Chapter 17, Cardiovascular Emergencies

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1. Introduction to Cardiovascular Emergencies and the Cardiovascular System

- Cardiovascular disease is the leading cause of death in America, accounting for one in three deaths [5].
- EMS plays a crucial role in reducing these deaths [6].
- This includes promoting healthy lifestyles and early medical care access [6].
- Increased CPR training for the public is also important [6].
- Utilizing evolving technology in dispatch for cardiac arrest response helps [6].
- Public access to defibrillation devices is a key factor [6].
- Recognizing the need for advanced life support care is vital [7].
- The use of cardiac specialty centers is also beneficial [7].

Component	Function
Heart	Pumps blood to supply oxygen and nutrients to body tissues [9]
Atrium (Upper Chamber)	Receives incoming blood [10]

Ventricles (Lower Chambers)	Pump outgoing blood [10]
Valves	Keep blood flowing in the proper direction [12]
Aorta	Receives blood from the left ventricle and distributes it to arteries [13]
Coronary Arteries	Supply blood to the heart muscle [24]
Arteries	Supply oxygenated blood to different body parts [27]
Arterioles/Capillaries	Receive blood from arteries, exchange nutrients/oxygen for waste [30]
Venules/Veins	Receive blood from capillaries, return oxygen-poor blood to heart [31]
Vena Cava	Returns oxygen-poor blood to the heart [33]
Red Blood Cells	Carry oxygen and remove carbon dioxide [37]
White Blood Cells	Fight infections [38]
Platelets	Help blood to clot [39]
Plasma	Fluid that carries blood cells [39]

2. Pathophysiology of Cardiac Conditions

- Heart-related chest pain often results from **ischemia**, meaning decreased blood flow to the heart [53].
- Ischemia signifies an inefficient supply of oxygen and nutrients [53].
- **Ischemic heart disease** involves reduced blood flow to heart muscle portions [54].
- If blood flow is not restored, heart tissue will die [54].

- **Atherosclerosis** is a disorder where calcium and cholesterol form plaque inside blood vessels [55].
- This plaque can completely block a coronary artery or other arteries [56].
- Fatty material builds up with age, narrowing the blood vessel lumen [56].
- The inner artery wall becomes rough and brittle [57].
- A crack in brittle plaque activates the blood clotting system [58].
- This leads to a blood clot partially or completely blocking the artery [58].
- A **thromboembolism** is a blood clot floating through a blood vessel [59].
- If it reaches a narrow area, it stops and blocks blood flow [60].
- Tissues downstream of the clot will suffer from hypoxia [60].
- If blood flow isn't resumed, the tissues will die [61].
- This sequence is a **myocardial infarct**, or heart attack [62].
- Death of heart muscle severely reduces the heart's pumping ability [63].
- Coronary artery disease is the leading cause of death for men and women in the U.S. [64].
- Peak incidence of heart disease is between 45 and 64 years old, but it can affect people from teens to 90s [65].
- **Risk factors for AMI** can be controlled, such as smoking, high blood pressure, high cholesterol, diabetes, lack of exercise, and obesity [66].
- Uncontrollable risk factors include age, family history, race, ethnicity, and male sex [66].
- **Acute coronary syndrome** describes symptoms from myocardial ischemia [67].
- This includes temporary ischemia causing angina pectoris or the more serious acute myocardial infarct [68].
- **Angina pectoris** occurs when the heart's oxygen need exceeds supply, often during stress [69].
- It can be a spasm but is usually from atherosclerotic coronary artery disease [69].
- Angina can be triggered by a large meal or sudden fear [70].
- Pain typically goes away with rest when oxygen demand decreases [70].
- Angina pain is described as crushing, squeezing, or pressure [70].
- It's often felt in the mid-chest or under the sternum [71].
- Pain can radiate to the jaw, arms (often left), back, or epigastrum [72].
- It usually lasts 3 to 8 minutes, rarely over 15 minutes [73].

