BIOMEDICAL TECHNOLOGY, THE FULCRUM FOR
MODERN MEDICAL PRACTICE

INTRODUCTION

The concept of disease is as old as life itself, and is dated back to the beginning of mankind. The desire to unravel the causes and mechanisms of disease intensified as the effects become more devastating. Over the centuries, evolutionary trends in the field of medicine have been from supernatural beliefs to the present state of our knowledge of modern medicine. Though that multiple disciplines have existed and developed in the field, the numerous developments are due to interaction and interdependence on advancements in diverse neighboring branches of science and steady strides made in medical technology. Fascinating therefore is the immense contributions by engineering and biology, which till date have been the bedrock of various medical technological advancements.

Though that earlier concepts of disease was marred by religious beliefs that affliction or disease was the outcome of curse or ‘evil eye of spirit, it has to be ward-off. The duty to do this was then left in the hands of Priests who offer prayer and sacrifices to invoke high power to please or overcome thin gods of afflictions. Medicine and religion become so firmly interlaced together during the early Greeks who had the belief that ‘Aesculapius’ is the god of healing. Even at then, all medical needs were not well met, and reasons still surged, and questions remained unanswered.

The period of ancient religious beliefs was followed by the philosophical and rational approach to disease by methods of observations which were promoted and championed by Socrates, Plato and Aristotle. This is known as philosophical concepts to all natural phenomena. 

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The real practice of medicine began with Hippocrates (460-377BC), the great Greek clinical genius of all times and the same is regarded as the father of medicine. He was the first to stress on father of medicine. He was the first to stress on the study of patients symptoms and describe methods of diagnosis. According to him, disturbances in equilibrium of the body result in an illness. He promoted recording of observations on cases in writing. This has been the main stay of medicine which till date and has been translated by biomedical informatics. The most famous work of Hippocrates and indeed the plough of modern medicine are his ‘aphorisms’ that is based on his vast experience. In the stance are

--those naturally very fat are more liable to sudden die than the thin.
--in acute diseases, coldness of extremities is bad.

He then introduced the ethical concept in the practice of medicine -hence till today the ‘Hippocratic Oath’ (the Medical initiation oath at the time of entry into medical practice).

The end of medieval period was marked by backward steps in medicine. This is because wide spread epidemics at that time could not be explained by ongoing knowledge from Hippocrates. Hence supernatural concepts and divine punishment for sins became the order of explanation. The dominant belief that held sway during this period was that life was due to influence of vital substance under the control of soul- the theory of vitalism. Hence no autopsy should be performed so as not to hurt the soul.

**Biomedical Engineering/Technology and the health field**

This is a relatively young and small field that deals on health and well being of people everywhere. Its development and advances are out of proportion in consideration to the age and size even as it images and position positively medical
science into the arena of technological prowess. This is because the concerns of Biomedical Engineers are very wide ranging, dealing with virtually all systems and parts of the human body. The biomedical engineers are involved in all phase of healthcare measurement and diagnosis, therapy and repair, and patient management and rehabilitation. Applying the traditional engineering principles and techniques, biomedical engineers technology, design, develop, make, and manage health devices, equipment and materials on the floor of manufacturing plants in one hand, and in another deal directly with healthcare clients or are in head-on for facilities in hospitals or clinics. Working in these arenas, Biomedical engineer can widely be called clinical Engineer.

**Biomedical Engineering/Technology practitioner/ Educator**

Often times, people who have engineering sensibility, though may not be engineer or medical personnel but can brilliantly put ideas in less glamorous circumstances are considered Biomedical engineers/technologist. Among them may be, mechanical, material, Electrical, optical, Engineers, Medical Physicist, Anatomist, Biotechnologist, pharmacologist, clinicians, medical laboratory scientist/pathologists, Biologist etc. Therefore, the curricula for training Biomedical Engineer/Technologist must embrace all these fields and more for the graduate to mitigate rightly, from learned courses the application of naturally acquired sensibility.

Biomedical engineering sensibility also has design component, which can come into play in a wide variety of medical situations. Consequently, whenever an individual or a team, designs a new health care application, such as a new cardiovascular or respiratory device, a new imaging machine, a new artificial arm or lower limb or jaw, or a new environment for someone with a disability or ill health, if there be engineering knowledge, skill and principles from the concepts that showcase design,
analysis in the operation of such biomechanical systems and there is application of electrical engineering knowledge, skill and principles to biosensors and bioinstrumentation, such biomedical Engineer/technologist have solve problems in healthcare. Also the same can be said to come to play when an individual or team makes an application that already exist work better.

