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Therapeutic Equipments and Their Applications in the Current Scenario of the Medical Fields

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***Abstract* — This paper is implementing the working of the Therapeutic equipments in the current scenario and their applications in the medical fields and their technologies. And this study analyses the security and privacy properties of these therapeutic equipments. These equipments compromise with the patient safety and patient privacy. Motivated by the desire to improve patient safety, and mindful over the conventional trade-offs between security and power consumption for resources. Many of the therapeutic equipments were been constructed and designed for the patient choices and according to their priority.**

Index Terms— Therapeutic Equipments; trade-off; Power Consumption.

I. Introduction

This paper deals with the basic implementation of the Therapeutic equipments that revolves around our daily life. These medicated equipments are not known to people. These application oriented equipments are useful in treating the diseased persons, their condition and terms for disease continuous cause recovery of damages.

II. Cardiac Pacemakers

A device capable of generating artificial pacing impulses and delivering them to heart is known as pacemaker system or pacemaker.

It consists of a pulse generator and electrodes. Sino Atrial node is responsible for the starting of heart beat; hence it is called as Natural Pacemaker.

A. *Types of pacemakers*

1. Internal pacemakers
2. External Pacemakers

1. Internal Pacemakers.

It is placed inside the body. It may be permanently implanted on the patients whose SA nodes are failed to function or those who suffered from permanent heart block.

Internal pacemaker systems are implanted with the pulse generator placed in a surgically developed pocket below the right or left clavicle, in left sub costal region. In case of women it is placed beneath the left or right major pectoral's muscle. Internal leads are connected to the electrodes that directly contact the surface of the myocardium.

The exact location of the pulse generator used in the internal pacemaker system depends on the following factors.

- Type and nature of the electrode used.
- Nature of the cardiac problems.
- Mode of operation of the pacemaker system.

There is no external connection for applying power. So the pulse generator should be completely self contained with a battery, which is capable of operating continuously for a specified period.

2. External Pacemakers

It consists of an externally placed pulse generator circuit connected to the electrodes placed on the myocardium. Temporary heart irregularities or disorders. Treating the patient from arrhythmias. Treatment of coronary patient and during the cardiac surgery.It consists of pulse generators. They are placed m the body and connected normally to the electrode with the help of wires introduced into the right ventricle.

The pulse generator may be strapped to the lower arm of the patient. There are three types of pacemakers based on the output waveforms they are: 1. Voltage pacemaker's 2.Current pacemakers 3.Current limited voltage pacemakers. The voltage pacemakers are the current circuits in which they are determine by the available voltage during the entire duration of pulses. They influence only the current and the output from them will be constant.

In the current pacemakers the current is determined by the internal resistance of the pacemakers. And in the current limited voltage pacemakers they are

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primarily a voltage circuits the maximum current in them is limited. They provide a low resistance. Normally the internal pacemakers are also called as implantable pacemakers. There is some basic type of implantable pacemakers: 1.single chamber pacemakers, 2.Dualchamber pacemaker's, 3.rateresponsivepacemaker's, 4.fixedrate pacemakers and many more. There are some programmable pacemakers in whom they are implanted in the human heart. They use 10 microwatt of power and it is used for more than 10 years which uses ceramic materials in their construction.

External Pacemakers

III. Cardiac Defibrillators

To overcome the disadvantage of defibrillation method in 1962, Bernard lawn from Harward School of public health and peter bent of Brigham hospital developed a new method known as dc defibrillation. In this dc defibrillation method, capacitors charged to a high dc voltage and then rapidly discharged through electrodes across the chest of patient. DC defibrillation are capable of correcting both the atrial fibrillation and ventricular fibrillation.

DC method produces some harm to the patient. Depending on the energy setting in the defibrillator, the amount of electrical energy discharged by the capacitor ranges between 100 to 400 joules. Discharge portion is approximately 5 ms.

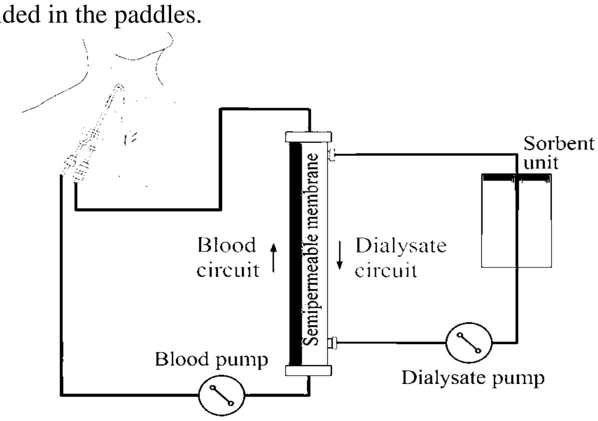
Ventricular fibrillation is the serious problem encountered by the inefficient cardiac patients who hail from any of the cardiac diseases. Restoration of normal rhythm in fibrillating heart as achieved by direct shock across the chest wall is called the Defibrillator. The shock can be delivered to the heart by means of electrodes placed on the chest of the patients(external fibrillation) or the electrodes placed directly against the heart when the chest is open(internal fibrillation). There are some different types of defibrillators are: 1.DC Defibrillators 2.DC Defibrillator with synchronizer 3.Automatic external defibrillators 4.Implantable defibrillators. A defibrillator analysis is basically meant to measure the energy content in the discharge pulses. It works on the principle that the energy contained in a pulse of arbitrary shape and time duration is given by:

$$E(t)_{out}=ke(t)^2_{in}$$

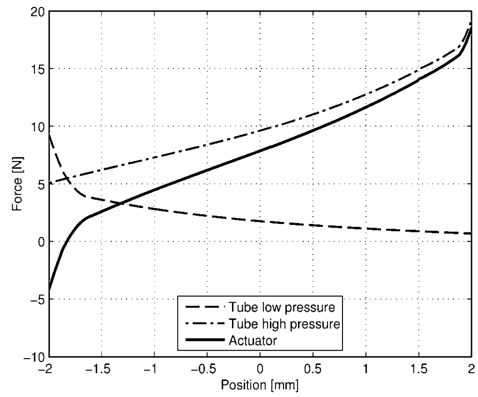
E(t)=energy in watts.

K=time constant.

In the defibrillator circuit for the internal use, smaller paddle shaped electrodes are used for the infants or children. For the external use, a pair of electrode is firmly pressed against the patient`s chest. Conductive jelly or saline is applied between each paddle surface and the skin. To prevent the accidental electric shock to the patients applying the electrodes to the patient, specially insulated handles are provided in the paddles.



A thumb switch is present in one or both of the handles and it is generally used to discharge the defibrillator. When the paddles are properly positioned, this prevents the operator from receiving a shock from the defibrillator. In earlier equipment, a foot switch was used instead of the thumb switches.



There is possibility of someone accidentally stepping on the foot switch in the excitement of an emergency, before the paddles are placed. Hence foot switches are not used and mostly thumb switches are preferred. And various methods are adopted to recharge the defibrillator after use. In some defibrillators charging is done by means of a charge switch located in the front panel of the unit. In recent models, the charge switch is located in the handle of one of its paddles. In few defibrillators, the charging process begins automatically after discharge. Improving IMD security and patient information (such as name and diagnosis) and medical privacy is, however challenging due to the rapidly changing telemetry (information about all the vital signs).

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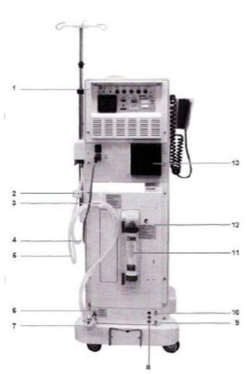
IV. HEAMODIALYSIS MACHINES

A. MODEL: Fresenius/4008S

BACK VIEW:



1. Monitor
2. Sampling value
3.Bracket for the dialyzer connection lines
4. Dialysate outlet tube
5. Dialysate inlet tube
6. Disinfection connector
7. Filter
8. CDS (red) option
9. Drain
10. Water connector (permeate)
11. DIASAFE plus
12. Vent tubing
13. Power supply unit

Hemodialysis removes wastes and water by circulating blood outside the body through an external filter, called a dialyzer that contains a semi-permeable membrane.

- The blood flows in one direction and the dialysate flows in the opposite. The counter-current flow of the blood and dialysate maximizes the concentration gradient of solutes between the blood and dialysate, which helps to remove more urea and creatinine from the blood.
- The concentrations of solutes (for example potassium, phosphorus, and urea) are undesirably high in the blood, but low or absent in the dialysis solution, Dialysis is an increasingly common type of treatment.
- The dialysis solution has levels of minerals like potassium and calcium that are similar to their natural concentration in healthy blood.
- The purpose is when the nephrons in the kidneys are failure or not working properly, the ions like potassium, creatinine etc we go through dialysis.
- Diseases of renal failure are:
  - Nephrotoxins
  - Diabetic
  - Nephropathy
  - Hypertension
  - Glomerulonephritis
  - Cystic Kidney Disease
- The Hemodialysis name itself contains hemo means blood and dialysis means the diffusion of solute molecules through a semi permeable membrane, normally passing from the side of higher concentration to that of lower.
- Semi membrane is one that allows the passage of certain smaller molecules of such crystalloids as GLUCOSE and UREA, but prevents passage of larger molecules such as the colloidal plasma PROTEINS and PROTOPLASM.
- Hemodialysis, also spelled haemodialysis, commonly called kidney dialysis or simply dialysis, is a process of purifying the blood of a person whose kidneys are not working normally. It is a method that is used to achieve the extracorporeal removal of waste products such as creatinine and urea and free water from the blood when the kidneys are in a state of renal failure. Hemodialysis is one of three renal replacement therapies (the other two being renal transplant and peritoneal dialysis). An alternative method for extracorporeal separation of blood components such as plasma.