- Shortness of breath, nausea, or sweating may be associated [74].
- Rest, oxygen, or nitro usually relieve it promptly [75].
- Angina is a serious warning sign, though it doesn't usually cause death or damage [75].
- **Unstable angina** is pain without a specific increase in oxygen demand [76].
- **Stable angina** is pain from exercise or activity increasing heart demand beyond its blood flow capacity [77].
- Patients with chest pain should always be treated as if having an acute myocardial infarct [78].
- AMI pain signals the death of heart cells due to blood flow obstruction [79].
- Dead cells become scar tissue and burden the heart [80].
- Heart muscle begins to die about 30 minutes after blood flow is cut off [81].
- Half the cells may be dead after about two hours [82].
- Over 90 percent of cells may be dead after four to six hours [83].
- Opening the coronary artery with drugs or angioplasty within the first few hours can prevent permanent damage [84].
- Immediate transport is essential [84].
- AMI is more likely in the left ventricle [85].
- **Signs and symptoms of AMI** include sudden weakness, nausea, and sweating [86].
- Chest pain, discomfort, or pressure, often crushing or squeezing, is common and doesn't change with breathing [86].
- Pain may be in the jaw, arms, back, abdomen, or neck [86].
- Irregular heartbeat, syncope, shortness of breath, nausea, vomiting, pink frothy sputum, or sudden death can occur [86].
- AMI pain differs from angina: it may occur at any time (not just with exertion), can last 30 minutes to several hours, and may not be relieved by rest or nitro [87].
- Not all AMI patients experience or recognize pain [88].
- A thorough assessment is needed for chest pain complaints [88].
- **Physical findings of AMI** include a fearful or nauseated appearance [89].
- Pulse can be fast, irregular, or slow (bradycardic) [90].
- Blood pressure can be decreased, normal, or elevated [91].
- Respirations can be normal or rapid and labored [92].
- Mental status changes or feelings of impending doom may be present [93].

- **Dysrhythmias** are abnormalities of heart rhythm [94].
- **Premature ventricular contractions (PVCs)** are extra beats in a damaged ventricle [95].
- PVCs are usually harmless and common in healthy and sick people [96].
- **Tachycardia** is a rapid heartbeat, 100 beats or more a minute [97].
- **Bradycardia** is a slow heartbeat, 60 beats per minute or less [98].
- **Ventricular tachycardia** is a very rapid heart rhythm, 150 to 200 beats per minute [100].
- It can quickly deteriorate into ventricular fibrillation [101].
- **Ventricular fibrillation** is disorganized, ineffective quivering of the ventricles [102].
- No blood is pumped, and the patient becomes unconscious within seconds [102].
- Defibrillation may convert this rhythm [103].
- **Asystole** is the absence of all electrical activity [109].
- It usually reflects a long period of ischemia [110].
- Nearly all patients with asystole will die [110].

3. Specific Cardiovascular Emergencies

- **Cardiogenic shock** occurs when body tissues don't get enough oxygen due to heart malfunction [111].
- This is often caused by a heart attack [113].
- The heart lacks power to pump enough blood through the circulatory system [114].
- It is more common in AMI affecting the inferior and posterior left ventricle [114].
- Early recognition of shock is important [115].
- **Congestive heart failure (CHF)** often occurs after an AMI [116].
- CHF develops when the increased heart rate and enlarged left ventricle cannot compensate for decreased heart function [116].
- The lungs become congested with fluid (pulmonary edema) when the heart fails to pump effectively [117].
- CHF can occur suddenly or slowly over months [117].
- Acute onset CHF with severe pulmonary edema is usually accompanied by pink, frothy sputum and severe dyspnea [118].

