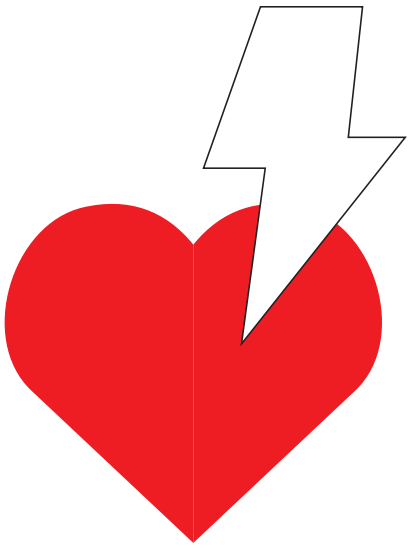
Medtronic
PHYSIO-CONTROL

LIFEPAK® 500
automated external defibrillator

Student Study Guide



Contents

Introduction

The purpose of this guide is to review some important concepts related to defibrillation with the LIFEPAK® 500 automated external defibrillator (AED). It will give you a basic understanding of automated defibrillation; however, this guide is only part of an entire program of defibrillation training. Other components include hands-on instruction and periodic skill reviews. Please read this guide and the LIFEPAK 500 AED Operating Instructions before attending class.

The information in this guide is based on currently available guidelines from the American Heart Association (AHA) and is provided for your general education and information. In 2000, AHA/ILCOR decided that lay rescuers would not be taught to check for a patient's pulse. Instead, the lay rescuer will check for signs of circulation: normal breathing, coughing, movement. Healthcare providers should continue to check for a patient's pulse, along with observing for signs of circulation.

This study guide will use the generic term pulse/circulation. The student should perform the method that they have been instructed to use for patient assessment. Guidelines evolve and some of your organization’s policies may differ from those outlined in this study guide. In all cases you should follow local protocols, policies and operating procedures, as well as the advice and direction of your instructor and medical director. You are responsible for being familiar with local protocols and standing orders.

It is important that you have successfully completed a course in cardiopulmonary resuscitation (CPR) before learning defibrillation. As an AED operator, you should be able to direct the CPR efforts of your team. You may have to perform CPR yourself.

Scientific research conducted over the years has demonstrated that early defibrillation is a key factor in saving someone in cardiac arrest. You will now have the potential to help save lives.

Early Defibrillation

In this chapter you will learn the *chain of survival* concept. The chain of survival represents the sequence of four events that must occur quickly to optimize a person's chance of surviving a cardiac arrest.

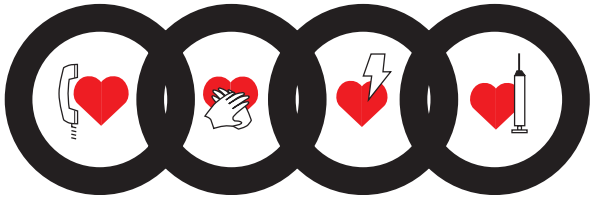
Key Points

There are four links in the chain of survival:

- Early Access
- Early CPR
- Early Defibrillation
- Early ACLS

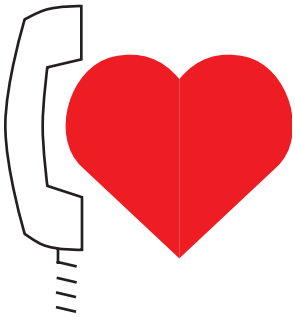
The Chain of Survival

The chain of survival was developed by the emergency medical community as a symbol of the four major events that should occur in out-of-hospital emergency cardiac care. Cardiac arrest victims have a better chance of survival if these events occur rapidly.[1] Early defibrillation is a major link in the chain.



Early Access

Sudden cardiac arrest means the heart has suddenly stopped beating. Everyone should be trained to recognize the signs of cardiac arrest. It is crucial to act immediately to access the emergency medical system (EMS) by calling "9-1-1" (or local emergency number). Public education is key to strengthening the early access link.

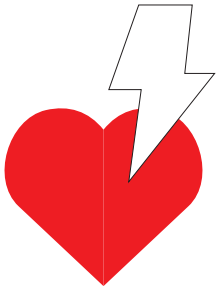


Early CPR

CPR provides enough circulation to temporarily keep small amounts of oxygenated blood circulating through vital organs. This helps keep the heart and brain viable until a defibrillator arrives. Ideally, CPR will be initiated by bystanders. Emergency dispatchers can also direct CPR over the telephone in some EMS systems.

When emergency responders arrive on the scene they will start CPR until an AED is attached to the victim.

The purpose of early defibrillation is to reestablish a normal heart rhythm. Scientific research has shown that early defibrillation greatly increases the chances of survival for someone in cardiac arrest.[2, 3, 4]



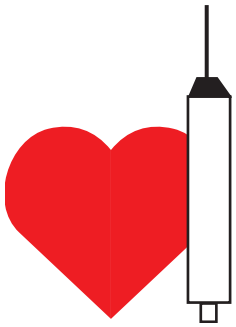
The sooner you deliver a shock, the more likely the heart will start pumping again.

