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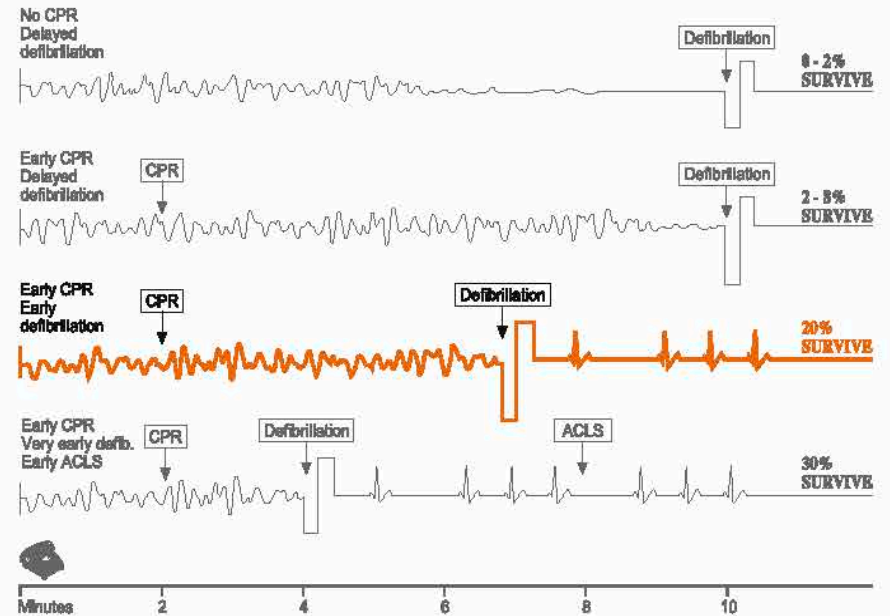


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**SingHealth**  
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# CPR + AED TRAINING COURSE



Accredited By:





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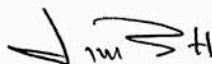
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## FOREWORD

In Singapore there are about 2,400 heart attacks every year. If heart attack does occur, actions taken during the first few minutes of an emergency are critical to a victim's survival. Sudden cardiac arrest is usually due to abnormal heart rhythms, causing the heart to stop pumping effectively. Cardiopulmonary resuscitation (CPR) and defibrillation, provided immediately after sudden cardiac arrest, can significantly increase a victim's chance of survival.

Accredited by the Singapore National Resuscitation Council, the Cardiopulmonary Resuscitation & Automated External Defibrillation Course aims to equip participants with the necessary life-saving skills and confidence to respond during cardiac emergencies.

Be prepared to save life. Join the Cardiopulmonary Resuscitation & Automated External Defibrillation Course.



**A/Prof. Lim Swee Hia**  
Director, Nursing

April 2010

**MODULE A**  
**CARDIOPULMONARY RESUSCITATION**  
**(CPR)**

## INTRODUCTION

Cardiac disease is the second main cause of death in Singapore and is responsible for about 24% of the mortality rate. About 2400 people developed acute heart attacks every year. Of these, at least 900 die shortly thereafter. 500 of these occur before the patient reaches the hospital. The survival rate for this group of pre-hospital collapses is about 2.6%

Public education and training are crucial in reducing "sudden death" because the majority of these deaths occur out of the hospital. One of the most startling ideas of modern medicine is that "sudden death" can be reversed. The actions taken during the first few minutes of an emergency are critical to a victim's survival. It can be learned and performed by anyone anywhere.

It is well known that the most important factors affecting survival in sudden cardiac arrest are external cardiac massage and timed to first electrical defibrillation. Since the defibrillation technique can be easily learned and employed by any trained person, it is important that one understands the basics for this technique clearly so that its application can be appropriate and correct.

The initial cardiac rhythm at the time of collapse in the adult is frequently an irregular, chaotic electrical cardiac rhythm or Ventricular Fibrillation (VF). The definitive treatment for VF is electrical therapy. If VF is not treated immediately, the casualty's chance of survival decreases by about 10% for every minute of delay in treatment.

The concept of "Chain of Survival" is the best approach to the treatment of casualty with cardiac arrest. The four links in this chain are (1) early access to the Emergency Medical Service (EMS), (2) early CPR, (3) early defibrillation and (4) early advanced cardiac care.

### The Chain of Survival



# SECTION 1 : CARDIOPULMONARY RESUSCITATION

## INTRODUCTION

In an emergency situation, when a person's heartbeat and/or breathing have/has stopped (cardiopulmonary arrest), life-support techniques or Basic Cardiac Life Support can be vital for the survival of that person. With early intervention and prompt recognition of cardiopulmonary arrest, the survival rate increases. There are many causes to cardiopulmonary arrest. However, in the adult victim, the most common cause is heart attack. The best approach to the treatment of sudden cardiac death is to adopt the concept of "Chain of Survival". There are 4 links to this chain - Early Access to Emergency Medical Service (EMS), Early Cardiopulmonary resuscitation (CPR), Early Defibrillation and Early Advanced Cardiac Care. CPR is an organised approach to assessing and providing interventions such as mouth-to-mouth breathing and chest compression. Although it encompasses more than one simple rescue technique and requires proper timing and a specific sequence to be effective, CPR can be learnt easily.

## EPIDEMIOLOGY OF CARDIAC ARREST

In the year 2000 alone, ischaemic and other heart diseases account for 25.1% of the total number of deaths in Singapore. Heart disease is the second commonest cause of death. About 2,600 people develop an acute heart attack in Singapore. Of these, at least 900 people died shortly after the heart attack. 500 of these deaths occur before the patients are able to reach the hospital. The total survival rate for this group of pre-hospital collapses (occurring outside the hospital or in the community) is about 2.6%. Public education and training in cardiopulmonary resuscitation (CPR) is important to improve on the survival rate of sudden cardiac arrest.

## SUDDEN DEATH

Sudden cardiac death or cardiac arrest occurs when the heart stops beating and spontaneous breathing ceases abruptly. Up to 50% of individuals may be brought back to life if CPR is provided in a timely and effective manner.

### *Biological and Clinical Death*

When cardiac arrest occurs, the victim loses consciousness and breathing stops quickly, within seconds of the arrest. During the early stage of cardiac arrest, prompt intervention is crucial to restore circulation to vital organs such as the brain. The sooner the circulation to the brain is restored, the higher the chance for a full recovery. Permanent and irreversible brain damage occurs within 4 to 6 minutes of clinical death and biological death results in 8 to 10 minutes.



### ***Some Causes of Sudden Death:***

- Heart attack
- Foreign body airway obstruction
- Drowning
- Stroke
- Drug overdose
- Severe asthma
- Electrocution
- Severe allergic reactions
- Severe trauma e.g. automobile accident

## **THE HEART**

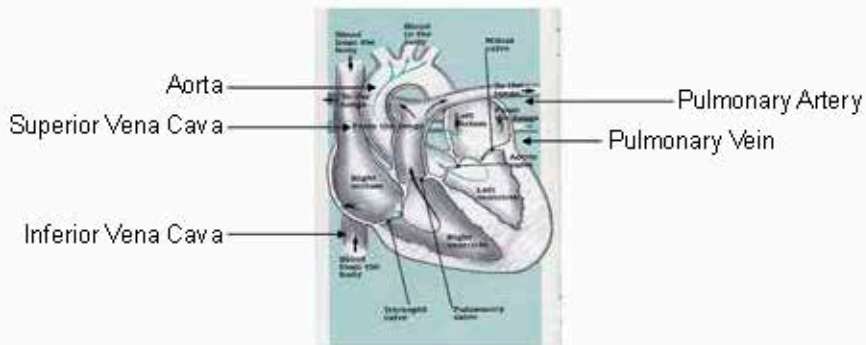
### ***Structure and Function***

The heart is a muscular organ (about the size of the owner's clenched fist). It has three layers of tissues. The outermost layer is known as the pericardium, the middle muscular layer is the myocardium and the innermost layer that forms the lining of the heart is known as the endocardium. Folds of the endocardium form the heart valves that act as "doors" which allow blood to flow in one direction only.

The heart is located within the chest slightly to the left of the owner's body. Its main function is to receive blood depleted of oxygen and then pumps it to the lungs for reoxygenation and at the same time pumps oxygenated blood to all parts of the body.

The heart is made up of four chambers. Each side of the heart is composed of an atrium and a ventricle. A common wall, known as the septum divides the left and right chambers of the heart. The right atrium receives deoxygenated blood from the superior and inferior venae cavae. The right ventricle receives the deoxygenated blood from the right atrium and pumps the blood to the pulmonary circulation for the blood to be reoxygenated in the lungs. The reoxygenated blood is then returned to the left atrium via the four pulmonary veins. The left atrium pumps the reoxygenated blood into the left ventricle, which will pump the blood into the systemic circulation via the aorta.

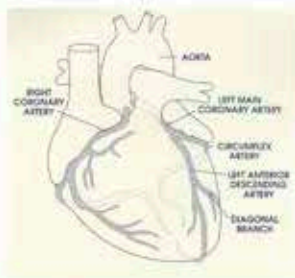
Thus, the right side of the heart deals with deoxygenated blood and the left side of the heart deals with oxygenated blood. The vessels that return blood to the heart are known as veins while those transporting blood away from the heart are known as arteries (Figure 1).



**Figure 1: Anatomy of the Heart**

### ***Coronary Circulation***

The heart, like the other parts of the body, needs oxygen and nutrients. These are provided by the two main coronary arteries that supply blood to the heart. The left coronary artery has two branches that supply blood to the top, front and left side of the heart. While the right coronary artery supplies blood to the right side and back of the heart (Figure 2).



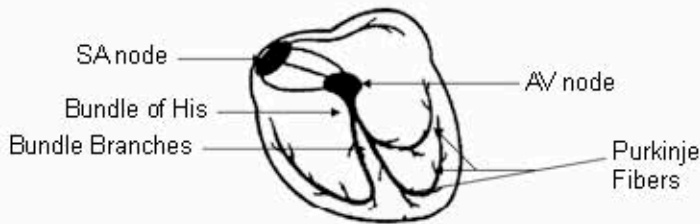
**Figure 2: Coronary arteries**

### ***Conduction System of The Heart***

The conduction system of the heart is composed of specialised cells that initiate and conduct electrical impulses through the heart (Figure 3). These electrical impulses normally originate from the sinoatrial (SA) node. The SA node is located at the junction of the superior vena cava and right atrium and it is able to initiate electrical impulses at 60 to 100 times per minute. This is the fastest intrinsic rate, therefore, the SA node is also known as the pacemaker of the heart. The impulses generated by the SA node are conducted along the myocardium of the atria to the atrioventricular (AV) node that is located at the right atrium near the tricuspid valve.