Being holistic in function in and around healthcare environment, Biomedical Engineer/Technologist is trained to determine which materials would improve the performance of a device. For example, improved prosthetic device, diagnostic or therapeutic technique, should reduce the cost of manufacturing medical device or machine, improve methods for packaging and shipping medical supplies, guides tiny surgical fools into the body, improve the plans for medical facility, or increase the effectiveness of an organization installation, calibration and maintain equipment in a hospital. The participation in the design and development of time- released drug capsules can involve an engineer’s sensibility. Hence healthcare technology principle is adopted rightly when Biomedical Engineering/Technology wealth of knowledge is as well coveted and medical synergy encouraged. This is the principle of modern healthcare plan. Medical synergy gives optimal holistic healthcare delivery.

**Biomedical Engineering/Technology and Medical Diagnosis**

Professionalism in medical science has called for sophisticated information availability and distribution so that expert healthcare deliver can be tagged holistic care. Appropriate care requires definite diagnosis such that cost of testing/investigation can be affordable to march specific accurate outcome. Also testing of human components requires the easiest, safest and less invasive method of sample collection from and by the patient. Medicine like other healthcare
professions, is an art as well as science but not the exact science, requires multiple
application of principles gleaned from other science professions as biomedical
engineering/technology. Therefore what may appear irrelevant at onset may at
diagnosis and treatment of individual patient appear necessary. To obtain and
maximize diagnostic benefits in patient care system, advanced technological
applications should carefully drive diagnosis care and aid targeted therapy. For
example by 1975 developed procedures which include but are not limited to total
body and brain scanners, position Emission Tomography (PET), updated ultrasound,
and nuclear imaging instruments have recently received upgrade such that X-ray
machines is challenged by Tomography machine, ultrasound scanner by 3D wetted
wire ultrasound scanner, magnetic Resonance imaging machine by high gradient
Resonance with high speed [signal –to-noise Ratio (SNR)] elimination machine.
Also Electrocardiogram (ECG) is challenged by Echocardiogram-Dopper
Echocardiography. The design and fabrication of these machines have solved the
problems hitherto were medically not diagnosable conditions with blood and body
fluid, even from removable tissue.

In the medical laboratory practice before and immediately after 1975, blood sugar,
pregnancy test, hemoglobin estimation, tuberculosis (TB) test, etc were only carried
out in the highly sophisticated shrine called laboratory. Recently, no priest so to say,
called medical laboratory scientist is needed for mere screening for these above
mentioned investigations. Biomedical engineer/technologist has introduced point-
diagnosis which has given patients self-screening ability, rapid diagnosis, and be-
the-first to know right. Today the advancement in the study of biomaterials and
medical materials science has increased the apt knowledge of diseases contraction,
and prevention has been the solid slogan in diagnostic and clinical medicine. Thanks
to Biomedical Engineers/Technologists who are fast meeting with the needs of
diagnostic and clinical medicine; and who through accurate, specific and reproducible testing results have brought healthcare delivery to be affordable to certain extent. Remember before and immediately after 1975 how many people cannot think of knowing their HIV status.

**Biomedical Engineering/Technology and Clinical Medicine**

In this new era of technological advancement, professionalism demands for specialization in all fields of medicine. The idea is to obtain maximum but adequate and appropriate services to healthcare delivery. The clinicians persist in management, treatment and rehabilitation of patients through the utilization of diagnostic information available. Immediately after medieval period this becomes a norm, and was encouraged by the brazen slogan of ‘division of labour’ and many specialties have to spring up to meet the needs of various clinical professions and their complexity. From 1975 onwards changes in healthcare delivery was reoriented to embrace technological advancement, and Biomedical Engineering become a young field yet to be allowed a place in medicine. But the new way of doing things demands recognition because numerous equipments are in use for medicare appropriate and targeted therapy. The effect on the part of Biomedical Engineers/Technologist is the design and fabrication of more sophisticated medical devices and equipment to meet with the need to combat imagining and re-imagining disease conditions.

The design and functional complexity of medical services and systems have increased for over 50 year but not as recent. This was enhanced by evolution in the use of a metronomic circuit for initial cardiac pacemaker to functions that encompass record keeping in electrocardiogram analysis, delivery of anesthesia, laser surgery, genetic and tissue engineering, and intravenous delivery systems that regulate
dosages as feedback is received from patient. As device functionality becomes more intricate, concerns arise regarding, efficacy, safety and reliability. The worker and patient safety were burning concern just as both want the device to operate as specified for a period of time without failure. To be successful the designer of medical device must ensure that all devices meet these requirements, and that user must be well trained. This means that there exist three irresistible components of healthcare delivery via

*The personnel management*

*The equipment management and*

*The environment management*

In any healthcare delivery sector the complex nature exists within the environment and includes facilities, equipment, drugs, information, finance, and a full range of human interventions interaction. The whole package is called ‘medical technology’. Also in clinical environment the patient must be consulted by skilled staff, contract labour and a wide variety of technologies coverage. This is the advocacy of Biomedical Engineering Technology for holistic healthcare delivery.

