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Review on Biomedical Engineering and Engineering Technology in Bio-Medical Devices

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ABSTRACT
Biomedical engineering and engineering technology in medical devices is very important as the rapid development of technology, the increase in diseases, and the presence of many medical and technical problems for some medical devices that need engineering solutions for medical devices, which leads to an increasing demand for medical engineers in order to deal with the increasingly complex biological problems. The need for a medical engineer is increasing every day. The research also deals with solving engineering problems in medical and life devices. In medical companies specialized in the manufacture of medical devices, or those specialized in the maintenance and sale of medical devices, or research centers such as universities which research the development of medical devices and analyze, understand and solve engineering problems and develop and invent new engineering devices.

Keywords-- Biomedical engineering, Medical system, Medical devices, Technology devices, Bio medical devices

INTRODUCTION

Medical engineering is concerned with applying engineering principles to medical problems including replacement of damaged organs, medical devices, health care systems, and computer applications for patient diagnosis. Medical engineering also includes the invention, manufacture, design, and development of new technology in academic fields, by conducting research on possible medical options, diagnostic procedures, and medical devices, medical engineering includes examining medical equipment to ensure that it is working safely and soundly [1,2]. It also studies tissues and stem cells, and the industrial interactions that include them, which have an important role in organ transplants, which improves the quality of life for millions of people, as well as the development of internal and external assistance devices such as Pacemakers, coronary arterial stents, prosthetics, prosthetics, dental devices and products, and it is worth noting that most medical engineers work within the scope of modern companies, or by opening their own projects[3, 4].

THE HISTORY OF BIOMEDICAL ENGINEERING

The origin of medical engineering goes back to ancient a civilization, that is since the time of the philosopher Alcaion, the philosopher Plato, and the Greek doctor Galen, who studied the world around them including the human body, through an organized scientific methodology 1200 years, specifically until the time of Maimonides, Leonardo da Vinci was also called the greatest engineer in history, as he applied physical, experimental, and analytical principles to the study of physiology. Medicine in 1838 AD, and contributed surprisingly to physiology and psychology, as he discovered the ophthalmoscope based on the same methodology where engineers, inventors, and scientists knew, the scientific methodology adopted in the study of physics, mathematics, science, and engineering, applies to medical engineering in which technology, knowledge, practical and theoretical aspects are shared in improving the life of the individual at the health level. Biomedical Engineering is one of the important branches of engineering, also known by another

term known as "Medical Technology Engineering", whatever the name, that discipline focuses on one goal, which is the design and maintenance of devices that are used to treat patients, and engineering is considered medical devices serve as a link between the fields of engineering and medicine, and we are now seeing what medical devices, with their various classifications, perform in terms of tasks, to help doctors reach an accurate diagnosis of pathological conditions, and then find appropriate treatment methods that help speed recovery and achieve positive results. In this article, we will learn about adequate information related to the specialization of Biomedical Engineering [5-8].

DEVELOPMENT OF ENGINEERING DEVICES – MEDICAL LIFE

Engineering companies can develop devices and maintain damaged ones. Engineering companies work in the general medical and medical technical fields. Accordingly, his responsibilities include the following Designing, testing and implementing new medical procedures such as computer programs and techniques for surgical and tissue engineering. Design and development of medical products and devices as well as their testing and modification. Maintenance of medical devices, before medical machines are sold to laboratories and hospitals, these devices must meet certain conditions. For example, these devices have to prove that they are both safe and effective. It is considered safe if patients or physicians who use it are not harmed or harmed when using it. So, precautionary measures must be taken. Many accidents occurred in recent years because of these machines, which led to an increase in the stringent tests that these machines must go through before they are approved. These machines are considered effective if they achieve their desired goal within a reasonable period of time. Medical engineering is a science that combines engineering sciences (mechanical, electrical, electronic and computer) with biomedical and physiological sciences, applying advanced engineering theories and techniques to deal with, analyze and solve biomedical problems. This is done by designing appropriate tools and devices to measure and understand physiological and biological systems and to develop devices capable of treating and dealing with diseases, which requires studying the way these devices work, maintain and model them. Medical engineering greatly allows for creativity, development and invention, due to the diversity of medical fields and the enormity of the physiological systems (the human body) that this field of engineering deals with, knowing that the most sophisticated, advanced and most expensive techniques are used in two fields, one of which is medical engineering [9-11]., many companies and universities invest millions of dollars in scientific research. Researchers are developing medical machines and artificial organs. Machines produced from scientific research projects are carefully checked to ensure that they comply with the laws and regulations in place in the country. Machines have to pass many tests and analyzes before their safety can be confirmed. After ensuring the safety of these machines, they are sold to hospitals and laboratories. Some countries like America and Germany are exporting machines to be sold in other countries. Among the most important areas of scientific research like biomaterials, medical imaging, medical mechanics, nano biotechnology, tissue engineering, and many others. The rapid development of technology, the increase in diseases, and the presence of many medical and technical problems that need solutions lead to an increasing demand for medical engineers in order to deal with increasingly complex biological problems, develop the work of previous devices to obtain better results, and invent new devices that help the doctor perform his task in a better manner. Better and faster, the need for a medical engineer is increasing every day [12-14].