Similar to the SA node, the AV node is also capable of generating electrical impulses. However, it has an intrinsic rate of 40 to 60 times per minute. From the AV node the impulses will be conducted to the Bundle of His, the Bundle Branches and then the Purkinje Fibers.

The electrical activity of the heart precedes its mechanical function. Therefore, in the normal heart, the heart beats at about 60 to 100 beats per minute.

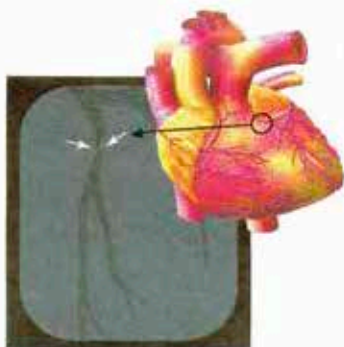


**Figure 3: Conduction system of the heart**

## **CORONARY ARTERY DISEASE**

The gradual build-up of fatty deposit substances or plaque, in the inner lining of the coronary artery results in a condition known as atherosclerosis of the coronary arteries or coronary artery disease. The plaque causes blood to flow through narrowed coronary arteries, hence reducing the amount of oxygen supply to the heart muscles, and causing intermittent or prolonged chest pain (Figure 4). Coronary artery disease may present as:

1. Angina pectoris / chest pain - is a result of hypoxia (lack of oxygen) of the cardiac muscle. The classic description of angina pectoris is a squeezing, pressing, vice-like discomfort over the substernal or left precordial region. The pain may radiate to the neck, jaw or shoulder or down the arms. A characteristic feature of angina is the gradual build-up of discomfort. It may also occur over the posterior thorax, interscapular area, lower jaw, neck, throat area or epigastrium. Rest or medicine, such as sub-lingual nitroglycerin may relieve this experience of discomfort or transient chest pain.
2. Heart attack / Acute Myocardial Infarction (AMI)
3. Sudden death - cardiac arrest may be the first presentation as coronary artery disease may occur without warning. Sudden death may occur as a complication of AMI, especially during the first 1 to 2 hours after onset.



**Figure 4: Narrowed artery**

## **HEART ATTACK / ACUTE MYOCARDIAL INFARCTION (AMI)**

The majority of heart attacks happen as a result of rupture of the atherosclerotic plaque. This attracts platelets and fibrin, which form a blood clot that leads to coronary thrombosis and total occlusion of the coronary artery. The onset of pain is sudden and, unlike angina pain, is not related to exertion. The patient is gripped by an excruciating vice-like pain behind the breastbone; it may radiate into the upper limbs, throat or jaw. Rest is essential, but may not ease the pain. The patient may also become breathless and sweat profusely. He may suffer sudden giddiness, causing him to sit down or lean against something for support. During the weeks before an attack, the patient may have experienced unusual tiredness, shortness of breath and unaccustomed indigestion.

The symptoms of a heart attack vary from person to person, especially with respect to the severity and site of pain. The patient may experience any or all of the above symptoms when having a heart attack.

### ***What One Should Do In A Heart Attack?***

Many people die unnecessarily each year because they do not recognise a heart attack or wait too long to get medical help. More than a third of heart attacks are fatal, and more than half of all deaths from heart attack occur in the first hour of onset. The chances of survival are much better if the patient gets to the hospital early.

This is what you should do:

- Recognise the symptoms of a heart attack
- If the patient is conscious, put him in a half-sitting position, with head and shoulders supported with pillows and knees bent

- If symptoms persist, call an ambulance (**telephone number: 995**) or go at once to your nearest hospital (Emergency Department)
- If possible, contact the patient's own doctor, as there may be a history of heart disease. If the doctor is not available, telephone 995 and ask for an ambulance. Inform the ambulance service that you suspect a heart attack
- If you are the patient, do let someone know of your symptoms so that he/she could monitor your condition and get help
- Loosen the patient's clothing around the neck, chest and waist to help circulation and ease his breathing
- Do not give the patient anything to eat or drink
- Do not allow him/her to move unnecessarily; it will put extra strain on the heart
- If the patient becomes unconscious, put him/her in the recovery position (See Figures 20 to 26)
- If the heart stops, perform cardiopulmonary resuscitation (CPR). Continue to do so until help/ambulance arrives

## **RISK FACTORS OF CORONARY ARTERY DISEASE**

### ***Definition of Risk Factor***

Risk factor is defined as a specific factor associated with a disease such as coronary artery disease.

### ***Types of Risk Factors in Coronary Artery Disease***

It can be categorised as:

1. Modifiable – can be changed
2. Non-modifiable – cannot be changed due to certain factors
3. Underlying medical condition, for example: hyperlipidaemia and diabetes mellitus

#### **1. Major Modifiable Risk Factors**

They are:

- **Cigarette Smoking**

Smokers have 2 to 4 times the risk of non-smokers for sudden cardiac death. The risk attributable to smoking is three times greater for developing a heart attack than for developing lung cancer. The inhaled nicotine makes the blood vessel smaller. The heart needs to pump harder and faster to push the blood through these smaller vessels. As a result, the blood pressure is likely to go up. Smoking also irritates the lungs that lead to breathing difficulties.

- **High Blood Pressure**

The cause is unknown in 90% of cases. Predisposing factors include: heredity, gender, ethnic group, obesity, sensitivity to sodium intake, the use of oral contraceptives in some women, heavy alcohol consumption and a sedentary lifestyle

- **High Blood Cholesterol**

High blood cholesterol or hypercholesterolaemia may be due to genetic factors, diabetes mellitus, obesity, over-eating or eating food that is rich in fats and cholesterol. If your blood cholesterol registers 5.0–5.5 mmol/L, it is considered to be borderline hypercholesterolaemia. But if your blood cholesterol level registers > 6.3 mmol/L, you are having hypercholesterolaemia (refer to Table 1).

Desirable blood cholesterol level	Borderline high blood cholesterol level	High blood cholesterol level
< 5.2 mmol/L	5.2 to 6.3 mmol/L	> 6.3 mmol/L

**Table 1: Blood Cholesterol Level**

- **Physical Inactivity**

An individual who does not engage in physical exercise has twice the risk of coronary artery disease than the active individual.

**2. Non-Modifiable Risk Factors**

- Sex - males are more prone
- Heredity - those with family history of heart disease would be at greater risk
- Increasing age - the elderly

**3. Other Related Risk Factors**

- Stress
- Underlying medical condition e.g. diabetes mellitus, obesity etc.

## ***Healthy Lifestyle or Prudent Heart Living***

Adopting a healthy lifestyle helps minimise the risk of heart attack. What one should do: Know and modify your risk factors (if any):

### Cigarette Smoking

- Stop smoking once and for all. Make a conscious effort to cut down one's smoking over 2 or 3 weeks and then stop it totally and for good
- Avoid a friend if she/he smokes too. Spend the first few days with people who are non-smokers. Tell everyone you are quitting cigarettes ("real friends do not tempt")
- Will power is all that one really needs. Having made the decision, stick to it firmly. Thousands have succeeded, so can you
- Some studies indicate that the smoker can lower the risk of another heart attack by up to 50% after giving up the habit. This benefit is obtained regardless of how long that person had smoked

### High Blood Pressure

- Get your blood pressure checked as often as your doctor recommends
- Stop smoking
- Follow your treatment as prescribed
- Follow a low salt diet, if prescribed, to reduce the amount of fluid the heart has to pump
- Learn relaxation or exercise techniques to reduce tension and stress in your life
- Lose weight, if necessary. The heart needs to pump harder to supply an overweight body

### High Blood Cholesterol

- Cholesterol or other body fats may be deposited more easily on the walls of the arteries when there is an excess of them circulating in the blood stream. This excess can come from food or from the body's production of these fat substances
- Decrease total fat intake
- Decrease saturated fat (e.g. lard and blended vegetable oil) intake, replace with unsaturated fat (e.g. pure soya bean, canola, corn and sunflower oil) whenever possible
- Limit intake of cholesterol rich food
- Increase fibre in your diet

- Maintain a healthy weight
- Limit intake of alcohol
- Eat more fruits, vegetables and whole meal products as they have a high fibre content, provide bulk and help to satisfy your appetite

### Physical Inactivity

- Develop healthy lifestyle and behavioural habits (exercise, eat a healthy diet)
- One should exercise regularly as this has a calming effect that lasts much longer than the exercise itself
- Exercise improves the health and general well-being in many ways as well as to burn more energy daily for more effective weight control

## THE CHAIN OF SURVIVAL

When a collapse occurs, the heart stops pumping blood. Brain damage begins after 4 to 6 minutes and death can occur in 8 to 10 minutes without oxygen. Therefore it is critical that blood flow and breathing be continued until medical help arrives. CPR (Cardio-Pulmonary Resuscitation) is a technique that can be performed to "artificially" maintain this blood flow and breathing. A person, trained in BCLS (Basic Cardiac Life Support) can perform CPR.

Modern life-style makes heart attack the number 2 killer after cancer in Singapore. Survival of sudden cardiac arrest depends on time and a series of critical responses called the "Chain of Survival." If one is neglected or delayed, survival is unlikely. This chain has four interdependent links.





### ***The First Link – Early Access***

Early Access encompasses the actions initiated after the patient's collapse and the arrival of Emergency Medical Service (EMS) personnel. Recognition of early warning signs, such as chest pain and shortness of breath, and the early access to EMS (call 995) is essential. Rapid response and intervention increase the chances of surviving a heart attack.

### ***The Second Link – Early Cardiopulmonary Resuscitation (CPR)***

CPR is most effective when started immediately after the patient collapses. It keeps oxygenated blood flowing to vital organs, such as the brain and the heart. In almost all the clinical studies, bystander CPR has shown a significant positive effect on survival. It is essential in maintaining blood flow and breathing until professional help arrives. Therefore the chances of successful resuscitation for an out-of-hospital collapse depend on prompt bystander CPR and a competent EMS.

### ***The Third Link – Early Defibrillation***

Studies have shown that early defibrillation is most important for the improvement of survival rates for out-of-hospital cardiac arrest patients. The only treatment for sudden cardiac arrest is defibrillation. Defibrillation converts an abnormal heart rhythm (ventricular fibrillation) to a normal one.

### ***The Fourth Link – Early Advanced Cardiac Life Support (ACLS)***

Early Advanced Cardiac Life Support (ACLS) is another critical link in the Chain of Survival concept. ACLS involves ventilation support, establishing intravenous access, administering drug therapies, controlling arrhythmias and preparing the victim for transport to the hospital. Where the Chain of Survival is strong, survival rates have been reported to be as high as 30 percent or more.

