Practical / medical devices

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ECG: Electrocardiography

The electrocardiograph is one of the basic medical devices that are available in clinics and hospitals. On this device, doctors rely on the initial diagnosis of heart work .

(ECG) Electrocardiography which is captured from the surface of the body using electrodes And display it on the display screen or print it on paper designated for that .For the standard recording of the heart signal, we need five electrodes installed in different places of the patient's body, and to avoid error in connecting the electrodes, it was agreed on the colors that distinguish the wires that connect with each of the electrodes, which are:

1- The right arm - Right Arm (RA) is white

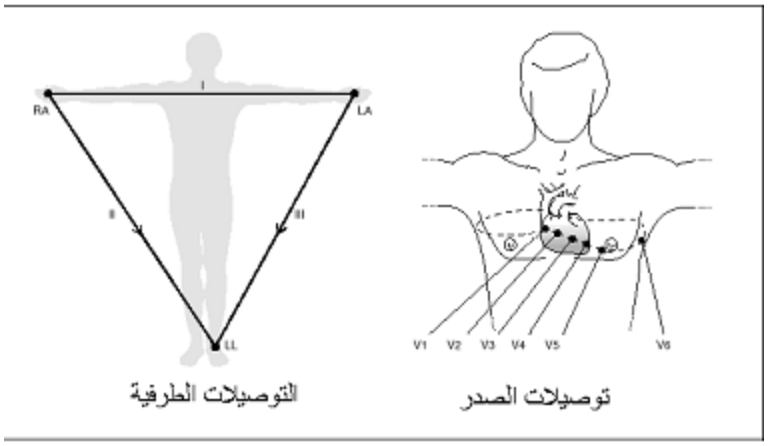
2- The left arm – left Arm (LA) is black

3- The right foot – Right Leg (RL) is green

4- The right foot Left Leg (LL) -is green

5- The chest Chest (C) is brown

Connect these terminals to the input of a difference amplifier through the connection picker (Lead Selector) . The right foot(RL) is used as a joint pole and the connection picker works Connect the appropriate polarities to the two inputs of the differential operation amplifier .



شكل١.١ توصيلات الأقطاب

The ECG signals that we get through two different pairs of electrodes have different waveforms and heights, depending on the chosen delivery method (Lead).

Electrode connections are divided into three types:

1- Biopolar Limb Lead :

Symbolizes it Lead III, Lead II, Lead I. This type represents the most famous placement of poles on the body and is called a triangle Einthoven Triangle.

First contact (Lead I): The left arm (LA) is connected to the non-reflective (positive) side of the amplifier input, and the right arm (RA) is connected to the negative reflective side.

Second contact (Lead II) : The left foot (LL) is connected to the non-reflecting side of the amplifier input, while the right arm (RA) is connected to the reflective side and it is connected *LA* with *RA*.

Third contact (Lead III) : The left foot (LL) is connected to the non-reflective side of the amplifier input, and the left arm (LA) is connected to the reflective side And it is connected *RL* with *RA.*

2- Unipolar Limb Lead :

AVR Connection (Lead AVR):

The right arm RA connects to the non-reflective entrance while the left arm LA and left foot LL are combined and connected to the reflective entrance.

AVL Connection (Lead AVL):

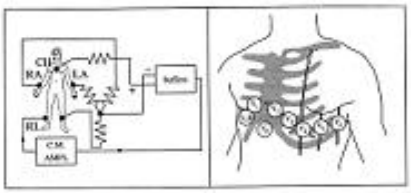
The left arm LA is connected to the non-reflecting entrance, while the right arm RA and the left foot LL are combined and connected to the reflective entrance.