The clinical Engineer in healthcare sector provides devices, equipment, systems, software, supplies, pharmaceutics, biotechnology, and medical and surgical procedures in use for prevention, diagnosis and treatment of human disease, for patient rehabilitation; and for assistive purpose. Consequently, technology can broadly be defined as ‘wholesomely virtually all the human interventions intended to advance and cope with disease and disabilities, devoured of spiritual alternatives. Can this then be the new and prevailing face of Healthcare delivery?
Modern trend in medical genetics the Biomedical Engineer vested concern

The modern medical evolution is determinant upon by technological advancement. Such can be affirmed of artificial intelligence a field of study. Artificial intelligence is the intelligence of machines and is the branch of computer science that aims to create it. That is to say the field tends to understand intelligent entities- think like humans, acts like humans, think rationally and act rational. Artificial intelligence seeks to explain and emulate intelligent behaviour by computational processes. This is the hallmark of targeted therapy against some genetic and cancer diseases. By artificial intelligence, a Biomedical engineer through biomedical informatics is able to simulate diseases in computer model human and intelligently create in full and integral sense therapeutic or assistive treasures that are appropriate. Often times when such possible measures are tried on living human, they work successfully. This complex method that is undergoing advancement has gained application in curative and assistive medicine. It is applicable these days in

*Rehabilitation medicine*

*Genetic medicine*

*Oncology*

*Tissue regenerative medicine*

*Pharmacology*

*Chiropractic*

In medical genetics which recognizes three broad disease conditions via;

Chromosomal structural abnormality and chromosomal numerical abnormality

These constitute about 50 percent of mortality in infants and childhood in western world and in underdeveloped countries 95 percent of all infant mortality is attributable to environmental factors such as poor sanitation and under nutrition. In simple terms and categorization, genetic disease can produce developmental defects, cytogenetic defect, single- gene defect, multifactorial disorder and pediatric
conditions. Most of these diseases/disorders/defects are incurable because gene mutation or cytogenetic abnormality characterized them. Biomedical engineering in a step wise action through polymerase chain reaction (PCR) technique before early 1970s was able to proffer diagnosis and by artificial intelligence had now established that factors like DNA/gene is responsible for these conditions. Presently, proteins, carbohydrates and lipids are been analyzed by microarray techniques which involve the use of biochip and computer monitor.

**Tissue Engineering**

This exciting field of engineering discipline encourages design and construction of spare parts for the human body to restore functions by the principles of biology and biomedical engineering. The basis for tissue engineering is the triad of signal for tissue induction, responding stem cells and the scaffolding of extracellular matrix. Since among many tissues in the human body bone have the highest propensity of regeneration and therefore is a prototype model for tissue engineering based on morphogenesis. Morphogenesis is the developmental cascade of pattern formation, body plan establishment, and culmination of the adult body form. The cascade of bone morphogenesis in the embryo is recapitulated by demineralized bone matrix to induced bone formation. The inductive signals for bone morphogenesis, the bone morphogenetic proteins (BMPs) were isolated from demineralized bone matrix. The understanding basic molecular principles of morphogenesis and development have been the mainstay of tissue engineering. Therefore tissue engineering can be define broadly as the science of design and manufacture of new tissues for functional restoration of the impaired organs and replacement of the lost part due to disease, trauma and tumours. Tissue engineering is based on principles of developmental biology and morphogenetic, biomedical engineering and biomechanics. Tissue body BMPs are produced by food and drug administration companies for spine fusion and
open fractures of tibia due to orthopedic trauma. The technique of tissue engineering has found resident in biotechnology, gene therapy and gene cloning.

**Prospects and Challenges in Biomedical Engineering- a step-wise direction in medicine.**

In this era of modern medical practices numerous challenges face the Biomedical Engineer/Technologist. These challenges originate from the diverse devices introduced in the health system, vast areas of functions, and because holistic healthcare delivery demands continual application of new advances in technologies. Hence, as the prospects exist so are the increasing challenges that evolve from areas already in existence. In the instance and for the brief of this lecture they include;

* Tissue regeneration medicine
* Rehabilitation medicine
* Clinical medicine and surgery
* Pharmacology
* Diagnostic medicine and pathology

**Tissue Regeneration Medicine**

Despite the exciting advances in clinical application of BMPs there also exist many challenges. Foremost among them is the need to develop synthetic scaffolds to deliver recombinant BMPs for skeletal tissue engineering. The development of synthetic scaffolds with an ability to respond to biochemical influences that are known to be critical for musculoskeletal structures will lead to quantum improvement of current tissue engineering approaches to bone, cartilage, and meniscus. The remaining challenges make the field of morphogene-based tissue engineering an exciting frontier with unlimited opportunities.