# ADULT ONE MAN CPR

MNEMONIC: DRS ABC

D: CHECK DANGERS

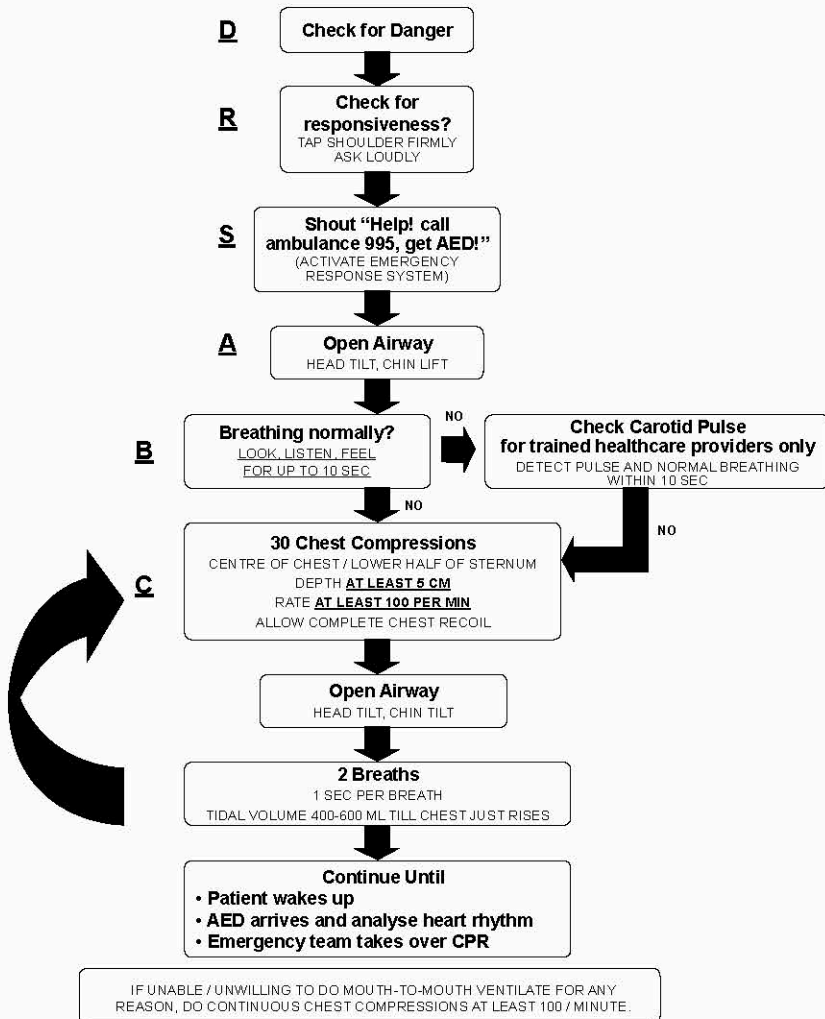
R: CHECK FOR RESPONSIVENESS

S: SHOUT FOR HELP

A: AIRWAY

B: BREATHING

C: CHEST COMPRESSIONS



## **STEP 1. CHECK FOR DANGER**

- Quickly assess the situation for danger, so that the rescuer operates in a safe environment.

## **STEP 2. CHECK FOR RESPONSIVENESS**


Quickly assess and determine whether the victim is responsive. The rescuer should tap or gently shake the victim on the shoulders and asks loudly: "Hello! Hello! Are you OK?"



- Avoid violent shaking of the victim as this might result in injury.
- Avoid unnecessary movements of the neck in the event of injuries to the head and neck.
- If the victim does not respond, he/she is likely to be unconscious. This may be due to:
  - An airway that is obstructed (blocked) by the tongue that has fallen backwards, food or secretions.
  - Breathing that has stopped.
  - The heart that has stopped beating, usually because of a heart attack.
- If the adult is unconscious, the rescuer will have to act quickly.

## SECTION 2 : PERFORMING ONE-MAN CPR

### CHECK FOR RESPONSIVENESS

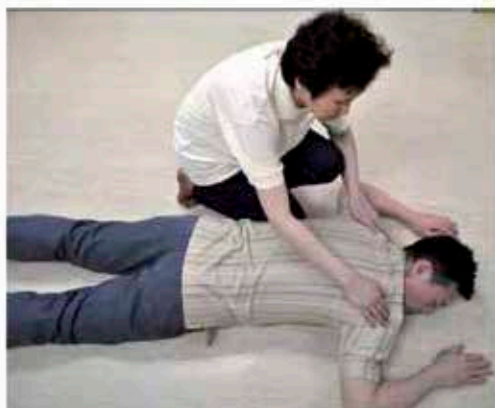
 Quickly assess and determine whether the person is responsive.

 Tap or gently shake the victim on his shoulders and ask loudly

- "Hello! Hello! Are you OK?"
- Do not shake the victim violently as this may result in injury for the victim



**Figure 6: Tap or gently shake the victim**



 If the victim does not respond, act quickly. The unconsciousness may be due to:

- An airway that is obstructed (blocked) by food or secretions or a tongue that has fallen backwards.
- Breathing that has stopped
- A heart that has stopped beating

## **ACTIVATE EMERGENCY MEDICAL SERVICES (EMS)**

- ☞ Activate EMS, call ambulance 995, GET AED and give the following information:
  - Someone is having a heart attack/unconscious
  - Location of the victim
  - Telephone number you are calling from
  - The number of persons who need help
  - Ask for immediate ambulance
  - Hang up the phone only after being instructed to do so
  
- ☞ If there is another person around, ask him/her to do the calling. Give him/her the information to provide to the ambulance dispatcher.
  
- ☞ Remove victim to a safe area if required



**Figure 7: Call for ambulance at telephone number 995**

## POSITION VICTIM

- ☞ To be effective, CPR must be performed on a victim who is lying flat on his/her back (supine) and on a firm and flat surface
- ☞ If the victim is lying face down, or on his/her side, roll the victim over as one unit onto his/her back before starting any of the procedures
- ☞ Support the nape of the neck gently during repositioning if the victim has or is suspected to have head/neck injury
- ☞ Lay the victim flat on his/her back on a flat, firm surface. Ensure that the victim's legs are straightened, and arms placed alongside the body



**Figure 8: Roll the victim onto his back**

## OPEN AIRWAY

☞ If there is no evidence of head or neck injuries, use the head-tilt and chin-lift manoeuvre to open the airway

- Using the palm of one hand, press the top of the head so that it is tilted backwards
- Lift the chin upwards with the fingers of the other hand



Figure 10: Open airway (head-tilt and chin-lift)


### Note:

- Do not press deeply into the soft tissue under the chin, this may obstruct the airway
- If head/neck injury is suspected, the head-tilt and chin-lift manoeuvre must not be performed. Use the jaw-thrust or gentle chin-lift manoeuvre

#### ***Jaw-Thrust manoeuvre:***

- ☞ Using four fingers on each side of the jaw, lift the jaw forward by applying steady upward and forward pressure at the angles of the mandible
  - ☞ With the thumbs, hold the mouth slightly open by displacing the chin downwards
- If the victim has started to breathe, this may be all that is required. At this point, place him in the recovery position (See Figure 20 to Figure 26)

## CHECK FOR NORMAL BREATHING

 Place your cheek close to the victim's face and look at his chest. Assess breathing for 10 seconds by the following method:

- Look (for the rise and fall of the chest wall).
- Listen (for the sounds of air escaping from the victim's mouth and nose).
- Feel (for the air escaping from the victim's mouth or nose brushing past your cheek).
- It is important to recognise that gasping is not normal breathing but a sign of cardiac arrest, begin CPR immediately.



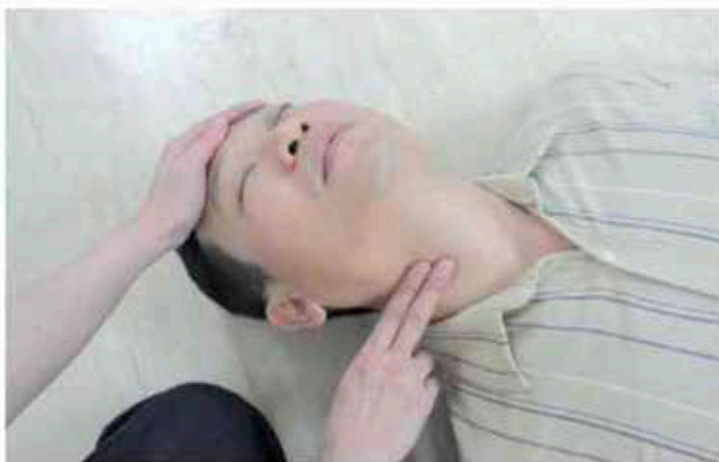
**Figure 11: Check breathing (look, listen and feel)**

Note: If one or more of these signs are present, one can presume that breathing is present. Turn him over onto his side in the recovery position, if there is no head/neck injury



**CHECK FOR PULSE ( For trained healthcare providers only. For layperson, go straight to locate hand position for chest compression)**

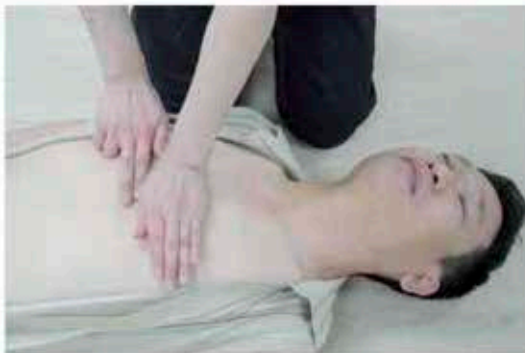
- ☞** Locate the neck (carotid) pulse and check for circulation for about 10 seconds. Place your fingers firmly in the hollow of the neck between the Adam's apple and the muscle at the side of the neck.
- Start chest compression if there is no pulse.



**Figure 13: Check the neck pulse**

## LOCATE HAND POSITION AND PERFORM 30 CHEST COMPRESSIONS FOLLOWED BY 2 VENTILATIONS

- ☞ Place yourself at the side of the victim
- ☞ Locate the lower margin of the ribcage, on the side nearest to you
- ☞ Place the heel of your hand on the lower half of the breast bone two fingers' width above the xiphoid process



**Figure 14: Locate landmark for chest compression**

- ☞ Keep the heel of your hand in place and put your other hand over it (fingers may be interlaced to keep them lifted off the chest). Keep your thumb and fingers raised; so that they do not press on the ribs. Press down at least 5 cm keeping your thumbs and fingers raised. Let the chest rise again.



