transluminal coronary angioplasty (PTCA) involves the following steps:**
 - 1. A tiny balloon is attached to the end of a long, thin tube.
 - 2. The tube is threaded into the narrowed coronary artery and inflated.
 - 3. The balloon is then deflated, and the tube and balloon are removed.
- D. Patients who have had a bypass procedure may or may not have a long scar on the chest.**
- E. Treat chest pain in a patient who has had any of these procedures in the same way you would treat chest pain in patients who have not had heart surgery.**

F. Some people have cardiac pacemakers.

1. Pacemakers help maintain a regular cardiac rhythm and rate.
2. They are inserted when the electrical system of the heart is so damaged that it cannot function properly.
3. These battery-powered devices deliver an electrical impulse through wires that are in direct contact with the myocardium.
4. The generating unit typically resembles a silver dollar and is usually placed under a heavy muscle or fold of skin in the left upper portion of the chest.
5. EMTs normally do not need to be concerned about problems with pacemakers.
6. When they do not function properly, pacemakers can cause a patient to experience syncope, dizziness, or weakness due to an excessively slow heart rate.
7. The pulse will ordinarily be less than 60 beats/min.
8. A patient with a malfunctioning pacemaker should be promptly transported to the emergency department.
9. When an AED is used, place the pads 1 from the pacemaker.

G. Automatic implantable cardiac defibrillators (AICDs) are sometimes used by patients who have survived cardiac arrest due to ventricular fibrillation.

1. These devices continuously monitor the heart rhythm and deliver shocks as needed.
2. Treat these patients like all other patients having an AMI, including performing CPR and using an AED if the patient goes into cardiac arrest.
3. The electricity from an AICD is so low that it will have no effect on responders.
4. Do not place AED patches over the pacemaker.

VI. Cardiac Arrest

A. Cardiac arrest is the complete cessation of cardiac activity—electrical, mechanical, or both.

1. It is indicated in the field by the absence of a carotid pulse.
2. Cardiac arrest was almost always terminal until the advent of CPR and external defibrillation in the 1960s.

B. Automated external defibrillation involves the use of a small computer (an automated external defibrillator [AED]) that analyzes electrical signals from the heart.

1. It identifies ventricular fibrillation and is extremely accurate.
2. It administers a shock to the heart when needed.
3. AEDs come in different models.
 - a. All models require some operator interaction (ie, applying the pads, turning on the machine).
 - b. The operator must push a button to deliver an electrical shock.
 - c. Most use a computer voice synthesizer to advise the EMT which steps to take.
 - d. The vast majority of the AEDs are semiautomated.
 - e. Shocks may be monophasic or biphasic.
 - i. Biphasic produces more efficient defibrillation and may require a lower energy setting.

4. Potential problems associated with AED use include the following:
 - a. Batteries can potentially die. Check the AED daily and exercise the battery as often as the manufacturer recommends to avoid a dead battery.
 - b. If the patient is moving, the computer may be unable to tell the difference between electrical signals from the heart and electrical signals from the arms and chest muscles.
 - i. Apply the AED only to pulseless, unresponsive patients.
 - c. The computer can become confused by a heart rhythm that is faster than normal but that should not be shocked. Most computers identify a regular rhythm faster than 150 to 180 beats/min as ventricular tachycardia, which should be shocked.
5. Advantages of AED use include the following:
 - a. Quick delivery of an electrical shock
 - b. Easier than performing CPR
 - c. No need for ALS providers to be on the scene
 - d. Remote, adhesive defibrillator pads, which are safer than paddles
 - e. Larger pad area than paddles, which means that the transmission of electricity is more efficient
6. Other considerations when using AEDs include the following:
 - a. Not all patients in cardiac arrest require electrical shock.
 - b. All patients in cardiac arrest should be analyzed with an AED; some do not have shockable rhythms.
 - c. Asystole (flatline) indicates that no electrical activity remains.
 - d. Pulseless electrical activity usually refers to a state of cardiac arrest despite an organized electrical complex.
7. Early defibrillation is an essential intervention for patients experiencing cardiac arrest.
 - a. Few patients who experience sudden cardiac arrest outside of a hospital survive unless a rapid sequence of events takes place.
 - b. Links in the chain of survival include:
 - i. Recognition of early warning signs and immediate activation of EMS
 - ii. Early CPR
 - iii. Early defibrillation
 - iv. Early advanced cardiac life support
 - v. Integrated post-arrest care
 - c. CPR helps patients in cardiac arrest by prolonging the period during which defibrillation can be effective.
 - d. Rapid defibrillation has successfully resuscitated many patients in cardiac arrest from ventricular fibrillation.
 - e. Defibrillation works best if it takes place within 2 minutes of the onset of the cardiac arrest.
 - f. Nontraditional responders are being trained to use AED.
8. When integrating the AED and CPR into patient care, keep the following in mind:
 - a. It is important to work the AED and CPR in sequence.
 - b. Do not touch the patient while the AED is analyzing the heart rhythm and delivering shocks.
 - c. CPR must stop while the AED is performing its job.
9. AED maintenance is important.
 - a. Become familiar with the maintenance procedures required for the brand of AED your service uses.
 - b. Read the operator's manual.
 - c. Document AED failure, which will aid communication with an EMS administrator, the medical director, the media, or a patient's attorney

- d. Make sure the battery is properly maintained.
 - e. Check your equipment, including your AED, at the beginning of each shift.
 - f. Ask the manufacturer for a checklist of items that should be checked daily, weekly, or less often.
 - g. Report any AED failure that occurs while caring for a patient to the manufacturer and to the US Food and Drug Administration (FDA).
 - h. Be sure to follow local protocol for notifying these organizations.
10. Medical direction should either teach you how to use the AED or approve the written protocol for its use.
- a. The EMT team and your service's medical director or quality improvement officer should review each incident in which the AED is used.
 - b. Quality improvement involves both the individuals using AEDs and the responsible EMS system managers.
 - c. Reviews should focus on speed of defibrillation (ie, the time from the call to the shock).
 - d. Shocks should be delivered within 1 minute.
 - e. Mandatory continuing education with skill competency review is generally required every 3 to 6 months for EMTs.

