SRFAC
SINGAPORE RESUSCITATION AND FIRST AID COUNCIL

Basic Cardiac Life Support and Automated External Defibrillation (BCLS+AED) Provider Course Manual

REV 1 / 2022

CONTENTS

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CHAPTER 1

Cardiac Arrest and You

1.1: INTRODUCTION

Based on national health statistics from the Ministry of Health in 2019, Singapore, ischemic heart disease (lack of blood circulation to heart muscles) is the **third most common cause of death, contributing to 18.8% of total mortality**.

A person with heart disease is prone to a heart attack, which could result in cardiac arrest and sudden death. According to a study conducted in Singapore*, the crude incidence rate of Out-of-Hospital Cardiac Arrest (OHCA) in 2019 was 56.7 per 100,000 population in 2019 (**3233 casualties**), of which, **2239 cases (74%)** of cardiac arrests occur in the home. Bystander CPR was performed on **1937 casualties (60%)** and bystander defibrillation was performed on **340 (10.5%)** of them. Out of **200 survivors (6.2%), 156 (4.8%)** of them survived to be discharged with good-to-moderate neurological functions.

Survival from sudden death can be maximized with the prompt application of basic life-saving skills of cardio-pulmonary resuscitation (CPR) and use of automated external defibrillators (AEDs). These can be performed by anyone, anywhere and anytime. All that is needed is the rescuer's two hands.

** White AE, Shaidah N, Asyikin N et al. Singapore Out-of-Hospital Cardiac Arrest Registry Report 2011-2019. July 2021. Republic of Singapore. Unit for Pre-hospital Emergency Care.*

1.2: THE HEART, LUNGS AND CIRCULATION

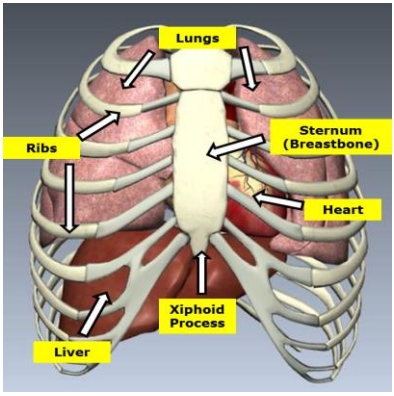


Figure 1-1 - The heart and lungs

The heart is a muscular pump located in the center of the chest and slightly towards the left. (See figure 1-1)

The heart has two halves. The right side receives low oxygen blood from all parts of the body through veins and pumps it to the lungs via the pulmonary arteries to pick up oxygen. (See figure 1-2)

The left side receives oxygen-rich blood from the lungs through the pulmonary veins and delivers it to all parts of the body, including the vital organs such as the heart, lungs, kidneys and brain.

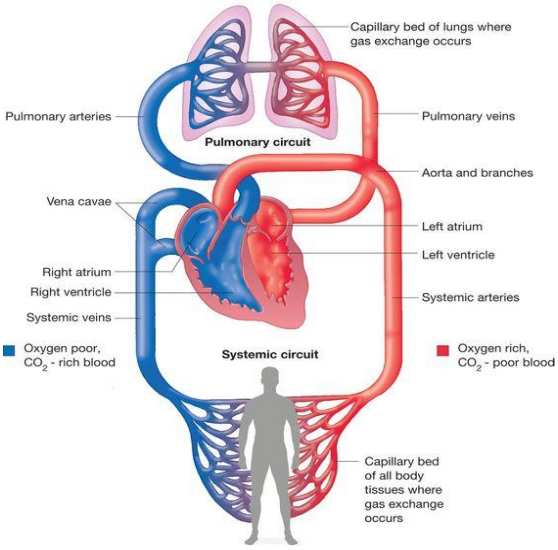


Figure 1-2 - The circulatory system

The heart muscles receive oxygen rich blood via a set of coronary arteries.

The pumping action of the heart is initiated by electrical signals from a pacemaker (sinoatrial or SA node), these signals travel to other parts of the heart in an orderly manner through a conductive network. The electrical signals from the heart can be picked up by an electrocardiogram (ECG). (See figure 1-3)

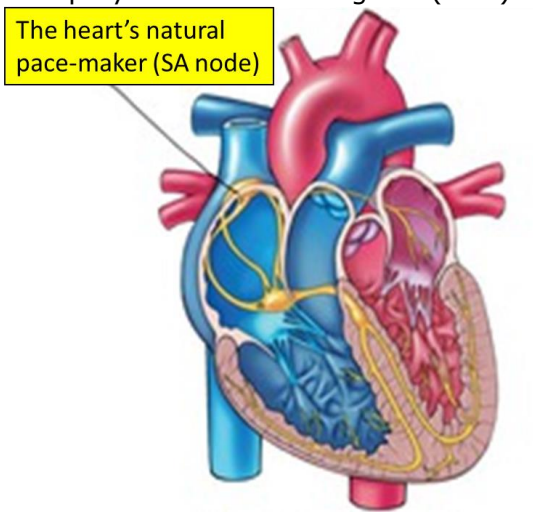


Figure 1-3 - The heart's electrical conduction

The pumping action gives rise to an organized heart-beat at regular rate of 60-100 beats per minute in a normal person.

On an ECG, normal heart rhythm, also known as the Normal Sinus Rhythm, appears as below (see figure 1-4):

Figure 1-4 - Normal Sinus Rhythm

The human body has two lungs which absorb oxygen from the air that is breathed in. 21% of air consists of oxygen, of which 5% is extracted by the lungs. The extracted oxygen is passed to the blood within the capillaries of the lungs. The capillaries confluence into the pulmonary vein, which transports the oxygenated blood into the left side of the heart. (See figure 1-5)

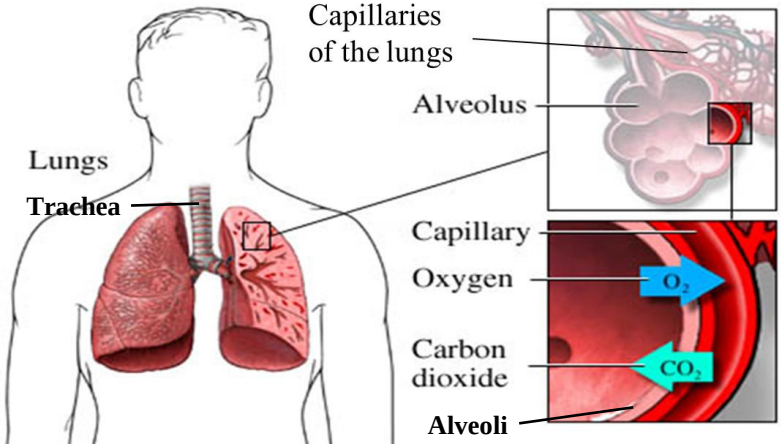


Figure 1-5 - Exchange of Oxygen and Carbon Dioxide in the lungs

The remaining 16% of unabsorbed oxygen is breathed out. This is extremely important in the context of mouth-to-mouth ventilation; the air that the rescuer ventilate into a cardiac arrest casualty can deliver sufficient oxygen to save and sustain life.

1.3: RISK FACTORS FOR HEART ATTACK

Survival rates of Sudden Cardiac Arrest is dismal even in the best cities. Prevention is of paramount importance to prevent heart attack from occurring. Several key risk factors contribute to the development of a heart attack. Human Beings can minimize the chance of getting a heart attack by controlling the risk factors. These are:

Smoking – Smoking promotes the development of plaques within the coronary arteries and increases the risk of heart attack by two-fold. This habit should be avoided altogether. (See figure 1-6)

Figure 1-6 - Avoid smoking

Blood Pressure – If the blood pressure is high, there will be tremendous stress on the heart. Frequent blood pressure checks and reduction of salt in the diet is important. Those with high blood pressure should take their medicines and check their blood pressure regularly as instructed. (See figure 1-7)

Figure 1-7 - Check your blood pressure regularly

Blood Sugars – Avoid a diet high in carbohydrates or refined sugars and control body weight through diet and exercise. (See figures 1-8 and 1-9) If you have diabetes, take your medications regularly as instructed.

Figure 1-8 - Eat healthily

Blood Lipids - Manage blood lipids (fats) by avoiding foods high in fats. Doing regular exercise could improve your blood lipid profile and take your medications regularly as instructed. (See figure 1-9)

Adopting healthy lifestyles by not smoking, eating foods in moderate amounts and regular exercise will decrease the risk of heart disease and other illnesses.

Figure 1-9 - Exercise regularly

1.4: WHAT HAPPENS IN A HEART ATTACK?

A heart attack occurs when cholesterol deposits and / or blood clots block one of the coronary arteries supplying the heart muscle. (See figure 1-10) The heart muscles beyond the blocked vessel dies due to lack of oxygenated blood. This is heart attack.

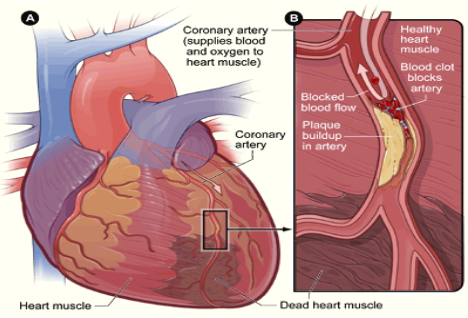


Figure 1-10 - Blocked coronary artery

Symptoms of a Heart Attack

A person who has a heart attack may experience any of these:

Pain – described as tightness or discomfort either over the chest or upper part of the abdomen. (See figure 1-11) This pain may also spread to the left shoulder, left arm, neck or lower jaw. Some may mistake this for indigestion or fatigue.

Shortness of breath – A sudden difficulty in breathing may be a warning sign of a heart attack.

Other Symptoms - Sweating, nausea, vomiting or dizziness

If a heart attack is not treated promptly, deterioration of heart function will occur and the casualty may develop a sudden cardiac arrest.

Figure 1-11 - Pain or discomfort over the chest or upper abdomen

Learn to recognize the symptoms of a heart attack. When someone experiences these, it is best to call for an ambulance (telephone: 995) and be taken to the nearest Emergency Department for immediate evaluation.

1.5: WHAT HAPPENS IN A CARDIAC ARREST?

When a portion of the heart muscles dies, it affects the electrical impulses within the heart. The orderly flow of electrical signals within the heart is disrupted. This is a dangerous situation and an irregular, chaotic electrical rhythm called Ventricular Fibrillation (**VF**) develops in many cases (see figure 1.12).

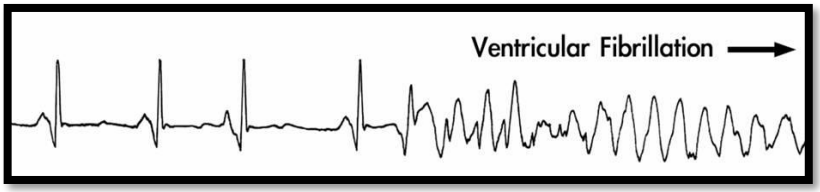


Figure 1-12 - Normal Sinus Rhythm to Ventricular

When VF occurs, the heart does not pump the blood to the rest of the body. This is a state of **cardiac arrest** and the casualty will be unconscious and stops breathing normally.

Biological death and Clinical death

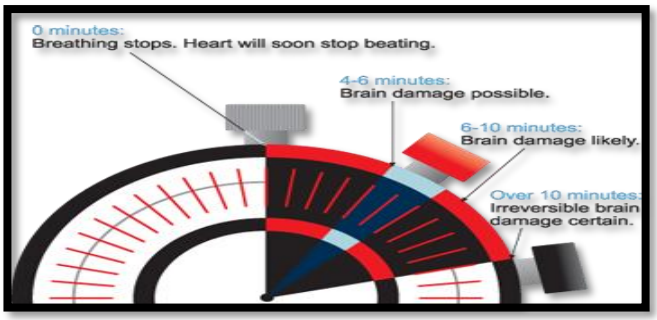


Figure 1-13 - Irreversible brain damage after 10 minutes

When cardiac arrest occurs, the heart stops pumping and circulation stops. The oxygen level in the blood decreases, causing brain damage. If this situation is reversed immediately, survival chance could be as high as 90%. With a 6 minutes delay, this drops to 40–50% and at 9 minutes, it is a dismal 10%. (See figure 1-13) This is known as clinical death. Unless the circulation is restarted quickly, organ death will start to occur. The most sensitive organ is the brain and if the

circulation to the brain is not started within about 4 minutes, permanent and irreversible brain damage will start to occur. This is known as biological death. It is therefore important to start CPR as quickly as possible

Air contains approximately 21% oxygen at sea level. During its passage through the body, only about ¼ of oxygen is utilised and hence exhaled air contains approximately 16% oxygen. When mouth-to-mouth ventilation is done during CPR, there is sufficient oxygen in the exhaled air to keep the casualty alive. Chest compression squeezes the heart between the breastbone and the spine, thereby helping to circulate the blood and deliver oxygen to the vital organs, especially the brain.

Immediate CPR and defibrillation are key components for increased chances of survival.

