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What Can We Do Before Defibrillation?

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1. Introduction

The introduction of closed-chest massage by Kouwenhoven, Jude and Knickerbocker in 1960 was one of the key components of resuscitation that made recovery from sudden cardiac arrest (SCA) a realistic possibility, both in hospital and in the community.
The guidelines for cardiopulmonary resuscitation (CPR) of American Heart Association (AHA) were progressing from 1992. The 1992 guidelines for CPR and emergency cardiac care (ECC) described early access, early CPR, early defibrillation, and early advanced cardiovascular life support (ACLS), namely the 'chain of survival', as essential components of a series of actions designed to reduce the mortality associated with SCA.
The 2000 guidelines for CPR and ECC reported that the intervals of collapse to conventional CPR and collapse to defibrillation were most powerful factors in determining survival from cardiac arrest. 2005 guidelines for CPR and ECC have reported that survival rates from witnessed cardiac arrest due to shockable rhythm (i.e., ventricular fibrillation or pulseless ventricular tachycardia) decrease 7–10% for every minute that passes between collapse and defibrillation if no CPR by bystanders is provided, but the decrease in survival rates is more gradual and average 3–4% per minute from collapse to defibrillation when bystander conventional CPR is provided.
Now the 2010 guidelines have been announced by AHA. Initiating chest compressions before giving rescue breaths (i.e. C-A-B rather than A-B-C) has been advocated.
In the past five decades, scientific knowledge about arrest pathophysiology and resuscitation mechanisms has increased substantially; it is also a cause of effectively translating the science of resuscitation into clinical care and improving resuscitation outcomes.

2. Recognition of SCA

Immediate recognition of cardiac arrest is the first step of the survival chain. Prompt emergency activation and initiation of CPR requires rapid recognition of SCA.
SCA is death resulting from an abrupt loss of heart function. The victim may or may not have diagnosed heart disease. Most of the cardiac arrests that lead to sudden death occur when the electrical impulses in the diseased heart become rapid (ventricular tachycardia) or chaotic (ventricular fibrillation) or both.
Agonal gasps are common early after SCA and can be confused with normal breathing. It has been recognized as a signal of SCA.
Pulse detection alone is often unreliable, and it may require additional time. Detection of a pulse can be difficult, and even highly trained healthcare providers often incorrectly assess the presence or absence of a pulse when blood pressure is abnormally low or absent.

Healthcare providers should take no more than 10 seconds to determine if a pulse is present. The lay rescuer should activate the emergency response system if he or she finds an unresponsive adult. The lay rescuer should not attempt to check for a pulse and should assume that cardiac arrest is present if an adult suddenly collapses, is unresponsive, and is not breathing or not breathing normally.

3. What can we do before defibrillation?

It's essential to integrate early defibrillation into an effective emergency cardiovascular care system.

- Early Access — quickly calling the Emergency Medical Services (9-1-1) system
- Early CPR — promptly giving cardiopulmonary resuscitation
- Early Defibrillation — having proper equipment and being trained to use it when indicated

Fig. 1. Adult Chain of Survival.

4. Call EMS

Calling the Emergency Medical Services (9-1-1) system or your local emergency number immediately is the first important help that you can provide to a SCA victim.
When phoning 911 for help, the rescuer should be prepared to answer the dispatcher's questions about location, what happened, number and condition of victims, and type of aid provided. The caller should hang up only when instructed to do so by the dispatcher and should then return to the victim to provide CPR and defibrillation if needed.

5. Early CPR

Victims of cardiac arrest need immediate CPR. CPR provides a small but critical amount of blood flow to the heart and brain. CPR prolongs the time VF is present and increases the likelihood that a shock will terminate VF and allow the heart to resume an effective rhythm and effective systemic perfusion. CPR is especially important if a shock is not delivered for 4, 5 or more minutes after collapse. Defibrillation does not "restart" the heart; defibrillation "stuns" the heart, briefly stopping VF and other cardiac electrical activity. If the heart is still viable, its normal pacemakers may then resume firing and produce an effective ECG rhythm that may ultimately produce adequate blood flow.