A growing number of emergency responders throughout the world are performing defibrillation because defibrillators have become more affordable, easier to use and maintain as well as more widely available. Most people believe that defibrillation is easier to learn than CPR.[5]

The International Association of Fire Chiefs (IAFC), the AHA, the National Heart, Lung and Blood Institute (NHLBI) and the European Resuscitation Council (ERC) have all endorsed the concept of early defibrillation. In some areas, where once only highly trained physicians, nurses or paramedics provided defibrillation, basic life support providers such as police, security guards, flight attendants and lifeguards now defibrillate. In Rochester, MN, when rapid defibrillation by police and paramedics was made a community objective in 1990, survival to hospital discharge from sudden cardiac arrest rose to 49 percent by 1995[6]. The strategy of defibrillation by basic life support personnel has decreased time to defibrillation by as much as 3.5 to 7 minutes.[7] Early defibrillation programs can double or triple survival rates.[1]

Early ACLS

Early advanced cardiac care is the treatment provided by the advanced cardiac life support (ACLS) team which is beyond the scope of practice of basic life support providers. ACLS skills include endotracheal intubation and intravenous administration of drugs.



Quick Review

1. The four links of the chain of survival are early _____ , early _____ , early _____ , and early _____ .

2. _____ keeps small amounts of blood circulating through vital organs .

3. The most effective treatment for VF is _____ .

4. Early defibrillation can increase survival rates from VF by _____ to _____ times the current rates.

5. When someone's heart stops beating, this is called _____ _____ .

Answers

1. early access, early CPR, early defibrillation, early ACLS
2. CPR
3. defibrillation
4. two to three
5. cardiac arrest

The Electrical System of the Heart

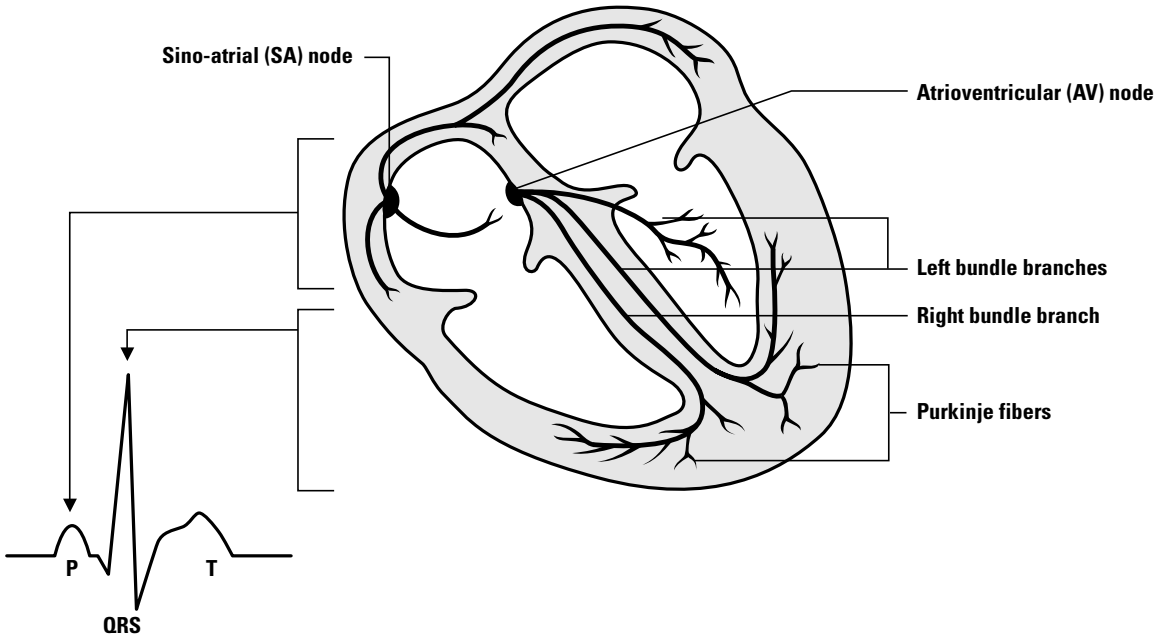
This chapter briefly reviews the electrical system of the heart, including the concepts of *conductive fibers, ECG, pacemaker* and *dysrhythmia*.

Key Points

- The heart has a network of specialized conductive fibers that conduct electrical impulses to the cardiac muscle tissues.
- A pacemaker is an area within the electrical system that generates electrical impulses. These impulses travel through the heart and stimulate it to contract.
- An electrocardiogram (ECG) is a graphical record of the impulses as they travel through the heart and excite the cardiac cells.
- Ventricular fibrillation (VF) is the most common initial cardiac arrest heart rhythm.
- An electrical shock is the most effective treatment for VF.
- Defibrillation must occur early to have the best chance of success.

Electrical System

The human heart has a channel of specialized tissue called *conductive fibers* that distribute electricity throughout the heart. This is known as the "electrical" system of the heart. This network delivers electrical impulses directly to the cardiac muscle tissue, which is stimulated to contract and pump blood. The pumping of the heart is the "mechanical" activity which results in a pulse. Without an electrical signal the heart will not pump. This chapter focuses on the electrical activity of the heart.



Normal conduction pathway in the heart

Pacemakers

Conductive fibers have the unique ability to generate their own electrical impulses. The heart's primary impulse generator is the sinoatrial (SA) node located in the right atrium. It is called the *primary pacemaker* because it is the site that normally generates impulses.

The conductive fiber network carries an impulse generated in the SA node through the cardiac muscle tissue of the atria. This causes the atria to contract. Next, the impulse travels through the network to the ventricles causing them to contract. The resulting action forces blood out of the ventricles into the connecting blood vessels.