1.6: OTHER COMMON CAUSES OF CARDIAC ARREST

A heart attack is the most common cause of cardiac arrest. There are other causes, which include:

Figure 1-14 - Other common causes of cardiac arrest

Death in these situations can be prevented if someone trained in CPR and first-aid skills provides prompt help.

1.7: THE CHAIN OF SURVIVAL

The essential steps for helping a cardiac arrest victim are illustrated in a system called the "Chain of Survival". The seven rings in this chain are: Prevention, Early Recognition and Access, Early CPR, Early Defibrillation, Emergency Medical Services (Ambulance), Advanced Cardiac Life Support and Recovery. (See figure 1-15)

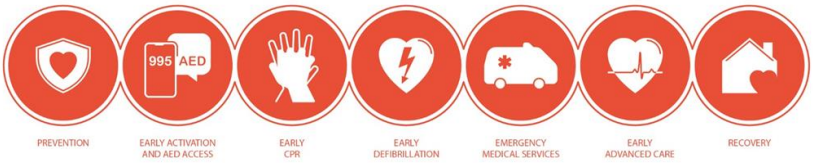


Figure 1-15 - The chain of survival

First Ring: Prevention
Prevention is better than intervention. A healthy diet and lifestyle can reduce the risk of heart diseases. Going for regular medical check-ups can help detect problems early and prompt the individuals to seek treatment early and adjust their diet and lifestyles.

Second Ring: Early Activation and AED Access
Call for ambulance (dial 995) and get an AED if visible and near-by. Follow the SCDF dispatcher's instructions.

Third Ring: Early CPR
The brain cells start dying within 4-6 minutes of cardiac arrest. CPR must be initiated as soon as possible to provide blood and oxygen flow to the brain and heart.

Fourth Ring: Early Defibrillation
Automated external defibrillators (AEDs) are increasingly available in the community, at lift lobbies, void decks, gymnasium, shopping malls, hotels, airports and schools etc. Apply onto the casualty and be ready to defibrillate.

Fifth Ring: Emergency Medical Services (Ambulance)
Quick access to the scene and transport to the hospital makes a difference to the casualty's chances of survival.

Sixth Ring: Advanced Cardiac Life Support
Medical teams will provide advanced cardiac life support at the hospital with the use of Intravenous/Intraosseous (IV/IO) medication and delivery of oxygen via mechanical systems (ie. Bag-Valve Masks and ventilators).

Seventh Ring: Recovery
To ensure a good survival outcome after OHCA requires continued community and medical support (ie. social services, physio/occupational therapy, nutritional guidance, etc) and therapy to re-habilitate the individual back to normalcy.

1.8: SCDF MYRESPONDER MOBILE APPLICATION

In Singapore, many of the emergency cases SCDF responds to could be quickly attended to by members of the public even before SCDF's arrival. For example, more than 3000 people suffer from Out-of-Hospital Cardiac Arrest (OHCA), with a survival rate of just 5%, which could be improved by simple medical intervention within the first few critical minutes. At the same time, there are more than 1,000 minor fires (such as rubbish chute/bin fire) that could easily be extinguished using publicly-available means. (See figure 1-16)

Cardiac Arrest	• Accept the myResponder alert, and proceed to the given location • You may use the app to locate nearby AEDs • Upon arrival at the patient's side, perform CPR, or apply an AED • Hand-over the case to the SCDF paramedics when they arrive
Minor Fire	• Accept the myResponder alert, and proceed to the given location • Extinguish the fire using available means, such as nearby extinguishers, buckets of water, domestic water taps and hoses, or drencher systems for rubbish chutes • Provide SCDF with up to 3 photos for scene assessment
Major Incident	• Accept the myResponder alert, but do not proceed any closer to the given location • Provide SCDF with up to 3 photos and 1 video of the developing incident, if it is safe to do so • If you receive any instructions for evacuation, do so immediately

Figure 1-16 – Incidents that will trigger myResponder notifications

Figure 1-17 – The myResponder mobile application is available on Apple and Android stores.

myResponder is an application by SCDF to alert members of the public to nearby fire and medical cases, and thereby save lives and increase the survival rate for OHCA, as well as mitigate minor fires in the first few critical minutes. myResponder is also a means by which members of the public may be asked to provide onsite information (via submission of photos and videos) for SCDF to gain an understanding of the situation. Through the 'Call 995' button in the app, users can also send their geolocation to SCDF's 995 Operations Centre, enabling SCDF to dispatch the emergency resources to the scene sooner.

myResponder works by notifying members of the public – also known as Community First Responders (CFRs) – of cardiac arrest and fire cases within 400m of their location. myResponder will also highlight nearby AEDs that may be available to responders, and provide guided advisories in the mitigation of minor fires. CFRs can then proceed to the stated location and assist by performing CPR or applying an AED to revive the patient, mitigating minor fires using available extinguishing means, or providing further information to SCDF's 995 Operations Centre.

Response is entirely voluntary, however, volunteers are encouraged to respond, when they are available and within safe and reasonable means.

Fig 1-18 – The above QR code works for both Apple iOS and Google Android OS and will direct to the App Store or Google Play respectively. The myResponder function is also available within the SGSecure application.

CHAPTER 2

Cardio-Pulmonary Resuscitation (CPR)

2.1: THE IMPORTANCE OF EARLY CPR

2.2: ADULT ONE-RESCUER CPR

2.3: CPR IN SPECIAL CIRCUMSTANCES

2.1: THE IMPORTANCE OF EARLY CPR

When the heart stops beating, blood stops flowing through the body. Unless the flow is restarted quickly, other organs in the body will stop functioning. For example, if the blood does not flow to the brain for 4 to 6 minutes, it could result in brain death. CPR is a series of actions required to restart the heart and get the blood flowing once again as soon as possible.

CPR includes mouth-to-mouth ventilation and chest compressions. When mouth-to-mouth ventilation is done during CPR, oxygen is introduced into the body. However, in view of COVID-19 pandemic, healthcare providers were taught on the use of bag-valve-mask (BVM) instead of mouth-to-mouth (MTM) ventilation. Chest compression squeezes the heart between the breastbone and the spine and thereby helps to circulate the blood and deliver the oxygen to the vital organs, especially the brain, heart, and kidneys.

If CPR is performed promptly and correctly:

- Heart function may be restored, and
- Circulation may be maintained until institution of other life support measures.

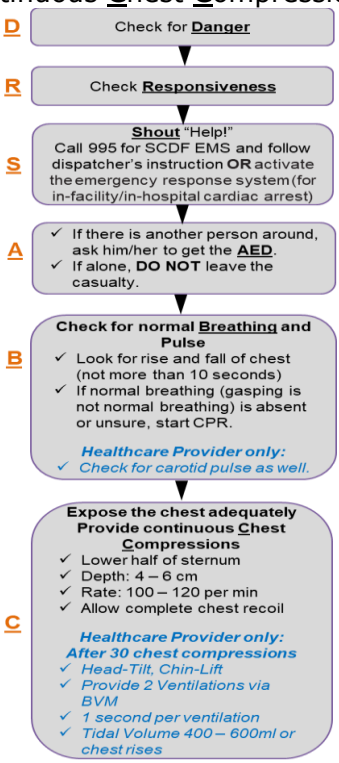
In many cases, rescuers in the community are unwilling and/or unable to provide ventilations. Hands only (chest compressions only) CPR can be initiated. This only requires continuous chest compressions without mouth-to-mouth ventilation, is easier to learn and is as effective as standard CPR.

The next section takes you step-by-step through the procedures needed to perform CPR – the basic skill needed to save lives in the event of cardiac arrest.

2.2: ADULT ONE-RESCUER CPR

MNEMONIC: **DRSABC**

D Check for **D**anger
R Check **R**esponsiveness
S **S**hout to get help and call 995 for Singapore Civil Defence Force (SCDF) Emergency Medical Services (EMS)
A Ask someone to get an **A**ED
B Check for Normal **B**reathing and Pulse (for trained Healthcare Providers)
C Provide continuous **C**hest **C**ompressions



Notes:
1. If you are a single rescuer and feeling tired, you may take a rest of not more than 10 seconds (preferably after 100 continuous chest compressions).
2. For Healthcare Provider only: If no BVM is available and you are unable or unwilling to do mouth-to-mouth ventilations, perform continuous chest compressions.

Figure 2-1 – One rescuer CPR steps
**BVM: Bag Valve Mask*

(D) Check for Danger

Ensure that the rescuer operates in a safe environment. Resuscitation should start where the casualty is found, unless the site is unsafe or unconducive (eg. roads which are still open to traffic, burning building, etc), then the casualty should be removed to a safe, flat and open space as soon as possible.

(R) Check for Responsiveness

- The rescuer should tap the casualty's shoulders firmly and ask loudly: 'Hello! Hello! Are you okay?' (See figure 2-2)
- Avoid violent shaking of the casualty as this may result in injury.
- Avoid unnecessary movements of the neck in the event of injuries to the head and neck.

Figure 2-2 – Tap shoulder for response

For CPR to be effective, the casualty must be lying on his/her back on a firm, flat surface. If the casualty is lying face down (prone position), or on his/her side, rescuer will need to roll the casualty over onto his/her back.

(S) Shout to get help

- If the adult is unresponsive, shout to get help from bystanders to call '995' for SCDF EMS or activate the emergency response system (for in-facility/in-hospital cardiac arrest). If alone, use a handphone to call 995 for SCDF EMS and put on speaker phone mode. An SCDF emergency medical dispatcher can help a lay rescuer recognise cardiac arrest, and once this is established, the dispatcher will guide the rescuer to begin CPR by providing

Figure 2-3 – Call 995 for an ambulance

instructions on how to perform Chest Compressions via a handphone. (See figure 2-3)

- In a situation where a lone rescuer found an unresponsive casualty in a remote area with no accessibility to activate emergency medical service, it is necessary for the lone rescuer to assess the casualty's responsiveness and breathing. If normal breathing is absent, chest compressions should commence immediately and continued for at least two minutes before leaving the casualty to seek help.

Note:

♥ However, if there is another person around, ask him/her to call 995 for SCDF EMS and get an AED.

(A) Ask someone to get an AED

Figure 2-4 – Ask someone to get an AED

- Ask someone to get an AED if there is one within a 60-second walking distance. The SCDF emergency medical dispatcher may be able to locate the nearest AED and summon help from CPR-trained rescuers in the vicinity. However, if you are the lone rescuer, do not leave the casualty. (See figure 2-4)

(B) Check for normal Breathing

Figure 2-5 - Look for normal breathing

- Look for the rise and fall of the chest. (See figure 2-5)
- Checking for normal breathing should not take more than ten seconds.
- It is important to recognize that gasping is **NOT** normal breathing but a sign of cardiac arrest (gasping can also happen in severe asthmatic

attack). Start chest compressions immediately if you are unsure whether the casualty has abnormal breathing or gasping. (See https://youtu.be/T85vd3CBs04 for video of contrast between gasping and normal breathing)

For trained healthcare providers

- Checking of carotid pulse and breathing should not take more than 10 seconds.
- Check for carotid pulse when checking for normal breathing. Slide your fingers down to the groove at the side of the neck near you (this is the location of the carotid pulse).
- If unsure about the presence of carotid pulse and no normal breathing, assume cardiac arrest and commence chest compressions.

(C) Chest Compressions

- Site of chest compression should be at the centre of the chest at the lower half of the sternum (breastbone). (See figures 2-6 and 2-7)
  - Ensure adequate exposure of the chest.
  - Kneel by the side of the casualty.
  - Place the heel of one hand on the lower half of the sternum (breastbone) and avoid the **Xiphoid Process**.
  - Place the heel of the second hand on top of the first.
  - Interlace the fingers of both hands and lift the fingers off the chest wall. (See figure 2-8)
  - Straighten both the elbows and lock them into position.
  - Position the shoulders directly over the casualty's chest. Use the body weight to compress the casualty's sternum (breastbone).
  - Depth of chest compression for adults must be at least 4 cm but not more than 6 cm.
  - The compression rate is 100–120 per minute.
  - Ensure complete recoil of the chest wall after each compression. (See figure 2-9)
  - Loud counting of the chest compressions should be encouraged: 1&2&3&4&5&, 1&2&3&4&10&,

1&2&3&4&15, 1&2&3&4&20, 1&2&3&4&25, 1&2&3&4&30… up to 100. Chest compressions consist of a series of rhythmic applications of pressure over the lower half of the sternum (breastbone). These compressions create blood flow to the vital organs (heart, lungs and brain).

- If tired after 100 compressions, rescuer can take up to 10 seconds of rest and then resume chest compressions.