Early CPR means giving CPR promptly and properly when necessary. When CPR is performed, mouth-to-mouth breathing and chest compressions circulate blood (and oxygen) to vital organs. This buys time until defibrillation, the next link in the chain of survival, can occur.
The Early CPR link is strengthened when bystanders or callers know CPR and Emergency Medical Dispatchers can give CPR instructions by phone.

6. Chest compressions

Chest compressions consist of rhythmic applications of pressure over the lower half of the sternum. These compressions create blood flow by increasing intrathoracic pressure and directly compressing the heart. Blood flow generated by chest compressions delivers a small but critical amount of oxygen and substrate to the brain and myocardium. In victims of VF SCA, chest compressions increase the likelihood that a shock will be successful.
The rescuer should compress the lower half of the victim's sternum in the center (middle) of the chest, between the nipples. The rescuer should place the heel of the hand on the sternum in the center (middle) of the chest between the nipples and then place the heel of the second hand on top of the first so that the hands are overlapped and parallel.

7. Open the airway: Lay rescuer and healthcare provider

The lay rescuer should open the airway using a head tilt– chin lift maneuver for both injured and noninjured victims. The jaw thrust is no longer recommended for lay rescuers because it is difficult for lay rescuers to learn and perform, is often not an effective way to open the airway, and may cause spinal movement. A healthcare provider should use the head tilt–chin lift maneuver to open the airway of a victim without evidence of head or neck trauma. If a healthcare provider uspects a cervical spine injury, open the airway using a jaw thrust without head extension.

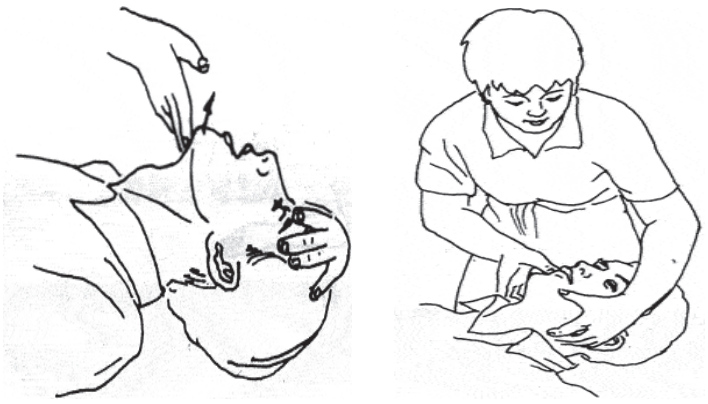


Fig. 2. Open the Airway with head tilt–chin lift maneuver or jaw thrust.

8. Breaths

Give 2 rescue breaths, each over 1 second inspiratory time and tidal volume of about 600 mL, with enough volume to produce visible chest rise. This recommended 1-second duration to make the chest rise applies to all forms of ventilation during CPR, including mouth-to-mouth and bag-mask ventilation and ventilation through an advanced airway, with and without supplementary oxygen.

1. During the first minutes of VF SCA, rescue breaths are probably not as important as chest compressions because the oxygen level in the blood remains high for the first several minutes after cardiac arrest. In early cardiac arrest, myocardial and cerebral oxygen delivery is limited more by the diminished blood flow than a lack of oxygen in the blood. During CPR blood flow is provided by chest compressions. Rescuers must be sure to provide effective chest compressions and minimize any interruption of chest compressions.
2. Both ventilations and compressions are important for victims of prolonged VF SCA, when oxygen in the blood is utilized. Ventilations and compressions are also important for victims of asphyxial arrest, such as children and drowning victims who are hypoxemic at the time of cardiac arrest.
3. During CPR blood flow to the lungs is substantially reduced, so an adequate ventilation-perfusion ratio can be maintained with lower tidal volumes and respiratory rates than normal. Rescuers should not provide hyperventilation (too many breaths or too large a volume). Excessive ventilation is unnecessary and is harmful because it increases intrathoracic pressure, decreases venous return to the heart, and diminishes cardiac output and survival.
4. Avoid delivering breaths that are too large or too forceful. Such breaths are not needed and may cause gastric inflation and its resultant complications.