B. PRINCIPLE:

- The principle of Hemodialysis is the same as other methods of dialysis; it involves diffusion of solutes across a semi permeable membrane.
- Hemodialysis utilizes counter current flow, where the dialysate is flowing in the opposite direction to blood flow in the extracorporeal circuit.
- Counter-current flow maintains the concentration gradient across the membrane at a maximum and increases the efficiency of the dialysis.
- It involves diffusion, osmomis and ultra filtration.
- Hemodialysis is diffusion across a semi permeable membrane (one that allows only certain molecules to pass through it). The semi permeable membrane is used to remove the wastes from the blood and at the same time correct the level of electrolytes in the blood. Before Hemodialysis can be performed, a surgeon must make a way for the blood to be pumped out of the body and then be returned after it has been cleansed.
- To do this, the surgeon uses an artery and a vein in the forearm.
- Arteries (which have muscles in their walls) bring oxygenated blood to the body from the heart, and veins return blood to the heart, which needs to have oxygen.
- The surgeon connects the radial artery in the forearm to a large vein called the cephalic vein. This connection is called an arterio venous shunt.
- A shunt carries something from one place to another. In this case it carries blood from an artery to a vein. After this shunt is made, the veins in the forearm get big and eventually form muscles in their walls like

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arteries.They are now strong and can be punctured many times for dialysis.

V. Anesthesia Machines

An anesthesia machine is a device which is used to deliver a precisely known but variable gas mixture including anesthetic and life sustaining gases to the patient's respiratory system. Generally, a variable concentration gas mixture of oxygen, nitrous oxide and anesthetic vapor like ether or halothane is obtained from the machine and is made to flow through the breathing circuit to the patient. It is composed of two parts: 1.The gas supply delivery unit, which consists of tubing and flow meters interconnected in parallel; and 2.The anesthetic vaporizer, which is used to produce an anesthetic vapor from a volatile liquid. In essence, a modern anesthetic machine has following basic sub systems:

- Gas supplies; pipeline and cylinders
- Gas flow measurement and control(flow meters)
- Vapor delivery
- Gas delivery
- Humidification
- Patient breathing circuit
- Ventilators
- Scavenging
- Monitoring system

These Machines have become extremely sophisticated, incorporating many built in safety features and devices, a breathing circuit, monitors all components. Monitors that are not built in can be added externally and often still be fully integrated. Moreover, their modular designs allow a wide variety of optional configurations and features even within the same product line. The term anesthesia workstation is therefore is therefore often used for modern anesthesia machines. Use of microprocessor provides options such as sophisticated ventilator modes, automated record keeping and networking with local or remote monitors as well as hospital information systems. Box shaped sections of welded steel or aluminum provide a rigid metal framework mounted on wheels with antistatic tires and brakes. Machine pressure regulators reduce cylinder gas pressure to 275kPa (40psi) before the gas flows through the machine. The regulator has one high-pressure inlet, one high-pressure outlet and two low-pressure outlets. The high pressure inlet is connected with the cylinder. Pressure Gauge is attached to the cylinders to indicate the contents of the gases in the cylinder. The various liquid that posses anesthetic properties are too potent to be used as pure vapors.

VI. Ventilators

When artificial ventilation needs to be maintained for a long time, a ventilator is used. Ventilators are also used during anesthesia and are designed to match human breathing waveform/pattern. These are sophisticated equipment with a large number of controls which assist in maintaining proper and regulated breathing activity. For short-term or emergency use, resuscitators are employed. The main function of a ventilator. Since natural inspiration is to ventilate the lungs in a manner as close to natural respiration as possible. Since natural inspiration is a result of negative pressure in the pleural cavity generated by the movement of the diaphragm, ventilators were initially designed to create the same effect. Positive-pressure ventilators generate the respiratory flow by applying a positive pressure greater than the atmospheric pressure to the airways. During the aspiratory flow delivery system creates a positive ventilator. During the inspiration, the aspiratory flow delivery system closes the outlet to the atmosphere. Anesthesia ventilators are generally small and simple equipments used to give regular assisted breathing during an operation. Intensive care ventilators are more complicated, give accurate control over a wider range of parameters and often incorporate 'patient triggering facility', i.e. the ventilators delivers air to the patient when tries to inhale. Lung compliance of the patient's lungs is the ratio of volume delivered to the pressure rise during the aspiratory phase in the lungs. This includes the compliance of the airways. Compliance is usually expressed as liters/cm h_2o.lung compliance is the ability of the alveoli and lung tissue to expand on inspiration. The lungs are normally stretched or expanded against the resistance of elastic fibers inspiration and expiration. The two set of muscles that move the rib cage in and out. Inspiration results from their relaxation. There is no active participation of lungs in the movement. When artificial ventilation needs to be maintained for a long time, a ventilator is used. Ventilators are also during anesthesia and are designed to match human breathing waveform/pattern.

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VII. Conclusions

During the two decades, there has been a tremendous increase in the use of electronic equipments in the medical field for clinical and research purposes. However, it is difficult to find all these in contented paper. The field of biomedical engineering is fast developing and new equipments are been evolved.

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