Title- Futuristic trends in medical Science- From the editor's lens!

Author & affiliation

Dr Ruby Dwivedi

Woman Scientist,

King George's Medical University, Lucknow

BACKGROUND

Medical science is an ever-developing field where newer trends are imperative for enhancing the quality and duration of life. Trends are basically documentation of progress and experimentation. Therefore to make progress visible thirst to attempt 'something new' needs to be raised. Future of medical science lies in adaptation to these trends and considering them as opportunities to accustom to new age therapeutic culture.

Medical Science is progressing rapidly owing to invention and incorporation of latest technological advancements. The core team includes doctors, researchers and bio-medical scientists/engineers. Their combined efforts have not only created new paths of success for the healthcare sector but also facilitated during times of crisis like Covid 19.

The healthcare sector is one of the highly demanding areas where constant, feasible and economical technological innovations are essential. The omnipresence of wearable devices that can track patient's data and seek suitable care using Internet of Medical Things (IoMT) is well appreciated in current times.

This chapter provides basic information regarding the current status and future trends of devices integral to medical sciences and healthcare.

WHAT IS IoMT?

'IoMT' stands for 'Internet of Medical Things' and refers to an 'interconnected network of physical objects or 'Things' integrated to exchange data between devices / systems using internet'.

It was first introduced in 1999 by Ashton.[1] Since then the technological advancements leading to IoMT based 'smart' devices has witnessed exponential growth in its usage.

Technically, it involves optimization of the data exchange and storage of the information on a secure cloud server from where interconnected computing devices forms a network to share data and communicate across the server.

In recent COVID-19 pandemic, IoMT played a crucial role aiding in patient monitoring, screening and treatment via telehealth, continuous monitoring of health condition in unexpected huge number of patients during both pre and post infection stage. IoMT based Smart devices are making an impact at a skyrocketing pace ubiquitously particularly in the global pandemic state.

THE DIGITAL TRANSFORMATION OF THE NEW ERA.

The two main drivers for fuelling an unprecedented growth in the manufacture and usage of medical devices particularly remote healthcare monitoring devices are-

a) Sedentary life style and oversaturated work schedules related disorders, and

b) Continued technical advancements in healthcare monitoring devices aiming to provide high-quality patient care at a fast pace.

Currently there are many digital developments, patents and healthcare solutions where technological innovations and digital transformation exemplified in expanded use of digital technology for remote monitoring, telehealth and self-health assessments via smart wearables. The digital transformation has enabled employment of technologies like virtual reality, augmented reality, artificial intelligence, sensors that uses block-chain, Fog and cloud computing, 5G network and big data analytics. [2-4]

THE TECHNOLOGIES INVOLVED.

The changing face of old evidence-based healthcare system into a smart and personalized healthcare system is attributed to the advent of newer devices pivoting around technologies like.

a) Virtual/ Augmented reality (VR/AR)

The potential applications of VR/AR can be categorized into -1) Clinical/ therapeutic, 2), Entertainment, 3) Business/ industry, and 4) Education/ training.

Virtual reality (VR) technology provides a three-dimensional enticing multisensory environment to creating a sense of “presence” by modified reality experiences. A head-mounted display (HMD) is worn that has a screen attached to it in close-proximity that provide a ‘transported to three-dimensional life-like world’ feeling.

VR works through an amalgamation of distraction, extinction learning, cognitive-behavioral principles, gate-control theory, and spotlight theory of attention.

VR has been applied in mental health and anxiety disorders, stroke and pain management, obesity management and prevention. VR aids as a supporting tool for treatment monitoring in

cancer patients by influencing psychological and physiological functions. They curtail psychological symptoms related to cancer and thereby facilitate emotional well-being of the patient.[5]

In Augmented reality, superimposed computer images manipulate the users' view of the real world. Apart from being a useful training tool AR can prove beneficial by aiding in visualization of invisible concepts and annotation by navigation in the virtual world.[6-8]

VR/AR trains the surgeons by simulating the environment so as to enable rehearsal and practice for improvement of surgical techniques in a controlled environment for eg. haptic elements for tactile perception. Similarly, XVision Augmedics facililtates visualisation of patient's anatomy with an accuracy rate of 98.9% by adding a 3D representation to facilitate X-ray vision when surgeons place spinal screws in cadavers.

Oxford VR is for alleviation of fear and symptoms associated with mental disorders. [9, 10]

b) Parallel, fog and cloud computing

Parallel processing techniques form the basis for distributed computing techniques involving paradigms like grid computing, cloud computing, fog and edge computing.

The big data generated needs to be segregated and maintained locally from the one that has to be shared across the cloud servers.