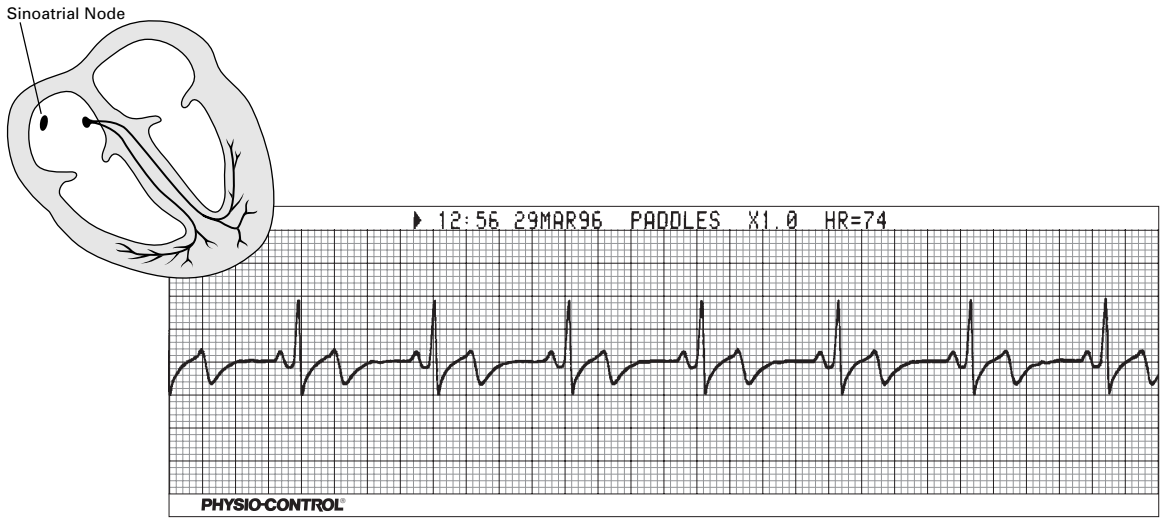
If the SA node fails to generate an impulse, another site in the network will usually take over and generate impulses. The atrioventricular (AV) node is an example of one site along the network that can also be a pacemaker.

Electrocardiograms

The electrocardiogram (ECG) is a measurement of the electrical activity in the heart. The impulses from the heart pass through body tissues and reach the skin. This electrical energy can be detected by disposable electrodes placed on the skin. The LIFEPAK 500 AED analyzes the electrical impulses it receives through the disposable electrodes.

The heart's electrical signals detected on the skin are a very low voltage so they must be amplified by the LIFEPAK 500 AED. AEDs also amplify any other electrical signals (called artifact) detected by the disposable electrodes. It is important to minimize all movement and extraneous sources of electrical signals because they could be confused with or mask the heart's electrical activity. Artifact may be induced by:

- Victim movement
- Muscle tremors
- Poor skin prep under the electrodes
- Use of dried out or poor quality electrodes
- Loose electrodes
- Interference from electronic devices and lighting



Normal Sinus Rhythm

Dysrhythmias

The ECG of a healthy heart shows an organized, uniform rhythm called *normal sinus rhythm* (NSR). The person with NSR will have a pulse you can feel at the carotid artery. This pulse is produced by the heart's pumping.

Dysrhythmias are abnormal heart rhythms that can prevent the heart from pumping properly. There are numerous causes of dysrhythmias including:

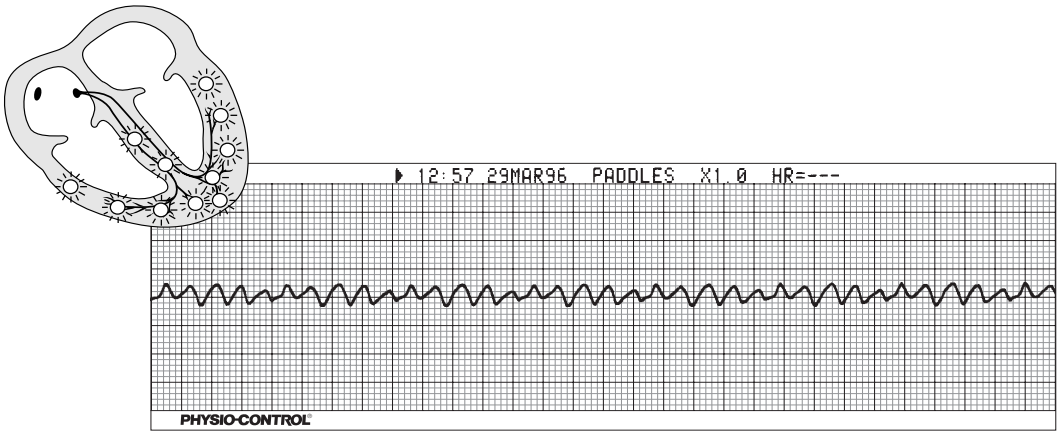
- Narrowing of the arteries of the heart (coronary heart disease)
- Chemical imbalances
- Trauma to the heart muscle
- Low blood oxygen levels (drowning, suffocation)
- Central nervous system damage
- Drugs and medications
- Electrocution
- Hypothermia (low body temperature)

Coronary heart disease—narrowing and hardening of the arteries—is a major cause of cardiac arrest. A *heart attack* (acute myocardial infarction or AMI) is caused by heart disease, too. However, when someone has a heart attack, the heart does not usually stop beating. Any of the above conditions may cause an abnormal rhythm.

Ventricular Fibrillation

Sudden cardiac arrest (SCA) means the heart has stopped beating unexpectedly. The most common dysrhythmia associated with SCA is ventricular fibrillation (VF). VF is an unorganized rhythm in which many sites in the heart attempt to function as the pacemaker. The chaotic electrical activity results in uncoordinated and ineffective cardiac muscle contractions which prevents the circulation of blood. There is no pulse/circulation or blood pressure. A heart in VF looks like a quivering bowl of jelly.