FIELD OF BIOMEDICAL ENGINEERING

At the present time there is nothing wrong with it, as there is a comprehensive renaissance in this field. There are liposuction devices, laser devices for treating long and short-sightedness, sonar devices of all kinds, magnetic, x-ray, tomography devices, electron microscopes, endoscopes and catheters for treating vascular blockages and installing stents. Modernity is still ongoing, and there is new every day [14], shown in below Fig. 1, 2 and 3.

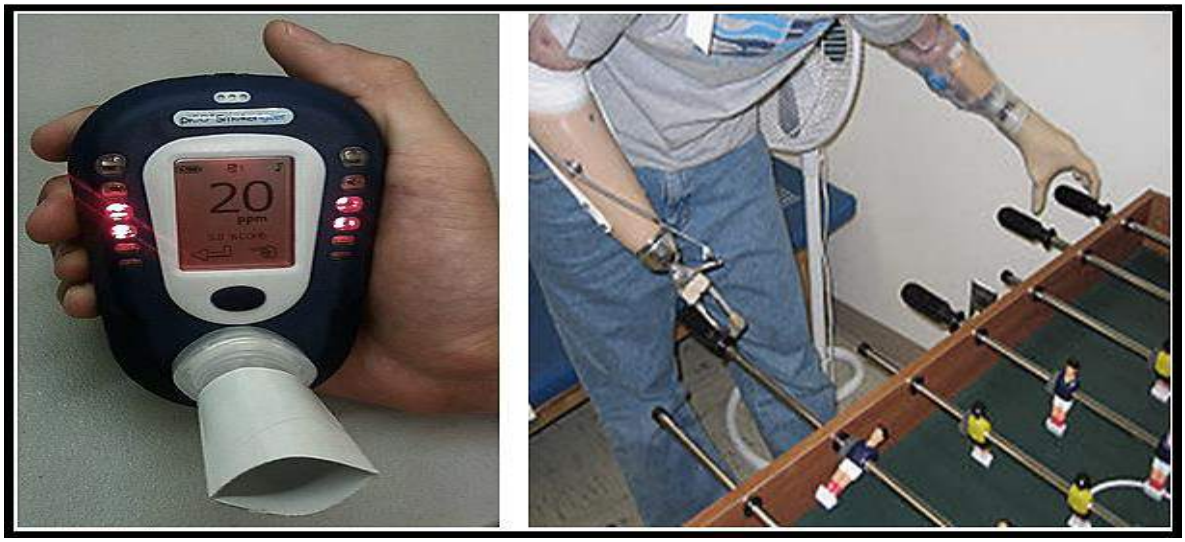

Figure 1: *Prosthetics and pressure devices engineering.*

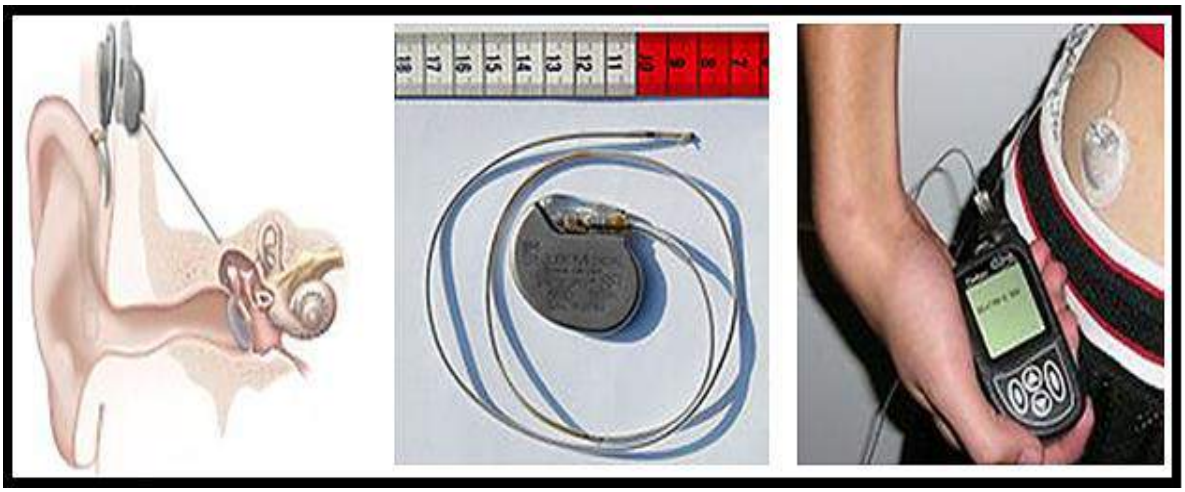

Figure 2: *Some of medical eengineering devices.*

Figure 3: *Medical engineering device for dialysis.*

SYSTEMS & INTEGRATIVE ENGINEERING

- **Engineering of Biological Materials:** Biological materials are materials that interact with living systems, and many international companies invest millions to manufacture these biological materials either naturally or produced in laboratories by various chemical methods. These materials can be placed anywhere in the body, such as the heart, and are widely used in surgical operations and in delivering medication or anesthetics to tissues. Other use of this material includes joint replacements, bone plates, artificial heart valves and blood vessels, tissue, molecular etc.
- **Cell Engineering:** It is considered an important part of biotechnology that overlaps with medical engineering. One of its goals is to create artificial organs with biomaterials in patients who need organ transplants. Medical engineers are currently looking for ways to invent such organs, and some of them have been able to reach this end through stem cells. For example, some artificial bladders were built in laboratories and transferred to some patients.
- **Genetic Engineering:** Genetic engineers alter the genetic content of some organisms. The goal of this manipulation is to stimulate these organisms to produce certain hormones and chemicals. For example, scientists modify the genes of a special type of bacteria to produce the necessary insulin for the human body, and then doctors inject insulin into patients with diabetes. The engineers were also able to transfer the genes responsible for the production of bioluminescent materials from the flies to the tobacco plants. Medical engineering is closely related to genetic engineering because it aims to improve the performance of vital organs. To achieve their goals, genetic engineers clone molecules and transfer genes from one organism to another [12].
- **Neural Engineering:** Neural engineering is a field of biomedical engineering that uses engineering techniques to repair or replace nervous systems. Neuro-engineering is related to cybernetics, computer engineering, and neural tissue engineering as well as materials science and nanotechnology. Neuro engineers are qualified to solve problems in both living and non-living tissues. The goal of neural engineering is to install devices that can produce nerve signals to achieve purposeful responses such as controlling a limb or interacting