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Review Article

An Overview of Medical Equipment Classifications

Abdulhameed Habeeb Alghanimi*

Department of Surgery, Alhussain University College, Najaf–Karbala, Iraq

ABSTRACT

This study dealing with medical equipment definitions, main parts, work, and its classifications depending on how to classify it and the aim of this classification. The doctors (end users), biomedical engineers (provider or maintenance), and clinic administrators (needs of patients) all one of them have their classifications. Also, the medical equipment can be classified according to its importance and risky or according to its principle of work. In this paper some of these classifications have been listed and explained briefly, also a flowchart for this classification has been illustrated. Finally, the study will be shown the major and most benefit classification.

Keywords: Medical equipment; Equipment classifications; Medical instrument classification; Diagnosis; Prevention; Monitoring

INTRODUCTION

A medical Equipment is defined in the world health organization as any instrument, apparatus, appliance, material or other article (whether used alone or in combination, and including the software necessary for its proper application) intended by the person under whose name it is to be supplied, to be used for human beings for the purposes of one or more of the following [1]:

- Diagnosis, prevention, monitoring, treatment or alleviation of disease.
- Diagnosis, monitoring, treatment, alleviation of or compensation for an injury or handicap.
- Investigation, replacement or modification of the anatomy or of a physiological process.
- Control of conception.

And does not achieve its principal intended action in or on the human body by pharmacological, immunological or metabolic means, but which may be assisted in its function by such means; or an accessory to such an instrument, apparatus, appliance, material or other article.

The medical equipment engineering is responsible for the development of devices, equipment, physical methods and forms of energy that require use in medical applications. Given that the medical technology is divided into different physical fields, there is therefore no unified technical conception to produce medical devices for that and according to medical requirements, the engineering technology provides equipment with specifications appropriate to these requirements Thus, we find in the field of medical manufacturing the use of multiple elements, groups, technological products, and tools in the field of optics, electronics, electric power, and atomic technologies. In addition, a lot of materials such as metal, plastic, and glass have been used, provided that these materials are subject to biological sterilization conditions when used.

The use of electronics in medicine, which is also called medical electronics, can convert vital units into amplified electrical units' millions of times so that they can therefore be measured, recorded, or shown, to become visible, and many medical work that can be done daily can also be converted into business with automatic control and has contributed micro electronic has evolved in reducing the size of medical devices significantly [2].

The basic technical characteristics are of particular importance for the producer and developer of medical devices, as well as for the user of medical devices to give them special importance when using or maintaining them. The fact that medical use is restricted is also one of the medical technical foundations, as this applies to the groups used for the total of various medical equipment, which includes in addition to the above on medical tools, medical furniture, multiple components, and artificial organs, and it is recognized that there is a classification of

Correspondence to: Abdulhameed Habeeb Alghanimi, Department of Surgery, Alhussain University College, Najaf–Karbala, Iraq, E-mail: abdorck@gmail.com

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medical devices that is mainly related to the function or the general structure of these devices according to their use in hospitals or clinics.

LITERATURE REVIEW

Medical device essential principles

The safety and performance principles have been applied to all medical devices [3]. The medical device using risks must be outbalanced by the benefits obtained from the medical device using.

The general principles:

- The health and safety of medical device using must not be compromised.
- The design and construction of a medical device has to conform with safety principles.
- The medical devices must be adequate with its intended purpose.
- The long term safety.
- The medical devices transport or storage must not be adversely affected.
- The medical devices benefits must be outweighed with the side effects.

Design and construction principles:

- Physical, chemical, and biological properties.
- Microbial contamination and infection.
- Environmental properties.
- Construction properties.
- Measuring function of medical devices.
- Radiation protection.
- Medical devices that have energy source.
- Medical devices with information provider.
- Clinical evidence.

The functional and structural principle of diagnostic equipment: If the information obtained by the doctor is insufficient to determine the diagnosis properly, then resort to the use of medical devices as auxiliaries for the diagnosis. The function of the diagnostic devices is to obtain information that determines morphology changes in the general position and structure, as well as pathway physical changes in the body.