If left untreated, VF results in death. The only effective treatment is *defibrillation*—the delivery of an electrical shock to a heart in VF.

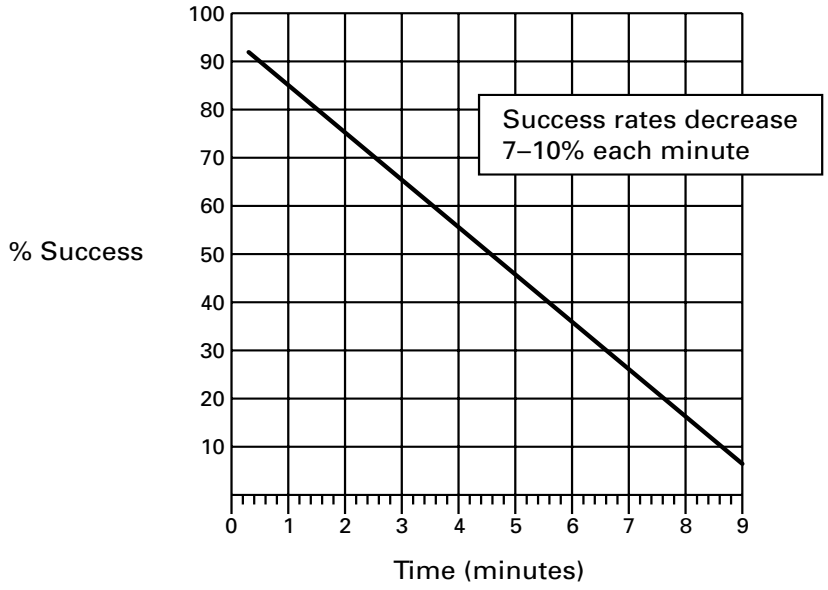


Ventricular Fibrillation

The goal of defibrillation is to reorganize the chaotic electrical activity of VF and return the heart to a normal rhythm. After a shock the SA node or another area of the heart can regain control as the primary pacemaker.

You must deliver defibrillatory shocks within minutes of cardiac arrest in order to have the best chance of victim survival. Success rates decline approximately 7 to 10 percent for every minute that defibrillation is delayed.[8]

Resuscitation Success vs. Time*



* Non-linear

Adapted from text: Cummins RO, *Annals Emerg Med.* 1989, 18:1269-1275.

Other Dysrhythmias

If you arrive early on the scene of a cardiac arrest you will be more likely to find VF or *pulseless ventricular tachycardia* (VT). Pulseless VT is a rhythm that often precedes VF. It occurs when a site in the ventricular muscle fires rapidly and takes over as the dominant pacemaker. As the heart rate increases, there is less time for the ventricles to fill with blood. This reduces the amount the heart can pump and blood pressure falls. If the blood pressure drops severely, consciousness and pulse/circulation will be lost. Like VF, if left untreated, pulseless VT will result in death within minutes. Both VF and VT are treated with electrical shocks.

There are some dysrhythmias of cardiac arrest which are not treated with electrical shocks. *Asystole* ("flat line" or no electrical activity of the heart) and *pulseless electrical activity* ("PEA"—electrical activity but no pumping of the heart) are examples of dysrhythmias that do not respond to external shocks.

Traditionally, dysrhythmia courses have been used to teach ECG interpretation skills necessary for defibrillation. Defibrillation technology has evolved to give us automated defibrillators which simplify defibrillator operation and greatly reduce the training needed to use a defibrillator. ECG interpretation is done by software internal to the defibrillator that has been tested in thousands of simulated cases in the laboratory and clinically field tested.

The LIFEPAK 500 AED is designed to advise the operator if a "shockable" rhythm is detected (rhythm is VF or pulseless VT). If a non-shockable rhythm is detected it is designed to give the operator a "NO SHOCK ADVISED" message. Although AEDs are designed not to shock victims with non-shockable heart rhythms you should never attach an AED to someone with a pulse/circulation.

The *500* automatically charges its capacitor only when a shock is advised. This combination of safety features helps protect the victim from an inappropriate shock.

Quick Review

1. Electrical impulses that cause the heart to beat are generated in the _____ (list an organ).

2. A graphical record of the heart's electrical activity is called an _____ .

3. VF is often the result of a disease process associated with _____ _____ .

4. The heart's main electrical impulse generator is in the _____ _____ . (specific location).

5. The ECG of a healthy heart shows an organized rhythm called _____ _____ _____ .

ANSWERS

1. heart
2. ECG
3. heart disease
4. right atrium (sinoatrial node)
5. normal sinus rhythm (NSR)

How to Defibrillate

The LIFEPAK 500 AED is easy to use because it gives prompts for each step in the defibrillation process. Read this chapter to understand why and how to do each step.

During the initial setup, the *500*'s operating features can be defined in various ways. Be sure to become familiar with the particular way your device has been set up. The procedure listed in this chapter is modeled after the default (factory) settings.