- With **right-sided heart failure**, blood backs up in the vena cava [119].
- This causes fluid to collect in other body parts, resulting in **dependent edema** like swollen ankles, feet, and legs [120].
- Right-sided failure can lead to inadequate blood supply to the left ventricle, causing a drop in systemic blood pressure [121].
- Patients may show signs of both left and right-sided heart failure, as left-sided failure often leads to right-sided failure [122].
- **Hypertensive emergencies** involve a systolic blood pressure over 100 mmHg or a rapid increase in systolic pressure [123].
- A common sign is a sudden severe headache [124].
- Other symptoms include a strong, bounding pulse, ringing in the ears, nausea, vomiting, dizziness, warm skin, nosebleeds, altered mental status, or sudden pulmonary edema [125].
- Untreated, a hypertensive emergency can lead to a stroke or a dissecting aortic aneurysm [126].
- Patients should be transported quickly and safely [126].
- Advanced life support assistance should be considered [127].
- An **aortic aneurysm** is a weakness in the aorta wall [128].
- The aorta dilates at the weakened area, risking rupture [129].
- Rupture causes almost immediate death due to blood loss [129].
- Uncontrolled hypertension is a primary cause of **dissecting aortic aneurysm** [130].
- A dissecting aneurysm occurs when the aorta's inner lining separates, allowing high-pressure blood flow between layers [131].
- Signs include very sudden chest pain in the anterior chest or back between the shoulder blades [132].
- It may be hard to distinguish from an AMI [133].
- Immediate, safe transport is crucial [133].

Characteristic	**Acute Myocardial Infarct (AMI)** [134]	**Dissecting Aortic Aneurysm** [135]
Onset of Pain	Gradual, usually slow	Abrupt without additional symptoms
Description	Tightness or pressure	Sharp or tearing

Severity	Increases with time	Maximum on onset

4. Patient Assessment and Emergency Medical Care

- **Patient assessment** starts with **scene size-up** to ensure safety and determine the nature of the illness [136].
- Dispatch information, clues, and family/bystander comments help determine the nature of illness [137].
- In the **primary assessment**, form a general impression [138].
- If the patient is unresponsive and not breathing, start CPR and call for an AED immediately [138].
- Assess the patient's airway and breathing [139].
- If dizziness or fainting occurred due to cardiac compromise, consider spinal injury [139].
- Assess breathing to see if the heart gets adequate oxygen [140].
- If shortness of breath with no respiratory distress and SpO2 below 95%, give oxygen at 4 L/min [140].
- If not improving quickly, use a non-rebreather mask [141].
- If not breathing or breathing inadequately, use a bag-valve mask with 100% oxygen [142].
- For pulmonary edema, use positive pressure ventilations with a BVM or CPAP [142].
- Assess circulation: pulse rate and quality, skin color, nature, and temperature, and capillary refill [142].
- Consider treating for cardiogenic shock early to reduce the heart's workload [143].
- Position the patient comfortably, usually sitting up and supported [144].
- Make a transport decision based on stabilizing life threats during the primary assessment [145].
- Most patients with chest pain need immediate transport [147].
- Follow local protocol for the most appropriate receiving facility [148].
- Use lights or sirens based on estimated transport time [149].
- Transport patients with cardiac problems gently to reduce stress [149].
- **History taking** involves investigating the chief complaint [150].

- Consider all complaints of chest pain, shortness of breath, and dizziness seriously [151].
- Ask about dyspnea: is it from exertion, position-related, continuous, or does it change with breathing? [152].
- Ask about cough, sputum production, nausea, vomiting, fatigue, headache, or palpitations [152].
- Ask about recent post-trauma [152].
- Obtain a **SAMPLE history** from responsive patients [153].
- Ask if they've had a heart attack, if they have heart problems, or risk factors for coronary artery disease [154].
- Ask about allergies and medications [154].
- Use the **OPQRST mnemonic** (Onset, Provocation, Palpation, Quality, Region, Radiation, Severity, Timing) for pain assessment as part of the SAMPLE history [154].
- The **secondary assessment** focuses on cardiac and respiratory systems, circulation, and respirations for chest pain situations [157].
- Measure and record vital signs: pulse, respirations, systolic and diastolic blood pressure in both arms, and SpO2 with a pulse oximeter [158].
- Use continuous blood pressure monitoring if available [159].
- Repeat vital signs at appropriate intervals and note the time [159].
- A 12-lead ECG tracing is valuable as early as possible for chest pain patients [160].
- **Reassessment** involves repeating the primary assessment to check for improvement or deterioration [161].
- Reassess vital signs at least every five minutes or with significant changes [161].
- Sudden cardiac arrest is a risk in cardiovascular emergencies [162].
- Have an AED immediately available if cardiac arrest occurs [162].
- If no AED, perform CPR until it is available [162].
- Reassess interventions and provide transport if not already done [163].
- **Communication and documentation** are essential [164].
- Alert the emergency department about the patient's condition and ETA [165].
- Follow medical control instructions and document assessment and treatment [165].
- **Emergency medical care for chest pain** includes ensuring a proper position of comfort [168].

