

# Internet of Medical Things in the Healthcare Sector: A Comprehensive Review

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**ABSTRACT:** The technological novelties in the healthcare sector have been going through a drastic change. Newer and improved technologies play a crucial role in changing healthcare dynamics. One of the very interesting technologies in the Healthcare domain is the Internet of Medical Things (IoMT). The Internet of Medical Things is a network of interlinked and connected devices that transmits important data from patients and delivers it to doctors (or vice versa) in real-time. The IoMT devices help in accurate diagnosis and reduce healthcare costs.

**KEYWORDS:** Internet of Medical Things, Healthcare, Technologies, Devices.

## I. INTRODUCTION

Internet of Medical Things is multifaceted of connected technology solutions, IoT medical devices, systems, and the overall framework used in the health care industry [2]. It describes the overall medical devices coupled to a healthcare provider's computer system through the internet. These devices can produce, accumulate, analyze, and convey healthcare data [1].

It's a wave of sensor-based tools — including wearables and devices for remote patient monitoring [4]. It includes a broad range of applications, wearables, sensor-based devices, and spaces. For example,

Patient beds with sensor-enabled on it which can monitor patient activity and can alert nurses if patients show any movement or if any of the vital conditions change. The connected medical devices software for data analytics and visualization can transform generated data into insight and it can provide medical staff, doctors, and hospital management valuable information required in the treatment and care of patients. IoMT deals with sensitive data such as patient's personal information and medical records, treatment plans, location, real-time change are health conditions [2].

When it involves IoMT devices development, the main target of the planning for the Internet of Things medical devices is shifted towards reliability and robustness instead of consumer likability [2].

## II. IOMT IN HEALTHCARE

Global healthcare spending is predicted to grow from \$7.1 trillion in 2015 to \$8.7 trillion by 2020 [7]. The emergence of the web of the Internet of Medical Things (IoMT) has introduced a monumental change in facilitating the management of diseases, improving disease diagnosis and treatment methods, and decreasing healthcare expenditure and errors [3].

The capabilities of IoMT are more precise diagnoses, lesser mistakes, and lower costs of care. The technology present in smartphones and applications allows patients to send their health details to doctors to improved examining of diseases and track and prevent chronic illnesses.

Some digital medicine companies, like Proteus Discover, have focused on smart pill capabilities on measuring medication treatment efficacy to enhance clinical outcomes. Others, like HQ's CorTemp, are using the pills to watch patients' internal health, wirelessly transmitting data such as core temperature — measurements which will be critical in life or death situations [4].



- Patient monitoring isn't the sole application IoMT finds in hospitals and clinics. MRIs, X-ray machines, CT scanners, and other equipment are often remotely monitored for performance issues. Long before the hospital staff notices a drag, the manufacturer or service vendor can detect issues that require to be corrected.
- GE, Siemens, Philips, and other companies use IoMT for distant diagnostics, predictive maintenance, and performance upgrades to their imaging products.
- Remote Patient Monitoring (RTM) enables many patients affected by chronic disease to avoid regular visits to the doctor. Heart patients and diabetics, especially, can enjoy RTM technology. Portable RTM devices can monitor patients' heart activity and glucose levels, and automatically alert the doctor when there's an issue.
- Advances in biosensor technology changed wearable smart devices that monitor the user's health. Weather embedded in apparel, attached to the body, or implanted, on-the-body IoMT sensors provide patients freedom while maintaining a closer look at their health conditions [5].

### III. GLOBAL IOMT MARKET

The IoMT market, which may be seen through either a component or an application lens is predicted to grow at a compound annual rate of growth (CAGR) of 30.8 percent, from \$41.2 billion in 2017 to \$158.1 billion by 2022. [2] This growth is because of the rapid digitization of health care systems to assist efficient patient care, the increase within the demand for mobile health care technologies, and a rise in demand from an aging population and other people affected by chronic diseases.

In 2017, North America accounted for the most important share of the IoMT market (\$13.3 billion or 33 percent of the entire market) followed by Europe (\$12.4 billion), Asia- Pacific (\$11.0 billion), the center East and Africa (\$2.4 billion) and South America (\$2.1 billion) [7].