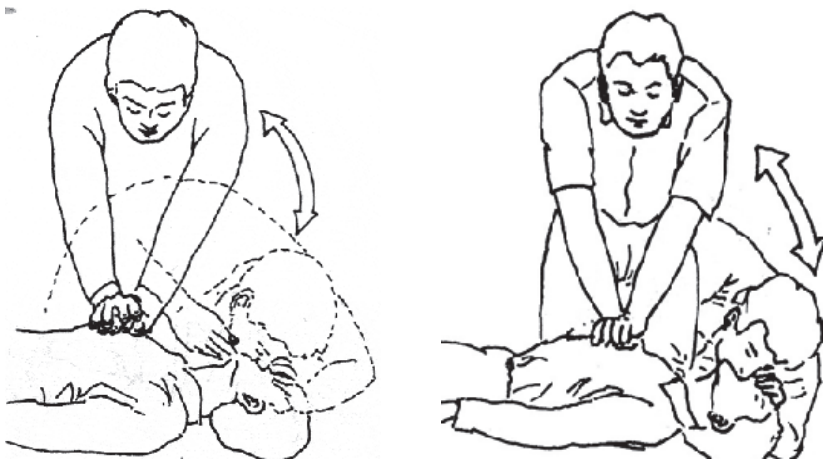


Fig. 3. Compression-ventilation ratio of 30:2CPR can be given by one or two rescuer.

9. Compression-ventilation ratio

A compression-ventilation ratio of 30:2 is recommended. This 30:2 ratio is based on a consensus of experts rather than clear evidence. It is designed to increase the number of compressions, reduce the likelihood of hyperventilation, minimize interruptions in chest compressions for ventilation, and simplify instruction for teaching and skills retention.

10. "A-B-C" to "C-A-B"

The newest development in the 2010 AHA Guidelines for CPR and ECC is a change in the basic life support (BLS) sequence of steps from "A-B-C" (Airway, Breathing, Chest compressions) to "C-A-B" (Chest compressions, Airway, Breathing) for adults and pediatric patients (children and infants, excluding newly borns).

The vast majority of cardiac arrests occur in adults, and the highest survival rates from cardiac arrest are reported among patients of all ages with witnessed arrest and a rhythm of VF or pulseless ventricular tachycardia (VT). In these patients the critical initial elements of CPR are chest compressions and early defibrillation.

In the A-B-C sequence chest compressions are often delayed while the responder opens the airway to give mouth-to-mouth breaths or retrieves a barrier device or other ventilation equipment. By changing the sequence to C-A-B, chest compressions will be initiated sooner and ventilation only minimally delayed until completion of the first cycle of chest compressions

Fewer than 50% of persons in cardiac arrest receive bystander CPR. There are probably many reasons for this, but one impediment may be the A-B-C sequence, which starts with the procedures that rescuers find most difficult: opening the airway and delivering rescue breaths. Starting with chest compressions might ensure that more victims receive CPR and that rescuers who are unable or unwilling to provide ventilations will at least perform chest compressions.

11. Encouraging Hands-Only (chest compression only) CPR

Cardiopulmonary resuscitation is traditionally defined as chest compression and ventilation. The need for chest compressions is unquestionable. The prompt initiation of effective chest compressions is a fundamental aspect of cardiac arrest resuscitation. Providing chest compressions of adequate rate, depth, complete chest recoil, minimizing interruptions and avoiding excessive ventilation are several most important factors of chest compression.