One of the important advantages here is that qualitative and quantitative information is obtained in the form of measurements results in diagnostic devices, and the role of the medical engineer or medical technician appears as a mediator for investing the device in accordance with the requirements of the doctor where the device then provides the information that he acquired to the doctor. A series of information appears from the patient as a result of biological, biochemical and functional interactions in the human body and the composition of the year. Therefore, this information foretells from the current state diagnosis of the body. This information can be identified and accessed by technical means, as it takes physical forms dependent on the information carriers (electrical voltage, sound, light) [4]. And if these carriers or some of them are not present, it is necessary to find artificially (for example information about the internal structures of the body can be achieved if X-ray is used).

- The first part of the diagnostic device is the picker of information and the function of quoting or capturing physical information, since most of the information quoted is not electrical in nature (audio, mechanical, visual) so the plug contains the inverter, the task of converting non-electric quantities into electrical quantities by their nature indicating the information vital basic.
- The task of the second part of the diagnostic device is to prepare information such as amplifying electrical signals, measuring them, and counting them.
- The task of the last part is to show information, and this is often done in the form of information that can be seen in representational or digital form, in the form of curves (variable time dependencies), in the form of spaces, sizes, or even in the form of an image.

It is then assumed that the doctor will be able to use this information and compare it with previous information or comparative values to determine the diagnosis. Diagnostic devices require energy in order to be used, so electrical energy is used from the devices 'nutrition network or by means of the devices' batteries [5]. The functional principle of diagnostic devices is general and uniform for all diagnostic devices, regardless of the quality and quantity of information. The manufacturer gives directions and warnings when using diagnostic devices to protect from external influences that appear in the form of noise. We can specifically mention the technique of communicating with the patient, *i.e.* the method of quoting the signal from the patient. Receiving or preventing it from reaching the device completely and the patient's own noise may appear when the required vital signs are overshadowed by signals from neighboring members, causing the blurring of the actual signals considered for measurement. Among the critical parasitic sources is the noise coming from outside to the entrance of the sensors or into the machine, which leads to false information in the output. We can mention the types of noise, the electromagnetic fields resulting from the transformers, electronic circuit equipment or processing devices. And that many errors can be distinguished when measuring, through the system of information and the occurrence of a sudden, irregular change resulting from noise effects.

Functional and structural principle of treatment equipment: In the case of treatment, the doctor first provides through contact with the patient treatment procedures where treatment requires medicinal materials or sends the patient to surgery, but if physical therapy is required then appropriate treatment devices are used and the function of the treatment devices is to provide energy with the appropriate therapeutic form to the body or The sick organ is to produce the desired therapeutic effect, as the function of the treatment devices is determined in generating or converting energy when in use. The device used in the patient is directly linked to a set of quantitative and qualitative monitoring devices for the energy applied and the stages of its effect on the patient. Obviously, the doctor or medical assistant (after training in using the devices) can initially perform this function.

The extended functional and structural principle of treatment devices is that the energy generated in the therapeutic apparatus leads to (biological) effects. In surgical procedures, for example, it can be used for cutting, cutting, blood clotting and in the case of organizational treatment control to influence the function of vital tissue, organs or nerves. The energy required to operate the therapeutic devices is provided from a suitable source (in general an electric current) where the energy is transferred by generators and according to the operating conditions to the energy appropriate for therapeutic use, that the power transformers (which are the opposite of the transformer used for diagnostic cases) convert the electrical energy into mechanical energy acoustic, thermal, and radiative, and this new form is applied to the patient for treatment by direct correlation units with the transducer and its function is to transfer energy without weakening it to the patient as it secures good correlation with the patient and also can in its medium determine the appropriate treatment places for space and depth accurately [4]. Quality related treatment information such as (number of pulses) frequency or associated with the quantity (current intensity) density energy flow treatment time is controlled by the treatment devices according to the treatment requirements, and here the biological knowledge is the basis for the success of the treatment provided to the patient.