### IV. OVERVIEW OF IOMT IN INDIA

In 2017, eHealth was introduced as a workflow-based ICT solution for hospitals within the government sector. Patients with access to the web can register themselves with the e-Hospital to access and consider their medical records while their physicians, through a pre-consented process, can use their data to supply remote suggestions and medical devices. Beyond government initiatives, many small and enormous private firms have supported the digitization initiatives in the Indian healthcare system. In clinical trials, IBM Watson helps pharmaceutical firms actively identify eligible trial participants to assist maximize placement into suitable clinical trials and ultimately improving enrolment target success [15].

More consumer devices today involve near field communication (NFC) – a typical for wireless connectivity – and frequency identification (RFID), allowing the applications for IoMT to still expand.

These devices gather and transmit the data to healthcare providers. This allows remote patient monitoring and preparation beforehand to tackle any issues when they occur [6].

**Table 1: Types of IoMT Devices**

Non Invasive/ Wearable Sensor Devices	Invasive/ Implantable Sensor Devices
Electrocardiogram Glucose Sensor(ECG)	Implantable defibrillator
Electromyography (EMG)	Wireless capsule endoscope
Temperature	Electronic pill for drug delivery
Pulse oximeter	
Blood Pressure	
Oxygen	

- IOMT comprises several smart devices:
- Heart rate and motion tracking with the help of smartwatches
- Measurement of glucose levels with the help of contact lenses
- The vital monitoring of the body's function by biometric stamps
- Other wearable devices such as clinical-grade wearables eg. smart belts which provide hip protection by detecting falls for the elderly people which are used as and when advised by the physician. Smart garments and activity trackers are examples of wearable devices.
- Patient monitoring devices are used by clinicians to monitor the patients who are recently discharged by the hospital and also to monitor patients managing chronic diseases [7].

#### V. BENEFITS OF IOMT

- Patient's health can be tracked in the hospitals and remotely with the help of wearable technology that is convenient both to the doctors and the patients and it also helps to manage the resources. Detailed patient data can be collected on the patient's condition.
- Medication intake monitoring helps to increase patient compliance and influences patient engagement.
- Timely diagnosis and personalized healthcare services can be provided to the patients based on the new reliable sources of patient datum which is possible with the help of connected technology.
- IOMT devices such as wearables and pills that have tracking capabilities can change the healthcare systems [7].

#### VI. CHALLENGES OF IOMT

- High security is needed to prevent the sensitive patient data in data streaming sensors such as treatment details and patient's condition from cyber-attacks. IoT, in general, implies dealing with huge amounts of data streaming from sensors. When it comes to IoT in medical devices, this data is often highly sensitive — patients' condition information and location, treatment details, etc. Therefore, it requires particular attention to proper security and practices to address possible cyber attacks in place
- For every IoT device requirement of continuous connectivity is essential. Reliable uninterrupted connectivity is important for every IoT device which is supposed to continuously manage real-time data. [7].
- FDA approval is required for the clinical grade medical devices for introduction in the market [16].

#### VI. IMPACT OF IOMT IN HEALTHCARE

Medtech companies will be able to adopt new changes in the healthcare systems from openings created by advanced sensors, artificial intelligence, 3D printing technologies. Doctor visits, healthcare at home, and chatbots utilize IOMT provided voice technologies.

IOMT capabilities are being utilized to aggregate data and also predictive analytic consultative services by the companies. Healthcare data are also provided to the organizations which previously had difficulties in obtaining data outside of their organizations. Medtech companies have opportunities to switch from providing innovative products to insightful partnership in healthcare [7].

#### VII. FUTURE OF IOMT

In 2018, four million wearable devices were in usage. According to Forbes by 2021 global IOMT market is expected to reach \$136.8 billion. Some of the benefits provided by IOMT in healthcare are:

- Better Pharmaceutical Management
- Improved patient care and outcomes
- Chronic diseases- remote monitoring
- Upgraded diagnosis and treatment
- Enhanced disease management

In order to prevent breachment of data and cyber-attacks the healthcare operations must oblige to frequent system updates imperative to patient healthcare record protection [7].

#### Key Developments in the IoMT Market

- Introduction of digital oncology medicines for cancer patients by Proteus Digital Health along with Fairview Health Services and the University of Minnesota Health in January 2019 which will help in bringing about better patient outcomes. This technology enables the patients to complete their oral chemotherapy course and offers patient's information.
- Wireless fetal monitoring devices by Monica Healthcare help in improving the birth experience for mothers [9].

