Defibrillation

Defibrillation is the passage of an electrical current across the myocardium in order to change the electrical activity of the heart from a chaotic to organized rhythm. It is a term usually used in relation to the treatment of ventricular fibrillation (VF) or ventricular tachycardia (VT); when used for the treatment of atrial fibrillation (AF) or atrial flutter, it is usually termed ‘cardioversion’.

What is Defibrillation?

The treatment for ventricular fibrillation and other life-threatening arrhythmias (abnormal heartbeats) is defibrillation. The heart stops pumping blood to the brain and body when it is in ventricular fibrillation. If not treated immediately, it will induce cardiac arrest and death within minutes. By shocking the heart with electricity, defibrillation restores a regular heartbeat.

When combined with CPR and specialized medical care, rapid defibrillation can save lives. Defibrillation does not treat the arrhythmia's underlying cause. It does not always work, especially in cases of severe, untreated cardiac disease or some end-stage conditions.

Defibrillator Machine

Defibrillators are devices that provide an electric pulse or shock to the heart to restore a regular heartbeat. They're used to prevent or treat arrhythmias, which are irregular heartbeats that are either too slow or too fast. If the heart abruptly stops beating, defibrillators can help restore it. Defibrillators are designed to work in a variety of ways. The goal of automated external defibrillators (AEDs), which are found in many public places, is to save the lives of those who have suffered a sudden cardiac arrest. In an emergency, even inexperienced people can operate these devices. Other defibrillators can help those who are at high risk of dying from a life-threatening arrhythmia. Implantable cardioverter defibrillators (ICDs) and wearable cardioverter defibrillators (WCDs) are two types of defibrillators. ICDs are surgically implanted inside the body, while WCDs are placed on the body. It takes time and effort to adjust to living with a defibrillator, and it's critical to be aware of the risks and issues that can arise.

Types of Defibrillator Machines

1. Manual Defibrillator

A healthcare professional's skill is required for manual external defibrillators. They're utilized in conjunction with an Electrocardiogram, which might be standalone or integrated. The voltage and timing for the electrical shock are manually determined after a healthcare provider assesses the heart rhythm. The majority of these units may be found in hospitals and on select ambulances. During or after cardiac surgery, such as a heart bypass, an internal defibrillator is frequently used to defibrillate the heart. Round metal plates are used as electrodes and come into direct touch with the myocardium. Paddles placed directly on the heart administer the shock in manual internal defibrillators. They're mostly employed in the operating room and, in rare cases, the emergency department during an open-heart surgery.

2. Automated External Defibrillators (AED Defibrillator)

Automated external defibrillators (AEDs) are a type of defibrillator designed for use by untrained persons. AEDs have equipment that can analyze cardiac rhythms. As a result, determining whether or not a rhythm is shockable does not necessitate the use of a qualified health expert. AEDs have improved outcomes for abrupt out-of-hospital cardiac arrests by making these units widely available.

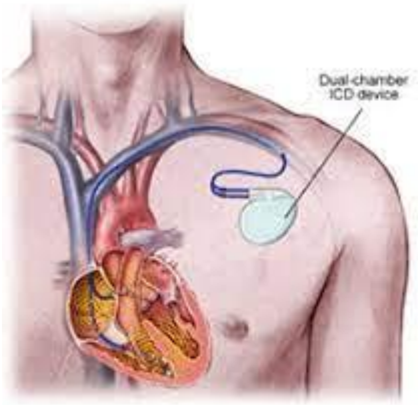
Trained health professionals will have more limited use of automatic defibrillators than manual external defibrillators. AEDs do not enhance outcomes in patients with in-hospital cardiac arrests, according to recent studies. AEDs have fixed voltages and do not allow the operator to adjust the voltage based on the situation. AEDs may also cause effective CPR to be delayed. AEDs frequently require the cessation of chest compressions and rescue breathing in order to diagnose rhythm. For these reasons, certain organizations, such as the European Resuscitation Council, advocate that if manual external defibrillators are readily available, they be used instead of AEDs.

AEDs have been widely available in many easily accessible regions because early defibrillation can greatly improve VF outcomes. AEDs have been incorporated into the basic life support algorithm (BLS). They are carried by many first responders, including firefighters, police officers, and security guards.

AEDs are available in two types: completely automatic and semi-automatic. A semi-automatic AED diagnoses heart rhythms and determines whether or not a shock is required. If a shock is recommended, the user must press a button to deliver it. A fully automated AED detects the heart beat and instructs the user to stand back while the shock is delivered automatically. Few types of AEDs have advanced features, like manual override or an ECG display.