**Figure 15: Cover hand with the heel of the other hand**

☞ With arms straight, rock forward pressing down on the lower half of the breastbone

☞ Use your body weight to compress the patient's chest by at least 5cm




**Figure 16: Compress vertically downwards**




**Figure 17: Keep thumbs and fingers raised**


☞ Do not compress

- too low on the chest - can cause damage to the liver located in the upper abdomen
- too high on the breastbone - is ineffective
- directly on the ribs - can cause severe fractures of the ribs

 Give 30 compressions then inflate the lungs twice by mouth-to-mouth respiration

 To achieve the desired heart rate of 60 per minute, the chest must be compressed at a rate of 100 per minute. This rate is achieved by counting loudly as you compress:

- 1 and 2 and 3 and 4 and 5 and
- 1 and 2 and 3 and 4 and 10 and
- 1 and 2 and 3 and 4 and 15
- 1 and 2 and 3 and 4 and 20
- 1 and 2 and 3 and 4 and 25
- 1 and 2 and 3 and 4 and 30

 Continue CPR until pulse returns or until the ambulance crew arrives to take over the management of the victim

## **TIPS FOR PROPER CHEST COMPRESSIONS**

- To give effective chest compressions, rescuer should “push hard and push fast”. (depth of at least 5cm, rate of at least 100 per minute)
- Locating the correct hand position for chest compressions should be done quickly.
- Make sure you allow the chest to be fully recoiled before starting the next compression.
- Do not lift the heel of your hand off the chest between each compression.

## **Step 10: MOUTH-TO-MOUTH BREATHING**

- After 30 chest compressions, perform 2 breaths

### **To perform mouth-to-mouth-breathing:**

- Maintain head tilt-chin lift.
- Pinch the nose with your thumb and index finger to prevent air from escaping through the victim's nose.
- Seal your lips around the victim's mouth and give 2 breaths.
- Release the nostrils after each breath.
- The chest should rise with each breath.
- The duration for each breath is 1 second.
- Ventilation volume is between 400 to 600 ml of air.
- Allow lung deflation between each breath.

- Quickly proceed to do another cycle of chest compressions (5 cycles of 30 compressions: 2 breaths)

Note

- Too great a volume of air is likely to cause air to enter the stomach and result in stomach (gastric) distension.

## **STEP 11: RE-ASSESSMENT**

### **FOR TRAINED-HEALTHCARE PROVIDER: RE-ASSESSMENT**

- Check pulse after every 5 cycles of CPR 30:2.
- If pulse is absent or unsure about the presence of pulse, start chest compressions and perform 5 cycles of CPR (30:2).
- If pulse is present, check for breathing.
- If breathing is absent, perform rescue breathing at a rate of 12 breaths per minute (one breath every 5 seconds) by giving one breath and count **2-a-thousand, 3-a-thousand, 4-a-thousand, 5-a-thousand**. Repeat the sequence until you have completed a total of 12 breaths.
- If both the pulse and breathing are present, position the victim in the recovery position.
- Continue to monitor the victim's pulse and breathing every minutes as these can stop suddenly.

### **For LAYPERSON:**

Continue Performing CPR until help arrives or victim starts moving.

**MODULE B**  
**AUTOMATED EXTERNAL DEFIBRILLATION**  
**(AED)**

# SECTION 1 : AUTOMATED EXTERNAL DEFIBRILLATION

## INTRODUCTION

It is well known that the most important factors affecting survival in sudden cardiac arrest are external defibrillation and time to first shock. Since the technique can be easily learned and employed by any trained person, it is important that one understands the basics for this technique clearly so that its application can be appropriate and correct.

The most frequent initial rhythm in sudden cardiac arrest is ventricular fibrillation (VF), and the single most effective treatment for VF is electrical defibrillation. Early defibrillation has been recognised as the crucial third link, in the chain of survival for emergency cardiac care. Epidemiological and clinical research have established that effective emergency cardiac care (ECC) depends on these four closely interconnected links. Therefore, it is important to ensure that all four links are given the special attention to achieve optimal patient survival.

The increasing availability of Automated External Defibrillators (AED) necessitates that all health care providers, especially emergency personnel, be equipped with the skills and knowledge to use an AED. Significant others who may be at the scene of sudden cardiac arrest event and where AED are available should also be equipped with the skills and knowledge to use an AED.

## CARDIAC ARREST

### Epidemiology of Cardiac Arrest

In Singapore, heart disease is the second commonest cause of death, being responsible for about 24% of total mortality. About 2,400 persons develop an acute heart attack in Singapore. Of these, at least 900 die shortly thereafter. At least 500 of these deaths occur before the patient is able to reach the hospital. The total survival rate for this group of pre-hospital collapses is about 2.6%.

It is well established that the initial cardiac rhythm at time of collapse is frequently chaotic electrical distribution of the heart. This is referred to as "Ventricular Fibrillation". If this rhythm is not converted immediately, the patient's chances of survival decreases. It is believed that for every minute of delay after the onset of Ventricular Fibrillation, the survival rate decreases by approximately 10%.

The definitive treatment for Ventricular Fibrillation is electrical cardiac defibrillation, which is the theme of this training programme.

## Definition of Cardiac Arrest

Sudden Cardiac Arrest occurs when the heart stops pumping suddenly. When this happens, the patient immediately loses consciousness and breathing stops.

### Causes of Cardiac Arrest

1. Common causes
  - Heart Attack
2. Uncommon causes
  - Drug overdose
  - Suffocation
  - Severe allergic reaction
  - Electrocutation

### Common Heart Rhythms in Cardiac Arrest

The most common heart rhythms associated with sudden cardiac arrest are:

1. Ventricular Fibrillation (VF): an uncoordinated, irregular heart rhythm resulting in no output from the heart.

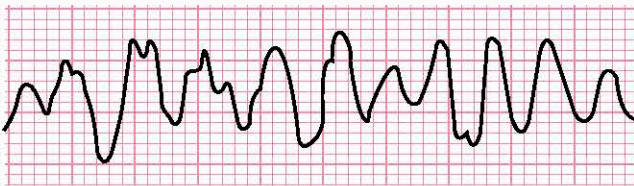


Figure 19: Ventricular Fibrillation

2. Asystole: flat line or a “Dead heart”.



Figure 20: Asystole



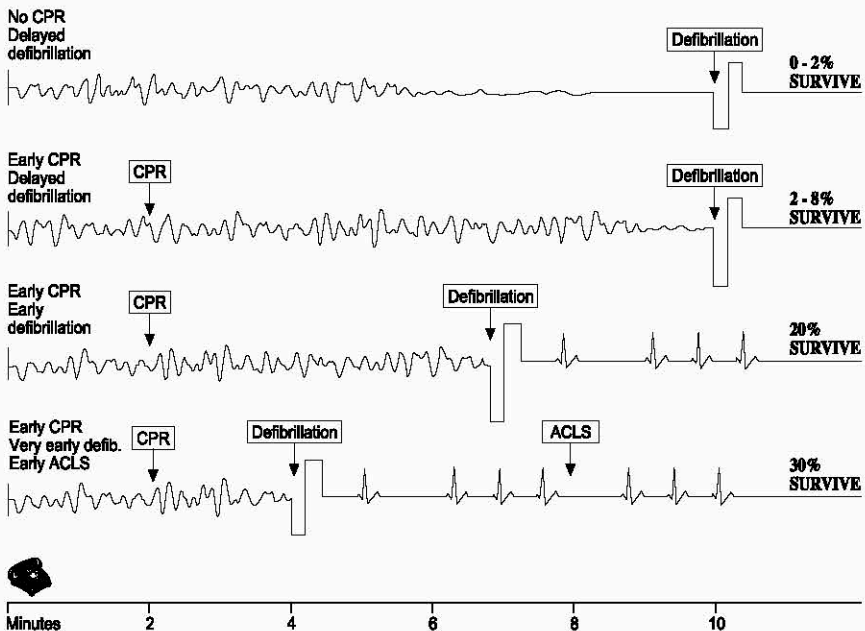
## SECTION 2 : DEFIBRILLATION

### THEORY OF DEFIBRILLATION

#### The Importance of Early Defibrillation

- The majority of people suffering from cardiac arrest have VF. VF is the most common initial rhythm in cardiac arrest. If untreated, it progresses to asystole and death of the patient.
- Immediate or rapid defibrillation is the only effective treatment for VF. The probability of successful defibrillation decreases over time – death rate increases by 10% for every minute without defibrillation.
- VF degenerates to asystole within 8 – 10 mins.
- Minimal chance of success if the patient goes into asystole.

NB: Not all arrested patients will survive. But research shows that early defibrillation and CPR are the most important factors if the patient is to survive.



Survival rates are estimates of probability of survival to hospital discharge for patients with witnessed collapse and with ventricular fibrillation as initial rhythm. Estimates are based on a large number of published studies, which are collectively reviewed.

This graph shows that the chance of survival of a patient who suffers a cardiac arrest due to VF is dependent on the speed in which the Chain of Survival is implemented.

Prior to cardiac arrest, the patient is in normal sinus rhythm. At the time of cardiac arrest the rhythm deteriorates to VF. The graph shows the relationship between the time treatment is given and the survival chance of the patient.

1. The first bar shows that if no CPR is given and defibrillation attempts are delayed, approximately 2% survive.
2. The second bar shows that if early CPR and delayed defibrillation is given, the survival chance increases to 8%. CPR only buys time.
3. The third bar shows 20% survival if early CPR and early defibrillation is delivered.
4. The fourth bar shows 30 – 40% chance of survival when the full Chain of Survival is implemented.

## SECTION 3: FUNCTIONS OF AUTOMATED EXTERNAL DEFIBRILLATOR

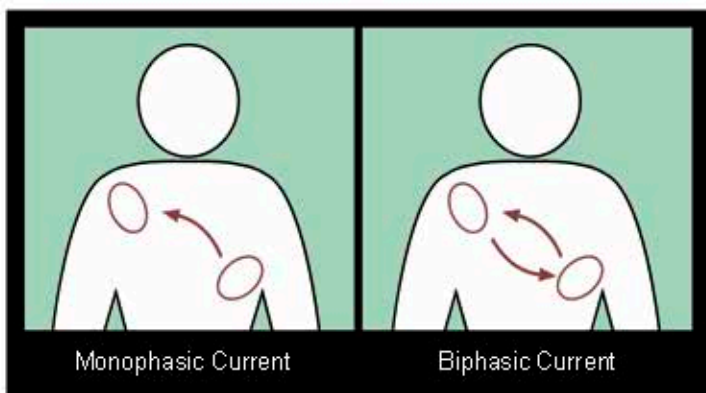
### FUNCTIONS

The AED is a device that delivers electrical shock to restart the pumping action of the heart. Its aim is to increase the survival rate of patients suffering from sudden cardiac arrest caused by VF. The function of the AED is to interpret heart rhythm and advise the operator whether or not a shock is needed. A computer algorithm in the AED identifies a shockable rhythm. It will then advise the operator “SHOCK” or “NO SHOCK” through a voice prompt and text message. The AED cannot check whether the patient has a pulse but it can detect any normal or electrical activity.