General functional components of medical equipment: The job for a device is dependent on the total of the partial jobs that it performs, and the general job of the device is the task essentially for the user, whereas the medical engineer is deemed to know the stages of work for the device and thus the partial functions that make up the total function of the device or group of devices when they are related to each other to perform a specific service. The following is the functional work followed in medical devices [6,7].

Pick up (or the plug, or sensor): Its mission in diagnostic devices is to achieve communication between the machine and the vital component and this is done through direct contact inside the body or indirect correlation, as in X-ray devices. The sensor is a very important and sensitive part of the transfer of physical quantities and the sensors used inside the body are needle shaped and it is assumed that the sensors (plugs) have appropriate physical properties either when used for external communication from the surface or from within the body so that their presence does not cause special biological reactions as well It must be sterile before use [8].

Inverter: In diagnostic devices is of particular importance in converting non-electrical quantities into electrical values that are easy to measure and treat. The exchanger communicates directly with the sensor so that together they form one group, and the switch gives an electrical value efforts, currents or provides relative quantities according to the type of bonding (resistance), capacitance induction) and there are often different modifiers related to the required measurement states (mechanical electrical chemical) [9].

Electrodes: They are special quote units for obtaining vital efforts from cells, nerves, and muscles where there is no need for switches and it is assumed that electrodes provide good conductivity between the vital part and the medical device and in cases of research or study and monitoring that require the application of the electrode for a long time it is assumed that the conductivity of the electrodes does not change and that no transformations occur Polarity. To achieve good conductivity, electrodes are made of metal coated with rough and to ensure the quality of this conductivity, a conductor the transport medium is placed between the electrode and the external surface of the body, and the electrodes that are used for the muscles and nerves are needle in order to ensure the accuracy of the transmission of vital signs. To obtain efforts a difference requires the use of at least two electrodes and the electrodes are connected to the vital signal processing device by special cables in order to prevent the effects of noise from entering with the measured vital signals [10].

Electronical functional group: Medical diagnostic devices generally consist of a series of electronic circuits the electronic group that are interconnected with each other and the task of this group begins immediately after the exchanger or sensor where a good correlation with the exchanger is achieved in order to not receive the received signals or a part of them, after which these values are processed and amplified and prepared to form Information ready to be given through electronic groups.

- **Measurement bridge:** It depends on the principle of making a change in the resistance values, which is reflected in the form of voltage or current, and this is done proportionally to the reference voltage used.
- **Amplifier:** Since the voltage presented by the commutator is mostly of a small value volt (10^{-}-10), then operational amplifiers must be used in order to reach a value that can be measured more easily and accurately. and amplification is done by cased amplifier amplifiers and mostly differential amp and process amplifier (op) are used to achieve this and here there are special requirements because the frequency is low and the response curve should be well and steady during that.
- **Power supply:** It is used to straighten the electrical energy of the device, where the public or private network current is used for feeding and in some cases by batteries located within the device.
- **Information display system:** The information is shown in the last stage where it is possible to read numbers or see pictures and curves according to the display units used.
- **Inverter:** Energy switches processing devices are a reversible process of plugs (sensors) where electrical energy is converted into radial or non-electric energy and for each type of energy there is a distinctive switch principle.

It can be said that passive ineffective medical devices are used to gain information in the diagnostic stages, while effective medical devices are used to transfer physical energy for treatment.

DISCUSSION

Medical equipment classification according to its functional work

This type of classification represents the major and the most important one, because it serves the engineers and medical staff in the same time and the Figure 1 below illustrates the main divisions.

