Al-Mustaqbal University College
Department of Medical Instrumentation Techniques Engineering
Class:Third
Subject: Medical Instrumentation (II)
Lecturer: Msc. Forqan Ali Wahhab
Lecture: Defibrillators

1. Defibrillation

As long as the heart tissue contracts concurrently it works as an effective blood pump. But when this concurrency cease to exist some problems begin to emerge.

• One of these problems is the disortion of normal heart rhythm which is called fibrillation. In fibrillation, hearth muscle fibers contract randomly and irregularly instead of contracting smoothly. If ventricles of the heart go in fibrillation state it is called ventricular fibrillation and if atria of the heart go in fibrillation state it is called atrial fibrillation.

• If the heart is in atrial fibrillation it can continue to pump blood because ventricles continue to contract maintaining the blood pressure. But if it is in ventricular fibrillation it can not continue pumping blood. In this situation patient dies after few minutes if no preventive action is taken.

• Figure 1 shows two **arrhythmia** and one normal hearth rhythm. Figure 1a is normal rhythm. Figure 1b is ventricular fibrillation and Figure 1.c shows ventricular tachycardia .

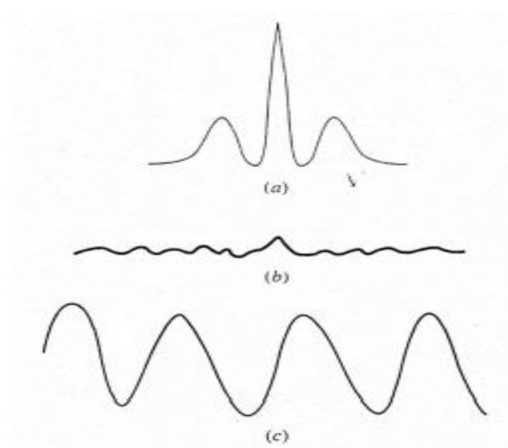

Fig. 1. a) Normal waveform b) ventricular fibrillation c) ventricular tachycardia

2. Defibrillators

- A defibrillator is a device that sends electrical energy, or shock, to the heart.
- The aim of using a defibrillator is to treat cardiac arrest. The need for this generally arises when the patient has ventricular fibrillation or ventricular tachycardia, which are life-threatening arrhythmias that occur when contraction of the ventricles become abnormal.
- Defibrillators have electrocardiogram (ECG) leads and adhesive patches (or paddles).
- The adhesive electrodes are the patches placed on the patient's chest that deliver the electric shock.