- A **shockable rhythm** is usually VF/VT and the AED has a chance to convert the heart rhythm back to normal rhythm.
- A **non-shockable rhythm** is usually asystole/PEA and the AED will not shock the patient because it will not have a chance of reviving the heart.

#### Biphasic vs Monophasic AED

Biphasic waveform defibrillators are now available in Singapore hospitals today in which the current flows in a positive direction for a specified duration, after which it reverses and flows in a negative direction. The monophasic waveform defibrillators in which current is delivered in one direction to the patient are still used by some hospitals.



### Recommended Joules for Monophasic and Biphasic Defibrillation

Monophasic defibrillation for Adult	Initial (1st) shock and all subsequent shocks – 360 Joules
Biphasic defibrillation for Adult	Initial (1st) shock and all subsequent shocks – 150-360 Joules or energy level recommended by manufacturer
Defibrillation for Infant and children	*4 Joules/kg Children

***\*Paddles should be appropriate for child's size.***

### INDICATIONS FOR USE OF AED

1. The AED is used on a patient in cardiac arrest. Cardiac arrest is indicated by:

Unconsciousness  
+  
No Breathing  
+  
No Pulse

***When in doubt, apply the AED***

2. The rescuer has access to an AED, and is competent in its use.

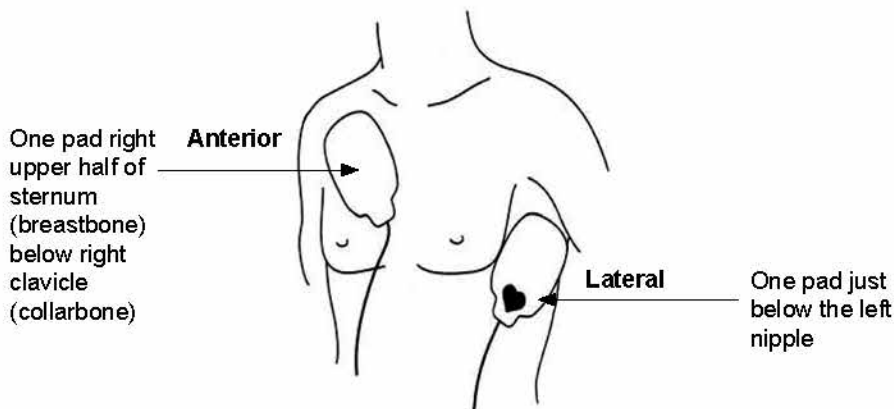
## PREPARATION OF CASUALTY

1. Verify cardiac arrest before applying defibrillation electrodes.
2. Remove or if necessary, cut away clothing from the casualty's chest, including any jewellery.
3. Look for and remove any medication patches from the casualty's chest (these patches can interfere with the defibrillation electrodes, and are used by people with heart disease).
4. Improve adhesion of electrodes to skin as necessary.
5. If the chest is very hairy in the areas where electrodes are to be placed, quickly shave the hair. This is necessary to ensure the electrodes stick onto the chest.
6. If the chest is wet (casualty is sweaty or has been in water), wipe dry immediately. Sweat or moisture on the chest will reduce good contact and adhesion of the electrodes onto the chest area.

## PLACEMENT OF DEFIBRILLATION PADS

1. Open package containing the defibrillation pads with attached cable and connector.
2. With the casualty's chest prepared, carefully pull off the protective backing from the pads.
3. Place one pad to the right of the upper half of the sternum (breastbone), just below the casualty's right clavicle (collarbone) and place the other pad just below and to the left of the left nipple. For female casualty, place it just below and to the left side of the breast. Do not place it over the breast.
4. Ensure that the electrodes are firmly attached by gently pressing the pad with fingers over the centre and around the edges to avoid "air-trap" to provide good adhesion. Good contact increases shock efficiency. If contact is insufficient for the defibrillator to operate, the "Check Electrode" message will be heard.

### Defibrillation Electrode Placement



**Anterior-lateral placement**

## SAFETY ISSUES

Safety is very important for the casualty, the AED operator and the bystanders. Hence, AED must only be used by personnel who are trained and authorised to use it. It is the responsibility of the AED operator to:

- maintain his/her knowledge and skills in AED
  - ensure that the area around the patient is clear
1. It is important not to allow anyone to come in contact with a casualty during
    - (a) Analysis : The defibrillator reads electrical activity in the heart through electrodes. CPR activity, touching or moving the patient can interfere with the accuracy of the machine's reading.
    - (b) Defibrillation : Ensure that no one is touching the casualty when shock is delivered as electricity can be transmitted.
  2. The casualty should not be placed on wet or metal surfaces when the AED is used on him/her as water and metal are good conductors of electricity. If there is water/metal between the casualty and the rescuer/AED operator/bystander, electricity can be transmitted to them. If the casualty is on a
    - (a) **WET** surface, remove the casualty to a dry area:
    - (b) **METAL** surface, place blankets between the casualty and the metal contact.
  3. The defibrillator should not be used in the presence of flammable gases and explosive environments.

DO NOT DEFIBRILLATE when

- **Casualty is responsive, breathing or has a pulse**
- **Someone is touching the casualty**
- **There are flammable gases or in explosive environments**

EXERCISE CARE when

- **Casualty is on a wet or metal surface**

## SECTION 4 : MEDICAL PROTOCOL AND DOCUMENTATION

### MEDICAL PROTOCOL

The AED Machine is programmed according to local medical guidelines on defibrillation.

1. Verify cardiac arrest – no response, no breathing and no pulse or signs of circulation
2. Start CPR (30 compressions & 2 ventilations) while awaiting AED
3. Prepare chest area for placement of defibrillation pad
4. Continue CPR till AED is attached to casualty
5. If shockable ECG rhythm is detected, the AED will charge up according to pre-set energy level (150 joules for biphasic defibrillator, 360 joules for monophasic defibrillator)
6. CPR advised for 1 minute:
  - following every shock or
  - if the AED detects a non-shockable rhythm and the casualty has no pulse or signs of circulation
7. Check for pulse or signs of circulation:
  - if the AED detects a non-shockable rhythm

#### Successful Defibrillation

At any time after a shock:

1. if there is pulse or signs of circulation, maintain an open airway by placing casualty in the recovery position. Do not disconnect the AED but continue to monitor the casualty every 5 minutes until handed over to medical personnel

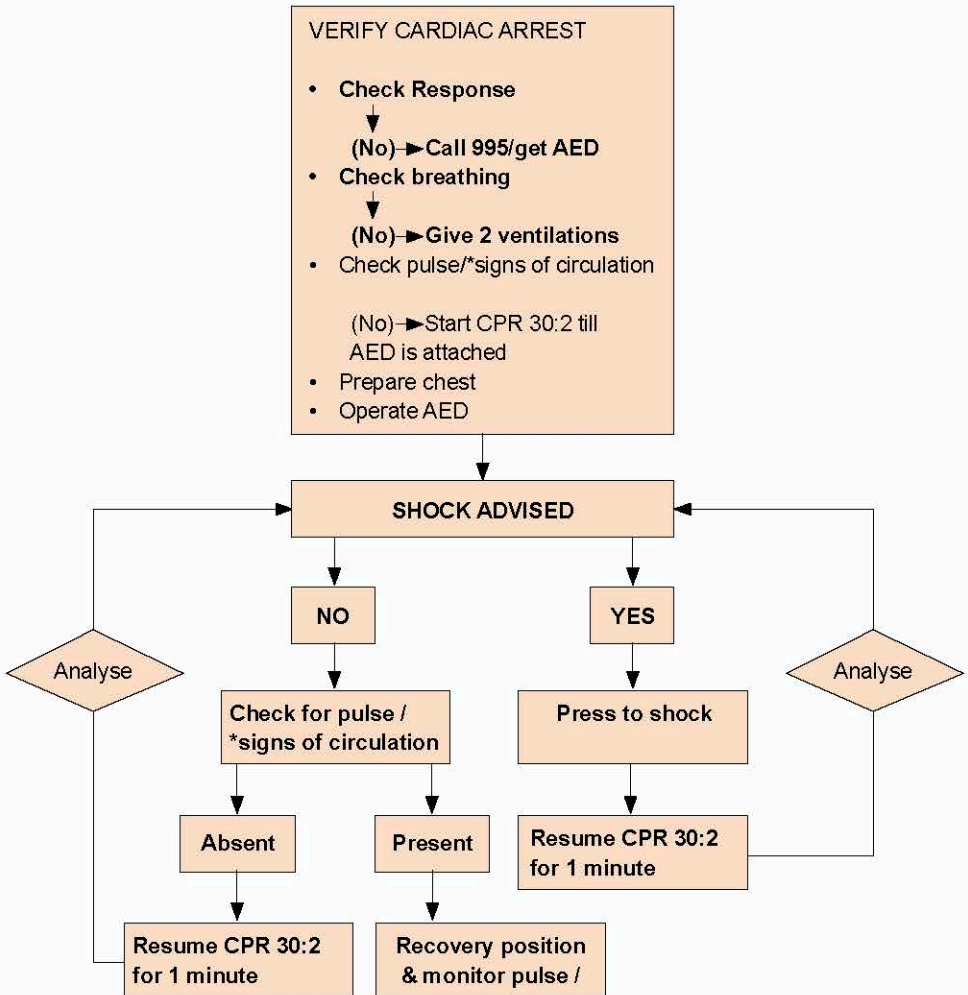
#### Unsuccessful Defibrillation

1. It is important to note that defibrillation may not be successful in all situations, especially if the casualty has arrested cardiac for some time
2. Check for pulse or signs of circulation if “no shock” is advised. If absent, continue CPR for one minute before subsequent analysis by the AED or until the arrival of the ambulance

#### When to stop Defibrillation

1. When prompted by the AED
2. When a doctor directs the resuscitation to cease or when ambulance arrives
3. when the person has been successfully resuscitated

## MEDICAL PROTOCOL – AED OPERATIONAL CHART



\*\* AED should remain connected until casualty is handed over to medical personnel