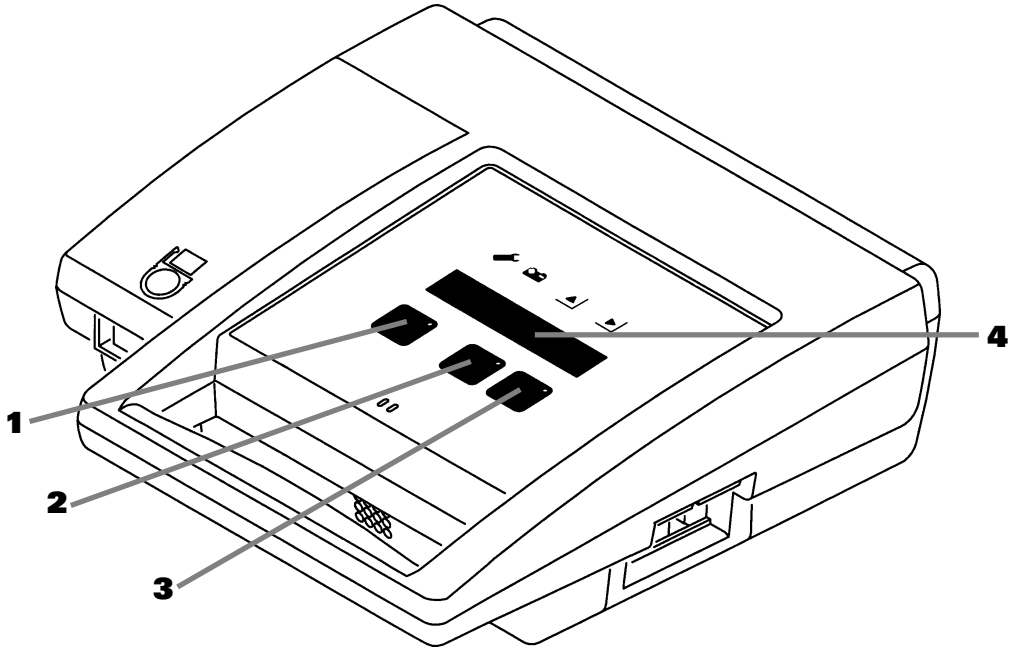
Note: This guide covers only the essentials of defibrillation using the LIFEPAK 500 AED. You must read the *LIFEPAK 500 AED Operating Instructions* to learn about other important information related to defibrillation. You should also study your local automatic defibrillation protocols.

Key Points

- Verify the victim is unconscious, breathless and pulseless/without circulation.
- Turn on the LIFEPAK 500 AED and attach disposable electrodes to the victim.
- Stop CPR and analyze the heart rhythm.
- Follow the voice prompts and screen messages.

The LIFEPAK 500 AED

The LIFEPAK 500 automated defibrillator analyzes the heart rhythm and advises the operator if a shockable rhythm is detected. The operator must press the SHOCK button to deliver the shock. It is simple to use because it interprets the heart's ECG signal and advises the operator what to do.



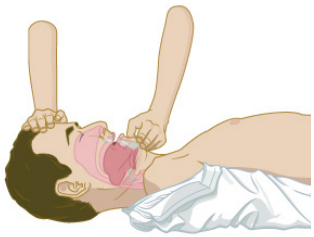
1. ON/OFF button
2. ANALYZE button (optional)
3. SHOCK button
4. Liquid Crystal Display (LCD)

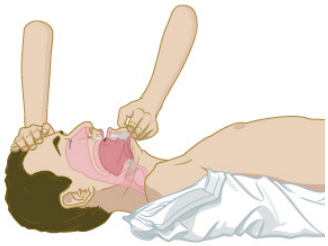
STEP 1

Verify that the victim is unconscious, breathless and pulseless/without circulation.

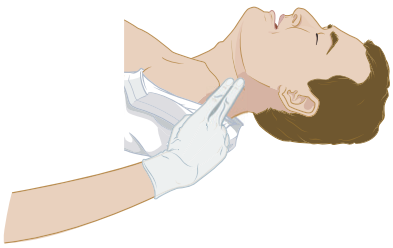
- The victim must be in cardiac arrest, which means he or she is unresponsive, not breathing and without pulse/circulation. First, see if the victim responds to a firm shake at the shoulders and by shouting "Can you hear me?"

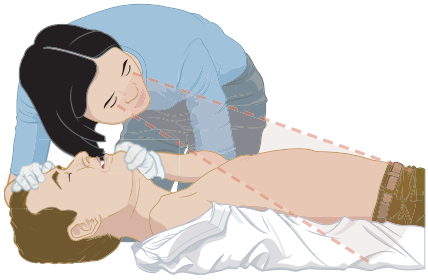
- If there is no response, call loudly for help, open the victim's airway using the head-tilt chin lift[9] and check for breathing. If you do not detect any breaths after 3 to 5 seconds, deliver two initial ventilations.





- Next, check for signs of circulation. If you have been trained, check the carotid pulse for 5–10 seconds. If there is no pulse/circulation, prepare the victim for the AED. Place the victim on a hard, firm surface. This makes CPR more effective. Attach an AED only to someone who is unconscious, not breathing and pulseless/without circulation.

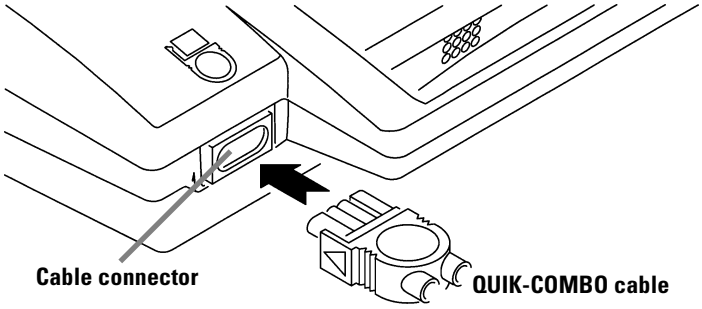




STEP 2

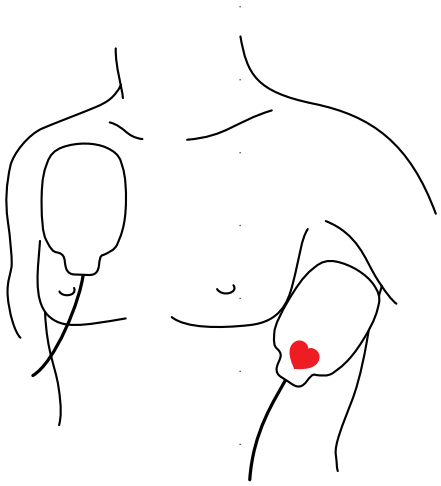
Turn on the LIFEPAK 500 AED and attach the disposable electrodes to the victim.

