FUTURISTIC TRENDS IN MEDICAL SCIENCE- FROM THE EDITOR'S LENS!

Abstract

IoMT based Smart devices are making an impact at a skyrocketing pace ubiquitously particularly in the global pandemic state. However considering the vast magnitude of need, healthcare is foreseen as the most challenging areas for IoMT. This chapter intends to describe the pivotal role of IoMT applications in improving healthcare system and to analyze the status of research implementations demonstrating effectiveness of IoMT benefits to the patient and healthcare system along with a brief insight into the technologies supplementing IoMT and challenges faced in developing a smart healthcare system

Keywords: IoMT, Digital Transformation and Technologies, Smart Healthcare Devices.

Author

Dr. Ruby Dwivedi
Woman Scientist
King George's Medical University
Lucknow, India.
rubydwivedi1611@gmail.com

I. 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.

II. WHAT IS IoMT?

An interconnected network of physical items or "Things" integrated to communicate data across devices / systems pertaining to healthcare or individual well being via internet" is known as the "Internet of Medical Things," or "IoMT." 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.

From a technical perspective, it encompasses the refinement of data exchange and the secure storage of information on a cloud server. This server then acts as the central hub, facilitating communication and data sharing among interconnected computing devices forming a network.

The Internet of Medical Things (IoMT) helped with patient screening, monitoring, and telehealth-based treatment during the recent COVID-19 pandemic. It enabled the continuous monitoring of the health condition of a significant number of patients, both before and after infection. IoMT-powered smart devices have been rapidly making a widespread impact, especially during the global pandemic crisis.

III. THE DIGITAL TRANSFORMATION OF THE NEW ERA

The two main drivers of an unprecedented rise in the manufacturing and application of medical devices particularly remote healthcare monitoring devices are;

- Health issues associated with a sedentary lifestyle and excessively busy work schedules, as well as
- Ongoing technological advancements in healthcare monitoring devices, with the goal of delivering rapid, high-quality patient care.

Presently, numerous digital innovations, patents, and healthcare solutions showcase technological advancements and digital transformation through the extensive use of digital technology for self-health evaluations, tele-health, and remote monitoring through the use of 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]

IV. THE TECHNOLOGIES INVOLVED.

Innovative devices based on technologies detailed below are credited with transforming the conventional evidence-based healthcare system into a smart and personalized healthcare system.

1. **Virtual/ Augmented Reality (VR/AR):** The possible uses of VR/AR can be divided into four categories: 1) Clinical/therapeutic, 2) Entertainment, 3) Business/industry, and 4) Education/training. VR technology offers an immersive three-dimensional sensory environment to induce a feeling of "presence" through altered reality experiences. Wearing a head-mounted display (HMD) with an attached screen that gives the impression of being in a realistic three-dimensional environment allows one to accomplish this.

   VR works by combining the spotlight theory of attention, cognitive-behavioral principles, extinction learning, gate-control theory, and distraction. Virtual reality (VR) has shown useful in the treatment of anxiety disorders, stroke recuperation, pain management, and the prevention and management of obesity. As an effective supplementary tool for therapy monitoring in cancer patients, it affects both physiological and psychological processes. Virtual reality (VR) aids in the reduction of psychological side effects related to cancer, enhancing patients' mental health.

   In Augmented Reality (AR), computer-generated images are overlaid onto the user's real-world view. Beyond its value as a training tool, AR can provide significant benefits by assisting in the visualization of abstract concepts and enabling annotation through navigation in the virtual realm. [6-8]

   VR/AR technology trains surgeons by creating a simulated environment that allows for rehearsal and practice to enhance surgical skills within a controlled setting. This includes incorporating haptic elements for tactile feedback. Additionally, X-Vision Augmedics enhances the visualization of a patient's anatomy with an impressive accuracy rate of 98.9%. It achieves this by providing a 3D representation that aids surgeons in achieving X-ray vision when placing spinal screws in cadavers. Oxford VR can reduce anxiety and symptoms related to mental health issues. [9, 10]

2. **Parallel, Fog and Cloud Computing:** Grid, Cloud, Fog and Edge computing are just a few of the distributed computing concepts that are built on top of parallel processing algorithms. The generated big data must be separated and stored locally, distinct from the data intended for sharing across cloud servers.