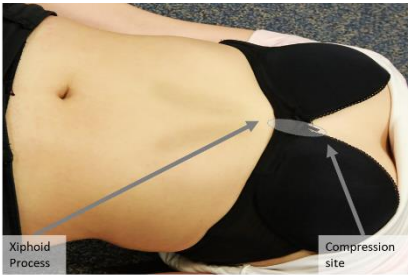


Figure 2-6 - Xiphoid Process (Female casualty) – to be avoided

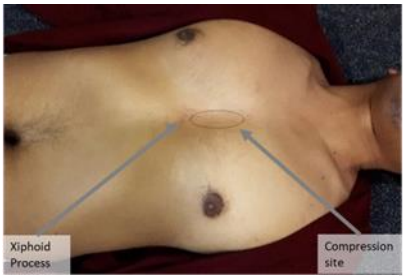


Figure 2-7 - Xiphoid Process (Male casualty) – to be avoided

Figure 2-8 – Lift fingers off the chest wall and interlock hands

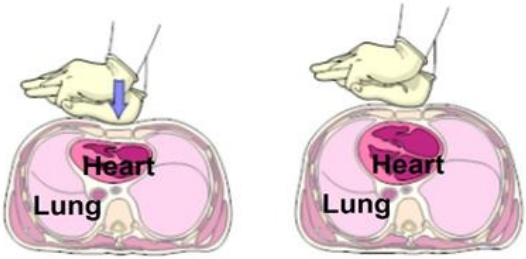


Figure 2-9 - Compression and release during CPR

For trained healthcare providers

- Perform 30 chest compressions and provide 2 ventilations via a BVM.
- Complete 5 cycles of 30 compressions and 2 ventilations before re-assessing breathing and circulation.

Perform BVM ventilations:

- Perform a Head-Tilt, Chin-Lift manoeuvre. An open airway will ensure BVM ventilations are effective. In the unresponsive casualty, muscle tone is impaired resulting in the tongue falling backward and obstructing the airway. (See figure 2-10) As the tongue is attached to the lower jaw, moving the lower jaw forward will lift the tongue away from the back of the throat and open the airway.

- **Head-tilt** - Place your palm on the forehead and push it backwards.

- **Chin-lift** – Use the index and middle fingers of your other hand to lift the bony part of the chin upwards. (See figure 2-11)

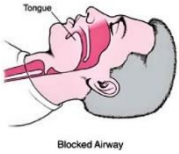


Figure 2-10 - The airway blocked by the tongue

Figure 2-11 - The Head-Tilt, Chin-Lift Manoeuvre

- When using a Bag Valve Mask (BVM), select a mask that fits over the mouth and nose of the casualty – The nasal portion of the mask over casualty's nose high enough to cover the bridge without air leaks

appropriate mask

and the lower portion of the mask over the chin, allowing it to seal along the two cheekbones. (See figure 2-12)

- **E – C hand placement –** 'E': Using one hand, hold the mask with
your middle and index finger wrapped around the connector stem of the mask. 'C': Extend your thumb underneath the casualty's jaw, and pull it upward into the mask. (See figure 2-13)

Figure 2-13 – 'E-C' hand placement

- While maintaining the upward traction on casualty's jaw, press the mask downward onto the face to attain a tight mask seal. (See figure 2-14)


Figure 2-14 – Maintaining the upward traction of the jaw and downward traction of the mask

- Perform ventilation by squeezing the bag steadily and smoothly using your other hand over 1 second. Then, release the bag to allow it to reinflate fully before providing second ventilation.

- Each ventilation should be enough to make the chest rise. This is approximately 400 – 600 ml of air.

- Do not interrupt chest compressions for more than 10 seconds to perform 2 ventilations.

Note:

- Do not press deeply into the soft tissues under the chin.
- Do not place your hands or the mask on the casualty's eyes as doing so may damage the eyes or cause a vagal reaction.
- Excessive force and rapid insufflation increase gastric distension.
- If BVM is not available, you may provide mouth-to-mouth ventilations if you are trained and willing to perform.
- If you are unable or unwilling to perform ventilations for any reasons, please perform continuous chest compressions at the rate of 100 – 120 per minute. If you are a single rescuer and feeling tired, you may take a rest of not more than 10 seconds (preferably after 100 compressions).

The cycles of 30 chest compressions to 2 ventilations (see figure 2-15) should be continued until one of the following occurs:

Figure 2-15 – 30 chest compressions followed by 2 ventilations via bag-valve-mask (BVM)

- An AED is connected to the casualty and prompts you to stop CPR.
- The ambulance crew arrives and takes over further care of the casualty.
- The casualty regains normal breathing or consciousness.

Continue to perform CPR until:

- Paramedic takes over from the rescuer; or
- AED prompts to analyse the casualty's heart rhythm, is charging or when shock is to be delivered; or
- Casualty wakes up or regains normal breathing.
- Healthcare providers who are trained and confident in pulse check should check the pulse after at least five cycles

of 30 compressions to two ventilations (done via a bag-valve mask). Checking of pulse should not take more than ten seconds. If unsure of the presence of a pulse by the end of ten seconds, the rescuer should resume CPR.

Summary on selection of appropriate mask & ventilation bag size for bag-valve-mask (BVM) ventilation

	Adult (>12 yrs old)	Child (1–12 yrs old)	Infant (<1 yr old)
			
Mask size 	Face mask should extend from the bridge of the nose to the cleft of the chin, covering the nose and the mouth but avoiding compression of the eyes.		
Ventilation bag size 	1500-2000 mls	500-1500 mls	500 mls

Note:

♥ **The tidal volume delivered should be sufficient to produce a normal chest rise**.

For Trained-Healthcare Providers

- Check for normal breathing and pulse after every 5 cycles of CPR 30:2.
- If normal breathing and pulse are absent or you are unsure, continue CPR 30:2.

- If pulse is present and normal breathing is absent, perform rescue breathing at a rate of **12 breaths per minute** (one breath every 5 seconds) by giving one breath and counting **2-a-thousand, 3-a-thousand, 4-a-thousand, 5-a-thousand**.
- Repeat the sequence until you have completed a total of 12 breaths. Re-assess for normal breathing and pulse.
- If both the breathing and pulse are present, maintain the casualty in a supine position and continuously monitor the casualty until help arrives.

2.3: CPR IN SPECIAL CIRCUMSTANCES

Resuscitation training should simulate the environment that rescuers may find themselves in. For example, healthcare providers should practice resuscitation skills on manikins on a trolley bed (see figure 2-16) or stand on a step stool at the side of the trolley bed. This is to ensure the elbows can be straightened to facilitate chest compressions.

Figure 2-16 – CPR on a trolley bed

For resuscitation involving two or more rescuers, one rescuer can focus on chest compressions with the other handling the ventilations. Additional rescuers can be delegated with other tasks such as calling 995 for SCDF or retrieving and using the AED.

Although chest compressions are commonly performed by kneeling at the side of the casualty, there may be specific circumstances involving narrow alleys, walkways or corridors where the rescuer may have to perform chest compressions by positioning over the head instead of the usual lateral side. (See figure 2-17)

Figure 2-17 – Overhead CPR

In the case of a passenger aircraft, a rescuer should kneel in the leg-space in front of the aisle seats to perform chest compressions if the casualty cannot be transferred within a few seconds to an area with adequate floor space such as the galley.

For transferring a collapsed person from a chair to the floor, the following link provides some guidance (see item 10iv within the document in the link) – http://lgnbe.org.uk/resources/g26.pdf.

The above-mentioned are not definitive guidelines to resuscitation in tight spaces but can be taken as a reference should anyone be caught in similar situations.

CHAPTER 3

AUTOMATED EXTERNAL DEFIBRILLATION (AED)

3.1: The Importance of Early Defibrillation

At the time of a sudden cardiac arrest, the most common underlying cardiac rhythm is an irregular and chaotic electrical rhythm (shockable rhythms) called **Ventricular Fibrillation (VF) or Ventricular Tachycardia (VT) without pulse**. (See figure 3-1) However, not all cardiac arrests present as VF and may appear as other electrical rhythms (eg. asystole which is non-shockable).

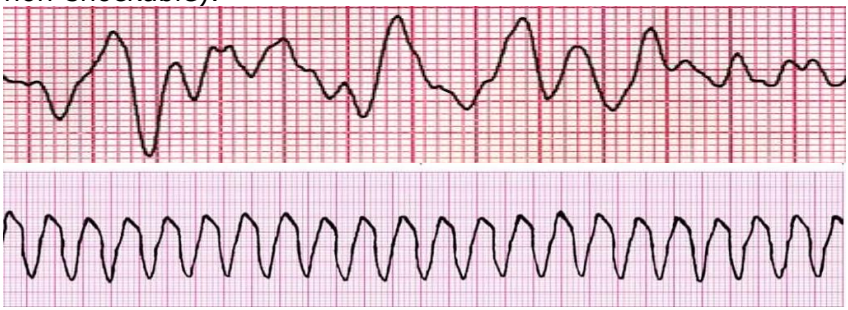


Figure 3-1 - Ventricular Fibrillation & Ventricular Tachycardia without pulse

During VF, the heart muscles do not contract effectively and delivery of blood to the rest of the body ceases. The treatment for VF is a shock administered using an AED. This shock, together with chest compressions, will reinstate normal heart rhythm and contractility if administered as soon as possible (within 4 minutes). The survival rate decreases by 7-10% for every minute of delay in treating VF. If delayed or untreated, VF eventually degenerates into a fatal rhythm known as **asystole** where the heart has no electrical activity as reflected by a flat line tracing. (See figure 3-2) At this juncture, the only treatment possible is to administer CPR.

In the past, only trained doctors, nurses and paramedics, could perform manual defibrillation as it requires the operator to recognize the cardiac rhythm of the casualty, whether it is **shockable** or **non-shockable**. Since the invention of AEDs, which are able to analyse the casualty's cardiac rhythm through the electrode pads and advise if a shock is needed, a lay rescuer can now perform the defibrillation, thus improving survival rates.

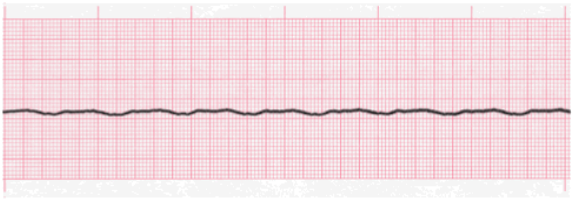


Figure 3-2 - Asystole

The AED should be brought to every person in cardiac arrest. Therefore, when calling 995 for SCDF ambulance, also call for an AED by instructing others nearby **"Get AED"**. However, if you are the lone rescuer, do not leave the casualty.

Research has shown that cardiac arrest casualties with VF who are treated promptly have the best chances of survival. Similar experiences from around the world has also demonstrated that more lives are saved if early CPR is combined with early defibrillation. (See figure 3-3)

Chain of survival factors in cardiac arrest and their impact on outcomes

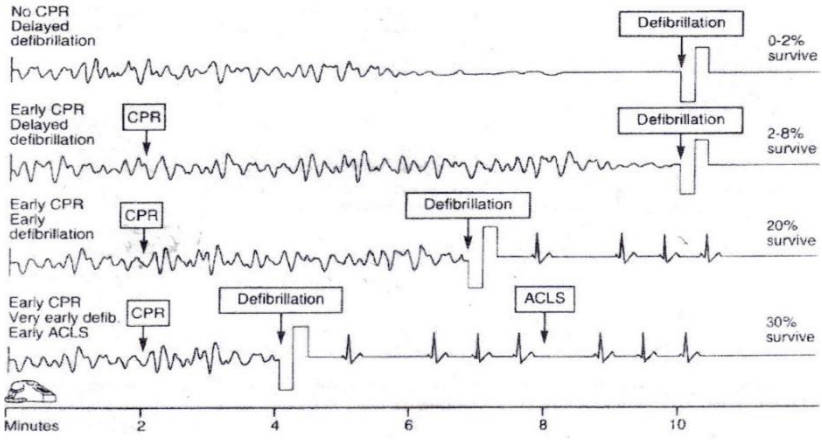


Figure 3-3 - Importance of the chain of survival

Richard O. Cummings ACLS – Principles and Practice. American Heart Association; 2003. Chapter 6: Defibrillation: Principles and Practice; p93

3.2: AUTOMATED EXTERNAL DEFIBRILLATORS (AEDs)

Automated External Defibrillators (AED) are devices that deliver electrical shocks to shockable rhythms like VF & Pulseless VT, allowing the heart to restore its function. AEDs are defibrillators designed to be small in size, lightweight and portable. They generally work on similar basic principles and do the following:

- Analyze the electrical rhythm of the heart.
- Determine whether the heart needs to be shocked.
- If a shock is required, it automatically charges to a pre-set energy level. If no shock is required, the device will not charge-up.
- Deliver electric shocks via attached AED pads.
- Advise the rescuer through voice prompts on key actions to deliver the shock, check the casualty or continue CPR.
- Some AEDs provide counting tempo to assist rescuers in chest compressions.

3.3: PREPARATION FOR AED USE

The rescuer must first ascertain that the scene is safe for use of an AED. Avoid the following:

- **Metallic surface -** Remove casualty from contact with metal surfaces. These can conduct electric currents to the rescuer.

- **Water** - Sweat and moisture are good conductors of electricity and pose danger to the rescuer. It also reduces the adhesion of pads to the chest wall. If the chest is wet, wipe dry quickly with a towel.