## **ROLES & RESPONSIBILITIES OF THE RESCUER**

1. High priority of defibrillation – respond immediately when call for assistance is heard.
2. Rapid defibrillation – verifies that the casualty is in cardiac arrest and set up AED.
3. Scene control – ensure all surrounding bystanders do not crowd around the casualty. The importance of scene control cannot be stressed strongly enough. In the presence of the casualty's family members, friends or bystanders, the use of a defibrillator in a resuscitation situation can create stress to the AED operator and may compromise the safety of those present.
4. Ensure that medical assistance has been called (activate Doctor/code blue team OR Call 995, when it is outside the hospital).
5. AED and first aid equipment are available.
6. Professional conduct – be confident in what you are doing. Avoid disagreeing with your colleagues
7. Rescuer/AED operator are required to minimize possible interference from bystanders and improve self-confidence by:
  - Assessing the scene upon arrival. Besides the casualty, the AED operator should attempt to identify significant bystanders.
  - Assigning a relative/friend of the casualty to look after those present. Allocation may promote a feeling of self-worth and value in the bystanders, such as getting someone to look after relatives/friends of the casualty.
  - Maintaining a calm and confident manner during the situation. Regular communication with significant bystanders (such as family members) is essential. The AED operator should quickly tell them what they intend to do and how they are going to do it.
  - Not disagreeing with colleagues. Dissent in treatment options should be presented as if a discussion of options is taking place.
  - Responding to changing attitudes with the bystanders, especially if the resuscitation is not going well.
  - Maintaining a professional attitude at all times. The rescuers must not use derogatory terms, swearing, or language that may be misconstrued.
  - Giving a complete summary of the resuscitation effort to the receiving emergency service, providing comprehensive casualty care and ensuring the professional standing of the rescuer.
  - If a doctor or trained paramedical personnel is present, give a brief summary of what has happened and what has been done. Then continue to assist as necessary.



## **DOCUMENTATION**

It is the responsibility of the AED operator to document all incidents and information related to the use of the AED.

The following information should be documented:

- Name of casualty, AED operator and bystander who helped in the CPR+AED
- Mark the time of collapse and the time AED was put on.
- Mark the time of each shock and record the total number of shocks delivered.
- Time of ambulance arrival and when/where the casualty is transported to by the ambulance.

## SECTION 5: OPERATING PROCEDURES OF LIFEPAK CR PLUS AED

### INTRODUCTION

The Medtronic LIFEPAK CR AED Plus Defibrillator is an Automated External Defibrillator (AED).

When the electrode pads are applied to the casualty's exposed chest, the AED analyzes the casualty's heart rhythm. If a shockable rhythm is detected, the AED will direct the operator, using both audio and visual guides, to deliver an intense pulse of electricity (shock) to the heart muscle. The shock is delivered through the electrode pads on the chest. Delivery of this pulse of electricity is called defibrillation.

Defibrillation is the recognized means of treating life-threatening irregularities of the heart beat, such as ventricular fibrillation, that cause cardiac arrest. Cardiac arrest is usually caused by a malfunction of the heart's electrical system, which prevents the heart from pumping blood throughout the body. This critical condition can cause death within minutes.

The CR Plus is designed specifically for infrequent use and for use by people whose only training is in CPR and in using AEDs. The AED operation is simple to follow and concise. It has a highly visible shock button that the operator presses when the AED issues a shock instruction. The heart rhythm analysis system is field proven and used in hundreds of thousands of devices globally.

The CR Plus tests itself, automatically, once a week and every time you turn it on. In addition, every month, it performs a more extensive self-test. An easy-to-read visual display indicates if the AED is ready for use or if it needs attention.

The CR Plus has a rechargeable internal lithium battery that can deliver up to 30 shocks. A replaceable CHARGE-PAK battery functions as the charger for the internal battery. The internal battery supplies power to operate the defibrillator while the CHARGE-PAK provides a trickle charge for the internal battery. It is important to keep a fresh CHARGE-PAK in the CR Plus, even when the CR Plus is stored.

For an occasional-use defibrillator, this 2-battery system is the best possible engineering trade-off between battery capacity, ease-of-care, reliability, long life, cost and size.

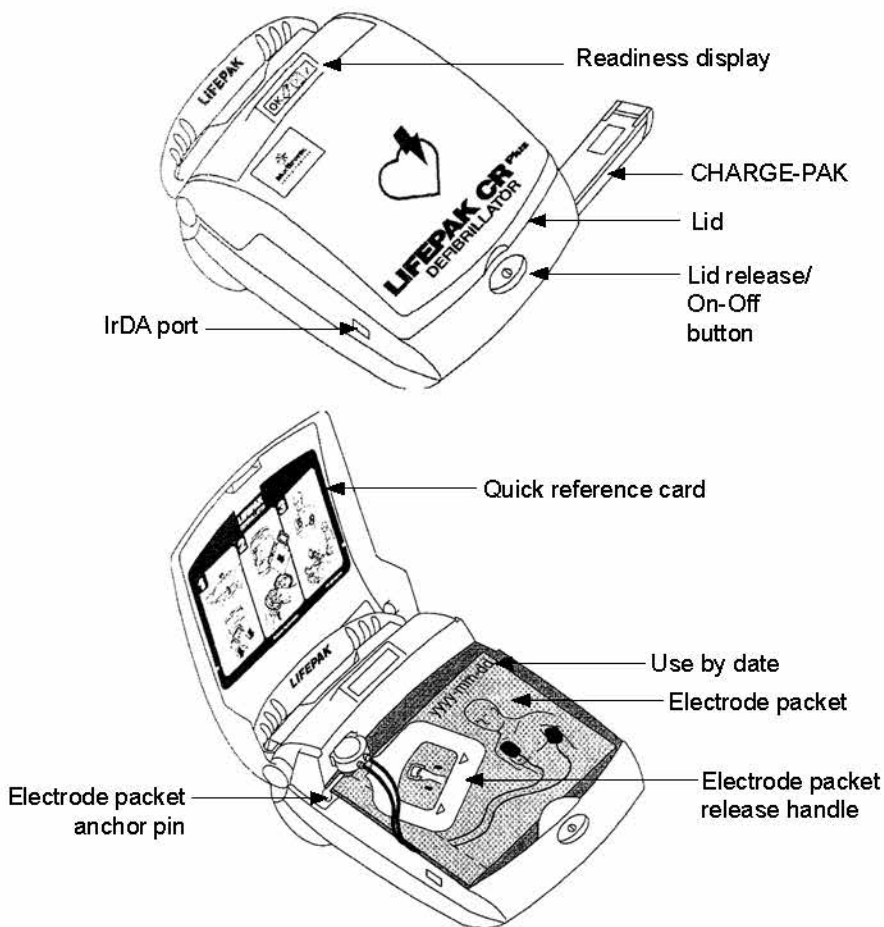
The CR Plus has been carefully designed to synchronize the CHARGE-PAK with the QUIK-PAK electrode life. This unique design feature makes it very easy to maintain both the battery system and the electrodes at the same time.

Anytime the icon on the readiness display illuminates, or when the Use By date is reached, it is time to replace the CHARGE-PAK battery and QUIK-PAK electrode pads.

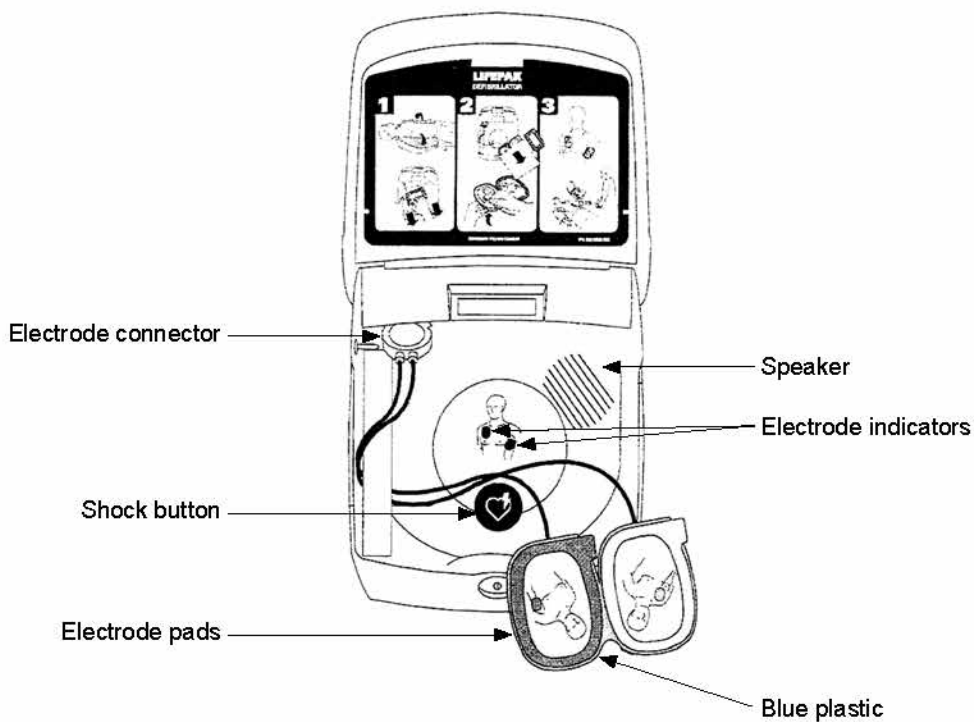
The CR Plus AED digitally stores data when it is turned on and the electrode pads are applied to the casualty. Casualty's data includes date and time, ECG data, and the number of shocks. All casualty and defibrillator data can be transferred to a PC by means of a serial infrared (IrDA) data port.

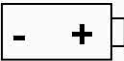


## FEATURES OF LIFEPAK CR PLUS AED

### A. Controls, Indicators And Labels



## B. Inside Features After Opening The Electrode Packet



FEATURE	DESCRIPTION
Quick reference Card	Step by step directions for using the CR Plus to treat casualty in cardiac arrest.
<p data-bbox="90 331 292 355">Readiness Display</p> <div style="display: flex; flex-direction: column; align-items: center; justify-content: center;"> <div data-bbox="493 496 546 520">OK I</div> <div data-bbox="415 603 538 663" style="margin: 10px 0;">  </div> <div data-bbox="456 767 538 855" style="margin: 10px 0;">  </div> <div data-bbox="423 959 538 1007" style="margin: 10px 0;">  </div> </div>	<p data-bbox="572 331 1031 475">Four indicators, visible when the defibrillator is turned off, allow you to determine, just by looking at the defibrillator, whether it is ready for use or needs attention. They include the following:</p> <ul style="list-style-type: none"> <li data-bbox="572 496 1031 584">❑ The <b>OK</b> indicator is visible when the defibrillator is turned off and ready for use.</li> <li data-bbox="572 603 1031 746">❑ The <b>CHARGE-PAK</b> indicator is visible when the CHARGE-PAK needs to be replaced or is not installed in the defibrillator. If needed, the defibrillator can be used in an emergency.</li> <li data-bbox="572 767 1031 911">❑ The <b>Attention</b> indicator appears when the internal battery is not fully charged. When this indicator first appears, the internal battery can power the defibrillator for a minimum of 6 shocks or 42 minutes.</li> <li data-bbox="572 930 1031 1038">❑ The <b>Wrench</b> indicator appears when there is a condition that prevents or could prevent normal operation of the defibrillator.</li> </ul>
Use by Date	Use by Date shown: yyyy-mm-dd. This date can be viewed through the clear plastic lid when it is closed.
Electrode Packet	A set of electrode pads is stored in this packet.
Electrode Packet Anchor Pin	This pin securely positions the electrode packet to the LIFEPAK CR® PLUS AED.