- Allow patients to sit up if comfortable [168].
- Loosen tight clothing [168].
- Give oxygen if indicated and continually reassess oxygen saturation and respiratory status [168].
- Use a nasal cannula for mild dyspnea, a non-rebreather for more serious difficulty [170].
- CPAP may be indicated for pulmonary edema [170].
- Assist unconscious patients or those in obvious respiratory distress with breathing [171].
- Prepare to administer low-dose aspirin and assist with prescribed nitro based on protocol [171].

5. Medications and Cardiac Monitoring

- **Aspirin** prevents new clots or prevents existing clots from getting bigger [173].
- The recommended dose is 162 to 324 mg [173].
- Low-dose aspirin is 81 mg [174].
- **Nitroglycerin (Nitro)** is available as a tablet, spray, or skin patch [175].
- Nitro relaxes blood vessel wall muscles and dilates coronary arteries [176].
- This increases blood flow and supply to the heart [176].
- It also decreases the workload of the heart [177].
- Side effects include decreased blood pressure and severe headache [178].
- **Contraindications for nitro** include systolic blood pressure less than 100 mmHg [179].
- Head injury is also a contraindication [179].
- Use of erectile dysfunction drugs within 24 to 48 hours is a contraindication [179].
- If the maximum prescribed dose (three doses) has been taken, it is contraindicated [180].
- For **cardiac monitoring** to be reliable, electrodes must be placed consistently [181].
- Basic principles for best skin contact and minimizing artifact should be followed [182].
- Shaving body hair from the electrode site may be needed [183].
- Rub the electrode site with an alcohol swab to remove oils and dead tissue

[183].

- Attach electrodes to EKG cables before placement [183].
- Confirm correct placement of electrodes on the chest or limbs [183].
- Once electrodes are in place, switch on the monitor [185].
- Print a sample rhythm strip to check for artifact [185].
- Verify that electrodes are firmly applied and the cable is plugged correctly [186].

6. Cardiac Surgeries and Assist Devices

- Open heart surgeries have been performed for decades to bypass damaged coronary arteries [187].
- In a **coronary artery bypass graft (CABG)**, a vessel from the chest or leg is sewn from the aorta to the coronary artery beyond the obstruction [188].
- **Percutaneous transluminal coronary angioplasty (PTCA)** dilates the affected artery instead of bypassing it [189].
- PTCA involves introducing a long, thin tube with a tiny balloon into a large artery [190].
- The tube is threaded into the narrowed coronary artery and the balloon is inflated [191].
- The balloon is then deflated, and the tube and balloon are removed [192].
- Sometimes a **stent** is placed inside the artery [193].
- Patients with bypass procedures may have a chest scar [194].
- Treat chest pain in patients with these procedures the same as those without [195].
- Some people have **cardiac pacemakers** to maintain regular rhythm and rate [196].
- Pacemakers are used when the heart's electrical system is damaged [197].
- These battery-powered devices deliver electrical impulses through wires contacting the myocardium [198].
- The generator is typically placed under muscle or skin in the upper chest [198].
- EMTs don't normally need to worry about pacemaker problems [199].
- Malfunctioning pacemakers can cause syncope, dizziness, or weakness due to a slow heart rate [199].
- The pulse will usually be less than 60 beats per minute [200].
- Patients with a malfunctioning pacemaker need prompt transport [200].