- **Gas** - Flammable gases and oxygen sources are fire hazards. Move the casualty away from these before applying AED.

Steps in chest preparation and applying the AED electrode pads (see figure 3-4):

- Expose the chest of the casualty to facilitate application of AED electrode pads. If needed, cut away the clothing.
- If chest hair prevents proper electrode pad placement, shave the hair from these sites promptly. AEDs come with a shaver blade to expedite this.
- Metallic objects such as necklace and chains should be moved away from the pads. These may result in sparks and potential burns to the chest wall.
- For casualties with a pacemaker or implanted cardiac defibrillator on the right, apply the pads at least four fingers' breadth away from these devices.
- Medication patches or monitoring electrodes on the chest wall should be removed as they may interfere with electrode pads placement.
- Wipe dry a wet or sweaty chest to ensure proper adhesion of the electrode pads to the chest. Application of AED electrode pads to the chest wall must be done quickly with minimal interruptions to chest compressions.

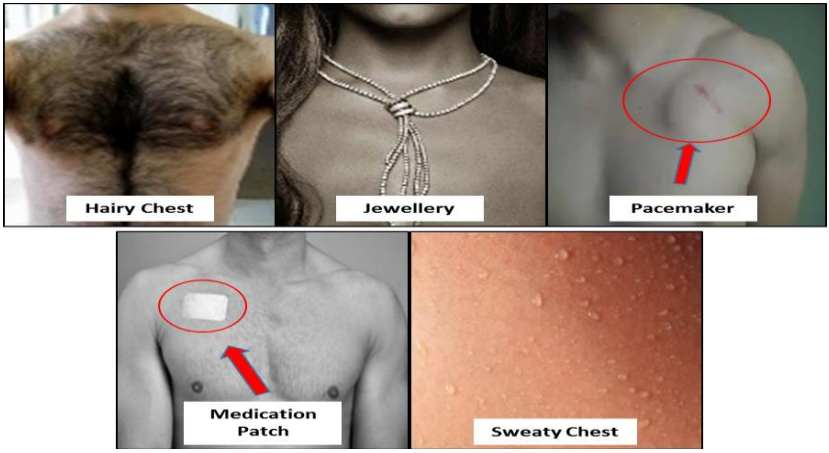


Figure 3-4 - Things to take note of during chest preparation

3.4: PLACEMENT OF AED ELECTRODE PADS

1. Switch on the AED. Some AEDs would automatically turn ON when the AED cover is lifted.

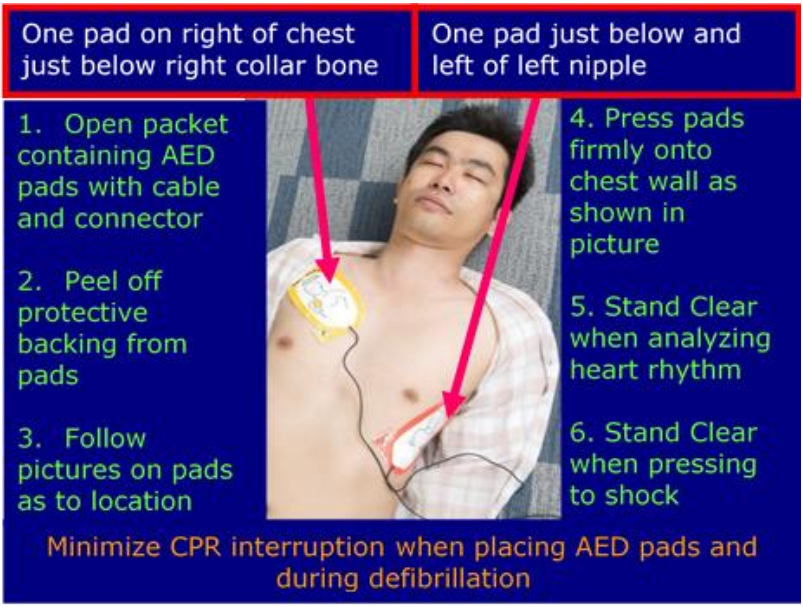
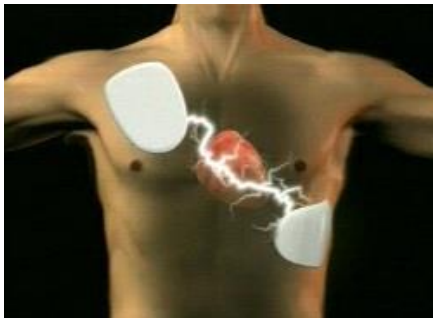


Figure 3-5 – Application and use of AED

2. Apply the AED pads on the chest according to the instructions on the AED. (See figure 3-5)

Figure 3-6 - How AED shocks the heart



3. The right pad is placed on the casualty's right chest just below the collar bone. The left pad is placed on the left

chest just below and to the left of the left nipple. (See figure 3-6)

4. Plug the connector end of the cable into the AED. Some AEDs already have pre-connected electrode pads cable and may start analysis once the pads are in place.

Minimize CPR interruption when preparing the chest and placing of AED pads

3.5: DEFIBRILLATION PROCEDURES

1. The AED will initially analyse the heart's electrical rhythm. It will give a voice prompt, such as

   "ANALYSING HEART RHYTHM. DO NOT TOUCH THE CASUALTY."

   If you hear this, stop chest compressions. Do not touch the casualty and do not allow others to touch the casualty while the AED is analysing.

2. Spread your arms apart and say clearly **"Stay Clear"**. (See figure 3-7)

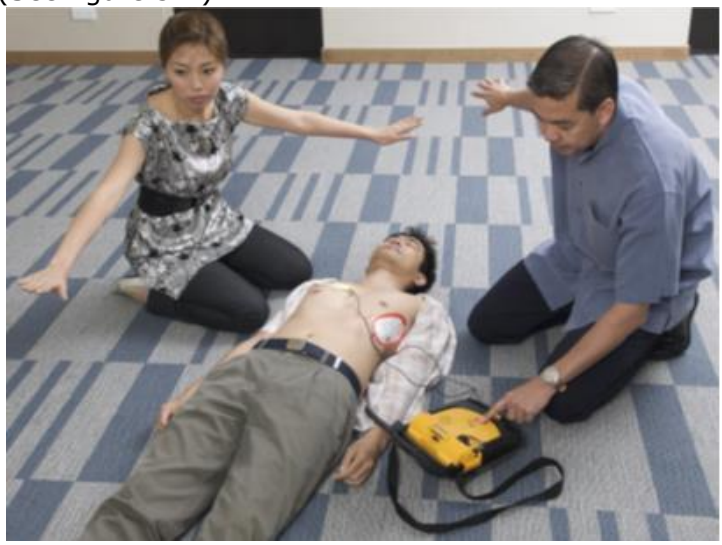


Figure 3-7 – "Stay clear!"

3. If the casualty has a shockable rhythm, AED machine will charge automatically. Charging takes a few seconds and may be indicated by a warning tone from AED. No one should touch the casualty during this brief charging phase.

4. Once the AED is fully charged, it will prompt "PRESS THE SHOCK BUTTON NOW". The rescuer then states clearly **"Stay Clear"**, ensures quickly that no one is touching the

casualty, and then presses the shock button on the AED firmly before releasing it.

5. Once the shock is delivered, restart chest compressions. Continue the chest compressions until the AED repeats the voice prompt (every 2 minutes): **"ANALYSING HEART RHYTHM. DO NOT TOUCH THE CASUALTY."**

6. If the AED prompts: "NO SHOCK ADVISED", the lay rescuer should resume continuous chest compressions until the emergency medical team arrives to take over, or the AED prompts the rescuer not to touch the casualty, or the casualty starts breathing normally.

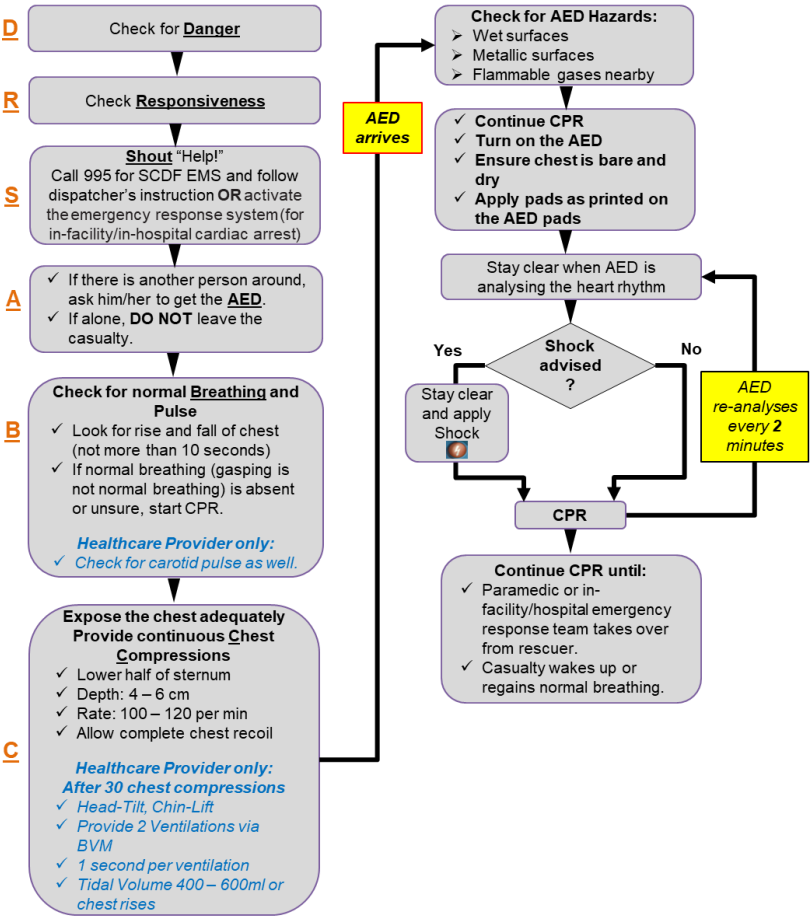
   Healthcare providers who are trained and confident in pulse check should check the pulse when the AED prompts to analyse the casualty's heart rhythm every two minutes, or when breathing or movement is detected. Checking of pulse should not take more than ten seconds. If unsure of the presence of a pulse by the end of ten seconds, the rescuer should resume CPR. If the pulse is present but not breathing, start rescue breathing.

7. Only stop CPR when:
   a. Paramedic takes over from rescuer; or
   b. AED prompts to analyse the casualty's heart rhythm, is charging or when shock is to be delivered; or
   c. Casualty wakes up or regains normal breathing.

8. Keep casualty in the same (supine) position and continue to monitor the casualty until help arrives.

9. Throughout this period, the AED should remain connected to the casualty.

Algorithm for One-Rescuer CPR and Use of AED



Notes:

1. If you are a single rescuer and feeling tired, you may take a rest of not more than 10 seconds (preferably after 100 continuous compressions).
2. For Healthcare Provider only: If no BVM is available and you are unable or unwilling to do mouth-to-mouth ventilations, perform continuous chest compressions.

Figure 3-8 – Flowchart of CPR and AED algorithm.

3.6: POST-INCIDENT PROCEDURES

Hand-over to emergency services

When paramedics takes over the casualty, they may require a summary of the events that has occurred:

- Time of collapse (best estimate)
- Whether the AED was used
- How many shocks were given?
- Any previous medical history and medications, if known.
- If available, provide a document that lists these events.

Assist the paramedics:

- Until casualty is loaded into the ambulance.
- The AED electrode pads should remain on the casualty while transporting to hospital.

What are the duties for the person in charge of the AED after AED has been used?

The facility or safety manager must be informed on the usage of AED.

The person in charge of the AED has the following responsibilities:

For commercial establishments or work places, or the local community centre or management office for residential areas
1. For AEDs located in places other than HDB blocks, they should be returned to the AED owner (building management or security staff) after use. 2. Replace the AED consumables such as the electrode pads, shaver kit, towel and gloves if used (replacement done by AED owner or AED vendor). 3. The AED battery must be checked. Contact the vendor of the AED device for advice on battery replacement. 4. If the AED was removed from a box with a key in a thin glass window, the glass may have been broken to retrieve the key. This glass piece would need to be

replaced and the key placed back onto the holder (replaced by the AED vendor).
5. Most AEDs have a chip that records the resuscitation sequence. Get the AED vendor to print the record from this chip. It is useful for audit and quality assurance purposes.
6. AEDs are almost maintenance-free.
7. The battery indicator on the AED needs to be checked annually (or as advised by the AED vendor) to ensure that it is still functional. Once it gives a low-battery display, steps to replace the battery promptly should be undertaken.

For Public Access AEDs from Housing Development Board (HDB)

1. SCDF Ambulance crew will convey the casualty to the hospital along with the public access AED. The used AED will be collected by the contracted vendor at the respective fire stations. The vendor will restock and replace the AED back to its original location.
2. AEDs are almost maintenance-free.
3. The battery indicator on the AED needs to be checked periodically to ensure that it is still functional. Once it gives a low-battery display, steps to replace the battery promptly should be undertaken (facilitated by SCDF/HDB).