Distributed fog computing technology has replaced centralized cloud computing in the architecture of data processing. A tiered hierarchy is created by fog computing between the main Cloud server and the hardware elements. By lowering the amount of data kept on cloud servers, this method lowers network bandwidth consumption and speeds up cloud computing response times, which lowers internet and network latency. Furthermore, by storing data at the edge location rather than in cloud storage, fog computing improves data security. [11]

3. **5G Networking:** The rapid advancements in technology have brought about the evolution of fifth-generation (5G) networks, which include new Radio Access Technology (RAT), enhancements in antenna technology, the utilization of higher frequencies, and the re-architecture of networks.

   From a technical point of view, 5G is basically a conglomeration of big data, cloud computing, artificial intelligence, and IoMT. The 5G-IoMT includes highly automated and intelligent activities at every stage that is synchronized from end to end. [12, 13]

   5G exhibits remarkable capabilities enabling simultaneous support of numerous medical devices, including sensors, mobiles, medical equipment, video cameras, and VR/AR systems. The advancement of 5G technologies is evident in various applications such as tele-consultation, telemedicine, intelligent medicine, and even remote surgery. [14, 15]

4. **Big data Visualization and Analytics (BDVA):** The vast amount of data must undergo precise analysis to ensure accuracy in decision-making. Big Data Visualization and Analytics (BDVA) is distinguished by attributes such as volume, variety, velocity, veracity, validity, volatility, and more. [16, 17] Utilizing Big Data Analytics has the potential to forecast disease outcomes, address epidemics, prevent avoidable fatalities, and enhance overall quality of life.

   In addition to collecting data from wearable sensors, the system also collects location, temperature, ambient, and medical data. Before sending this data to physicians or other remote users, database analytics extracts, cleans, and performs statistical analysis on it.[18, 19]

5. **Artificial Intelligence (AI):** AI utilizes clinical, laboratory, and demographic data to screen, diagnose, and forecast the prognosis of different diseases. AI has the potential to aid in the detection, extensive screening, monitoring, resource allocation, and prediction of potential interactions with newly proposed therapies. [20, 21]

6. **Block-Chain:** Extensive data sharing can potentially result in data fragmentation, causing gaps in transmitted information that can hinder the therapeutic process. 'Blockchain' technology was created to generate links amongst the network's data repositories in order to solve this problem. Blockchain is essentially an ever-expanding list of records, or blocks, where each item is hashed—a cryptographic technique—to the one before it. It is basically a safe chain of records that is created such that each record contains a cryptographic hash of the one before it and is impervious to tampering. [22, 23]

V. 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.

The Whoop Strap, which measures respiratory rate, disposable patches and biosensors developed by Philips for COVID-19 detection, Taiwan's comprehensive testing and tracing architecture, Scripp's "DETECT" system capable of gathering data from smart wearable devices, Eko's electrocardiogram tool designed to assess cardiac complications related to COVID-19, the portable ultrasound device "Lumify," along with other handheld portable ultrasound solutions, and AI-CT algorithms developed by Israeli technology company Aidoc Medical for COVID-19 detection are some examples.

Smart gadgets and remote health monitoring systems, along with robotics and drones, telemedicine and teledentistry platforms, and screening and early diagnosis, management, and enhanced quality of life, can all contribute significantly to illness prevention.

Raising life expectancy and lowering rates of morbidity and death greatly depends on the monitoring of critical functions, such as heart rate, skin temperature, and mobility, as well as nutritional condition and rehabilitation for aged or infected patients.

The creation of a Smart Hospital Information System has made it possible to connect lab data with several equipment, such as an MRI or CT scan, improving the detection of medical emergencies. This, in turn, facilitates medical staff in monitoring and making appropriate treatment decisions. It's worth noting that the transition to 'smart' hospitals can also lead to cost reductions by detecting abnormalities early, which could otherwise impact the accuracy of specific medical device readings and result in higher maintenance costs.