Encouraging Hands-Only (compression only) CPR for the untrained lay rescuer has been advocated by AHA 2010 guidelines. That is not only because Hands-Only CPR is easier to perform by those with no training, but also because it can be more readily guided by dispatchers over the telephone. Performing chest compressions alone is reasonable for trained laypersons if they are incapable of delivering airway and breathing maneuvers to cardiac arrest victims. The provision of chest compressions with ventilations is reasonable for trained laypersons who are capable of giving CPR with ventilations to cardiac arrest victims.

12. CPR or CCR?

Cardiocerebral resuscitation (CCR) is a new approach to the resuscitation of patients with witnessed cardiac arrest and a shockable rhythm developed by the University Of Arizona

Sarver Heart Center Resuscitation Group that significantly improves neurologically intact survival. For ACLS, it advocates either prompt or delayed single defibrillation shock, based on the three-phase time-sensitive model of ventricular fibrillation. Endotracheal intubation is delayed, excessive ventilations avoided, and early administration of epinephrine is advocated. CCR is not recommended for individuals with respiratory arrest. Endotracheal intubation has adverse effects not only due to the relatively long interruptions of chest compressions during placement but also due to the adverse effects of positive pressure ventilation and frequent hyperventilation.

13. Electrical therapies

Integration of AED into a system of care is critical in the Chain of Survival in public places outside of hospitals. To give the victim the best chance of survival, 3 actions must occur within the first moments of a cardiac arrest: activation of the EMS system, provision of CPR, and operation of a defibrillator.

14. AED

Automated external defibrillator （AED） is designed to treat victims of sudden cardiac arrest, where no explicit advanced directive regarding resuscitation is recorded. An AED should be used when a victim is found to be unresponsive and not breathing normally and in a shockable rhythm for example ventricular fibrillation and ventricular tachycardia.

Defibrillation will take priority to cardiopulmonary resuscitation unless there is more than one rescuer, where cardiopulmonary resuscitation can be commenced until the AED is brought to the scene, and its use can be initiated.

15. Sequence of actions when using an AED

The following sequence applies to the use of both semi-automatic and automatic AEDs in a ventricular fibrillation and pulseless ventricular tachycardia victim

1. Follow the adult BLS sequence. Do not delay starting CPR unless the AED is available immediately.
2. As soon as the AED arrives:
   If more than one rescuer is present, continue CPR while the AED is switched on.
   If you are alone, stop CPR and switch on the AED.
   Follow the voice / visual prompts.
   Attach the electrode pads to the patient's bare chest.
   Ensure that nobody touches the victim while the AED is analysing the rhythm.
3. If a shock is indicated:
   Ensure that nobody touches the victim.
   Push the shock button as directed
   Continue as directed by the voice / visual prompts.
   Minimise, as far as possible, interruptions in chest compression.
   If no shock is indicated:
   Resume CPR immediately using a ratio of 30 compressions to 2 rescue breaths.

Continue as directed by the voice / visual prompts.

4. Continue to follow the AED prompts until:
   Qualified help arrives and takes over OR the victim starts to show signs of regaining consciousness, such as coughing, opening eyes, speaking, or moving purposefully and starts to breathe normally or you become exhausted.

16. AED electrode pad placement in adults and/or children

The AEDs in the Trust may have adult and/or child AED electrode pads, depending on the age of the client group in that particular service area.
Adult AED pads are used on individuals above the age of 8 years,