3.7: RETRIEVAL OF AUTOMATED EXTERNAL DEFIBRILLATOR

Public access Automated External Defibrillators (AEDs) in Singapore are typically secured in a locked box with a break glass mechanism. The glass must be broken to retrieve the key and to unlock the box.

During emergencies, members of the public responding to potential cardiac arrests case have been reported to have suffered injuries while retrieving AEDs, such as by being cut by glass while breaking the pane of glass or while trying to retrieve the key. (See figure 3-9)

Figure 3-9 – Examples of injuries sustained when retrieving key

A recent survey of cardiac arrest responders who retrieved AEDs conducted locally highlighted that a pattern of injuries exists.

Jonathan SY Ng, Reuben JS Ho, JY Yu, YY Ng. Factors influencing success and safety of AED retrieval in out of hospital cardiac arrests in Singapore. Korean J Emerg Med Ser. 2022 Aug; 26(2), 97-111.

The following are recommendations for retrieval of AEDs:

1. Download the SCDF myResponder application! (See Chapter 1.8) Responders with the app have a much better chance to find the nearest defibrillator with the help of the AED map.
2. To safely retrieve the AED:
    a. Do not use your bare hands/elbows to break the glass – most injuries from retrieving occur with breaking the glass. Use personal items instead e.g. mobile phone, shoes, keys etc. to reduce the risk of injuries sustained.
    b. Clear all glass fragments around the edges with the object used to break the glass before retrieving the key. Another common mechanism of injury is due to lacerations when reaching for the key inside.

3.8: SAMPLE PRACTICAL SCENARIOS (FOR ADULTS)

The following scenarios may be used by the instructor to depict possible situations which you may encounter due to the varied nature of an emergency. By practicing these scenarios, you can be more confident to assist a casualty in emergencies.

1) Shock – No Shock – No Shock
2) No Shock – Shock – No Shock
3) Shock – Shock – No Shock
4) No Shock – No Shock – Shock
5) No Shock – No Shock – No Shock

3.9: CHILD/INFANT DEFIBRILLATION

Use of AED in Children

Out-of-hospital cardiac arrest in children are usually from non-cardiac causes with majority of the casualties presenting with non-shockable cardiac rhythms (asystole or pulseless electrical activity).

Thus, proper ventilation and oxygenation are critical in paediatric resuscitation.

However, ventricular fibrillation in out-of-hospital paediatric arrest also occurs. Reviews of out-of-hospital paediatric cardiac arrest have reported incidence of shockable rhythms **(ventricular fibrillation or pulseless ventricular tachycardia)** as the initial cardiac rhythm to be from 5-19%.[1] School-going children and adolescents were reported to have higher incidence of shockable rhythms compared to infants, toddlers and preschoolers.[2]

1. *Kitamura T, Iwami T, Kawamura T, Nagao K, Tanaka H, Nadkarni VM, Berg RA, Hiraide A. Conventional and chest-compression-only cardiopulmonary resuscitation by bystanders for children who have out-of-hospital cardiac arrests: a prospective, nationwide, population-based cohort study. Lancet. 2010 Apr 17;375(9723):1347-54. doi: 10.1016/S0140-6736(10)60064-5.*
2. *Akahane M, Tanabe S, Ogawa T, Koike S, Horiguchi H, Yasunaga H, Imamura T. Characteristics and outcomes of pediatric out-of-hospital cardiac arrest by scholastic age category. Pediatr Crit Care Med. 2013 Feb;14(2):130-6.*

Recommendation for AED Use in Children

The International Liaison Committee on Resuscitation (ILCOR) advocates early use of AEDs on children to analyse rhythms and provide defibrillation in cases of cardiac arrest with shockable rhythms. When recognised early and rapidly treated, paediatric patients with ventricular fibrillation or pulseless ventricular tachycardia have a higher survival rate than those with other rhythms.

It is recommended that a paediatric dose-attenuating system be used in children aged 1-12 years to reduce the energy dose

delivered by the AED. This may be done either via a paediatric-specific pad-cable system or an AED with a key or switch to select a smaller dose. If a paediatric dose-attenuating system is unavailable, then a standard AED should be used.

Use of AED for Child/Infant

- If an AED with paediatric pads or mode is not available, an AED with adult pads may be used.
- In these cases, the risk/benefit ratio may be favourable, and the use of an AED (preferably with paediatric pads or mode) should be considered.
- For AEDs **with** paediatric pads or mode:
    - When the AED arrives, switch it on.
    - Switch to the paediatric electrode pads or mode.
    - Attach the electrode pads according to the illustrations on the placement of electrode pads (see figure 3-9).
    - Follow the AED's instructions and continue chest compressions and ventilations until medical help arrives.
- For AEDs **without** paediatric pads or mode:
    - When the AED arrives, switch it on.
    - If only adult pads are available, ensure that the pads do not touch or overlap each other. Attach the defibrillation pads on front (right pad on central sternum) and back (left pad on the upper back between the shoulder blades) in an anterior-posterior electrode pads placement as shown (see figure 3-9).
    - Follow the AED's instructions and continue chest compressions and ventilations until medical help arrives.

Placement of Defibrillation Pads for Children/Infant

1. For AEDs recommending anterior-anterior electrode pads placement, ensure that the electrode pads are not touching or overlapping each other, and are at least 2cm apart (see figure 3-10).

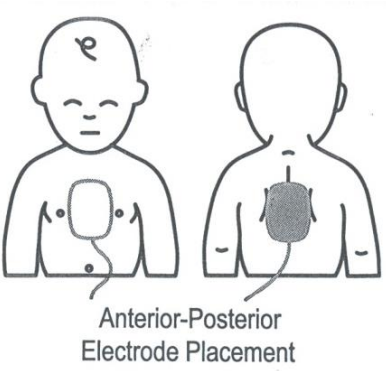


Figure 3-9 - Anterior-posterior AED electrode pads placement for children

Figure 3-10 - Anterior-anterior AED electrode pads placement

CHAPTER 4

CHILD CARDIO-PULMONARY RESUSCITATION (CPR)

4.1: CHILD CPR

4.1: CHILD CPR

This module addresses children from 1 to 12 years of age.

Children in this age group rarely collapse (goes into cardiac arrest) owing to a primary heart problem. Cardiac arrest is usually secondary to other events, such as respiratory illness or major trauma. Therefore, rescuers must detect and promptly treat early signs of respiratory and circulatory failure to prevent cardiac arrest.

Note:

- ♥ If a child is below 12 years old but of a larger size or a child that is above 12, perform chest compressions as in Adult CPR.

(D) Check for Danger

Ensure that the rescuer operates in a safe environment. Resuscitation should start where the casualty is found, unless the site is unsafe or unconducive (eg. roads which are still open to traffic, burning building, etc), then the casualty should be removed to a safe, flat and open space as soon as possible.

(R) Check for Responsiveness

- The rescuer should tap the child's shoulders firmly and ask loudly: 'Hello! Hello! Are you OK?' (see figure 4-1)
- Avoid violent shaking of the child as this may result in injury.
- Avoid unnecessary movements of the neck to prevent injuries to the head and neck.

Figure 4-1 – Check for responsiveness

For CPR to be effective, the casualty must be lying on his/her back on a firm, flat surface. If the casualty is lying face down (prone position), or on his/her side, rescuer will need to roll the casualty over onto his/her back.

(S) Shout to get help

- If the child is unresponsive, shout to get help from bystanders to call '995' for SCDF EMS or activate the emergency response system (for in-facility/in-hospital cardiac arrest). (see figure 4-2) If alone, use a handphone to call 995 for SCDF EMS and put on speaker phone mode. An SCDF emergency medical dispatcher can help a lay rescuer recognise cardiac arrest, and once this is established, the dispatcher will guide the rescuer to begin CPR by providing instructions on how to perform Chest Compressions via a handphone. (See figure 4-3)

Figure 4-2 – Get help

Figure 4-3 – Call 995

- In a situation where a lone rescuer found an unresponsive casualty in a remote area with no accessibility to activate emergency medical service, it is necessary for the lone rescuer to assess the casualty's responsiveness and breathing.

- If normal breathing is absent, CPR (chest compressions and ventilations) should commence immediately and continued for at least two minutes before leaving the casualty to seek nearby assistance or obtain phone access and return to the casualty immediately to continue CPR. However, in the process, if there is another person around, ask him/her to call 995 for SCDF EMS and get an AED.

(A) Ask someone to get an AED

- Send someone to get an AED if there is one within a 60-second walking distance. The SCDF emergency medical dispatcher may be able to locate the nearest AED and summon help from CPR-trained rescuers in the vicinity. However, if you are the lone rescuer, do not leave the casualty.

(B) Check for normal Breathing

Figure 4-4 – Look for normal breathing

- Look for the rise and fall of the chest (see figure 4-4).
- Do not take more than 10 seconds.
- It is important to recognize that gasping is **NOT** normal breathing but a sign of cardiac arrest. Start chest compressions immediately if you are unsure whether the casualty has abnormal breathing or gasping. (See https://youtu.be/T85vd3CBs04 for video of contrast between gasping and normal breathing)

For trained healthcare providers

- Checking of carotid pulse and breathing (not more than 10 seconds) should be done.
- Check for carotid pulse when checking for normal breathing. Slide your fingers down to the groove at the side of the neck near you (this is the location of the carotid pulse). (See figure 4-5)

Figure 4-5 – Checking carotid pulse

- If unsure about the presence of pulse and normal breathing at the end of 10 seconds, assume cardiac arrest and commence chest compressions.

(C) Chest Compressions

- Site of chest compression should be at the centre of the chest at the lower half of the sternum (breastbone). (See figure 4-6 and 4-7)

Figure 4-6 – Start chest compressions

Figure 4-7 – The Xiphoid Process

- Ensure adequate exposure of the chest.
- Kneel by the side of the casualty.
- Place the heel of the palm of the one hand on the lower half of the sternum (breastbone) and avoid the **Xiphoid Process**. (See figure 4-7)
- Place the heel of the second hand on top of the first.
- Interlace the fingers of both hands and lift the fingers off the chest wall. (See figure 4-8)
- Straighten both the elbows and lock them into position.
- Position the shoulders directly over the casualty's chest. Use the body weight to compress the casualty's breastbone.

Figure 4-8 – Interlace the fingers of both hands

- Depth of chest compression for children must be 1/3 the anterior-posterior diameter of the child's chest (about 4 to 5 cm).
- The compression rate is 100–120 per minute.
- Ensure complete recoil of the chest wall after each chest compression.

- Loud counting of chest compressions should be encouraged: 1&2&3&4&5&, 1&2&3&4&10&, 1&2&3&4&15, 1&2&3&4&20, 1&2&3&4&25(or say "two-five"), 1&2&3&4&30.

After 30 chest compressions, open the airway and perform ventilations via BVM. (refer to the section on BVM in chapter 2)

For community first responders (and health care providers without appropriate sized BVM available), if able, trained and willing:

- Perform a Head-Tilt, Chin-Lift manoeuvre. An open airway will ensure ventilations are effective. (see chapter 2)
  - Pinch the casualty's nose with your index finger and thumb; and seal your lips around the casualty's mouth.
  - Provide 2 breaths by blowing steadily into the child's mouth for about 1 second per breath, sufficient to make the chest visibly rise.
  - Release the nose after each breath.

- Do not interrupt chest compressions for more than 10 seconds to perform 2 breaths.

Note:

♥ If you are unable or unwilling to perform ventilations for any reasons, please perform continuous chest compressions at the rate of 100 – 120 per minute. If you are a single rescuer and feeling tired, you may take a rest of not more than 10 seconds (preferably after 100 compressions).

For trained healthcare providers

- Check for normal breathing and pulse after every 5 cycles of CPR 30:2.

- If normal breathing and pulse are absent or you are unsure, continue CPR 30:2.

- If pulse is present and normal breathing is absent, perform rescue breathing at a rate of **20 breaths per minute** (one breath every 3 seconds) by giving one breath and counting **2-a-thousand, 3-a-thousand**.
- Re-assess for normal breathing and pulse after 20 breaths.
- If both the breathing and pulse are present, position the casualty in the supine position and continuously monitor the casualty until help arrives.

If there are 2 trained healthcare providers

- The ratio of chest compressions to ventilations is 15:2.
- Perform 10 cycles of 15 compressions and 2 ventilations within 2 minutes.

Continue performing CPR until:

- Paramedic takes over from rescuer; or
- AED prompts to analyse the casualty's heart rhythm, is charging or when shock is to be delivered; or
- Casualty wakes up or regains normal breathing.
- Keep casualty in the same (supine) position and continue to monitor the casualty until help arrives.
- Healthcare providers who are trained and confident in pulse check should check the pulse after at least five cycles of 30 compressions to two ventilations (done via a bag-valve mask). Checking of pulse should not take more than ten seconds. If unsure of the presence of a pulse by the end of ten seconds, the rescuer should resume CPR.