Dentistry has also embraced 'smart' technology, with recent advancements aimed at improving the efficiency, comfort, and reliability of dental procedures. Dental practice is about to undergo a transformation thanks to the combination of big data analytics, cloud computing, machine learning, and artificial intelligence algorithms. For instance, patients can take pictures and communicate pertinent data with distant dentists for in-person consultations using MouthWatch's TeleDent service, which provides a simplified tele-dentistry platform.

Machine learning approaches have been developed in oncology to precisely measure immune cells closely adjacent to oral cancer cells. This precision enables a deeper understanding of the cancer's spread and resistance, ultimately aiding in the determination of prognosis.[24-28]

VI. THE ROADBLOCKS

Despite the potential benefits and convenience of these healthcare monitoring devices in reducing the necessity for hospital visits, there are significant obstacles that must be addressed. Issues such as privacy, data security, data management, cost-effectiveness,

environmental considerations, and standardization pose major challenges. Addressing these challenges is crucial for the development of cost-efficient, flexible, and standardized systems that can effectively meet healthcare needs and gain widespread acceptance.[29-30]

REFERENCES

[1] Ashton K. That 'internet of Things' Thing. *RFID Journal*, 2009;22:97-114.
[2] Qiu F. Hospital Archives Intelligent Management System Based on 5G Network and Internet of Things System. *Microprocess Microsyst*. 2021;80:103564.
[3] Javed AR, Fahad LG, Farhan AA, Abbas S, Srivastava G, Parizi RM et al. Automated cognitive health assessment in smart homes using machine learning. *Sustain. Cities Soc*. 2021;65:102572.
[4] Islam SMR, Kwak D, Kabir MH, Hossain M, Kwak K. The Internet of Things for Health Care: A Comprehensive Survey. *IEEE Access* 2015;3:678–708
[5] Chirico A, Lucidi F, De Laurentiis M, Milanese C, Napoli A, Giordano A. Virtual reality in health system: beyond entertainment. A mini-review on the efficacy of VR during cancer treatment. *J Cell Physiol.* 2016 Feb;231(2):275–87. doi: 10.1002/jcp.2511
[6] Li A, Montaño Z, Chen VJ, Gold JI. Virtual reality and pain management: current trends and future directions. *Pain Manag.* 2011;1(2):147–157. doi: 10.2217/pmt.10.15.
[7] Birckhead B, Khalil C, Liu X, Conovitz S, Rizzo A, Danovitch I et al. Recommendations for methodology of virtual reality clinical trials in health care by an international working group: iterative study. *JMIR Ment Health.* 2019;6(1):e11973. doi: 10.2196/11973. https://mental.jmir.org/2019/1/e11973/
[8] Wang SS, Teo WZ, Teo WZ, Chai YW. Virtual reality as a bridge in palliative care during COVID-19. *J Palliat Med.* 2020 doi: 10.1089/jpm.2020.0212.
[9] Wang S., Parsons M., Stone-McLean J., Rogers P., Boyd S., Hoover K. Augmented reality as a telemedicine platform for remote procedural training. *Sensors.* 2017;17(10) doi: 10.3390/s17102294.
[10] Gerup J, Soerensen CB, Dieckmann P. Augmented reality and mixed reality for healthcare education beyond surgery: an integrative review. *Int J Med Educ.* 2020 Jan 18;11:1–18. doi: 10.5116/ijme.5e01.eb1a. https://www.ijme.net/pmid/31955150
[11] Ahanger TA, Tariq U, Nusir M, Aldaej A, Ullah I, Sulman A. A novel IoMT-fog- cloud-based healthcare system for monitoring and predicting COVID-19 outspread. *J Supercomput.* 2021 Jun 21:1-24. doi: 10.1007/s11227-021-03935-w
[12] Li S, Xu LD, Zhao S. 5G internet of things: a survey. *J Ind Inf Integration.* 2018 Jun;10:1–9. doi: 10.1016/j.jii.2018.01.005.
[13] Akpakwu GA, Silva BJ, Hancke GP, Abu-Mahfouz AM. A Survey on 5G Networks for the Internet of Things: Communication Technologies and Challenges", *IEEE Access.* 2018;6:3619-3647. https://doi.org/10.1109/ACCESS.2017.2779844
[14] Li D. 5G and intelligence medicine-how the next generation of wireless technology will reconstruct healthcare? *Precis Clin Med.* 2019 Dec;2(4):205-208.
[15] Stefano GB, Kream RM. The micro-hospital: 5G telemedicine-based care. *Med Sci Monit Basic Res* 2018;24:103–4. doi: 10.12659/MSMBR.911436.
[16] Wang Y, Kung L, Wang WYC, Cegielski CG. An integrated Big Data analytics- enabled transformation model: application to health care. *Inf Manag.* 2018;**55**(1):64– 79. doi: 10.1016/j.im.2017.04.001
[17] Wang Y, Kung L, Byrd TA. Big data analytics: understanding its capabilities and potential benefits for healthcare organizations. *Technol Forecast Soc Change.* 2018;**126**:3–13. doi: 10.1016/j.techfore.2015.12.019.
[18] Raghupathi W, Raghupathi V. Big Data analytics in healthcare: promise and potential.
[19] *Health Inf Sci Syst.* 2014;**2**:3. doi: 10.1186/2047-2501-2-3..
[20] Jagadeeswari V, Subramaniyaswamy V, Logesh R, Vijayakumar V. A study on medical Internet of Things and Big Data in personalized healthcare system. *Health Inf Sci Syst.* 2018 Sep 20;6(1):14.
[21] Adly AS, Adly AS, Adly MS Approaches Based on Artificial Intelligence and the Internet of Intelligent Things to Prevent the Spread of COVID-19: Scoping Review. *J Med Internet Res.* 2020;22(8):e19104.
[22] Chatterjee P, Tesis A, Cymberknop LJ, Armentano RL. Internet of Things and Artificial Intelligence in Healthcare During COVID-19 Pandemic-A South American Perspective. *Front Public Health.* 2020;8:600213
[23] Norfeldt L, Botker J, Edinger M, Genina N, Rantanen J. Cryptopharmaceuticals: increasing the safety of medication by a blockchain of pharmaceutical products. **J. Pharm. Sci-Us.** 108(9), 2838–2841 (2019