- AED pads should not be placed directly over a pacemaker [201].
- **Automatic implantable cardiac defibrillators (AICDs)** are used in patients who survived cardiac arrest from ventricular fibrillation [202].
- AICDs continuously monitor heart rhythm and deliver shocks when needed [202].
- Treat patients with AICDs like any AMI patient, including CPR and AED use if they go into cardiac arrest [203].
- The AICD's electricity is low and won't affect rescuers [204].
- An **external defibrillator vest** has built-in monitoring electrodes and defibrillation pads [205].
- The vest is worn under clothing and attached to a monitor [206].
- It uses high-energy shocks similar to an AED [207].
- Avoid contact with the patient if the vest warns of a shock [207].
- The vest should stay in place during CPR unless it interferes with compressions [208].
- To remove the device or vest, remove the battery from the monitor, then the device [209].
- **LVADs (left ventricular assist devices)** enhance the left ventricle's pumping in severe heart failure or after an MI [211].
- Most common LVADs have an internal pump and external battery pack [213].
- Pumps are almost always continuous, so most patients won't have a palpable pulse unless the device malfunctions [214].
- EMTs shouldn't typically deal with LVAD issues directly [215].
- Contact medical control if unsure what to do [216].
- Transport all LVAD supplies and battery packs with the patient [216].

7. Cardiac Arrest and Defibrillation

- **Cardiac arrest** is the complete stop of heart activity, electrical, mechanical, or both [218].
- It is indicated by the presence or absence of a carotid pulse [219].
- Cardiac arrest was nearly always fatal until CPR and external defibrillation in the 1960s [219].
- With good CPR, early defibrillation, and advanced care access, some patients can survive without neurological damage [220].

- An **Automated External Defibrillator (AED)** is a computer that analyzes heart electrical signals [221].
- It identifies ventricular fibrillation and is highly accurate [223].
- An AED administers a shock when needed [224].
- AED models require some operator interaction, like applying pads or turning the machine on [225].
- The operator must push a button to deliver a shock [226].
- Many AEDs use a computer voice to guide the EMT through steps [226].
- Most AEDs are semi-automated and very accurate [226].
- **Advantages of AEDs** include quick shock delivery [227].
- They are easy to operate and don't require advanced life support on scene [227].
- Remote adhesive defibrillator pads are safe to use [227].
- Large pad area with manual paddles makes electricity transmission more efficient [227].
- Not all cardiac arrest patients need a shock, but all should be analyzed with an AED [228].
- Some rhythms, like asystole (flat line), indicate no electrical activity and don't need a shock [228].
- Pulseless electrical activity (PEA) is cardiac arrest with an organized electrical complex but no pulse; it doesn't need a shock [229].
- **Early defibrillation** is essential for cardiac arrest patients [229].
- Few out-of-hospital cardiac arrest patients survive without a rapid sequence of events [230].
- These events are the **chain of survival links** [230].
- All links must be present for survivability [230].
- The links are: recognition of early warning signs and calling EMS immediately [231].
- Immediate CPR with high-quality chest compressions is crucial [231].
- Rapid defibrillation is necessary [232].
- Basic and advanced EMS care is the next link [232].
- Advanced life support with post-arrest care is vital [232].
- Finally, recovery is the last step [232].
- CPR helps by prolonging the time defibrillation can be effective [234].
- Rapid defibrillation has successfully resuscitated many patients [235].