AVF Connection (Lead AVF):

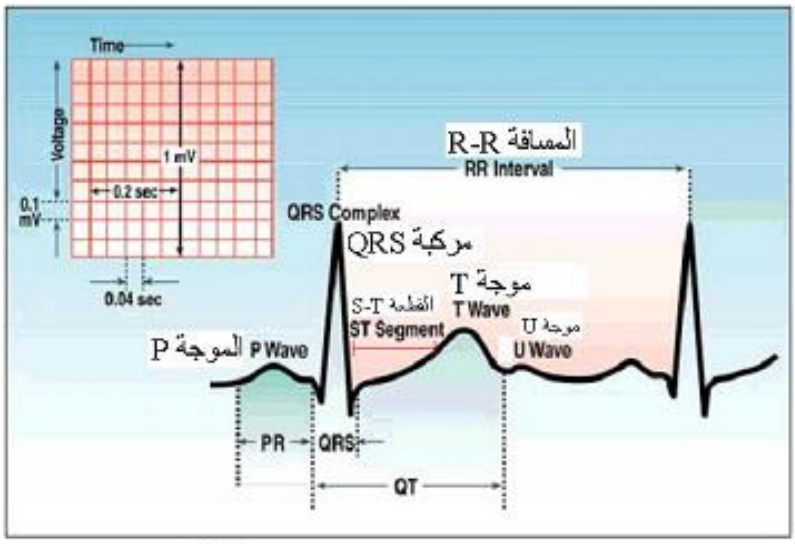
The left foot LL is connected to the non-reflecting entrance while the right arm RA and the left arm LA are combined and connected to the reflective entrance.

3- Unipolar Chest Lead :

This is the third type of electrode connections, which is denoted by the symbol (V1-V6) Leads V, It consists of six locations spread over the rib cage, one of which connects to the non-reflective entrance of the amplifier, while the three terminal poles (RA, LA, LL) are collected by means of a network of Wilson's resistors, and the total connects to the reflective entrance of the amplifier.



شكل (١.٢) التوصيلات الصدرية أحادية القطب Unipolar Limb Lead



شكل ١.٣ إشارة مثالية لتخطيط القلب ECG

Heart rate calculation

1- ***HR*** **= 1500** divided by the number of large squares sandwiched between two successive R waves.

2- HR = 60 divided by the time between two successive R waves.

Pacemaker

Pacemaker parts

It consists of two main parts :

Alarm Generator: It is a small metal box containing the operating battery in addition to many complex electrical circuits that monitor the number of heart beats as well as the electrical stimulation strength of the heart router and integrated electronic circuits to generate oscillations that simulate the oscillations generated by the *SA* node.

Electrical conduction: It is a flexible, insulating wire that connects the pacemaker to the right ventricle and transmits electrical impulses to and from the heart.

شكل (٢.٢) منظم ضربات القلب

2- Battery

The pacemaker battery has special specifications in terms of size, power, and battery life. The energy required by the pacemaker for one pulse is in the range of 25 microjoule, which is a very small value if compared with the energy of the defibrillator, which ranges from 15 to 300 joule.

The specifications of the lithium pacemaker battery are:

- the open circuit voltage 2.8 Volt
- The low voltage of the control circuit 2.2 Volt
- The current value is equal 10 μA
- The internal resistance of the battery is equal to 10 K Ohms
- Discharging time is 1.5–5 ms
- Battery life is more than ten years (probability of 99.6%)
- Battery size and weight: Approximately half of the regulator's size is occupied by the battery