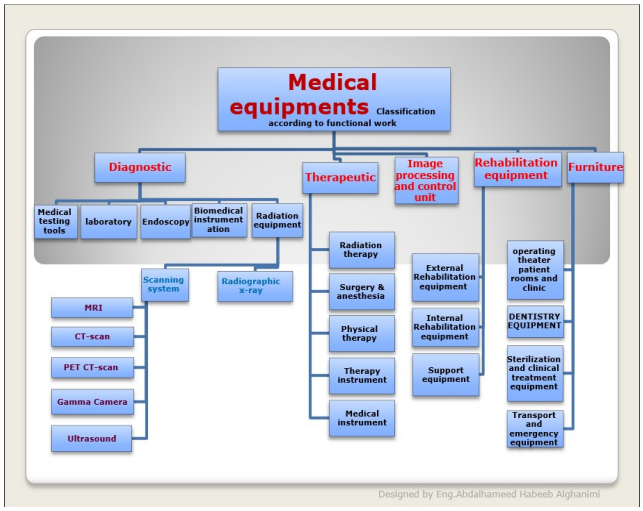

Figure 1: Classification of medical equipment.

Diagnostic and monitoring equipment: This equipment which are used to diagnose diseases or help the doctors to find the cause of diseases.

Biomedical instrumentation: Which are used to monitor the physical and chemical vital signs which are divided into:

- Reaction measurement equipment (like electrocardiogram, electromyogram and Electroencephalography).
- Pressure measurement equipment (like invasive and non-invasive blood pressure measurement, lung pressure measurement and tonometer.
- Flow measurement equipment (like pulmonary function test and heart rate).
- Dynamics measurement equipment (like balistogardiography, nystagmography).
- Thermal measurement equipment (like thermometer and infrared).
- Volume measurement equipment (like spirometry and blood volume measurement).
- Velocity measurement equipment (like Doppler ultrasound flowmeter and air flowmeter).
- Acoustic measurement equipment (like phonocardiography and fetal sign monitor).
- Blood and air gas measurement equipment (like oxygen meter, spo meter and co meter).
- Electrical elements measurement equipment (like plethysmography).
- Telemetry measurement equipment (like telemetry monitoring on the medical/surgical floor and wireless digital X-ray cassette).
- Laboratory devices (Like centrifuges, co incubator, spectrophotometer, and microscope).
- Endoscopies and medical radars (Like colonoscopy, colposcopy, gastroscopy, laparoscopy, bronchoscopy, duodenoscopy and UWB-radar).
- Medical testing tools include the simple mechanical examine tools like: Stethoscope, lights, sphygmomanometer and Excitation hammer).
- Radiation equipment is the most widely imaging techniques that use the radiation to produce a medical image as illustrated below:

Scanning system

- Computing Tomography (CT-scanner).
- Magnetic Resonance Imaging (MRI).
- Positron Emission Tomography (PET).
- Gamma camera.
- Gamma scanner.
- Ultrasound systems (Sonar and Echo).
- Dental X-ray (Panoramic radiograph OPG).

Radiographic X-ray

- Ordinary X-ray.
- Digital X-ray.

Therapeutic equipment:

Radiation therapy equipment is including the equipment that is used to destroy the cancer cells like:

- Linear accelerator.
- Gamma knife.
- Cyber knife.

Surgery and anesthesia equipment is including the equipment that can be founded in the operation rooms like: electrical saw, drilling machine, surgical cautery, anesthesia machine, patient monitor, aspirator, celling light (projectors) and cryosurgery.

Physical therapy equipment which include several divisions as following as:

- Low frequency equipment (like shockwave and electromagnetic field).
- High frequency equipment (microwave and shortwave).
- Thermal and light therapy equipment (like water bath, wax bath, thermal, infrared, ultraviolet, hydraulical and mechanical devices).

Therapy instrument includes devices used in treatment depending on fluids (medicines), evaporation, gases, and these tools include:

- Needle syringes.
- Injection for washing and cleaning.
- Automatic needles for needles.
- Various blood transfusion devices.
- Gas treatment devices (fumes).
- Steaming devices.
- Aerosol equipment.
- Aerosol ultrasound equipment.
- Oxygen delivery devices.

Medical instrument includes simple tools that constitute medical mechanical assistance, such as:

- Cutting and separating tools.
- Opening, fixing, grabbing and snapping tools.
- Sewing and fitting tools.
- Orthopedic surgical instruments.
- Special tools for the throat, nose, ear, eye, urinary system, for pregnant women to help with delivery, to compensate.