- Press the ON/OFF button. The green LED indicator illuminates when the device is ready to go. Speak to the device to give a verbal report if required by local protocols. Remove the disposable electrode pads from the packaging. Make sure the electrode cable connector is plugged into the *500*.



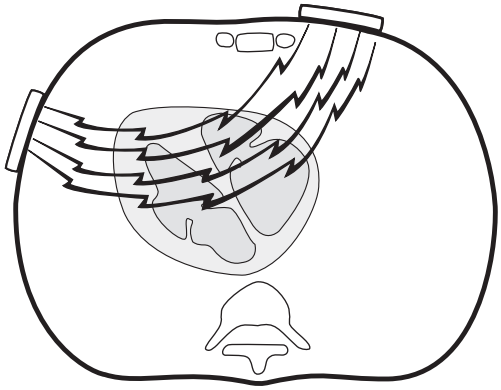
Connecting the QUIK-COMBO™ electrode cable

- Bare the victim's chest. Remove anything that comes between the electrode and bare skin such as clothing, medication patches, sweat, moisture, a **thick** layer of chest hair. If possible, avoid placing the electrodes directly over surgically implanted devices such as internal cardioverter/defibrillators or implantable pacemakers. Remember, the electrode should touch only bare skin.
- Remove the self-adhesive backing and place the electrodes on the victim by following the diagrams on the electrodes. Press the electrodes firmly to the skin. Do not place over the breast bone. Bone is a poor conductor of electricity.
- Depending on the setup of your AED, analysis will occur automatically or the AED will prompt *PUSH ANALYZE*, and this message will appear on the screen.

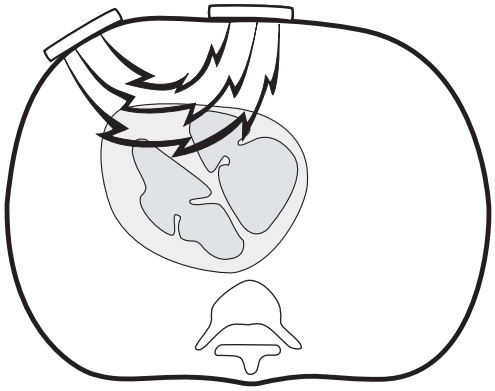


Electrode placement

Correct electrode placement allows more current to pass through the heart.



Correct electrode position
(Current passes through the ventricles)



Incorrect electrode position
(Current misses part of the ventricles)

STEP 3

Clear the area and analyze the heart rhythm.

- Tell everyone to stand clear of the victim while analysis is in progress. Wait about 6 to 9 seconds for the analysis to finish and the next message and voice prompt to occur.
- Once the analysis of the heart rhythm begins, the STAND CLEAR, ANALYZING NOW, STAND CLEAR message and voice prompt will occur. Stop all motion prior to analysis.

> **Do not touch the victim and do not cause any victim movement during analysis.**

STEP 4A

SHOCK ADVISED

The *SHOCK ADVISED* voice prompt and message occur when the AED determines the rhythm is shockable. The AED will automatically begin charging.

- Make certain no one is touching the victim. Do this by saying "I'm clear, you're clear, everybody's clear" and scan the victim from head to toe and observe that all is clear.
- Push the SHOCK button when the AED gives the *PUSH TO SHOCK* prompt.

The AED will automatically analyze again after shocking to see the results of the shock.

The AED will automatically analyze after shocks 1 and 2, 4 and 5, etc. (e.g., after the first 2 shocks of each set of 3 consecutive shocks). Listen to the voice prompts and stand clear during analysis and shock.

- After a *NO SHOCK ADVISED* or 3 consecutive shocks the AED will prompt you to check the victim's pulse/circulation.
- The AED will prompt you to perform CPR for up to 1 minute if there is no pulse/circulation. It will then prompt you to check for a pulse/circulation after one minute of CPR, and if no pulse/circulation, reanalyze.
- Your local protocols may dictate a maximum number of shocks to give.
- If the victim has a pulse/circulation, support airway and breathing. Monitor closely while awaiting transport.
- If advanced life support units arrive, they should take control of the resuscitation effort. Brief them with a short report covering the actions taken prior to their arrival. They may ask you to continue your defibrillation procedures.