    - Weight of 12.5 – 15.5 gram
    - Volume: 5-8 cm^3

Defibrillator Device

شكل(٣.١) جهاز إنعاش القلب (الصدمات الكهربائية) Defibrillator

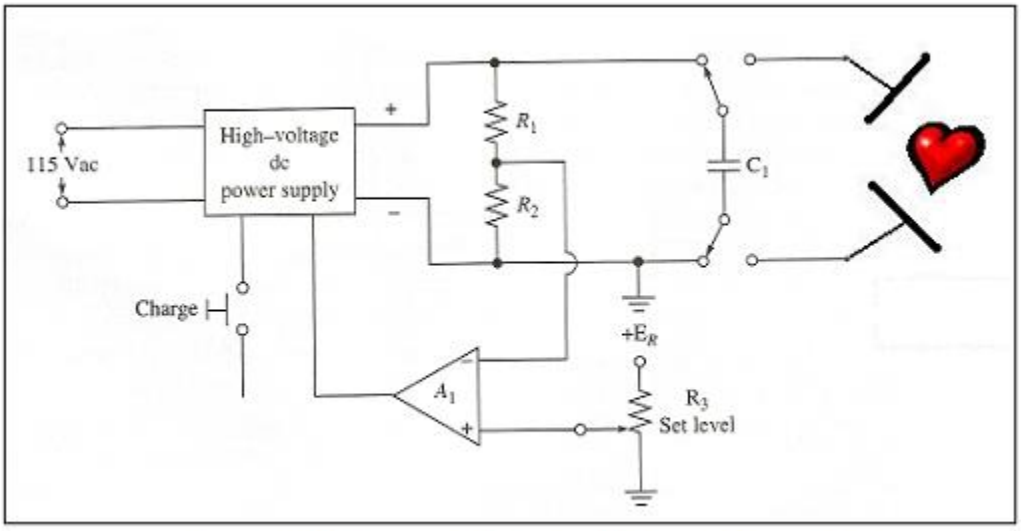
The Defibrillator device (electric shocks) is one of the most important devices in hospitals and medical centers. By means of it, the atrial rhythm can be restored to the heart when an irregularity occurs in the work of the heart, which is scientifically called (Cardiac Arrhythmias), or when the heart stops completely or suddenly. By using the cardiopulmonary resuscitation device, the heart returns to doing its role regularly.

How does a Defibrillator device work?

Works by firing an electric shock through **Paddles** Attached to the patient's body, this electric shock causes all muscle cells to contract momentarily, and then the heartbeat is corrected or restored .

We obtain the electric shock by storing the electrical energy in a capacitor through a high source of continuous voltage difference through a source of power or an internal battery. The charging process continues for several seconds until the alarm

sound is heard. Until it is proven that the charging process has been completed and the capacitor is ready for use. After that the condensate is discharged into the patient's body through **Paddles.**



شكل (٣.٢) الدائرة الإلكترونية الأساسية لجهاز إنعاش القلب

The energy stored in the capacitor ranges from 50–300 Joule

$$E = \frac{C.V^2}{2} \qquad (1)$$

The capacitance of a capacitor can be calculated from the following equation:

$$C = \frac{2E}{V^2} \qquad (2)$$

Where :

E: Stored energy is expressed in units of joules or watts per second. (Watt-Second)

C: Capacitance: It is measured in farads (F).

V: voltage across the capacitor : It is measured in volt (V).

Defibrillator Analyzer

It is a device that analyzes the performance of the Defibrillator device by discharging the charge in it, meaning that it replaces the patient. The device has an internal resistance of 50 ohms, which is equivalent to the lowest resistance of the human body .

The most important functions of the Defibrillator device are:

1- **Measurement of the discharged energy value**

2- Measure the voltage value

3- Measure the current value

4- discharge time

5- Store the waveform with the possibility of drawing it

- ***Security and safety procedures for Defibrillator device users:***

  1- Clean the two Paddles of jelly or cream to keep them dry.

  2- Do not touch the discharge device containing the charge when discharging the electric shock.

  3- Not to discharge the charge and the two ends in the air.

  4- Not discharging the charge and the two sides are attached .

Centrifugal device

A centrifuge is based on rotational motion and centrifugal force .

$$\omega = \frac{2 . \pi}{T}$$

$\omega = 2\pi f$ فان $\frac{1}{T} = f$

$$F = mr \omega^2$$

The reciprocal of time is the frequency and its symbol F, and it represents the number of cycles completed by the moving body in one second. This means that the centrifugal force is directly proportional to the mass of the body, so the parts with a large mass will suffer from a greater centrifugal force than the parts with a small mass. The force is also directly proportional to the square of the rotational speed.

Electric centrifuges:

Electric centrifuges are classified according to size, rotational speed and axis type:

The common characteristic of centrifuges is that they contain the following components:

1- On and off switch

2- Electrical engine , The centrifugal device is a kinetic device that is moved by a motor that rotates the head

3- A timer whose main function is to determine the time required to separate the material, as it controls the start and stop of the device .

4- Axis and sample holder

5- outer cover The outer cover is intended to close the device to provide external protection while it is in operation

6- Engine speed control switch through which the engine speed is determined.

7- Breaker :It works to speed up the stopping of the rotation after the end of the operating time, as it works to produce the inverter current for the rotation .In order to slow down the movement of the device and thus speed up its stop .