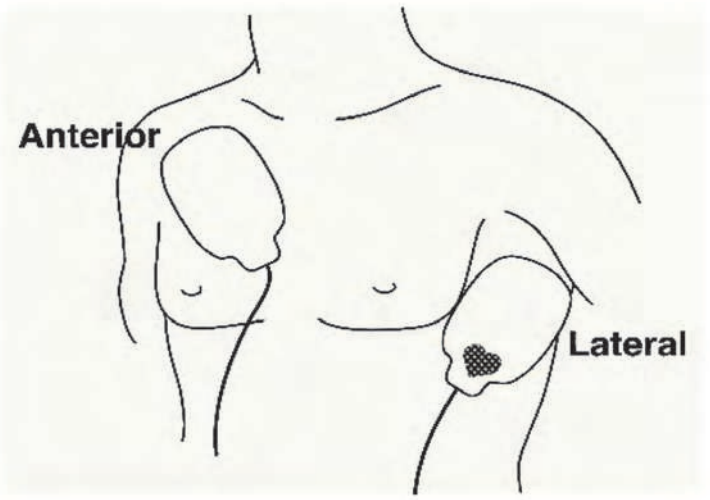


Fig. 4. AED electrode pad placement.

Place one AED pad to the right of the sternum (breast bone), below the clavicle (collar bone). Place the other pad in the left mid-axillary line, in line with the armpit and below the left breast.
It is important that this pad is placed sufficiently laterally and that it is clear of any breast tissue.
Although most AED pads are labelled left and right or carry a picture of their correct placement, it does not matter if their positions are reversed.
It is important if this happens 'in error', the pads should not be removed and replaced because this wastes time and they may not adhere adequately when re-attached.
The victim's chest must be sufficiently exposed to enable correct pad placement. Chest hair will prevent the pads adhering to the skin and will interfere with electrical contact. Shave

the chest only if the hair is excessive, and even then spend as little time as possible on this. Do not delay defibrillation if a razor is not immediately available.
Child reduced energy AED electrode pads are suitable for children 1-8 years of age, these are placed in the anterior posterior position, with one pad, placed in the centre of the chest between the nipples and the other on the back between the scapulae (shoulder bones).

17. Automated rhythm analysis

AEDs have microprocessors that analyze multiple features of the surface ECG signal, including frequency, amplitude, and some integration of frequency and amplitude, such as slope or wave morphology. Filters check for QRS-like signals, radio transmission, or 50- or 60-cycle interference as well as loose electrodes and poor electrode contact. They are extremely accurate in rhythm analysis. Although AEDs are not designed to deliver synchronized shocks (ie, cardioversion for VT with pulses), AEDs will recommend a (nonsynchronized) shock for monomorphic and polymorphic VT if the rate and R-wave morphology exceed preset values.

18. Safety during AED use

1. Defibrillation if the victim is wet
   As long as there is no direct contact between the user and the victim when the shock is delivered, there is no direct pathway that the electricity can take that would cause the user to experience a shock.
   Dry the victim's chest so that the adhesive AED pads will stick and take particular care to ensure that no one is touching the victim when a shock is delivered.
2. Defibrillation in the presence of supplemental oxygen
   If supplemental oxygen is being delivered by a face mask, remove the face mask and place it at least one metre away before delivering a shock. Do not allow this to delay shock delivery.
3. Minimise interruptions in CPR
   The importance of early, uninterrupted chest compressions is emphasised throughout resuscitation guidelines. Interrupt CPR only when it is necessary to analyse the rhythm and deliver a shock.

When two rescuers are present, the rescuer operating the AED applies the electrodes while the other continues CPR. The AED operator delivers a shock as soon as the shock is advised, ensuring that no one is in contact with the victim. Radio-Frequency interference from devices, such as Mobile phones can cause improper AED operation, and should be switched off near life support equipment. The AED electrode pads must completely adhere to the patient's skin, air pockets between the skin and electrode pads can cause patient burns. The AED may prompt the Operator that there is 'Poor Pad Contact', if this occurs; re-check all electrical and patient connections.
Do not use dried out AED electrode pads.
Attach the AED pads only to the patient's bare chest, do not allow the AED electrode pads to touch each other or other ECG electrodes, lead wires, dressings, transdermal patches, etc. Such contact can cause electrical arcing and patient skin burns during defibrillation and it may also divert the defibrillation current away from the heart.

If the AED detects a possible problem with the AED electrode pads or cable, It may alert the Operator with a 'Replace Pads' prompt, if this occurs remove the pads and replace with a new set.