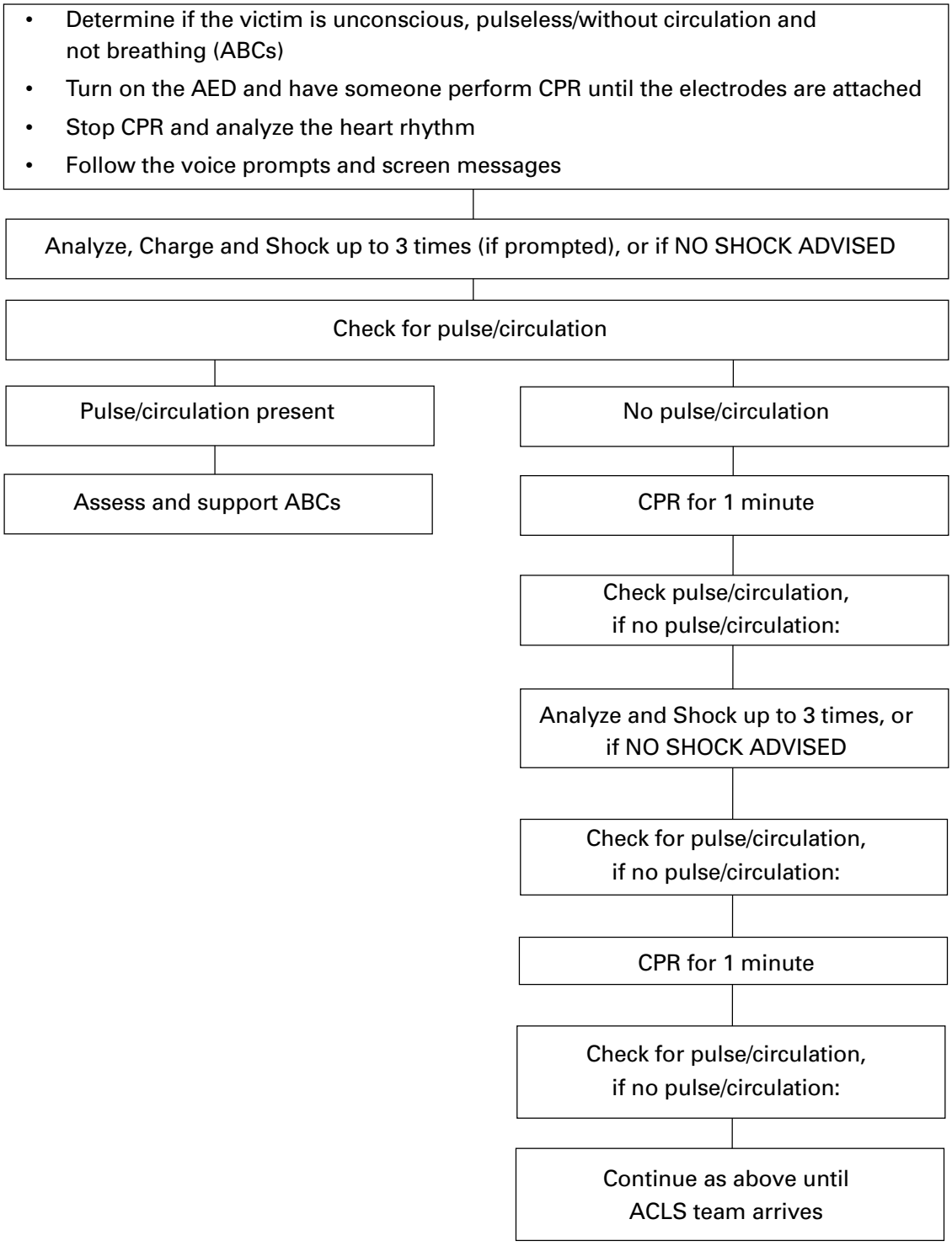
STEP 4B

NO SHOCK ADVISED

Not all heart rhythms of cardiac arrest require a shock. When the LIFEPAK 500 AED detects one of these rhythms it will give you a message of NO SHOCK ADVISED. The AED will prompt you to check for a pulse/circulation. Always check the victim's pulse/circulation when the defibrillator analysis results in NO SHOCK ADVISED.

- If there is no pulse/circulation, the AED will prompt you to perform CPR for 1 minute. Your local protocols will dictate how to proceed when the result you get is a repeated NO SHOCK ADVISED message.

Automated External Defibrillation Procedure



Continuous Patient Surveillance

The LIFEPAK 500 AED monitors the ECG—even when it is not analyzing. Sometimes the heart's rhythm will spontaneously change from a non-shockable rhythm to a shockable rhythm. If the Continuous Patient Surveillance System (CPSS) detects a potentially shockable rhythm, the AED will prompt *PUSH ANALYZE*.

In these situations, the LIFEPAK 500 AED is warning you the rhythm has changed and it is possible the victim needs to be shocked. Stop all victim movement and check the pulse/circulation. If there is no pulse/circulation, press ANALYZE.

NOTE: CPSS is not active in LIFEPAK 500 AEDs that do not have an ANALYZE button or when Autoanalyze 2 is selected. In these cases, the LIFEPAK 500 AED analyzes automatically.

Troubleshooting

If the *CONNECT ELECTRODES* message appears there is either an inadequate connection to the AED or the electrodes are not adhered firmly to the skin. Do a quick check of the connection to be sure the electrode connector is completely inserted into the AED.

If the disposable electrodes do not stick to a hairy chest, quickly shave the hair with a razor. Remove moisture with a cloth. Remove creams or ointments and medication patches that could come in contact with the electrodes.

Remember not to touch the victim when analyzing and shocking. The LIFEPAK 500 AED will not analyze if it detects victim movement through the electrodes.

Motion artifact is the ECG signal distortion created by movement of the victim or defibrillation cables. It can cause incorrect interpretation of the ECG. To prevent this situation, the LIFEPAK 500 AED has special circuitry that detects motion. The unit avoids analyzing the rhythm until all motion has stopped. It will display the *MOTION DETECTED* and *STOP MOTION* messages. It will not analyze the rhythm if motion is detected.