CHAPTER 5

ADULT/CHILD FOREIGN BODY AIRWAY OBSTRUCTION (FBAO)

5.1: Introduction

Complete airway obstruction is an emergency that will result in death within minutes, if not treated immediately. A casualty can develop airway obstruction from either intrinsic or extrinsic (foreign body) causes.

Intrinsic Causes

- The tongue can fall backward into the pharynx and obstruct the airway in an unconscious casualty in the supine position.
- Blood from head and facial injuries can flow into the airway.
- Regurgitated stomach contents can enter the airway.

Extrinsic Causes

Foreign bodies, e.g., food, dentures etc.

Contributing Factors

1. Large, poorly chewed pieces of meat/food.
2. Elevated blood alcohol levels.
3. Dentures.
4. Playing, crying, laughing, and talking with food in the mouth.

Precautions

1. Cut food (eg. fish balls, meat balls, fruit, etc) into small pieces. Chew slowly and thoroughly, especially when a child is eating or if the adult is wearing dentures.
2. Avoid excessive intake of alcohol.
3. Avoid laughing and talking when the mouth is full.
4. Discourage the child from running or playing while eating.

5.2: RECOGNITION OF FOREIGN BODY AIRWAY OBSTRUCTION (FBAO)

Foreign Body Airway Obstruction (FBAO) can be either partial or complete. Coughing is the body's natural defence against airway obstruction.

Figure 5-1 – The universal sign of choking

A casualty with **partial** (mild) airway obstruction will cough to expel the foreign body. If the casualty is wheezing (breathing noisily with a wheezing sound) or coughing, this means that the airway is partially obstructed. Do not interfere. Allow the casualty to cough to expel the object himself/herself.

In **complete** airway obstruction, the casualty is unable to speak, breathe or cough and may become cyanotic (blue). The casualty will clutch the neck with thumb and fingers, the universal distress signal for choking (see figure 5-1) that requires immediate action (see figure 5-2).

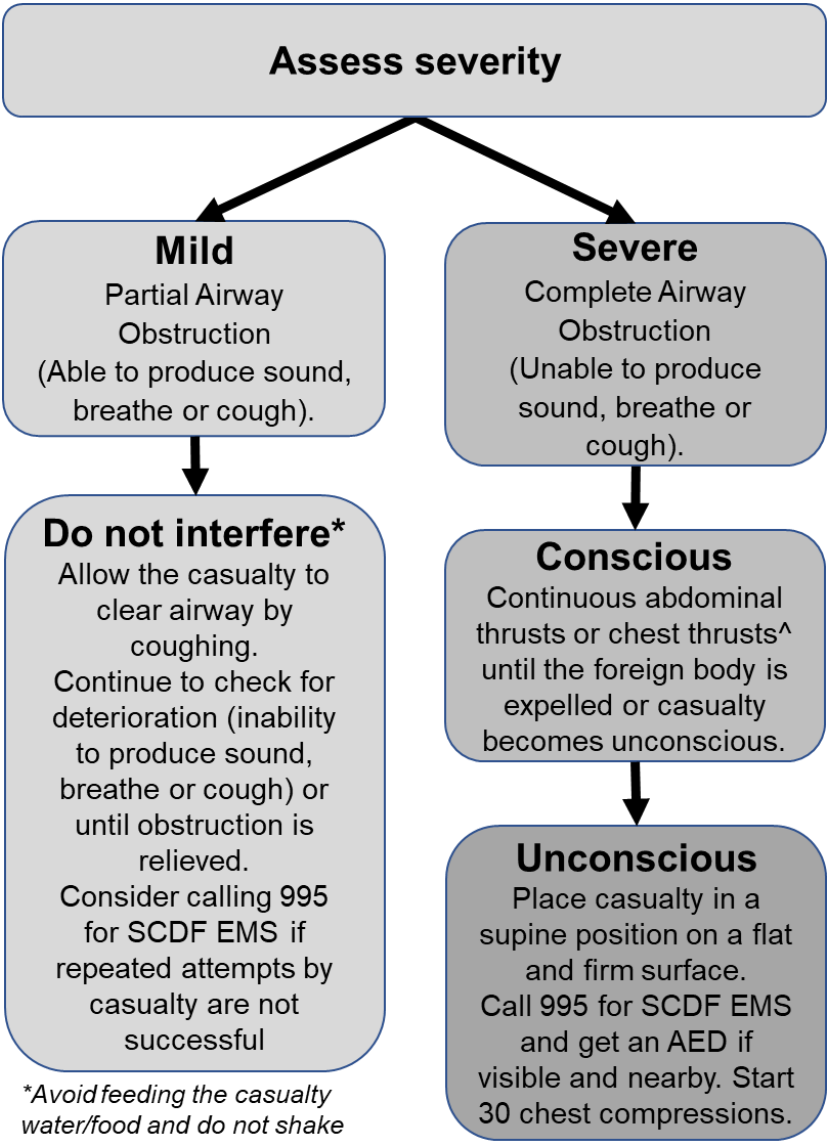


Figure 5-2 – Flowchart for conscious and unconscious foreign body airway obstruction

5.3: RELIEF OF FOREIGN BODY AIRWAY OBSTRUCTION (FBAO)

Techniques used to relieve FBAO include the Heimlich Manoeuvre (abdominal thrusts) and chest thrusts for pregnant and obese casualties.

The **Heimlich Manoeuvre**, also known as the sub-diaphragmatic abdominal thrusts or abdominal thrusts is recommended for the relief of FBAO in responsive adults (aged > 12 years) and children (aged 1 – 12 years). The Heimlich Manoeuvre elevates the diaphragm and increase airway pressure, which forces air out from the lungs. This creates an artificial cough which can expel the foreign body from the airway.

In obese or pregnant casualties, **chest thrusts** should be used instead of abdominal thrusts.

Complications from Heimlich Manoeuvre

If performed incorrectly, it may cause injuries to the internal organs resulting in rupture or laceration of abdominal or thoracic viscera.

5.4: HEIMLICH MANOEUVRE

Step 1: Assessment

- Ask: "Are you choking?". (See figure 5-3) If the casualty is choking, the casualty will not be able to speak, breathe or cough but may nod his/her head. Tell the casualty that you can help.

Figure 5-3 – Ask "Are you choking?"

Note:

♥ If the casualty is able to cough, instruct the casualty to cough as hard as possible. If casualty is unable to cough, perform the Heimlich Manoeuvre.

Step 2: Position of rescuer

- If the casualty is standing, the rescuer stands behind the casualty.
- If the casualty is sitting, the rescuer kneels and positions himself/herself behind the casualty.

Figure 5-4 – Stand or kneel behind the casualty.

Step 3: Locate the landmark

- Put your arms around the casualty's abdomen.
- Locate the navel.
- Place 2 fingers above the navel (see figure 5-5) and well below the tip of xiphoid process.

Figure 5-5 – Place 2 fingers above the navel and make a fist with the other hand with the thumb in the palm.

- Make a fist with the other hand with the thumb in the palm. (See figure 5-6)

Figure 5-6 – Place the fist 2 fingers above the navel.

- Place the thumb side of the fist against the casualty's abdomen in the midline and just above the 2 fingers' spacing. (See figure 5-6)

Step 4: Heimlich Manoeuvre

- Lean the casualty forward with one hand, while maintaining the fist against the abdomen. (See figure 5-7)
- Grasp your fist with your other hand.

Figure 5-7 – Lean the casualty forward.

- Give quick inward and upward abdominal thrusts in one motion into the casualty's abdomen. (See figure 5-8)
- Deliver each abdominal thrust firmly and distinctly with the intent of relieving the obstruction. Perform continuous abdominal thrusts until the foreign body is expelled or the casualty becomes unconscious.

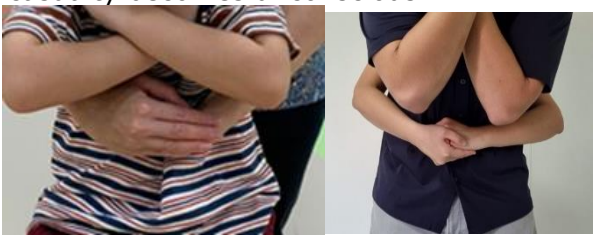


Figure 5-8 – Give quick inward and upward abdominal thrusts

Note:

♥ Usually, this procedure will force the foreign object out of the throat and the airway obstruction will be relieved.

The Self-Administered Heimlich Manoeuvre

- To treat one's own complete FBAO, the casualty makes a fist with one hand, places the thumb-side on the abdomen above the navel (2 fingers' breadth) and below the xiphoid process, grasps the fist with the other, and then presses inward and upward toward the diaphragm with a quick motion.

- If unsuccessful, the casualty can also press the upper abdomen over any firm surface such as the back of a chair, side of a table or porch railing. Several abdominal thrusts may be needed to clear the airway.

5.5: CHEST THRUSTS

This technique is used as an alternative for obese or pregnant casualties.

Step 1: Assessment

- Ask: "Are you choking?" (See figure 5-9) If the casualty is choking, the casualty will not be able to speak, breathe or cough but may nod his/her head. Tell the casualty that you can help.

Figure 5-9 – Ask "Are you choking?"

Step 2: Position of rescuer

- If the casualty is standing, the rescuer stands behind the casualty.
- If the casualty is sitting, the rescuer kneels and positions himself/herself behind the casualty.

Step 3: Location of landmark

- Place your arms under the casualty's armpits encircling the chest. (See figure 5-10)
- Make a fist with one hand with the thumb in the palm. (See 5-11)
- Place thumb-side of fist on the middle of the casualty's sternum (breastbone). (See figure 5-12)

Figure 5-10 – Place arms under the casualty's armpits encircling the chest

Figure 5-11 – Making a fist with thumb in the palm

Figure 5-12 – Place thumb-side of fist on the middle of the casualty's sternum

Step 4: Chest thrusts

Figure 5-13 – Give quick backward thrusts

- Grasp your fist with your other hand and bring yourself close to the casualty before giving quick backward thrusts. (See figure 5-13)

- Deliver each backward thrust firmly and distinctly. Perform continuous backward chest thrusts with the intent of relieving the obstruction until the foreign body is expelled or the casualty becomes unconscious.

5.6: RELIEF OF UNCONSCIOUS ADULT/CHILD FBAO

If the casualty becomes unconscious, proceed with the following steps.

Step 1: Position the casualty

Support and position the casualty lying on his/her back on a firm flat surface. (See figure 5-14)

Figure 5-14 – Support the casualty

Step 2: Activate the Emergency Medical Service (EMS)

Rescuer shouts: "Help! Call ambulance 995 and get an AED!" (see figure 5-15) However, if there is another person around, ask him/her to call 995 for SCDF EMS and get an AED.

Figure 5-15 – Get help!

Step 3: Start 30 chest compressions

- Locate the landmark and perform 30 chest compressions using the same location and techniques used for chest compressions in CPR. (Refer to Adult CPR, page 17 to 26; or Child CPR, page 48 to 53) (See figure 5-16)

Figure 5-16 – Perform chest compressions using the same location and techniques as CPR

Step 4: Open the airway

- Perform the Head-Tilt, Chin-lift manoeuvre to open the airway.
- While maintaining head tilt, open the mouth gently to check for visible foreign bodies.
- If no foreign body is seen, perform another 30 chest compressions. (See figure 5-16)
- If a foreign body is seen, maintain the open airway with the Head-Tilt, Chin-Lift manoeuvre (see figure 5-17) and insert the index finger of your other hand into the casualty's mouth along the inside of the cheek.
- Use a hooking action to dislodge the foreign body and manoeuvre it out of the mouth. Take care not to force the foreign body deeper into the throat. This manoeuvre is known as the **finger sweep.** (See figure 5-18)

Figure 5-17 – Head-tilt and chin-lift manoeuvre

Figure 5-18 –Finger sweep

Note:

- Do not perform blind finger sweep. Blind finger sweep may push the object back or further into the airway.
- However, if there are no objects found in the mouth, repeat steps 3 and 4 until object has been removed.
- For lay rescuers – Once object has been removed, check for breathing. If breathing is absent, repeat steps 3 and 4 until breathing resumes or emergency help arrives. For trained healthcare providers – See step 5.

Step 5: Bag-valve-mask (BVM) ventilation

Figure 5-19 – Provide BVM ventilations

- Attempt one ventilation via BVM (1st ventilation). (see figure 5-19) If BVM is not available and you are willing and trained, you may provide mouth-to-mouth ventilations.
    - Perform a Head-Tilt, Chin-Lift manoeuvre. An open airway will ensure ventilations are effective. (See chapter 2)
    - Pinch the casualty's nose with your index finger and thumb; and seal your lips around the casualty's mouth.
    - Provide 1 breath by blowing steadily into the casualty's mouth for about 1 second per breath, sufficient to make the chest visibly rise.
    - Release the nose after each breath.