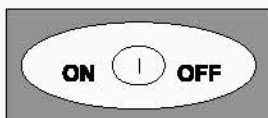
FEATURE	DESCRIPTION
Electrode Packet Release Handle	When you pull this big, red handle, it tears open the electrode packet.
Lid Release / On-Off Button	The lid release/On-Off button opens the CR Plus lid and turns the defibrillator on. Pressing and holding the button for approximately two seconds after the lid is open turns off the defibrillator.
Electrode Connector	This connects the electrode pads to the defibrillator. To aid in casualty transport, the connector can be unplugged from the CR Plus and plugged into another defibrillator equipped for QUICK-PAK electrodes.
Speaker	This projects the voice prompts that lead you through the process of using the defibrillator.
Electrode Indicators	The electrode indicators flash red until the electrode pads are applied to the casualty's exposed chest. When the electrode pads are applied, the indicators turn solid green and the CR Plus can perform an analysis.
	In addition, electrode indicators briefly flash when the defibrillator performs an automatic self- test.
Shock Button	The SHOCK button is available only on the semi-automatic CR Plus. Pressing this button will deliver a shock to the casualty. You cannot deliver a shock to a casualty unless the defibrillator instructs you to do so.

FEATURE	DESCRIPTION
Electrode Pads	The QUICK-PAK electrode pads are applied to the casualty's exposed chest; they transfer the defibrillator energy (shock) to the casualty. The electrode pads must be removed from the blue plastic before applying them to the patient.
Blue Plastic	The Plastic liner that protects the conductive adhesive gel until the electrode pads are used.
CHARGE-PAK	The CHARGE-PAK functions as a battery charger, delivering a trickle charge to the internal battery. A CHARGE-PAK can provide a charge for approximately two years, as long as the defibrillator is not used.

## OPERATING STEPS OF LIFEPAK CR PLUS AED

### Step 1 – Preparation

- Establish that the casualty is in cardiac arrest, as instructed in your CPR training.
- Request others for help. Call 995 for emergency ambulance service.
- Place the CR Plus next to the casualty, as soon as available.



- Press the Lid Release/ On-Off button to open the lid and turn on the CR Plus.



- The voice prompt sequence begins, guiding you through response steps.
- **Follow the instructions provided by the CR Plus voice prompts in the order indicated.**

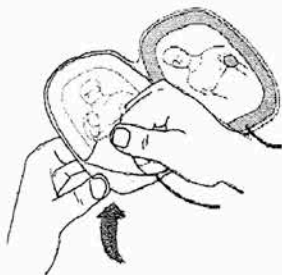


- **Remove clothing from the casualty chest.**
- If casualty's chest is dirty or wet, wipe the chest clean and dry.
- If casualty's chest is excessively hairy, clip or shave the chest hair.

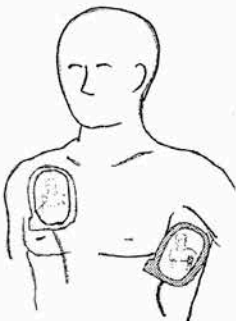




- The voice prompt sequence begins, guiding you through response steps.
- **Follow the instructions provided by the CR Plus voice prompts in the order indicated.**



- **Remove the electrode pads, one at a time, from the blue plastic.**



- **Apply electrode pads to the casualty's chest, as shown.**
- The sticky side of the electrode pads must be pressed firmly onto the casualty's bare skin.

## Step 2 – Analysis And Monitoring



- As soon as the electrode pads are connected properly, electrode indicator lights will turn from red to green.
- The CR Plus automatically begins analyzing the casualty's heart rhythm.
- **Listen to the voice prompts.**
- **Do not touch the casualty unless instructed to do so.**

**If no shock is advised**, the CR Plus will instruct you to

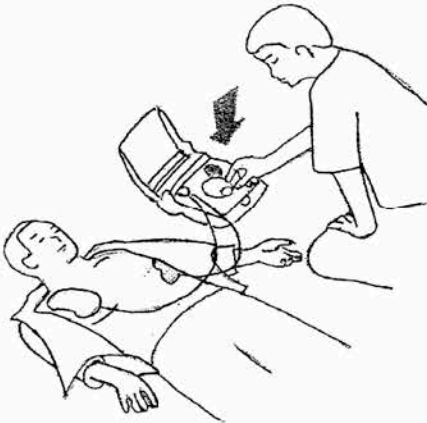
- **Check for signs of circulation, and**
- **Perform CPR if needed**

**If shock is advised**, the CR Plus will instruct you to

- **Stand by to shock,**
- **Everyone Clear** – Make sure no one is touching the casualty, and
- **PRESS FLASHING BUTTON**

Cr Plus will also emit a warning tone.

### Step 3 – Shock Delivery



- Make sure no one is touching the casualty.
- **Press the red, flashing SHOCK button to deliver the shock.**
- The CR Plus will then tell you the shock was delivered and to begin providing chest compressions and rescue breaths.
- After one minute of CPR, the CR Plus goes back to analyzing the casualty's heart rhythm to see if a shock is advised.
- **Follow the voice prompts.**

#### **Note**

- When the CR Plus's energy is fully-charged, you can disarm it at any time by pressing the On/Off button to return it to standby mode.
- If you do not press the Shock button within 15 seconds of being prompted, the CR Plus will disarm itself and re-evaluate the casualty's heart rhythm.



- If casualty starts moving or breathing, keep the electrode pads on the casualty and connected to the CR Plus.
- Attend to casualty as instructed in your CPR Training.

## TROUBLESHOOTING

If the CR Plus detects a problem or system fault during use, it provides a voice prompt indicating the problem. The table lists the common problems and possible corrective actions.

PROBLEM / POSSIBLE CAUSES	CORRECTIVE ACTION
<b>“CHECK PADS FOR GOOD CONTACT” VOICE PROMPT IS HEARD</b>	
<ul style="list-style-type: none"> <li>• Inadequate connection to the defibrillator</li> <li>• Electrode pads are not adhered properly to the casualty</li> <li>• Electrode pads are dry, damaged or have passed the expiry date</li> <li>• Electrode pads are not removed from the blue plastic</li> </ul>	<ul style="list-style-type: none"> <li>• Check to be sure that the connector is completely inserted</li> <li>• Firmly press electrodes on casualty’s skin. Clean, shave, and dry the patient skin prior to placing pads on skin</li> <li>• Replace the electrode pads</li> <li>• Remove the electrode pads from the blue plastic and apply them to the casualty’s chest</li> </ul>
<b>DEFIBRILLATOR CANNOT DELIVER THE REQUIRED SHOCK</b>	
<ul style="list-style-type: none"> <li>• Defibrillator internal battery power is low</li> </ul>	<ul style="list-style-type: none"> <li>• Administer CPR if the casualty is not responding, not breathing normally, not moving, or if you cannot detect a pulse</li> </ul>
<b>VOICE PROMPTS SOUND FAINT OR DISTORTED</b>	
<ul style="list-style-type: none"> <li>• Defibrillator internal battery power is low</li> </ul>	<ul style="list-style-type: none"> <li>• Administer CPR if the casualty is not responding, not breathing normally, not moving, or if you cannot detect a pulse</li> </ul>

PROBLEM / POSSIBLE CAUSES	CORRECTIVE ACTION
<b>“MOTION DETECTED” AND “STOP MOTION” VOICE PROMPTS ARE HEARD</b>	
<ul style="list-style-type: none"> <li>• Casualty movement because of location</li> <li>• Casualty movement because of breathing</li> <li>• Vehicle motion</li> <li>• Electrical/radio frequency interference</li> </ul>	<ul style="list-style-type: none"> <li>• Move casualty to stable location, if possible</li> <li>• Stop CPR during analysis</li> <li>• Check casualty for normal breathing</li> <li>• Stop vehicle during analysis, if possible</li> <li>• Move communication or other suspected devices away from the defibrillator when possible</li> </ul>
<b>DEFIBRILLATOR DOES NOT DELIVER VOICE PROMPTS OR BEEPING TONES AFTER YOU OPEN IT (TURN IT ON)</b>	
<ul style="list-style-type: none"> <li>• Depleted internal battery</li> </ul>	<ul style="list-style-type: none"> <li>• Administer CPR if the casualty is not responding, not breathing normally, not moving, or if you cannot detect a pulse</li> </ul>
<b>THE READINESS DISPLAY IS BLANK</b>	
<ul style="list-style-type: none"> <li>• The defibrillator has been turned on</li> <li>• Operating temperature is too low or too high</li> <li>• LCD not operating properly</li> </ul>	<ul style="list-style-type: none"> <li>• Normal condition when the defibrillator is in use</li> <li>• Operate the defibrillator within 0° to 50°C</li> <li>• Contact the authorized service personnel</li> </ul>

**5.1 OPERATING PROCEDURES OF HEARTSTART FR2**

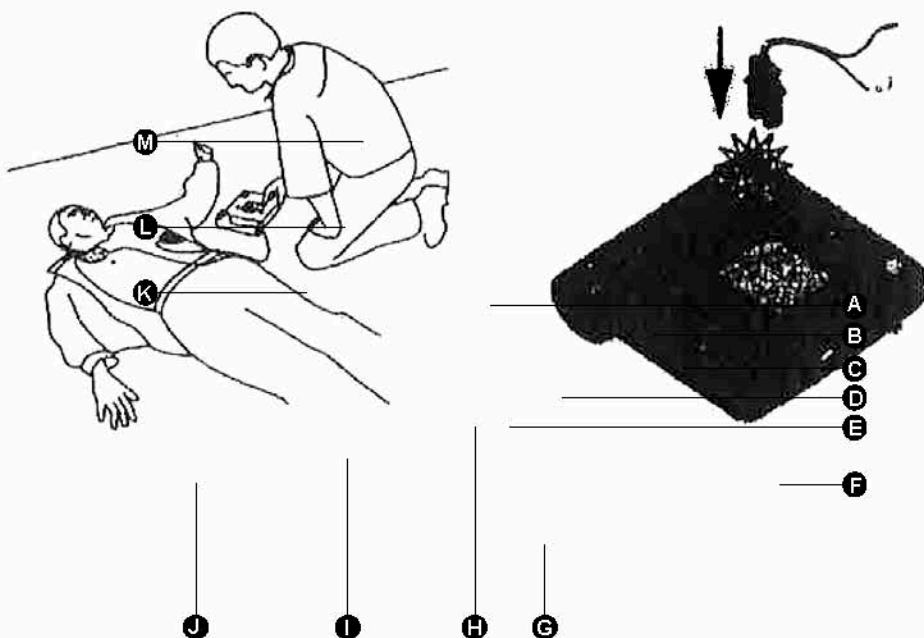
**A. Introduction**

The Heartstart FR2 AED is lightweight, portable and battery powered. Voice prompts provide instructions and patient information, and are reinforced by messages on the LCD screen.