with nervous systems to improve their performance. and that neuro-engineering is a new field, the engineering of medical devices that use magnetic resonance magnetic fields to show the internal organs in the body, the (PET) device uses radioactive materials injected into the body to take pictures. Radioactive materials, such as Oxygen-15, which breaks down over a short period of time and releases radiation, are attached to molecules bound for the organ to be imaged. For example, when imaging the brain, these radioactive materials are attached to glucose molecules. The goal of PET imaging is to see how active certain areas of the organ are being imaged. Although this imaging method may be more expensive than others, it has many characteristics that distinguish it from other imaging methods.

CLASSIFICATION OF MEDICAL ENGINEERING DEVICES

Biomedical Engineering devices are classified according to the physical classification into three basic categories i.e. electronic medical equipment, radiation equipment group, and radiation equipment group. This technique is used in imaging many vital organs such as the brain, heart, kidneys and others. Computerized medical imaging is based on X-rays. Using this imaging, the skeleton can be seen in high resolution. Before starting the imaging process, the patient is injected with a contrast material in order to increase the resolution of the image. The first tomography machine was built in England. The first filming took place in 1971 in London. This type of imaging has side effects and may affect the nucleic acids in the patient's body. The resolution of the resulting image is directly proportional to the amount of radiation emitted by this device. Computerized tomography is used to diagnose malignant and benign tumors in different areas of the body. One of the newest

medical diagnostic devices is the camera the size of a pill, this camera can be swallowed like any pill. This pill can take about 15 color images as it passes through the pharynx and esophagus. The goal of this camera is the early detection of gastrointestinal cancer, which increases the chance of a cure. This camera sends the captured images to a device in the doctor's office, which reviews these images and assesses the patient's condition based on them. The width of this bead is approximately 9 millimeters. This tool will make a big difference in the field of medical diagnostic devices. This device was developed at the University of Washington. It is the science that combines biomedical sciences, as well as physiological and engineering sciences, such as computer engineering, electrical engineering, and mechanical engineering, with the aim of which is the design of medical and prosthetic devices. To understand the nature of diseases in all aspects and to deal with them, and it is one of the most prestigious departments of engineering colleges, and students are more interested in it than all other departments, so whoever engages in that specialization in many of the prestigious engineering colleges must obtain excellent grades in the first preparatory year.