3. Cardioverter-Defibrillators

Automatic internal cardiac defibrillators (AICDs), also known as implantable cardioverter-defibrillators (ICDs), are pacemaker-like implants. According to the device's programming, they continuously monitor the patient's heart rhythm and automatically administer shocks for life-threatening arrhythmias. Many current equipment's can discriminate between ventricular fibrillation, ventricular tachycardia, and other arrhythmias that are more benign, such as supraventricular tachycardia and atrial fibrillation. Prior to synchronized cardioversion, some devices may attempt overdrive pacing. When ventricular fibrillation is life-threatening arrhythmia, the device is programmed to deliver an unsynchronized shock right away.



In some situations, the patient's ICD may fire frequently or incorrectly. This is a medical emergency since it depletes the device's battery life, gives the patient severe discomfort and worry, and in extreme situations, can even produce life-threatening arrhythmias. Some emergency medical personnel now have a ring magnet to place over the device, which essentially inhibits the device's shock function while still allowing the pacemaker to work (if the device is so equipped). EMS workers may deliver sedation if the gadget shocks regularly but adequately.

A wearable defibrillator is a portable defibrillator which can be worn by risky patients. If VF or VT is identified, the equipment watches the patient 24 hours a day and can immediately deliver a biphasic shock. Patients who are not immediate candidates for ICDs should use this device.

Defibrillator Uses

In cardiac resuscitation, defibrillation is frequently used (CPR). CPR is a procedure that uses an algorithm to restore cardiac and pulmonary function. Only some types of cardiac dysrhythmias, such as ventricular fibrillation (VF) and pulseless ventricular tachycardia, require defibrillation. Defibrillation is not recommended if the heart has fully stopped, as in asystole or pulseless electrical activity (PEA). If the patient is cognizant and has a pulse, defibrillation is not recommended. Electrical shocks administered incorrectly can result in serious dysrhythmias such as ventricular fibrillation.

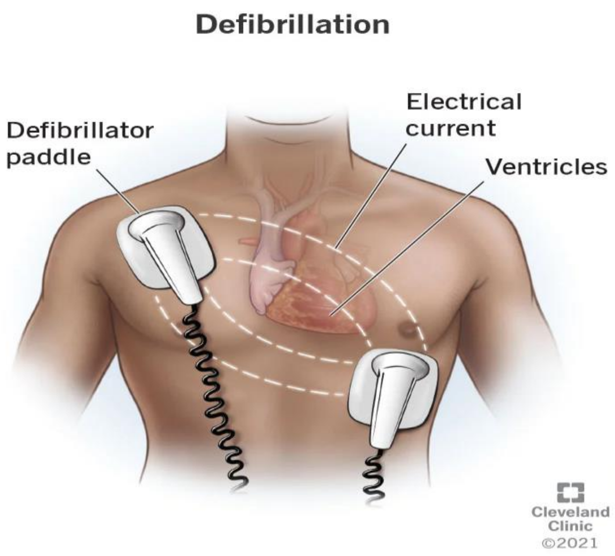
Out-of-hospital cardiac arrest survival rates are dismal, often less than 10%. In-hospital cardiac arrests have a greater success rate of 20%. The specific heart rhythm of persons who have experienced a cardiac arrest can have a major impact on survival rates. People with a shockable rhythm (such as VF or pulseless ventricular tachycardia) had better survival rates of 21-50 percent compared to people with a non-shockable rhythm (such as asystole or PEA).

Why is Defibrillation Performed?

Your heart is a pump-like muscle that pumps blood around your body. There are two upper chambers (atria) and two lower chambers in this structure (ventricles). Your heart, like other pumps, requires an energy source to work. The energy in your heart comes from an electrical conduction system built into it that transfers electrical signals through the four chambers. To produce a regular heartbeat, electrical signals coordinate the chambers. Certain signal faults result in a disordered, inefficient, quivering rhythm. Defibrillation sends an electrical shock through the heart, causing all of the cardiac cells to contract simultaneously. This brings the heart's abnormal beat to a halt and allows it to resume normal electrical activity. To be effective, defibrillation must be performed within minutes of the onset of a life-threatening ventricular arrhythmia.

Defibrillation is used to treat ventricular arrhythmias that are immediately life-threatening, such as:

- Ventricular fibrillation is a condition in which your heart's lower chambers, or ventricles, beat so quickly and irregularly that they quiver or shake. Your heart pumps very little or no blood to your brain and body as a result. Without defibrillation, death occurs in five to ten minutes.
- Without a pulse, ventricular tachycardia occurs when the ventricles beat excessively quickly. The heart's efficiency suffers as a result of this. It lowers the quantity of blood your heart can pump to your brain and other parts of your body. If there isn't enough blood to produce a pulse or you pass out, you'll need to be treated with defibrillation. Without a pulse, ventricular tachycardia can quickly progress to ventricular fibrillation.