The Heartstart FR2 detects ECG signals and delivers the defibrillation shock using two self adhesive defibrillation pads. The defibrillation pads, cable and connector are supplied as one disposable assembly. It determines proper defibrillation pad contact by monitoring impedance between the two attached defibrillation pads.

The defibrillation shock is delivered using an impedance compensated biphasic waveform of 150 joules. The defibrillation shock can be delivered using the SHOCK Button. The Forerunner will not deliver the shock unless the SHOCK button is delivered.

**B. Features Of The Heartstart FR2**



	<b>FEATURES</b>	<b>DESCRIPTION</b>
A	On / Off	Initiates voice & screen prompts. Press again to turn off.
B	Status Indicator	Shows when the Forerunner is ready to use based on automatic self-tests.
C	Battery Latch (Lithium Battery)	Slide to eject the battery.
	Microphone	Located behind the battery latch. Records voice information when optional PC voice data card is installed.
D	Optional Manual Override Button (Available on Model EM only)	Permits qualified users to manually charge the Forerunner and deliver the shock.
E	Contrast Buttons	Adjust LCD screen contrast & are used to control other functions.
F	Disposable/ Recyclable Battery	Provides power for the Forerunner.
G	Optional PC Data Card	Stores ECG & event data and can also store voice data. Separate cards provide setup & training options.
H	LCD Screen	Displays text prompts & patient I event information. ECG & heart rate can be displayed on Models E & EM.
I	Shock Button	Controls shock delivery. The button flashes when the Forerunner is ready to deliver a shock.
J	Speaker	Provides audible instructions & information about the Forerunner & the patient's status.
K	Defibrillation Pad Placement Illustration	Shows the location for placement of defibrillation pad.
L	Connector Socket	Insert the defibrillation pads connector into the connector socket. The LED flashes to indicate the socket location. The LED is covered when the defibrillation pad connector is properly inserted in the socket.
M	Defibrillation Pads	Disposable & self-adhesive. Defibrillation pads include attached cable & connector .

## C. Operating Steps Of Heartstart FR2

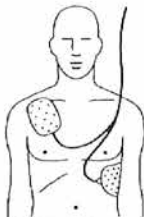
### STEP 1 - PREPARATION

Press the On / Off button to turn on the Heartstart FR2.



Follow the instructions provided by the FR2 voice and screen prompts in the order indicated.

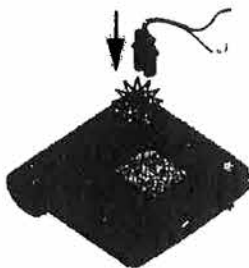
- Remove clothing from the patient's chest. Wipe moisture from the patient's chest and clip or shave excessive chest hair, if necessary.
- Open the defibrillation pads package. Check to see that the pads, the attached cable and connector are undamaged.
- Pull off the protective backing from the defibrillation pads and check that the gel has not dried out. If the pads are damaged or the gel has dried out, use a new set of pads.
- Place each pad on the patient. The pads must be placed with the sticky side on the patient's skin.



#### IMPORTANT:

Refer to the drawing on the back of each pad for correct positioning. One pad goes just below the patient's right collarbone, and the other one goes over the patient's ribs in line with the armpit and below the left breast.

- Connect the pads to the Heartstart FR2. Insert the defibrillation pads connector firmly in the connector socket. A flashing light shows you where the socket is located, at the top left of the Heartstart FR2.





## STEP 2 - ANALYSIS AND MONITORING

Follow the instructions provided by the Heartstart FR2 voice and screen prompts in the order indicated.

- As soon as the FR2 detects the defibrillation pads are connected properly, it automatically begins analysing the casualty's heart rhythm .
- If no shock is advised, the Heartstart FR2 provides voice and screen prompts to tell you so. The FR2 instructs you to perform CPR if needed, and performs background monitoring of the casualty's heart rhythm while you give appropriate care to the casualty.
- No more voice prompts are given, until and unless the Heartstart FR2 :
  - ♥ detects a change in the casualty's heart rhythm that may be a shockable rhythm, or
  - ♥ detects interference with rhythm analysis.
- If the Heartstart FR2 detects a potentially shockable heart rhythm, it automatically goes back to analysing the rhythm to see if a shock is advised.
- If a shock is advised, the Heartstart FR2 charges to prepare for shock delivery. It gives the voice warnings and screen prompts to tell you that a shock is advised.
- Make sure no one is touching the patient.
- While the Heartstart FR2 is charging, it continues to analyse the casualty's heart rhythm. If the rhythm changes and a shock is no longer appropriate, the Heartstart FR2 disarms and dumps the charge. Voice and display prompts advise you what action to take .

### **Note**

***When the Heartstart FR2 is fully charged, you can disarm it at any time by pressing the On/Off button to turn off the FR2 and return it to standby mode.***

## **STEP 3 - SHOCK DELIVERY**

Press the SHOCK button to deliver the shock.

### *Important:*

*You must press the button for a shock to be delivered. The Heartstart FR2 will not automatically deliver a shock.*

- There are four ways you can tell that the Heartstart FR2 is ready to deliver a shock:
  - ♥ You hear a voice prompt telling you to deliver a shock,
  - ♥ You see the Shock button flashing,
  - ♥ You hear a steady tone, or
  - ♥ You see a screen prompt telling you to press the orange (Shock) button.
- After you press the Shock button, a voice prompt tells you the shock was delivered.
- Immediately after a shock, the Heartstart FR2 will provide a pause for 1 minute of CPR.
- The Heartstart FR2 goes back to analysing the casualty's heart rhythm immediately after 1 minute of CPR. The Heartstart FR2 continues to provide voice and text prompts to guide you through additional shocks, if appropriate.

### Note

*If you do not press the Shock button within 30 seconds of being prompted, the FR2 will disarm itself and provide a pause for CPR.*

- Pause for CPR. The heartstart FR2 is programmed to automatically pause for 1 minute after every shock to allow you to perform CPR. After the voice and screen prompts tell you that the FR2 has paused, there are no further voice prompts during the rest of the pause, so that you can provide uninterrupted care.
- During the pause, the FR2 screen shows a bar that fills in as the pause time is used up. The screen also shows how much time has gone by since the FR2 was turned on, and how many shocks have been delivered.

## D. Troubleshooting

If the Forerunner detects an error condition or system fault during use, it provides a voice or display prompt, or a combination of both. The following are the common errors :

Error Condition	Corrective Action by AED Operator
<p>Screen Prompt of the following:</p> <ul style="list-style-type: none"> <li>- not ready for use</li> <li>- self test failed</li> </ul> <p>The Status indicator displays a flashing or solid red X.</p>	<ul style="list-style-type: none"> <li>• Install a new battery and observe the BIT (Battery Insertion Test).</li> <li>• If the BIT fails, contact the Heartstart FR2 customer service.</li> </ul>
<p>A screen prompt alerts to low battery condition.</p>	<ul style="list-style-type: none"> <li>• Replace the battery as soon as possible.</li> </ul>
<p>A screen prompt instructs to replace the battery immediately. The Status Indicator displays a flashing red X.</p>	<ul style="list-style-type: none"> <li>• Replace the battery immediately.</li> </ul>
<p>Status Indicator does not light up.</p>	<ul style="list-style-type: none"> <li>• Install a new battery and observe the BIT. If the BIT fails, contact the Heartstart customer service.</li> </ul>
<p>Voice &amp; screen prompts instructs to attach the defibrillation pads &amp; to plug in the connector.</p>	<ul style="list-style-type: none"> <li>• Check the defibrillation pads connector.</li> <li>• Check the defibrillation pads on the patient &amp; position the defibrillation pads on the patient as shown by the illustration on the defibrillation pads.</li> <li>• If necessary, wipe moisture from the casualty's chest &amp; shave excessive chest hair.</li> <li>• Replace the defibrillation pads if the prompt continues.</li> </ul>
<p>Voice &amp; screen prompts to check the defibrillation pads or to press the defibrillation pads firmly to the casualty's chest.</p>	<ul style="list-style-type: none"> <li>• Check that the defibrillation pads are not applied to clothing.</li> <li>• Press the pads firmly to the patient's bare chest.</li> </ul>
<p>Voice &amp; screen prompts to replace the defibrillation pads.</p>	<ul style="list-style-type: none"> <li>• Replace the defibrillation pads.</li> </ul>
<p>Voice &amp; scree prompts that the ECG analysis has been interrupted.</p>	<ul style="list-style-type: none"> <li>• Discontinue CPR; do not touch the patient. Attempt to eliminate patient motion, if possible.</li> </ul>

Error Condition	Corrective Action by AED Operator
	<ul style="list-style-type: none"> <li>• Stop the patient transport vehicle if needed.</li> <li>• Check for &amp; remove possible causes of radio &amp; electrical interference.</li> </ul>
<p>Voice &amp; screen prompts that a shock was not delivered when the shock button was pressed.</p>	<ul style="list-style-type: none"> <li>• Check for defibrillation pads for proper placement.</li> <li>• Check the defibrillation pads connector.</li> <li>• Press the defibrillation pads to the casualty's chest.</li> <li>• Replace the defibrillation pads if necessary.</li> </ul>
<p>Screen prompts alert you that there is a data card error.</p>	<ul style="list-style-type: none"> <li>• Remove the card. Contact Heartstart for a new set-up card.</li> <li>• Remove the card. Ensure that the card is a Heartstart card &amp; was installed correctly .</li> </ul>

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