VII. Emergency Medical Care for Cardiac Arrest

A. When preparing to use an AED, it is the EMT's job to make sure that the electricity from the AED injures no one.

- 1. Do not defibrillate patients in pooled water; electricity will diffuse through the pooled water.
 - a. You can defibrillate a soaking wet patient, but dry the patient's chest.
- 2. Do not defibrillate patients who are touching metal.
- 3. 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.
- 4. It is often helpful to shave a hairy patient's chest before pad placement to increase conductivity.
- 5. Determine the patient's NOI and/or MOI.
 - a. Perform spinal stabilization for trauma patients during the primary assessment.

B. Follow local protocols for AED use (see Skill Drill 14-2).

C. Follow local protocols for patient care following AED use.

- 1. After the AED protocol is completed, one of the following is likely:
 - a. Pulse is regained.
 - b. Pulse is not regained, and the AED indicates that no shock is advised.
 - c. Pulse is not regained, and the AED indicates that a shock is advised.
- 2. If ALS is responding to the scene, stay where you are and continue the sequence of shocks and CPR.
- 3. If ALS is not responding to the scene and protocols agree, begin transport when one of the following occurs:
 - a. The patient regains a pulse.
 - b. Six to nine shocks are delivered (or as directed by local protocol).
 - c. The machine gives three consecutive messages (separated by 2 minutes of CPR) that no shock is advised (or as directed by local protocol).

D. Transport considerations include the following:

1. If you perform CPR during transport, it is ideal to have two EMTs in the patient compartment while a third drives.
2. Additional shocks may be delivered at the scene or en route with the approval of medical control.
3. AEDs cannot analyze rhythm while the vehicle is in motion.
 - a. Do not defibrillate in a moving ambulance (for safety reasons as well).
 - b. Come to a complete stop if more shocks are ordered.

E. Coordinate with ALS personnel according to your local protocols.

1. If you have an AED available, do not wait for paramedics to arrive.
2. Notify ALS personnel as soon as possible after you recognize a cardiac arrest.
3. Do not delay defibrillation.

VIII. Summary

- A. The heart is divided into the right and left sides, each with an upper chamber called the atrium and a lower chamber called the ventricle.
- B. The aortic valve keeps blood moving through the circulatory system in the proper direction.
- C. The heart's electrical system controls heart rate and coordinates the work of the atria and ventricles to pump blood.
- D. To supply the myocardium with more oxygen during periods of exertion or stress, the coronary arteries dilate to increase blood flow.
- E. The carotid, femoral, brachial, radial, posterior tibial, and dorsalis pedis arteries provide pulses.
- F. Coronary artery atherosclerosis is the buildup of cholesterol plaques inside blood vessels that may eventually lead to occlusion, resulting in cardiac compromise.
- G. AMI, or heart attack, occurs when heart tissue downstream of a blood clot suffers from a lack of oxygen and, within 30 minutes, begins to die.
- H. Angina pain occurs when heart tissues do not receive enough oxygen but are not yet dying. The pain of an AMI is different from the pain of angina.
- I. Signs of AMI include crushing chest pain; sudden onset of weakness, nausea, and sweating; sudden arrhythmia; pulmonary edema; and even sudden death.
- J. Sudden death is one serious consequence of heart attacks, usually from cardiac arrest caused by arrhythmias (eg, tachycardia, bradycardia, ventricular tachycardia, and, most commonly, ventricular fibrillation).
- K. Symptoms of cardiogenic shock, caused by heart attack, include restlessness; anxiety; pale, clammy skin; increased pulse rate; and decreased blood pressure.
- L. CHF, caused by heart attack, occurs when damaged heart muscle can no longer contract effectively enough to pump blood.
- M. Treat a patient with CHF by monitoring vital signs. Give oxygen via nonrebreathing face mask. Allow the patient to remain sitting up.

- N. For patients with chest pain, obtain a SAMPLE history; follow the OPQRST mnemonic to assess the pain; measure vital signs; ensure the patient is in a comfortable position; administer prescribed nitroglycerin and oxygen; and transport the patient.**
- O. The three most common errors in using certain AEDs are failure to keep a charged battery in the machine, applying the AED to moving or squirming patient, and applying the AED to a responsive patient with a rapid heart rate.**
- P. Do not touch the patient while an AED is analyzing the heart rhythm or delivering shocks.**
- Q. Effective CPR and early AED use are critical to cardiac arrest patient survival.**
- R. The chain of survival includes recognition of early warning signs and immediate activation of EMS, immediate CPR by bystanders, early defibrillation, early advanced care, and integrated post-arrest care. Seconds count at every stage.**

Post-Lecture

Unit Assessment

1. Which side of the heart receives oxygenated blood from the lungs?
2. What is the function of the red blood cell?
3. What causes chest pain?
4. In what condition does plaque build up in the walls of blood vessels?
5. What controllable risk factors place a person at high risk for myocardial infarction?
6. Typically, how long does the pain from angina last?
7. In which ventricle is an AMI more prone to occur?
8. What percentage of AMI patients do not reach the hospital due to sudden death?
9. What is the cause of cardiogenic shock?
10. What are causes of error with an AED?

Knowledge Objectives

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