ENGINEERING MAINTENANCE OF MEDICAL DEVICES

The purpose of maintenance of engineering devices such as electrical, mechanical, helps doctors to do their work to the fullest, helps patients to recover better, provides complete comfort, and helps greatly in diagnosing diseases, especially tumors inside the body that cannot be predictable existence without these devices. BME is also traditionally known as "bioengineering", but this term has also come to refer to biological engineering. This field seeks to bridge the gap between engineering and medicine, combining design and problem solving engineering skills with the biomedical sciences of pre-medical treatment, including diagnosis, monitoring, and treatment while adhering to relevant industry standards. This includes making recommendations for equipment, procurement, routine testing, and preventive maintenance, a role also known as a Biomedical Equipment Technician (BMET) or clinical engineering. Such a development is as common as new field shifts from being an interdisciplinary major among already established fields to being considered a field in its own right. Much of the work in biomedical engineering consists of research and development, and spans a wide range of subfields. Notable applications of biomedical engineering include the development of biocompatible synthetics, various diagnostic and therapeutic medical devices ranging from medical equipment to micro implants, common imaging equipment such as magnetic resonance and ECG/EKG, regenerative tissue growth, and pharmaceutical drugs and therapeutic biological. It is an umbrella term for the group of biological studies that use computer programming as part of their methodology, particularly in the field of genomics. Common uses of bioinformatics include identification of candidate genes and nucleotides (SNPs). This determination is made with the aim of better understanding the genetic basis of disease, unique adaptations, or desirable characteristics (particularly in agricultural species), bioinformatics also attempts to understand the regulatory principles within DNA and protein sequences.

CLINICAL ENGINEERING

Clinical engineering is the branch of biomedical engineering that deals with the actual implementation of medical equipment and technologies in hospitals or other clinical settings. The main roles of Clinical Engineers include training and supervising Biomedical Equipment Technicians (BMETs), selecting technology products/services and managing their logistical implementation, working with government regulators on inspections/reviews, and acting as technical advisors to other hospital staff e.g. doctors, administrators, IT, etc. Clinical engineers also advise and collaborate with medical device manufacturers regarding prospective design improvements based on clinical experiences. In addition to monitoring the progress of the latest technology to redirect purchasing patterns accordingly. Their inherent focus on the practical implementation of technology tends to keep them geared more towards incremental level redesigns and retro fittings, as opposed to revolutionary research and development or ideas that will be many years after clinical adoption. However, there is a growing effort to expand this time horizon within which clinical engineers can influence the path of biomedical innovation. In their various

roles, they form a "bridge" between primary designers and end users, by combining the perspectives of being close to the point of use, while also being trained in product and process engineering. But also industry/systems engineers to help address process/optimization research, human factors, cost analysis, etc. See also Safety Engineering for a discussion of the procedures used to design safe systems. Clinical Engineering Department has been set up with a Director, Supervisor, Engineer and Technician. One engineer for every eighty beds in the hospital is the ratio. Clinical engineers are also authorized to audit pharmaceuticals and associated stores to monitor FDA recalls of gaseous items. Select the Medical Devices Directive detailed procedures for obtaining certification. In general, these procedures include testing and verification that must be included in specific deliverables such as risk management file, technical file and quality system deliverables. The risk management file is the first product to stipulate the following design and manufacturing steps. The risk management phase should lead the product so that the product's risk is reduced to an acceptable level in relation to the expected benefits to patients from using the device. In the technical file contains all the data documents and records supporting the certification of the medical device. The FDA technical file contains similar content although it is organized in a different structure. Quality system outputs usually include actions that ensure quality throughout the product life cycle.

CONCLUSION

Biomedical engineering is the most common name, and there are two other names i.e. the first is medical engineering, and the second is bio engineering. For example, the manufacture of a rubber valve for the heart to control blood flow is a joint work between the biomechanical engineer who knows the mechanism of the heart's work, and the medical materials engineer who can choose the best materials suitable for the human body. The human heart performs an involuntary mechanical action by stimulating an electrical impulse of approximately six volts, so the right ventricle pumps blood into the right atrium with an involuntary movement that is not controlled by the human being, the occurrence of circulatory failure.