- If there is no resistance, airway is clear. Check for normal breathing and pulse. If unsure of the presence of normal breathing and pulse within 10 seconds, start CPR.

- If there is resistance (i.e., the chest does not rise), the airway may be blocked. Reposition the casualty's head with the Head-Tilt, Chin-Lift manoeuvre, and re-attempt to ventilate (2nd ventilation).

- Repeat steps 3 to 5 until help arrives and takes over or the casualty starts breathing, coughing, talking, or moving.

- Check for normal breathing and pulse.

- If normal breathing or pulse are absent or you are unsure, start CPR.

- If pulse is definitely present but the casualty is not breathing, perform rescue breathing at a rate of 12 breaths per minute (one breath every 5 seconds) by giving one breath and counting **2-a-thousand, 3-a-thousand, 4-a-thousand, 5-a-thousand**. For children, perform rescue breathing at a rate of 20 breaths per minute for 2 minutes (one breath every 3 seconds) by giving one breath and counting **2-a-thousand, 3-a-thousand**. Repeat the sequence until you have completed a total of 12 breaths (for adult) or 20 breaths (for child). Re-assess for normal breathing and pulse.

- If both the breathing and pulse are present, monitor the casualty till help arrives.

Summary of Unconscious Adult/Child FBAO Relief for Healthcare Providers

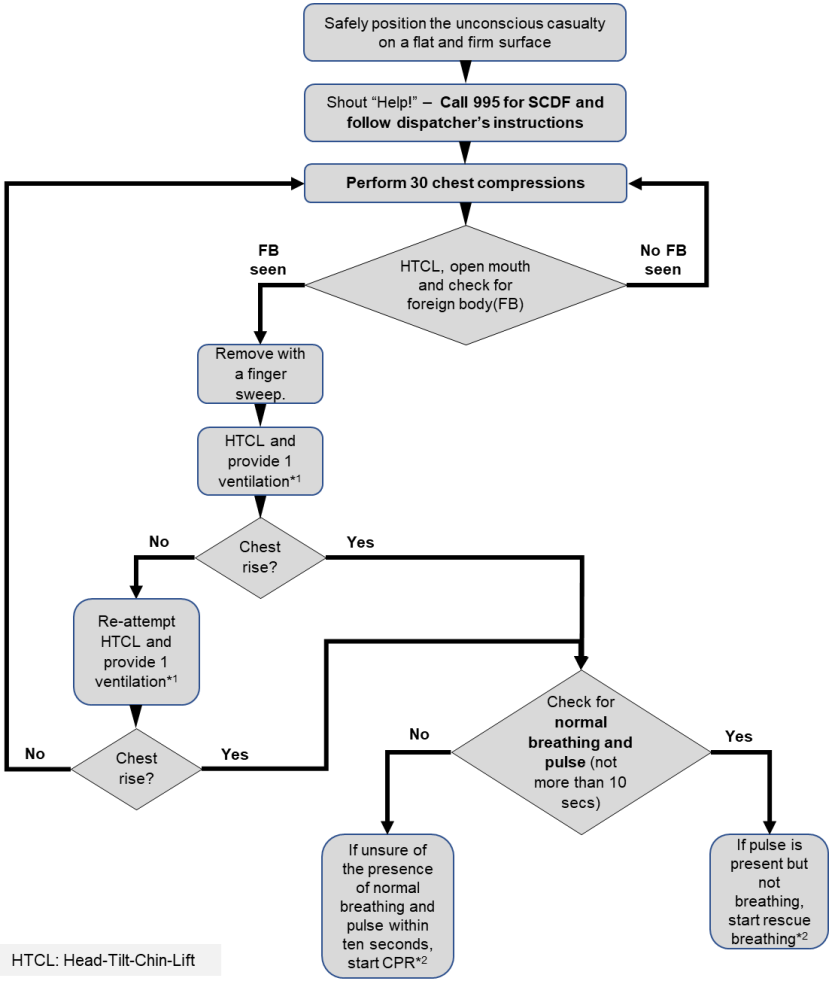


Figure 5-20 – Unconscious Adult/Child FBAO Relief for healthcare providers

Note:

1. For healthcare providers, provide ventilations via a bag-valve-mask (BVM). If there is no BVM available and you are unable or unwilling to do mouth-to-mouth ventilations for any reason, check for normal breathing and pulse for not more than 10 seconds.
2. If no BVM is available and you are unable or unwilling to do mouth-to-mouth ventilations, perform continuous chest compressions. If you are a single rescuer and feeling tired, you may take a rest of not more than 10 seconds (preferably after 100 compressions). (Refer to Adult CPR, page 17 to 26; or Child CPR, page 48 to 53)

CHAPTER 6

Infant Cardio-Pulmonary Resuscitation (CPR)

6.1: INFANT CPR

6.1: INFANT CPR

This module addresses the care of infants with cardiac arrest, up to 1 year of age.

Infants rarely collapse (goes into cardiac arrest) owing to a primary heart problem. Cardiac arrest is usually secondary to other events, such as respiratory illness or major trauma. Therefore, rescuers must detect and promptly treat early signs of respiratory and circulatory failure to prevent cardiac arrest.

(D) Check for Danger

Ensure that the rescuer operates in a safe environment. Resuscitation should start where the infant is found, unless the site is unsafe or unconducive (eg. roads which are still open to traffic, burning building, etc), then the infant should be removed to a safe, flat and open space as soon as possible.

(R) Check for Responsiveness

- The rescuer should tap the infant's shoulders and the sole of the feet and ask loudly: 'Hello! Hello! Are you OK?' (see figure 6-1).
- Avoid violent shaking of the infant as this may result in injury.
- Avoid unnecessary movements of the neck to prevent injuries to the head and neck.

Figure 6-1 – Check for responsiveness

For CPR to be effective, the infant must be lying on his/her back on a firm, flat surface. If the infant is lying face down (prone position), or on his/her side, rescuer will need to roll the infant over onto his/her back.

(S) Shout to get help

- If the infant is unresponsive, shout to get help from bystanders to call 995 for SCDF EMS or activate the emergency response system (for in-facility/in-hospital cardiac arrest). (See figure 6-2) If alone, use a handphone to call 995 for SCDF and put on speaker phone mode. An SCDF emergency medical dispatcher can help a lay rescuer recognise cardiac arrest, and once this is established, the dispatcher will guide the rescuer to begin CPR by providing instructions on how to perform Chest Compressions via a handphone.

- In a situation where a lone rescuer found an unresponsive infant in a remote area with no accessibility to activate emergency medical service, it is necessary for the lone rescuer to assess the infant's responsiveness and breathing. If normal breathing is absent, CPR (chest compressions and ventilations) should commence immediately and continued for at least two minutes before leaving the infant to seek nearby assistance or obtain phone access and return to the infant immediately to continue CPR. However, in the process, if there is another person around, ask him/her to call 995 for SCDF EMS and get an AED.

Figure 6-2 – Get help

(A) Ask someone to get an AED

- Ask someone to get an AED if there is one within a 60-second walking distance. The SCDF emergency medical dispatcher may be able to locate the nearest AED and summon help from CPR-trained rescuers in the vicinity. However, if you are the lone rescuer, do not leave the casualty.

(B) Check for normal Breathing

Figure 6-3 – Look for rise and fall of chest

- **Look** for the rise and fall of the chest (See figure 6-3).
- Do not take more than 10 seconds.
- It is important to recognize that gasping is **NOT** normal breathing but a sign of cardiac arrest. Start chest compressions immediately if you unsure whether the casualty has abnormal breathing or gasping. (See https://youtu.be/T85vd3CBs04 for video of contrast between gasping and normal breathing)

For trained healthcare providers only

- Locate the brachial pulse (inner aspect of the upper arm, between the infant's elbow and shoulder) with the index and middle fingers.
- Apply gentle pressure and feel for the pulse at the same time as checking for normal breathing. (See figure 6-4)
- Checking for normal breathing and pulse should not take more than 10 seconds.
- If unsure about the presence of pulse and normal breathing at the end of 10 seconds, assume cardiac arrest and commence chest compressions.

Figure 6-4 – Check brachial pulse and normal breathing

(C) Chest Compressions

- Site of chest compression should be at the centre of the chest at the lower half of the sternum (breastbone). Ensure adequate exposure of the chest. Locate the correct hand position for chest compressions:
    - Use your index finger to draw an imaginary line between the nipples to the centre of the sternum. (See figure 6-5)
    - Place your middle (third), and ring (fourth) fingers next to your index finger (see figure 6-6) on the center of the infant's chest.
    - Lift up your index finger but maintain the middle and ring fingers on the sternum and commence chest compressions using the pulp of the fingers. (See figure 6-7)

Figure 6-5 – Trace location

Figure 6-6 – Place middle & ring fingers next to index finger

Figure 6-7 – Prepare for chest compressions

- Depth of chest compression for infants must be 1/3 the anterior-posterior diameter of the infant's chest (about 3 to 4 cm).
- The compression rate is 100–120 per minute.
- Ensure complete recoil of the chest wall after each compression.

Figure 6-8 – Compress the lower half of sternum

- Loud counting of the compressions should be encouraged: 1&2&3&4&5&, 1&2&3&4&10&, 1&2&3&4&15, 1&2&3&4&20, 1&2&3&4&25 (or say "two-five"), 1&2&3&4&30.

After 30 chest compressions, open the airway and perform ventilations via BVM. (See figure 6-9) (refer to the section on BVM in chapter 2)

Figure 6-9 – In healthcare settings, BVM is used to deliver ventilations for the infant. The mask should fit from the infant's bridge of the nose to the chin.

For community first responders (and health care providers without appropriate sized BVM available), if able, trained and willing:

- Perform a gentle Head-Tilt, Chin-Lift manoeuvre. An open airway will ensure ventilations are effective. (See chapter 2)
- Make a tight seal by placing your mouth over the infant's nose and mouth.
- Provide 2 breaths by blowing steadily into the infant's nose and mouth for about 1 second per breath, sufficient to make the chest visibly rise. (See figure 6-10)

Figure 6-10 – Provide 30 chest compressions followed by 2 ventilations.

- Do not interrupt chest compressions for more than 10 seconds to perform 2 breaths.

Note:

♥ If you are unable or unwilling to perform ventilations for any reasons, please perform continuous chest compressions at the rate of 100 – 120 per minute. If you are a single rescuer and feeling tired, you may take a rest of not more than 10 seconds (preferably after 100 compressions).

For trained healthcare providers

- Check for normal breathing and pulse after every 5 cycles of CPR 30:2.
- If normal breathing and pulse are absent or you are unsure, continue CPR 30:2.
- If pulse is present and normal breathing is absent, perform rescue breathing at a rate of **30 breaths per minute** (one breath every 2 seconds) by giving one breath and counting **2-a-thousand**.
- Re-assess for normal breathing and pulse after 30 breaths.
- If both the breathing and pulse are present, position the casualty in the supine position and continuously monitor the casualty until help arrives.

If there are 2 trained healthcare providers

- The ratio of chest compressions to ventilations is 15:2.
- Perform 10 cycles of 15 compressions and 2 ventilations within 2 minutes.

Continue to perform CPR until:

- Paramedic takes over from rescuer; or
- AED prompts to analyse the casualty's heart rhythm, is charging or when shock is to be delivered; or
- Casualty wakes up or regains normal breathing.
- Keep casualty in the same (supine) position and continue to monitor the casualty until help arrives.
- Healthcare providers who are trained and confident in pulse check should check the pulse after at least five cycles of 30 compressions to two ventilations (done via a bag-valve mask). Checking of pulse should not take more than

ten seconds. If unsure of the presence of a pulse by the end of ten seconds, the rescuer should resume CPR.

CHAPTER 7

INFANT
FOREIGN BODY AIRWAY OBSTRUCTION (FBAO)

7.1: INTRODUCTION

Complete airway obstruction is an emergency that will result in death within minutes, if not treated immediately. Choking in an infant occurs most commonly during eating or playing.

In a witnessed choking event, the chances of survival will increase if the rescuer is able to intervene when the infant is still conscious. The obstructed airway of a conscious infant can be cleared using back blows and chest thrusts.

Precautions

- Do not "force-feed" milk. Allow rest in between.
- Check the teat of the milk bottle prior to feeding. The size may be too large for the infant.
- Cut food into very small pieces and feed the infant (if on a weaning diet) small spoonful each time.
- Discourage moving about (crawling) or playing while eating.