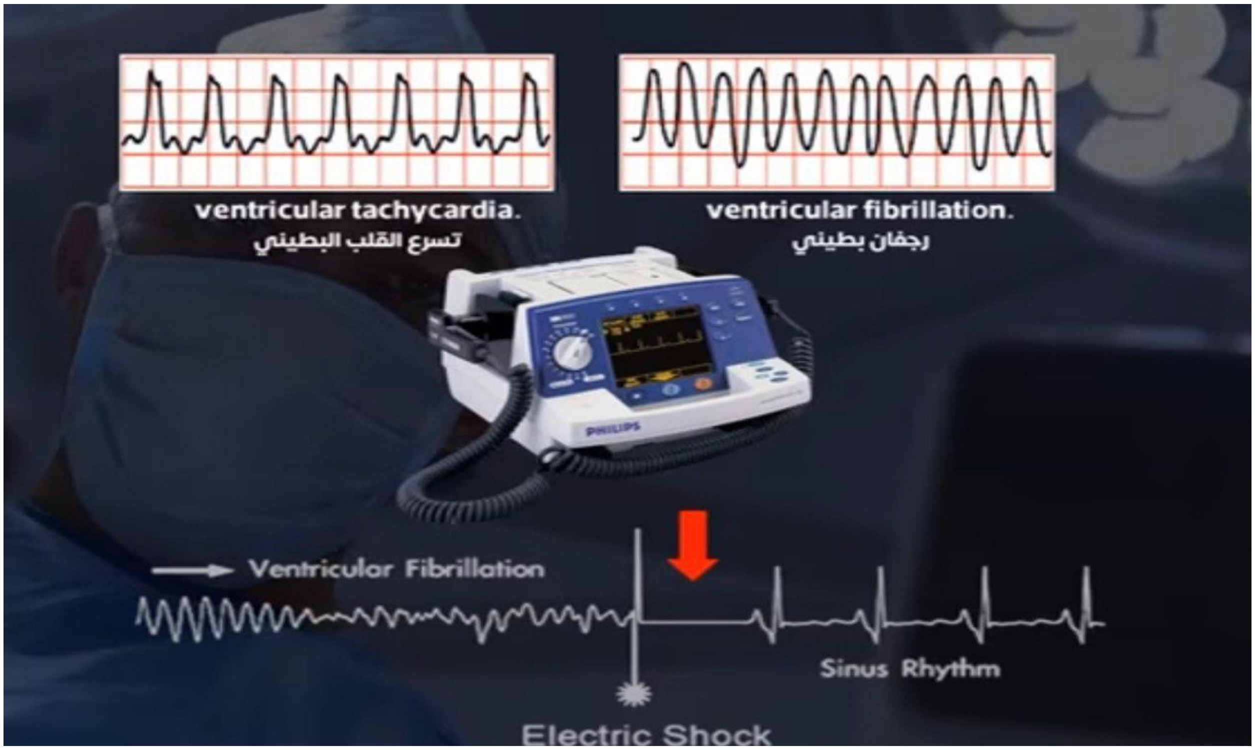

Fig2. Defibrillators

3. Operating Systems

The direct current shock given can have a monophasic or biphasic waveform. In monophasic shock, the shock is given in only one direction from one electrode to the other. In a biphasic shock, initial direction of shock is reversed by changing the polarity of the electrodes in the latter part of the shock. Biphasic shocks are more effective than monophasic shocks and need lesser energy. Typically when 360 Joules are delivered for defibrillation in a monophasic defibrillator, 200 Joules are given in a biphasic defibrillator.

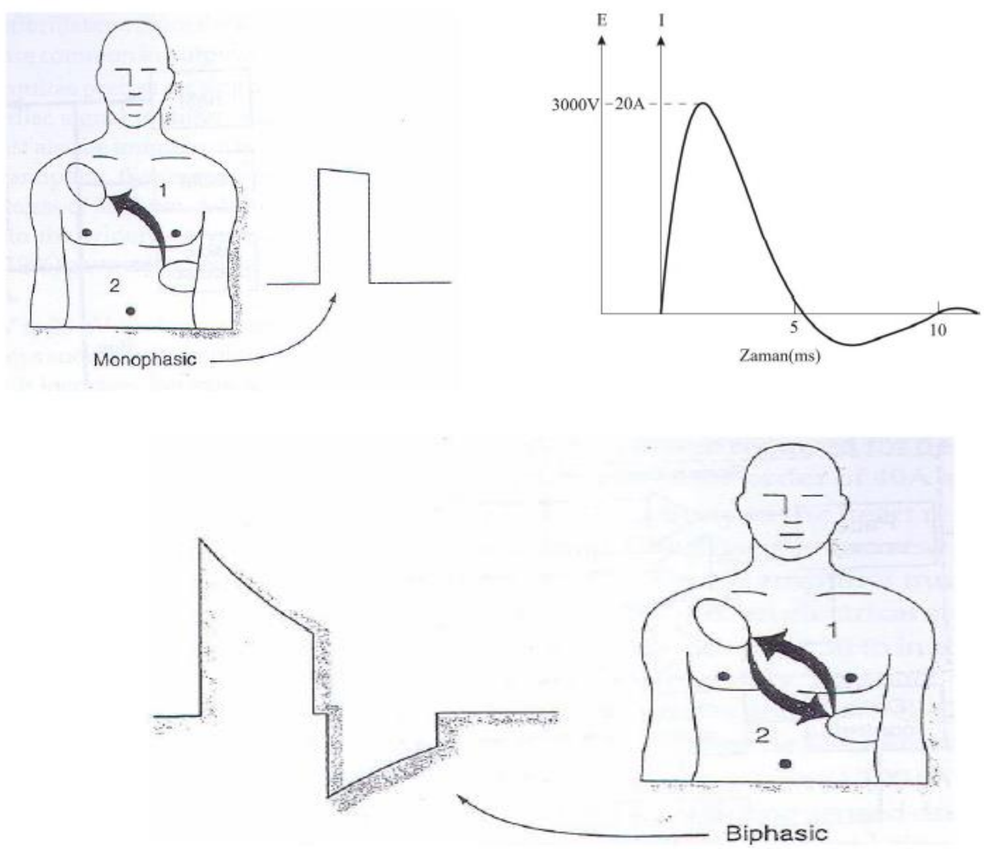

Fig3. Monophasic or Biphasic waveform

4. How Does a Defibrillator Work?

The shock produced by the defibrillator is generated via a built-in battery, which releases a massive pulse of energy. This electrical energy is directed down two wires, each ending at a pad, known as a paddle. With a defibrillator in a hospital, a doctor applies a conductive gel to maximise the flow of electricity to the patient. The paddles have insulated, plastic handles to prevent the user being shocked along with the patient.