19. Precautions in using AED devices

Do not place AED pads over medication patches such as nitroglycerin. Remove the patch before placing the AED pad.
Do not apply pads over an implanted pacemaker or defibrillator.
Do not use alcohol to wipe the patient's chest before applying the AED pads.
Do not attach pads to any patient unless the patient is unresponsive, no breathing and no pulse.
Do not press the shock button unless until no one is in contact with the patient.
If a child pad is available, use the Child pad for children.
Do not use AED's on infants (NO AEDs are designe) yet for infant patients).

20. Manual defibrillation

At present it is clear that both low-energy and high-energy biphasic waveform shocks are effective, but definitive recommendations for the first and subsequent energy levels for all devices cannot be made because devices vary in waveform and reported shock success. Although both escalating-energy and nonescalating-energy defibrillators are available, there is insufficient data to recommend one approach over another.

21. Which is first, compression or defibrillation?

Prompt defibrillation is recommended if bystanders have ready access to an AED or if police or EMS personnel with AEDs arrive during the electrical phase, that is, the first 4 or 5 min of ventricular fibrillation arrest. During the circulatory phase of ventricular fibrillation arrest (VF 5-10 min), the fibrillating myocardium has used much of its energy stores, and chest compressions that perfuse the heart are necessary and, therefore, advocated prior to and immediately after a defibrillator shock.

22. Criteria for not starting CPR

Scientific evaluation shows that few criteria can accurately predict the futility of CPR. In light of this uncertainty, all patients in cardiac arrest should receive resuscitation unless

- The patient has a valid Do Not Attempt Resuscitation (DNAR) order
- The patient has signs of irreversible death (eg, rigor mortis, decapitation, decomposition, or dependent lividity)
- No physiological benefit can be expected because vital functions have deteriorated despite maximal therapy (eg, progressive septic or cardiogenic shock).

23. References

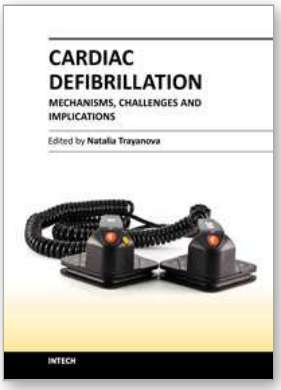
2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 2005; 112:IV1-IV203.

2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care: Part 5, 6. Circulation 2010; 122(suppl 2):S298 – S337.

Wang S, Li C, Ji X, et al. Effect of continuous compressions and 30:2 cardiopulmonary resuscitation on global ventilation/perfusion values during resuscitation in a porcine model. Crit Care Med 2010; 38: 2073-2075.

Ewy GA. Cardiocerebral resuscitation: the new cardiopulmonary resuscitation. Circulation 2005; 111:2134–2142.

Kern KB, Hilwig RW, Berg RA, et al: Importance of continuous chest compressions during cardiopulmonary resuscitation: improved outcome during a simulated single lay-rescuer scenario. Circulation 2002:645-649.



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The only known effective therapy for lethal disturbances in cardiac rhythm is deï¬brillation, the delivery of a strong electric shock to the heart. This technique constitutes the most important means for prevention of sudden cardiac death. The efficacy of defibrillation has led to an exponential growth in the number of patients receiving implantable devices. The objective of this book is to present contemporary views on the basic mechanisms by which the heart responds to an electric shock, as well as on the challenges and implications of clinical defibrillation. Basic science chapters elucidate questions such as lead configurations and the reasons by which a defibrillation shock fails. Chapters devoted to the challenges in the clinical procedure of defibrillation address issues related to inappropriate and unnecessary shocks, complications associated with the implantation of cardioverter/defibrillator devices, and the application of the therapy in pediatric patients and young adults. The book also examines the implications of defibrillation therapy, such as patient risk stratification, cardiac rehabilitation, and remote monitoring of patient with implantable devices.

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