- Defibrillation works best within two minutes of cardiac arrest onset [235].
- Non-traditional first responders are trained to use AEDs [235].
- The fifth link is advanced life support and post-arrest care [236].
- This includes continued ventilations at 10 to 12 breaths per minute [237].
- Maintaining oxygen saturation between 94-99% is important [237].
- Ensuring blood pressure is above 90 mmHg is necessary [237].
- Targeted temperature management is used upon hospital arrival [237].
- Cardiopulmonary and neurologic support, plus advanced assessment/interventions, are included [237].
- The final link is recovery, which can take a year or longer for survivors [238].
- **Integrating AED and CPR** involves working them in sequence [240].
- Apply the AED only to pulseless, unresponsive patients [240].
- Do not touch the patient while the AED is analyzing or delivering a shock [240].
- CPR must stop while the AED delivers a shock [240].
- **AED maintenance** is important [241].
- Become familiar with the maintenance procedures for your AED brand [242].
- Read the operator's manual [242].
- **Common AED errors** include machine failure to shock V-fib [243].
- Applying the AED to a moving or transported patient is an error [243].
- Turning the AED off before analysis or shock is complete is another error [243].
- **Operator errors** include failing to apply AED pads [244].
- Not pushing analyze or shock buttons when advised is an error [244].
- Pushing the power button instead of the shock button is an error [244].
- Ensure the battery is maintained and check equipment daily [244].
- Ask the manufacturer for a checklist of items to check [245].
- Report AED failures to the manufacturer and the FDA [246].
- Follow EMS procedures for notifying these organizations [247].
- **Medical direction** must approve the written protocol for cardiac arrest care [248].
- The EMT team and medical director should review each AED incident for quality improvement [248].
- Review should focus on the speed of defibrillation [250].
- Shocks should be delivered within one minute of the call [251].

- Mandatory continuing education with skill review is usually required for EMS providers [251].
- **Emergency medical care for cardiac arrest** involves ensuring AED electricity injures no one [253].
- Do not defibrillate patients in pooled water [254].
- You can defibrillate a soaking patient, but dry the chest first [255].
- Do not defibrillate patients touching metal that others are touching [255].
- Carefully remove nitro patches from the chest and wipe the area before defibrillation to prevent ignition [256].
- Shaving a hairy chest can increase conductivity [257].
- Determine the nature of illness or mechanism of injury [258].
- Spinal mobilization may be needed for trauma patients during primary assessment [258].
- Call for advanced life support assistance for cardiac arrest patients in a tiered system [258].
- Use a well-organized team approach [258].
- The AED algorithm guides actions [259].
- If you witness cardiac arrest, begin CPR with chest compressions [260].
- Attach the AED as soon as it's available [260].
- Follow the skill drill for AED steps and local protocols [260].
- After AED protocol, one of three things likely occurs [261].
- A pulse is regained (ROSC - return of spontaneous circulation) [262].
- No pulse, and the AED advises no shock [263].
- No pulse, and the AED advises a shock [263].
- If ALS is responding, stay and continue the shock/CPR sequence [264].
- If ALS is not responding and protocols allow, begin transport [265].
- Transport if the patient regains a pulse [265].
- Transport after 6-9 shocks or if the AED gives three consistent "no shock advised" messages separated by two minutes of CPR [265].
- **Cardiac arrest during transport**: If a pulseless, unconscious patient becomes pulseless during transport, stop the vehicle immediately [266].
- Begin CPR if the AED isn't immediately ready [267].
- Call for ALS and other resources [268].
- Analyze the rhythm, deliver a shock if indicated, and immediately resume CPR

[269].

- Continue resuscitation per local protocol [269].
- If a conscious chest pain patient becomes unconscious en route, check the pulse and stop the vehicle [270].
- Begin CPR, analyze the rhythm, deliver a shock, begin chest compressions, and continue resuscitation [270].
- Transport to the hospital is included [270].
- Coordinate with ALS personnel per local protocol [271].
- Do not wait for paramedics to arrive if an AED is available [271].
- Notify ALS personnel as soon as possible after recognizing cardiac arrest [272].
- Do not delay defibrillation [272].
- Inform paramedics of your actions upon their arrival and interact according to local protocols [273].

8. Return of Spontaneous Circulation (ROSC) and Conclusion

- **Return of Spontaneous Circulation (ROSC)** is when a pulse is regained [262].
- When ROSC is achieved, monitor spontaneous respirations [275].
- Provide oxygen via bag valve mask at 10 breaths per minute [275].
- Maintain oxygen saturation between 95% and 99% [275].
- Assess the patient's blood pressure [275].
- See if the patient can follow simple commands [276].
- If advanced life support is not on scene or en route, immediately transport to the closest appropriate hospital based on local protocols [276].