7.2: RECOGNITION OF FOREIGN BODY AIRWAY OBSTRUCTION (FBAO)

- Choking develops very abruptly and is associated with coughing, gagging or stridor (a high pitched, inspiratory noisy sound).
- If the infant has an infection (e.g. fever, nasal congestion, voice hoarseness), suspect epiglottitis and croup.
- Bring the infant immediately to a hospital as the back blows and chest thrusts technique may not relieve the airway obstruction. (See figure 7-1)

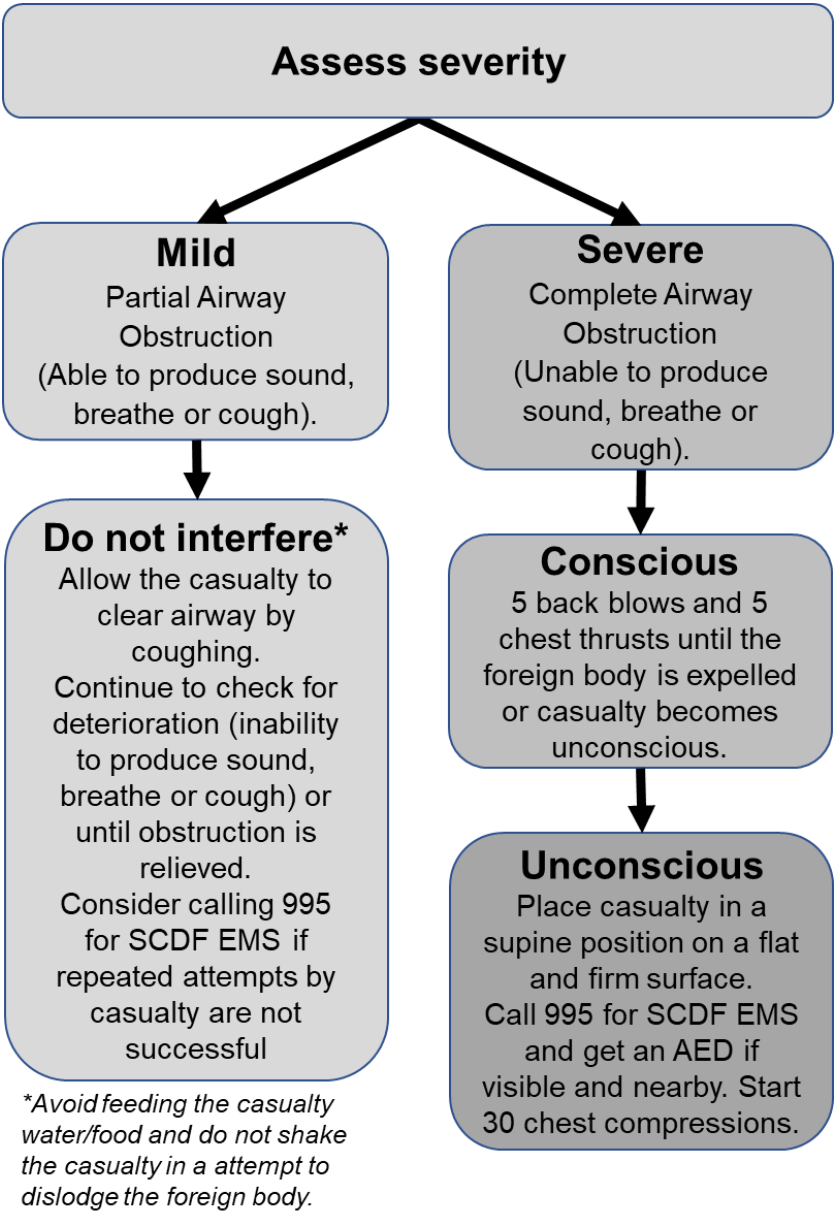


Figure 7-1 – Summary of infant FBAO relief

7.3: RELIEF OF CONSCIOUS INFANT FOREIGN BODY AIRWAY OBSTRUCTION (FBAO) USING BACK BLOWS AND CHEST THRUSTS

Step 1: Assessment

- Infant is conscious and has stridor.
- If the obstruction is getting worse (complete airway obstruction), you will notice at least one of the following:
    - Loss of voice.
    - Increased breathing difficulty.
    - The infant's face may turn blue.
- Immediately attempt to relieve the airway obstruction.

Step 2: Back blows and chest thrusts technique

- Slide your arm under the infant to support the head with your palm and the back with your forearm. (See figure 7-2)

Figure 7-2 – Support the head and back of the infant's body

- "Sandwich" the infant:
    - With your other hand, support infant's jaw with your thumb on one side and the rest of your fingers on the other side. Place your forearm on the infant's chest. (See figure 7-3)

Figure 7-3 – "Sandwich" the infant

- Support the infant's head and body as a unit.
- Stride one leg forward (same side as the forearm supporting the infant) by bending the knee. Ensure that the foot is flat on the floor. Do not tip-toe.
- Straddle the infant facing downwards with the head lower than the body. (See figure 7-4)
- Rest the forearm that is supporting infant's chest) onto the thigh (same side as the hand, making sure that the infant's head is lower than the body.

Figure 7-4 – Straddle the infant facing down with the head lower than the body

- Deliver 5 back blows forcefully between the shoulder blades with the heel of your other hand. (See figure 7-5)

Figure 7-5 – Deliver 5 back blows between the shoulder blades

- "Sandwich" the infant and turn the infant over with head lower than the body.
- Rest the forearm that is supporting the infant's back onto the thigh (same side as the hand) to support the infant.
  - Draw an imaginary line between infant's nipples with the ring (fourth) finger to the centre of the chest. Place your middle and index fingers (third and second) next to your ring (fourth) finger. (See figure 7-6)

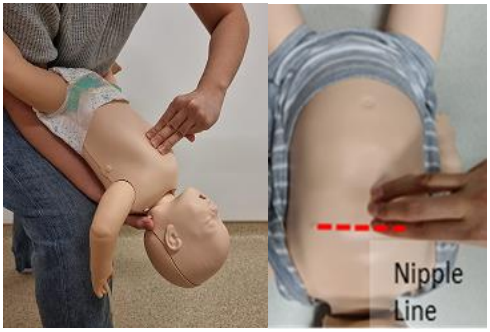


Figure 7-6 – Trace location for chest thrusts

- Lift up your ring (fourth) finger and deliver 5 chest thrusts over the lower half of the sternum (breastbone). (See figure 7-7)

Figure 7-7 – Deliver 5 chest thrusts

- If a foreign body is seen, place the infant on a firm flat surface and remove the foreign body with your little finger.
- Repeat back blows and chest thrusts until the foreign body is expelled or the infant becomes unconscious.

Note:

- Do not tip-toe when performing back blows and chest thrusts as the rescuer may lose balance and fall.
- Each back blow and chest thrust should be delivered with sufficient force and with the intention of expelling the foreign body.

Other options of supporting the infant with FBAO
(See figures 7-8 to 7-11)

Figure 7-8 and 7-9 – Sitting on a chair

Figure 7-10 and 7-11 – Kneeling on the floor

7.4: RELIEF OF UNCONSCIOUS INFANT FBAO

If the infant becomes unconscious, proceed with the following steps.

Step 1: Position the infant

- Support and position the infant lying on his/her back on a firm, flat surface.

Step 2: Activate Emergency Medical Service (EMS)

- Rescuer shouts: "Help! Call ambulance 995 and get an AED!" However, if there is another person around, ask him/her to call for an ambulance "995" and get an AED.

Step 3: Start 30 chest compressions

- Locate the landmark and perform 30 chest compressions using the same location and techniques used for chest compressions in CPR. (See Infant CPR, page 70-76, see figure 7-12)

Figure 7-12 – Provide 30 chest compressions

Step 4: Open the airway

- Perform the gentle Head-Tilt and Chin-Lift manoeuvre to open the airway.
- While maintaining Head-Tilt, open the mouth gently to check for visible foreign bodies.
- If no foreign body is seen, perform another 30 chest compressions. (See figure 7-17)

- If foreign body is seen, maintain open airway with Chin-Lift and insert the little finger of your other hand into the infant's mouth along the inside of the cheek.

Figure 7-13 – Use little finger to remove foreign body.

- Use a hooking action to dislodge the foreign body and manoeuvre it out of the mouth. Take care not to force the foreign body deeper into the throat. This manoeuvre is known as the **finger sweep**. (See figure 7-13)

Note:

- ♥ Do not perform blind finger sweep. Blind finger sweep may push the object back or further into the airway.
- ♥ However, if there are no objects found in the mouth, repeat steps 3 and 4 until object has been removed.
- ♥ For lay rescuers – Once object has been removed, check for breathing. If breathing is absent, repeat steps 3 and 4 until breathing resumes or emergency help arrives.
  For trained healthcare providers – See step 5.

For Trained-Healthcare Provider

Step 5: Bag-valve-mask (BVM) ventilation

- Attempt one ventilation via BVM (1st ventilation). (See figures 7-14 and 7-15) If BVM is not available and you are willing and trained, you may provide mouth-to-nose-and-mouth ventilations. (See figure 7-16)

Figure 7-14 and 7-15 (right) – Bag-valve mask ventilations

  - Perform a Head-Tilt, Chin-Lift manoeuvre. An open airway will ensure ventilations are effective. (See chapter 2)

- Seal your lips around the casualty's nose and mouth.
- Provide 1 breath by blowing steadily into the infant's mouth for about 1 second per breath, sufficient to make the chest visibly rise.

Figure 7-16 – Mouth-to-mouth-and-nose ventilation

- If there is no resistance (chest rises), airway is clear. Proceed to check for normal breathing and pulse. If unsure of the presence of normal breathing and pulse within 10 seconds, start CPR.

- If there is resistance (chest does not rise), the airway may be blocked. Reposition the infant's head with the Head-Tilt, Chin-Lift manoeuvre. Re-attempt to ventilate (2nd ventilation).

- Repeat steps 3 to 5 until help arrives and takes over or the casualty starts breathing, coughing, talking, or moving.

- Check for normal breathing and pulse.

- If normal breathing or pulse are absent or you are unsure, start CPR.

- If pulse is definitely present but the infant is not breathing, perform rescue breathing at 30 breaths per minute (one breath every 2 seconds) by giving one breath and count "2-a-thousand". Repeat the sequence until you have completed a total of 30 breaths. Re-assess for normal breathing and pulse.

- If both the breathing and pulse are present, monitor the casualty till help arrives.

Summary of Unconscious Infant FBAO Relief for Healthcare Providers

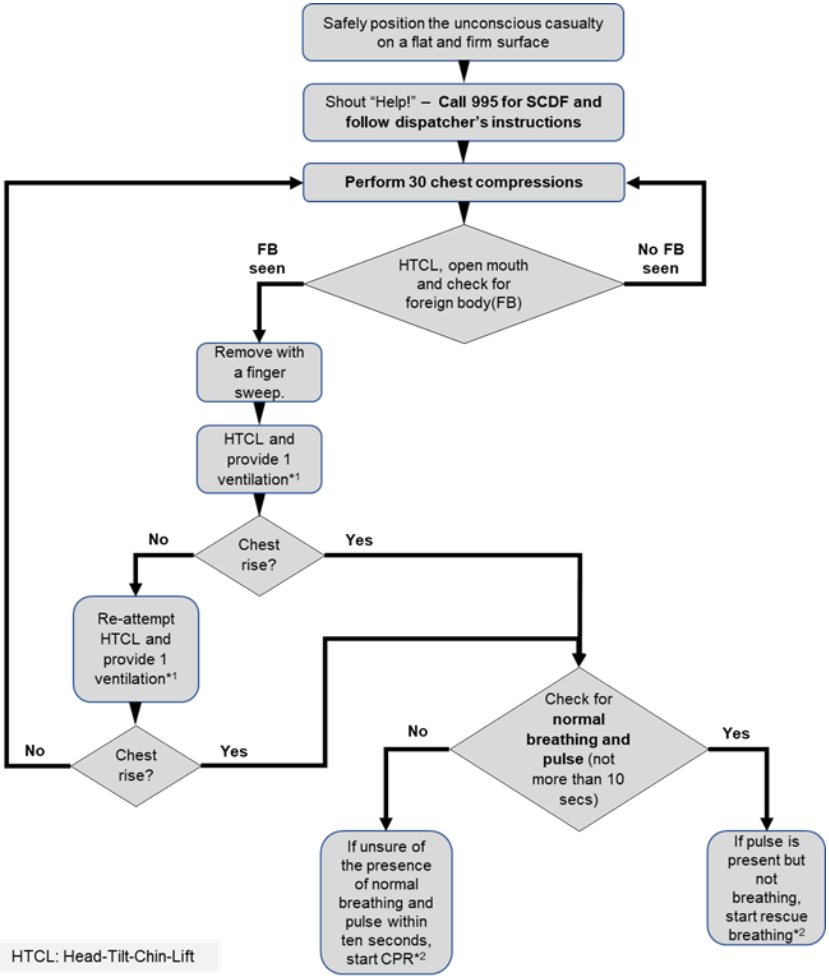


Figure 7-17 – Unconscious Infant FBAO Relief for healthcare providers

Note:

1. For healthcare providers, provide ventilations via a bag-valve-mask (BVM). If there is no BVM available and you are unable or unwilling to do mouth-to-mouth ventilations for any reason, check for normal breathing and pulse for not more than 10 seconds.
2. If no BVM is available and you are unable or unwilling to do mouth-to-mouth ventilations, perform continuous chest compressions. If you are a single rescuer and feeling tired, you may take a rest of not more than 10 seconds (preferably after 100 compressions).