If the *MOTION DETECTED, STOP MOTION* message occurs, try to eliminate all sources of motion such as breathing assistance, CPR compressions, and electrode/cable movement.

If motion stops within 20 seconds, analysis will continue. If the motion does not stop within 20 seconds, analysis will stop. Push ANALYZE (if button present) to restart analysis. In LIFEPAK 500 AEDs that do not have an ANALYZE button, analysis will restart automatically.

Readiness Display

The LIFEPAK 500 AED with the biphasic waveform includes a Readiness Display on the device's handle that can be seen at all times. OK displays if the automatic self-test is completed successfully. If the self-test detects that service is required or if the device detects that the battery needs replacement, the OK indicator disappears and a service and/or battery indicator appear(s).

To obtain more specific information, turn on the device and observe symbols (indicators) on key panel.

Low Battery Detection

When the battery symbol is lit and the low battery message is displayed, the battery is low. Lithium batteries will provide approximately eleven more shocks. If they have been properly maintained, sealed lead-acid (SLA) batteries will provide approximately six more shocks.

When the battery symbol flashes on and off and the *REPLACE BATTERY* voice prompt and message occur, the battery is very low and should be replaced immediately.

Service Indicator and Message

When the service indicator is on (but not flashing), you can still use the AED for therapy. Contact an authorized service person to correct the problem as soon as possible.

When the AED detects a problem that requires immediate service, the service indicator flashes and the *CALL SERVICE* message is displayed. Turn the AED off, then on again. If the *CALL SERVICE* message is still displayed you will not be able to use the AED until the problem is corrected. Contact authorized service personnel immediately to correct the problem.

NOTE: For LIFEPAK 500 AEDs without a readiness display: If the self-test detects a problem, an audio alarm will be activated. Turn the device on and refer to LOW BATTERY DETECTION and SERVICE INDICATOR AND MESSAGE information.

Quick Review

1. True or False: CPR is always done before defibrillation.

2. After analyzing and getting the SHOCK ADVISED message, you must always _____ the scene before shocking.

3. What will the machine do immediately after the first shock is delivered?

4. Should you analyze while CPR is in progress?

5. Number the five general AED steps in the correct order.

   ___ If SHOCK ADVISED, clear the victim and push the SHOCK button when the AED says PRESS TO SHOCK.

   ___ Turn on the LIFEPAK 500 AED and attach the defibrillator electrodes to the victim.

   ___ Press the ANALYZE button again after shocking to see the results of the shock (device may be configured to automatically reanalyze).

   ___ Determine if the victim is unconscious, not breathing and pulseless/without circulation.

   ___ Stop CPR and analyze the heart rhythm.

6. When the battery symbol is flashing, and *REPLACE BATTERY* voice prompt and message occur, the battery should be replaced _____ .

ANSWERS

1. False, Defibrillation has priority when device is available and ready.
2. clear
3. analyze
4. No. There must be no motion when analyzing.
5. 4, 2, 5, 1, 3
6. immediately

Safety First

This chapter briefly reviews some of the safety precautions you must know about defibrillation. Always consider the safety of the rescuers and the victim.

Key Points

- Attach the defibrillator only to someone who is unconscious, not breathing and pulseless/ without circulation.
- Make sure no one is touching the victim before analyzing or shocking.
- Be sure the electrodes are firmly adhered to the victim's bare chest.
- Move oxygen well away from the rescue effort.
- Use Infant/Child Reduced Energy Defibrillation Electrodes when using an AED on young children.

Cardiac Arrest Only!

Be certain the victim is unresponsive, breathless and pulseless/without circulation. Remember:

- Shake and shout
- The ABCs:
  - open the **A**irway
  - check for **B**reathing
  - check **C**irculation (pulse/circulation, coughing or movement)

The Safety Zone

Defibrillation can be dangerous if performed improperly. The good news is that AEDs are very safe if you take several important precautions. First—**never touch the victim when the device is analyzing or shocking**.

When analyzing or shocking maintain a buffer or *safety zone* around the victim. Imagine an invisible shield surrounding the victim. Allow no one to penetrate this zone.

Finally, check each time before shocking by saying "I'm clear, you're clear, everybody's clear" and looking to see that no one is within the safety zone.

Electrodes firmly adhered

Make sure the victim's chest has been wiped dry, excess chest hair removed, and the electrodes are firmly adhered to the victim's chest. Allow no air gaps between the electrodes and skin. Good technique when applying the defibrillation electrodes will minimize the possibility of a spark.

Defibrillation in the presence of oxygen

Use care when defibrillating near oxygen sources (such as bag-valve-mask devices). Remove oxygen from the victim and place it well away from the rescue effort prior to delivering a shock to help prevent a fire hazard.

Age/Weight Limit

Follow your local protocol regarding age recommendations. The LIFEPAK 500 AED may be used on children under eight (8) years of age or 55 lbs (22kg) only if the Infant/Child Reduced Energy Defibrillation Electrode is used and the biphasic AED has a pink connector.

Quick Review

1. You should attach a defibrillator only to someone who is _____ , not _____ and _____ .

2. Excessive chest hair should be _____ before defibrillation.

3. When oxygen is used prior to defibrillation, it should be placed _____ from the rescue effort.

4. A biphasic AED with Infant/Child Reduced Energy Defibrillation Electrodes may be used on a patient under _____ years of age.

5. What are two very important words to remember in defibrillation? (Hint: they start with the letters "S" and "F".) _____

ANSWERS

1. unconscious, not breathing, and pulseless/without circulation
2. removed
3. away
4. 8 years old (or according to local protocol)
5. Safety First!

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