How is Defibrillation Performed?

The technique for defibrillation differs based on the type of device. It usually entails the following steps:

- Until a heart defibrillator is available, the clinician will begin CPR.
- Two sticky defibrillator electrodes or paddles lubricated with special jelly will be applied to your upper right chest and lower left rib cage area by the provider. The upper right chest and upper left back are two possible positions. A doctor will create a thoracotomy incision in your chest and place the electrodes directly on your heart muscle in rare circumstances.
- The provider or the AED will assess your cardiac rhythm and, if necessary, shock your heart.
- The provider or the AED will re-analyze the resulting heart rhythm and, if necessary, administer further shocks. A team of healthcare professionals will offer CPR and advanced life support (ALS) treatments as needed during this period.

Complications of Defibrillation

Defibrillation comes with dangers and potential problems. Defibrillation's life-saving benefits significantly exceed the hazards. The following are some of the risks and potential complications:

- Burns on the skin
- Myocardial necrosis (death of heart muscle tissue)
- Various cardiac arrhythmias include asystole (no heart rhythm, also known as "flatlining"), ventricular fibrillation following pulseless ventricular tachycardia, and other less dangerous arrhythmias.

Safety

Oxygen concentrations as high as 60% have been measured in enclosed environments using oxygen-powered medical devices, 24% oxygen doubles the rate of combustion and 30% oxygen increases combustion rate 10-fold. In an oxygen-enriched atmosphere, sparking from poorly applied defibrillator paddles in an oxygen-enriched environment can cause a catastrophic fire.

The risk of fire during attempted defibrillation can be minimized by taking the **following precautions**:

◆ Remove any oxygen mask or nasal cannula and place ≥ 1 m away from the patient's chest

◆ Leave any bag-valve device connected to a tracheal tube or other airway adjunct (e.g., laryngeal mask airway, Combi tube, or laryngeal tube). Alternatively, disconnect any bag-valve device from the tracheal tube (or other airway adjunct), and remove it ≥ 1 m from the patient's chest during defibrillation.

◆ If the patient is connected to a ventilator, leave the ventilator tubing (breathing circuit) connected to the tracheal tube during defibrillation.

Application of defibrillation electrodes

Self-adhesive defibrillation pads are generally replacing defibrillation paddles. They improve safety by avoiding the need to lean over the patient during defibrillation and provide better electrical contact with the skin compared with the flat metal plates of defibrillation paddles, minimizing the risk of electrical arcing and fire. Optimal electrode position is one that results in greatest current flow across the myocardium. The standard position to achieve this is the sternal electrode placed to the right of the sternum, immediately below the clavicle and the apical paddle placed in the mid-axillary line (Fig. 63.5), level with the V6 ECG electrode position.

Acceptable alternative positions include:

◆ Bi-axillary.

◆ Anterior (left sternal edge): posterior (between the left clavicle and spine).

◆ Posterior (behind the right clavicle): apical

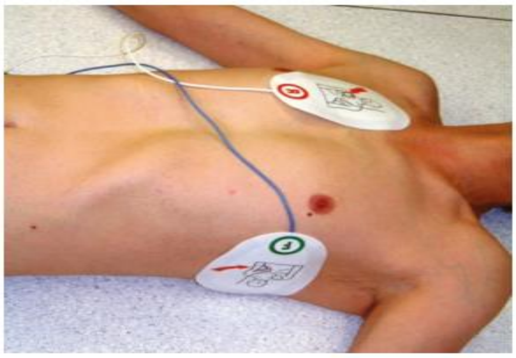


Fig. 63.5 Anterior-apical defibrillation electrode placement.
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Clinical aspects of defibrillation

Defibrillation is one of the few interventions that have been shown to improve survival from cardiac arrest and it is therefore a key link in the **chain of survival**. The probability of successful defibrillation and neurologically-intact survival to hospital discharge is time critical, with every minute that passes between collapse and defibrillation resulting in an increase in mortality of 7–10%, this increase is slowed marginally in patients receiving bystander resuscitation. In order to reduce delays in defibrillation, the introduction of public access defibrillators in areas of high population density (e.g., airports, shopping centers, railways stations, etc.) has resulted in significantly improved survival rates, particularly in some urban areas. In more rural areas rapid activation of trained community responders is also contributing to early defibrillation. CPR versus defibrillation as the initial treatment. Although early studies suggested that a period of cardiopulmonary resuscitation (CPR) for 1–3 minutes prior to defibrillation increased the defibrillation success rate, subsequent larger studies failed to repeat these observations. It is now recommended that when

treating both in- and out-of-hospital cardiac arrest, rescuers should provide good-quality CPR, while a defibrillator is quickly applied and charged, but routine preshock CPR (e.g. 2 or 3 minutes) is no longer recommended. One shock versus three shock sequence With first shock efficacy of biphasic waveforms exceeding 90%, failure to successfully defibrillate is more likely to suggest the need for a period of CPR, rather than a further shock. The previous recommendations for up to three shocks before resuming CPR have now been superseded by a single shock sequence. Only on the rare occasion of a monitored VF/non-pulsatile VT arrest, it is acceptable to deliver three stacked shocks using a manual defibrillator before commencing 2 minutes of external chest compression and ventilation if necessary. Automatic external defibrillators (AEDs) are all programmed to deliver a single shocks before recommencing the 2-minute CPR cycle.