[24] Lovett L. Eko Lands EUA for device that Helps Detect Coronavirus Patients with Cardiac Complications. Available online: https:
[25] //www.mobihealthnews.com/news/eko-lands-eua-device-helps-detect coronavirus- patients-cardiac-complications (accessed on 11 may 2021).
[26] Groves M. Philips Receives FDA Clearance for the Use of Its Ultrasound Portfolio to Manage COVID-19-Related Lung and Cardiac Complications. Available online: https://www.philips.com/a-w/about/news/archive/standard/news/press/2020/2 0200513-philips-receives-fda-clearance-for-the-use-of-its-ultrasound-portfolio-to- manage-covid-19 related-lung-and-cardiaccomplications. html (accessed on 11 May 2021).
[27] Applied Radiology. Aidoc's AI-CT Algorithms FDA Cleared for COVID-19. Available online: https://www.appliedradiology. com/communities/CT- Imaging/aidoc-s-ai-ct-algorithms-fda cleared-for-covid-19 (accessed on 11 May 2021)
[28] Muthu B, Sivaparthipan CB, Manogaran G. *et al.* IOMT based wearable sensor for diseases prediction and symptom analysis in healthcare sector. *Peer-to-Peer Netw. Appl.* **13,** 2123–2134 (2020). https://doi.org/10.1007/s12083-019-00823-2
[29] Bisio C, Garibotto F, Lavagetto A, Sciarrone. "When eHealth Meets IoMT: A Smart Wireless System for Post-Stroke Home Rehabilitation," *IEEE Wireless Communications* 2019;26(6): 24-29. doi: 10.1109/MWC.001.1900125.
[30] Shamayleh A, Awad M, Farhat J. IoMT Based Predictive Maintenance Management of Medical Equipment. *J Med Syst* 2020;**44:**72 https://doi.org/10.1007/s10916-020- 1534-8