The diagram shows a simplified version of a defibrillator circuit. With all switches open the 'paddles' are attached across the patient's chest. S1 is then closed in order to charge the capacitor. S1 is then opened and S2 is closed; this causes the capacitor to discharge through the patient, hopefully restoring normal cardiac rhythm

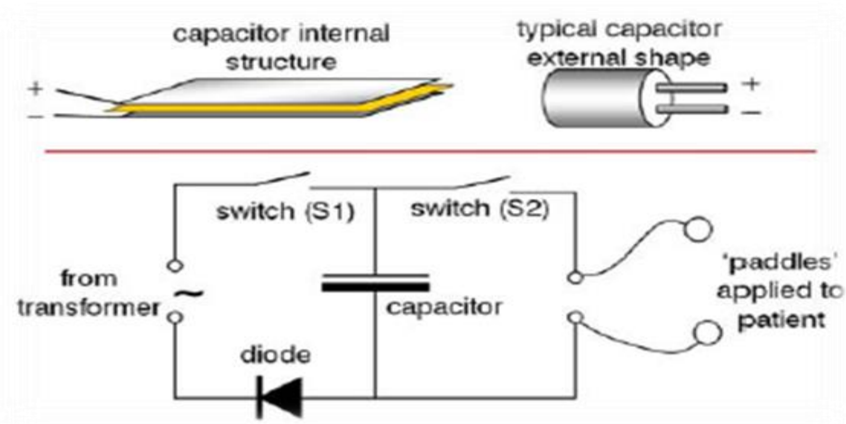

Fig4 : Circuit of defibrillator

5. Components

The dc defibrillator device consists of several key modules, each of which controls a particular part of the machine and these units are:

1. Electrodes

Electrodes are the components through which the defibrillator collects information for rhythm analysis and delivers energy to the patient's heart. Many types of electrodes are available including hand-held paddles, internal paddles, and self-adhesive disposable electrodes. In general, disposable electrodes are preferred in emergency settings because they increase the speed of shock and improve defibrillation technique.

Fig.5: hand-held paddles

Fig.6:internal paddles

Fig.7: self-adhesive disposable electrodes

2. Batteries

Essentially they are containers of chemical reactions and one of the most important parts of the AED system. Initially lead batteries and nickel-cadmium were used but lately non-rechargeable lithium batteries, smaller in size and with longer duration without maintenance (up to 5 years), are rapidly replacing them. Since extreme temperatures negatively affect the batteries, defibrillators must be stored in controlled environments. Also it is important to dispose of the batteries using designated containers as they contain corrosive and highly toxic substances.

3. Capacitor

The electrical shock delivered to the patient is generated by high voltage circuits from energy stored in a capacitor which can hold up to 7 kV of electricity. The energy delivered by this system can be anywhere from 30 to 400 joules.

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6. Defibrillator types in general :

1. Manual external defibrillator

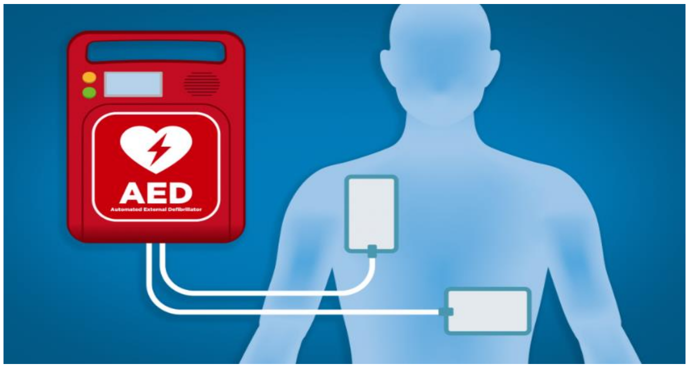
2. Requires more experience and training.
3. Common in hospitals where capable hands are present.
4. In conjunction with an ECG, the trained provider determines the cardiac rhythm.
5. Then manually determines the voltage and timing of the shock—through external paddles—to the patient's chest.

Fig 8 : Manual external defibrillator

2. Automated external defibrillator (AED)

1. Use computer technology.
2. Thereby making it easy to analyze the heart's rhythm and effectively determine if the rhythm is shockable.
3. They can be found in medical facilities, government offices, airports, hotels, sports stadiums, and schools.

Fig 9 :Automated external defibrillator (AED)



3. Manual internal defibrillator

1. Use internal paddles directly to the heart.
2. Only common in the operating room.

Fig .10: Manual internal defibrillator

7. Malfunctions and problems Defibrillation

1. Battery malfunction.
2. Paddle malfunction.
3. Malfunction in one of the control buttons.
4. Malfunction of the ECG signal cable.