Energy levels

First shock efficacy of the BIPHASIC SHOCK using 150–200 J has been reported as 86–98%. Ideally, the initial biphasic shock energy should be at least 150 J for all waveforms when defibrillating ventricular arrhythmias. If the first shock is unsuccessful, there is no evidence to suggest that either a fixed or escalating energy protocol is more effective. However, although an escalating strategy reduces the number of shocks required to restore an organized rhythm compared with fixed-dose biphasic defibrillation, rates of return of spontaneous circulation or survival to hospital discharge are not significantly different between strategies. Both fixed or escalating strategies are acceptable, but when using a manual defibrillator, it is reasonable to increase the energy for subsequent shocks. The lower efficacy of the monophasic waveform means the initial and all subsequent monophasic shocks should be delivered at 360 J

Detrimental effects of defibrillation

Interruptions to chest compressions adversely affect the outcome of a resuscitation attempt. One of the commonest causes of these interruptions is defibrillation, due to pre-shock and post-pauses in chest compressions associated with ECG analysis, delivery of the shock and a pulse check. In order to minimize interruptions to chest compressions associated with defibrillation, it is now recommended to continue chest compressions whilst the defibrillator is charged. Immediate resumption of chest compressions following defibrillation is also emphasised, without pausing for a pulse check, which should only then take place after 2 minutes of CPR. Defibrillation should be achievable with an interruption in chest compressions of no more than 5 seconds.

Early defibrillation in conjunction with high quality minimally interrupted chest compressions is critical to survival following sudden cardiac arrest. Survival rates decrease 7–10% with each minute that passes without defibrillation and an initial shockable rhythm of ventricular fibrillation (VF) will then deteriorate into pulseless electrical activity (PEA) and asystole. It is important however, to realize that early defibrillation alone does not usually improve survival and that integration of high quality minimally interrupted chest compressions is essential for optimal outcome.

Defibrillation in children

Shockable rhythms occur in only 7–15% of paediatric and adolescent arrests with a much lower percentage than in adult cardiac arrest. *Common causes of VF in these children include* trauma, congenital heart disease, drug overdose, and hypothermia. Ideally, paediatric self-adhesive pads with electrical attenuators should be used for children aged less than 8 years, but when these are not available, adult pads are acceptable, as long as there is no direct contact between the two electrodes. The recommended energy levels for both monophasic and biphasic defibrillation are 4 J/kg for the initial and all subsequent shocks.

MCQ TEST

1- The recommended energy levels for both monophasic and biphasic defibrillation in pediatric are
    a) 2jouls/kg
    b) 4 joules/kg
    c) 6jouls/kg
    d) 8jouls/kg
    e) 10 joules/kg
2- The level of biphasic shock for defibrillating ventricular arrhythmias are
    a) 150-200 J
    b) 200-300 J
    c) 360 J
    d) More than 360 J
    e) Less than 150 J
3- All the following are types of defibrillators except one
    a) Automatic internal cardiac defibrillators
    b) Automated external defibrillator
    c) Implantable cardioverter defibrator
    d) Wearable defibrillator
    e) Ventricular defibrillator
4- the precautions during defibrillation
    a) Remove any oxygen mask or nasal cannula
    b) Leave any bag-valve device connected to a tracheal tube
    c) Leave any bag-valve device connected to laryngeal mask airway
    d) If the patient is connected to a ventilator, leave the ventilator tubing (breathing circuit) connected to the tracheal tube during defibrillation
    e) All the above
5- Optimal electrode position during defibrillation is
    a) the apical electrode placed to the right of the sternum, immediately below the clavicle and the apical paddle placed in the mid-axillary line.
    b) the sternal electrode placed to the right of the sternum, immediately below the clavicle and the apical paddle placed in the mid-axillary line
    c) the sternal electrode placed to the right of the sternum, immediately below the clavicle and the apical paddle placed in the mid-clavicular line

d) the sternal electrode placed to the left of the sternum, immediately below the clavicle and the apical paddle placed in the mid-axillary line
e) the sternal electrode placed to the right of the sternum, immediately above the clavicle and the apical paddle placed in the mid-axillary line