Image processing and control unit include medical devices to store information for the analysis and evaluation of measured amounts or measured groups or equipment to monitor the

patient through the information from him, and to determine appropriate treatment in accordance with the current case like:

- Warning devices for borderline cases.
- Measuring devices to change the time of the heart.
- Instruments for determining average values.
- Special treatment devices for medical images (like Hospital Information System (HIS), Radiology Information System (RIS), Laboratory Information System (LIS), picture archiving and communication system (PACs)).
- Special devices for therapeutic control and planning (like Computerized Maintenance Management System (CMMs)).

Rehabilitation equipment: External rehabilitation equipment includes devices that are used during treatment procedures or are used for amputated or weakly functional parts:

- Bio-pumps.
- Forcing supply equipment.
- Medical organs container.
- Defibrillator equipment.
- External heart stimulation equipment.
- Heart and lung machine.
- Artificial kidney.

Internal rehabilitation equipment includes devices manufactured from biomaterials but are blamed with biomaterials (biocompatible), where they perform long-term functionality to compensate for a sick organic or tissue part, for example:

- Artificial blood vessels and arteries.
- Pacemaker pacemakers.
- Artificial heart.

Support equipment includes functional auxiliary elements for some parts of the body, especially for cases of aging diseases or low level of organic and sensory functional performance such as:

- Mechanical prosthesis.
- Bio-electrical prosthesis.
- Orthosis.
- Supporting the spine.
- Supportive ligaments.
- Help walking like walking stick and patient chair.
- Orthoptics like driving machine for the blind and glasses.
- Hearing aid.
- Help to speak.
- Dental assistance and dental prostheses.

Medical furniture: Operating theater patient rooms and clinic like:

- Clinics brushes.
- Medical safes.
- Medical beds.
- Patient carts.
- Lifting and transport equipment.
- Operating table.
- Operations lighting unit.
- Operating theater chairs.
- Special case tables.

Dentistry equipment like:

- Dental units.
- Dental chairs.
- Dental technology engines.
- A hole machine.
- Precision turbine engines.
- Cutting and smoothing engines.
- Smelting and casting tools.

Sterilization and clinical treatment equipment like:

- Steam sterilization.
- Hot air sterilization.
- Gas sterilization.
- Plasma sterilization.
- Chemical treatment and washing machines (infection control).
- Chemical scrubbers.
- Chemical spray devices.
- Ultrasound cleaning devices.

Transport and emergency equipment like:

- Artificial respirators (ventilator).
- Emergency Cardiac Arousal Devices (DC-shock).
- Defibrillator.
- Doctor's bag for emergency cases.
- Quick medical aid supplies.

The devices can be classified according to how the information is given to:

- Measuring tools with numerical indicators are generally termed meter.
- Vision devices with continuous images and terminated with a "scop" skopy.
- Schematic recording devices end with the name "graphy".
- Mostly, not one device is used, but a set of "polygraphy" devices. This combination follows the required function, for example: groups:
- Diagnosing lung function.
- Patient monitoring (ICU).
- Monitor the fetus.
- Heart and blood circulation devices.

Technical equipment for laboratory, it includes analyzers for chemical functions and vital samples from the human body and include large numbers of medical equipment for biological laboratory analysis.

Test equipment, it includes devices for testing nervous and sensory ability through excitation, and studying the quantitative and qualitative reaction to these excitations:

- Audiometer.
- Optic stimulation.
- Scale the sense of taste and smell.
- The current excitation device.
- A timed reaction meter.

Medical equipment classification according to its risky and importance:

- Low risk equipment, which include the equipment that need sterile or used for measuring functions.

- Low-medium risk equipment.
- Medium-high risk equipment.
- High risk equipment.
- Active implantable medical equipment.

This classification is guided by a group of rules which are invasive, non-invasive, active and, special devices rules.

CONCLUSION

The medical equipment classifications can help us to regulate and organize the medical equipment and classify them according to its work, importance, position, or risk. These classifications can serve in many practical works and for different disciplines (who needs this classification). Also the medical equipment classifications research includes medical equipment definition, principle explanation, and main basic parts.

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