The data processing architecture has moved from centralized cloud computing to distributed fog computing technology. Fog computing creates a hierarchy of layers between the hardware components and the Cloud server (core level). It reduces the amount of data stored across the cloud servers thereby reducing the network bandwidth and response time in cloud computing subsequently minimizing internet and network latencies. Fog computing also enhances data security since the data stays locally on the edge and not in cloud space.[11]

c) 5G networking

Rapid development have led to evolution of fifth generation (5G) network comprises of new Radio Access Technology (RAT), antenna improvements, use of higher frequencies, and rearchitectured networks.

Technically, 5G is not a solitary entity but amalgamation of IoMT, big data, cloud computing, and artificial intelligence. The 5G-IoMT architecture is end-to-end coordinated and has sharp, automated and intelligent operations during each phase. [12, 13]

5G is powerful enough to support thousands of medical devices simultaneously, from sensors to mobiles, medical equipment, and video cameras and VR/AR. Maturing 5G technologies

exemplify in the form of tele-consultation, telemedicine, intelligence medicine and even remote surgery.[14, 15]

d) Big data visualization and analytics (BDVA)

The enormous data needs to be analyzed appropriately for accuracy in decision-making.

Big Data Visualization and Analytics (BDVA) is characterized by features like volume, variety, velocity, veracity, validity, volatility etc. [16, 17]

Big Data Analytics can be useful in predicting disease outcomes, treat epidemics, avoid avertible deaths and improve quality of life.

The system collects the data from wearable sensor along with climate, temperature, environment, location and medical data. The database analytics processes the data by extracting, cleaning and statistical analysis before forwarding to doctors or remote users.[18, 19]

e) Artificial intelligence (AI)

AI uses clinical, laboratory and demographic data to screen, diagnose and predict prognosis of various diseases.

AI can facilitate detection, large-scale screening, monitoring, resource allocation, and prediction of possible interactions with the new proposed therapies.[20, 21]

f) Block-chain

The large amount of data sharing might lead to fragmentation of the data thereby creating a void in transmitted information, leading to hampering in the therapeutic process.

To overcome this, 'Block-chain' technology was evolved to establish a connection among the data repositories present in the network**.** The Block Chain is 'a growing list of records (blocks) where records are connected to each other using a cryptographic method called hashing. Each record contains a cryptographic hash of the previous record, to chain the records together and make them resistant to modifications'. [22]

SMART HEALTHCARE DEVICES: PRESENT AND FUTURE.

There are many smart devices that have become an integral part of our healthcare practice. After the disastrous challenge that COVID 19 posed to researchers, scientists, engineers, medical practitioners all across the globe, an increased focus on developing newer devices that could facilitate better dealing in such scenarios in future has been made.

For instance, Whoop Strap for measuring respiratory rate, disposable patches and biosensors by Philips to detect COVID-19, Scripp's 'DETECT' that can collect data from smart wearable devices, testing and tracing architecture devised by Taiwan, Eko's electrocardiogram low ejection fraction tool for assessment of cardiac complications associated with COVID-19, 'Lumify' (a portable ultrasound device) and other hand-held portable ultrasound solutions, AI-CT algorithms for COVID-19 detection by Aidoc Medical (An Israeli technology company). [23-25]

Remote health monitoring systems and smart devices together with telemedicine/ teledentistry platform, robots and drones can contribute significantly in disease prevention by enabling screening, early diagnosis with subsequent management and facilitated living.

Health monitoring of vital functions such as heart rate, skin temperature, movement monitoring [26], nutrition status and rehabilitation of elderly or infected patients are more significant leading to an increase in life expectancy and decrease in morbidity/ mortality .[27]

A Smart hospital information system has been developed where various devices like MRI/ CT can be linked with laboratory data to allow improved identification of medical emergencies thereby facilitating medical staff in monitoring and taking appropriate decisions for the treatment. It is notable that by making the hospitals 'smart' equipment costs could also be reduced due to the early detection of abnormalities that could affect the accuracy of specific readings from the medical devices that could otherwise lead to higher maintenance costs. [28]

Dentistry has also benefitted from 'smart' technology. Newer advancements are aiming to pace up the work of the dentist along with comfort and assurance of reliability of the process to the patient. The penetration of artificial intelligence algorithms, machine learning techniques, big data analytics and cloud computing is on its path to transform dental practice.

MouthWatch's TeleDent service provides a compact tele-dentistry platform allowing patients to click images and forward the relevant information to remotely based dentist for live consultation.

In the field of Oncology, machine learning have been developed to quantify immune cells in the vicinity of oral cancer cells with precision so as to provide better insights about spread, and resistance facilitating determination of prognosis.

THE ROADBLOCKS.

Although the promise and ease of use of these devices for healthcare monitoring appears to alleviate the need for hospital visit. But the associated challenges like privacy, security and management of data, cost efficacy, environmental concerns and standardization are major

roadblocks and need to be addressed for cost efficient, flexible and consistent systems fit for healthcare needs to enable mass acceptance.

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