REFERENCES

1. Galton, F (1877). Typical laws of heredity. *Nature*, 15, 492-553, Available at: https://www.nature.com/articles/015492a0.
2. Layla Abd al Jaleel Mohsen, Atared Saad Jebur AL-Mashhadi, Rajaa Abdulameer Ghafil , 2021, Review on the Use of Mathematical and Computer Programs in Accounting for Engineering Systems, Journal of Analog and Digital Devices, 6, 2 ,P : 1-5 ., Available at : https://www.researchgate.net/profile/Atared-Saad-Al-Mashhadi.
3. Broemeling, Lyle D.(2011). An Account of Early Statistical Inference in Arab Cryptology. *The American Statistician*, 65 (4), 255-257, Available at: http//:doi:10.1198/tas.2011. 10191.
4. Kawther Mejbel Hussein., Review in Digital Data in Supporting of Information Technologies., Journal of Digital Integrated Circuits in Electrical Devices ., Volume-6, Issue-1 (January-April, 2021) ., P: 23-29 ., Available at: https://www.researchgate.net/profile/Kawther-Mejbel-Hussein .
5. Yates, F (1964). Sir Ronald Fisher and the Design of Experiments. *Biometrics*, 20 (2), 307-321.
6. Nagham Mahmood Aljamali ,Afaq Jaber Kadhium , Alaa Hamza Jaber Al-Jelehawy , (2021)., Review in Protection of Laboratory and Electrical Equipment in Laboratories and Institutions., Journal of Controller and Converters., Volume-6, Issue-1 ,P: 24-30 .
7. Stanley, Julian C. (1966). The Influence of Fisher's "The Design of Experiments" on Educational Research Thirty Years Later, *American Educational Research Journal*, 3 (3), 223-229, Available at: http//:doi:10.3102/00028312003003223.
8. Agresti, Alan; David B. Hichcock (2005). Bayesian Inference for Categorical Data Analysis (PDF). *Statistical Methods & Applications*, 14 (3), 298, Available at: http//:doi:10.1007/s10260-005-0121-y.

9. Rao ‹Singiresu (2002). Applied Numerical Methods of Engineers and Scientists. Upper Saddle River ‹New Jersey: Prentice Hall. ISBN 013089480X ., Available at: http://ijens.org/Vol_20_I_05/203705-6161-IJMME-IJENS.pdf.
10. Anaam Jawad Alabbasy, Radhiyah Abdul Baqi Aldujaili , Alaa Hamza Jaber Al-jelehawy, Nagham Mahmood Aljamali ., (2021)., Review on Basic Rules for the Quality of Health Institutions and Medical Laboratories., Journal of Pharmaceutical Quality Assurance and Quality Control., Volume-3, Issue-1., P:16-22 .
11. Atkinson ‹AC and Donev ‹AN and Tobias ‹ RD (2007). Optimum Experimental Designs ‹with SAS . Oxford University Press. pp.511 + xvi. ISBN 978-0-19-929660-6 . Available at : http//:doi:10.3102/00028312003003223. JS TOR 1161806.
12. Stigler, S.M. (1989). Francis Galton's Account of the Invention of Correlation. *Statistical Science*, 4 (2), 73-79, Available at: 10.1214/ss/1177012580.
13. Pearson, K. (1900). On the Criterion that a given System of Deviations from the Probable in the Case of a Correlated System of Variables is such that it can be reasonably supposed to have arisen from Random Sampling. *Philosophical Magazine. Series 5*, 50 (302), 157-175, Available at: 10 .1080/14786440009463897.
14. Neyman, J (1934). On the two different aspects of the representative method: The method of stratified sampling and the method of purposive selection. *Journal of the Royal Statistical Society*, 97 (4), 557-625. Available at: https://hiast.edu.sy/sites/default/files/Master PHD/5ce65535e1d4a.pdf .
15. Nagham Mahmood Aljamali ,Widad Hashim Yahya Almuhana .,(2021)., Review on Biomedical Engineering and Engineering Technology in Bio-Medical Devices., Journal of Advances in Electrical Devices ., Volume-6, Issue-2 (May-August). P: 18-24 .
16. McCarney R, Warner J, Iliffe S, van Haselen R, Griffin M, Fisher P (2007). "The Hawthorne Effect: a randomised, controlled trial". BMC Med Res Methodol. 7 (1): 30., Available at : http//:doi:10.3102/00028312003003223. JS TOR 1161806.
17. Nelder, J.A. (1990). The knowledge needed to computerise the analysis and interpretation of statistical information. In Expert systems and artificial intelligence: the need for information about data. Library Association Report, London, March, 23–27., Available at : http//:doi:10.3102/00028312003003223. JS TOR 1161806.