**Rehabilitation Medicine**
In the field of medical rehabilitation, exciting efforts have been rewarding as rehabilitator design are an evolving art and science. Numerous processes in designing patient-machine interface, mechanical linkage, control algorithms, safety mechanisms, assessment procedures, and networking software are more challenges in overcoming further advances. Still there exist current uncertainties in optimal therapeutic parameters, existing rehabilitators, which have successfully enhanced movement recovery. The great and commendable advances in neurorecovery mechanisms and technological advances in sensors, actuators, and computational algorithms, rehabilitators will continue to improve so that rehabilitation therapy will be affordable, increasable accessible and effective as the slogan of modernization in everything about man continues.

**Clinical Medicine/ Surgery**

Clinical medicine is as dynamic as life itself so is diseases which appear re-imaging and orthodox when considered along the line of contamination from our environment. The area mostly involved is respiration. Though that the design of respiratory devices is in many ways, challenges continues to be as with earlier designers. These challenges include among others device performance, safety, user interface, legal, biocompatibility, marketing, affordability, and adaptability tissue to face. Many respiratory devices are relatively small, and compact, and most ably reduce resistance to air flow and remove dead air promptly. It must be rugged and easy to use at homes and hospitals. New models are challenge enough to Biomedical Engineer/Technologist when consider the many of principles and the effectual integration.

Computer- integrated surgery is a new, rapid and evolving paradigm change that affects the way surgical actions can be taken. Technical advances in medical
imaging, tracking, robotics, and integration are paving the way to a new generation of systems for minimally invasive surgery. The advances in computer-integrated surgery (CIS) is gaining recognition in healthcare delivery and we hope that the affordability and accessibility of services in this vein will not be-labour the Biomedical Engineer/Technologist to over bearing challenges.

**Pharmacology**
The news of generational drugs development poses challenges to Biomedical Engineer because there are need to improve on the already existing devices in the field.

Controlled-released delivery devices have been in used for more than 30 years. The main principle behind these operations is of diffusion, dissolution, ion exchange, and Osmosis. Optimal design of a drug delivery system will require a detailed understanding of release mechanisms, properties of drugs, and carrier materials, barrier characteristics pharmacokinetics; and the integration of all these principles are from time to time reviewed so as to obtain maximum and efficient services. There exist challenges now that biotechnology principles have developed protein and macromolecular therapy. The design of new delivery systems are invoked and on trial.

**Diagnostic Medicine/ Pathology**
The human breast (particularly female) is prone to diseases and afflictions, and these have drawn in concern to Biomedical Engineer. Cumulative efforts have yielded the diagnosis of two basis dangerous lesions of the organ. Of no argument is that currently available modality for early detection of small cancer is effective and near accuracy by X-ray mammography. The machine has suffered from a relatively low positive prediction such that 65 percent to 85 percent of positive predictions do turn
out to be negative. Hence adjunct modalities that can differentiate benign from malignant lesions is considered highly desirable. These include; \textit{Electrical impedance scanning (EIS) and Scintimammography}

EIS relies on the differences in conductance and capacitance between healthy tissue and malignant tissue. EIS have 50 to 62 percent accuracy and 81 percent overall sensitivity advantages when compared with mammography and MRI.

The scintimammography of the breast uses a single gamma emitting traces and an imaging gamma detector fitted with a collimator. Recently concluded studies have insisted that scintimammography can provide diagnostic information complementary to that of X-ray mammography, and comparable performance has been reported between it and contrast-enhanced MRI as adjunct to X-ray mammography. Challenges on the use of scintimammography are technical and include

\textit{Positioning the camera close to the breast.}

\textit{Dealing with the significant scatter radiation arising from gamma rays emitted from region of the heart and liver.}

\textit{Correction for contrast degradation due to partial volume averaging attenuation of gamma from the lesion.}

\textbf{CONCLUSION}
The onset of medical practice was devoid of biomedical engineering field and suffered as a result of philosophical and religious beliefs. Modern day medicine evolved from scientific principles to be an art and science, and then remained rudimentarily effective and efficient as pathology pivoted development and service delivery. Biomedical engineering and technology is currently advancing and directing medical technology towards lucrative and complex field, and encourages healthcare technology as it promotes professionalism and specialization. Biomedical engineering/technology advocates medical technology management as the pivot for targeted and holistic therapy.

THANK YOU AND REMAIN GREEN IN HEALTH
REFERENCES