#### IoMT in COVID-19

- Major risk parameters for COVID-19 such as the skin temperature, oxygen saturation, pulse rate, respiratory rate, etc. can be screened within two minutes by VinCense- device based on the Internet of Medical Things (IoMT) technology [8].
- In COVID-19 cases the number of cured patients, number of active cases, and number of deaths in various regions can be tracked and monitored with the help of IOMT technology. This can help to analyze the disease severity and activity which is further predicted by AI that helps in making better decisions [10].
- Doctors and healthcare workers are most susceptible during their period of service, CIoMT technology helps to remotely monitor the patient's Blood Pressure Level, Heart rate, Electrocardiogram (ECG), Electromyography (EMG), Electroencephalogram (EEG), Pulse rate, Glucose level, etc with the help of fingertip medical data [11-13].
- X-ray and computed tomography (CT) scan can be taken by the lab technicians through the live stream video images which are further computed by visual sensors enabled by Artificial Intelligence [14].

#### VIII. CONCLUSION

Even though the automation in the healthcare sectors has not been in force till now in the country but its operational efficiency shall help in preparing the healthcare sector. This productivity too poses some risks in its operation and enactment like breaching of information and theft of data. Keeping in mind, both its benefits and the challenges, the Internet of Medical Things seems to be a helpful and promising initiative in the healthcare sector.

#### REFERENCES

1. What is Internet of Medical Things? [cited 2020 Aug 3]. Available from: <https://www.newenglandcollegeonline.com/resources/healthcare-administration/what-is-the-internet-of-medical-things/>
2. Internet of Medical Things & Medical Software Development. [cited 2020 Aug 4]. Available from: <https://www.digiteum.com/internet-medical-things-medical-software-development>
3. Alsubaei F, Abuhussein A, Shandilya V, Shiva S. IoMT-SAF: Internet of medical things security assessment framework. Internet of Things, vol. 8, pp.100123, 2020.
4. How the Internet of Medical Things is impacting Healthcare. [cited 2020 Aug 6]. Available from: <https://healthtechmagazine.net/article/2020/01/how-internet-medical-things-impacting-healthcare-perfcon>
5. Internet of Medical Things (IoMT) - The Future of Healthcare. [cited 2020 Aug 7]. Available from: <https://igniteoutsourcing.com/healthcare/internet-of-medical-things-iomt-examples/>
6. RFID –IoT Agenda. [cited 2020 Aug 7]. Available from: <https://internetofthingsagenda.techtarget.com/definition/RFID-radio-frequency-identification>.
7. Medtech and the Internet of Medical Things. Deloitte Centre for HealthSolutions. [cited 2020 Aug 8]. Available from: [gx-lshc-medtech-iomt-brochure%20IOMT.pdf](https://www.deloitte.com/au/assets/pdf/medtech-iomt-brochure%20IOMT.pdf)
8. Healthcare startup MedIoTek's IoMT device helps prescreen COVID-19 patients. [cited 2020 Aug 8]. Available from: <https://yourstory.com/2020/04/coronavirus-healthtech-startup-mediotek-iomt-device-covid-19>.
9. Internet-of-Medical-Things (IoMT) Market (COVID-19 Impact Analysis). [cited 2020 Aug 9]. Available from: <https://www.pharmiweb.com/press-release/2020-08-10/internet-of-medical-things-iomt-market-covid-19-impact-analysis-research-with-size-shares-driv>
10. Vaishya R, Javaid M, Khan IH, Haleem A. Artificial Intelligence (AI) applications for COVID-19 pandemic. Diabetes & Metabolic Syndrome: Clinical Research & Reviews; 2020.



11. Ting DS, Carin L, Dzau V, Wong TY. Digital technology and COVID-19. *Naturemedicine*, vol. 26, pp. 459-61, 2020.
12. Pan XB. Application of personal-oriented digital technology in preventing transmission of COVID-19, China. *Irish Journal of Medical Science (1971)*, vol. 27, pp. 1-2, 2020.
13. Sood SK, Mahajan I. Wearable IoT sensor based healthcare system for identifying and controlling chikungunya virus. *Computers in Industry*, vol. 91, pp. 33-44, 2017.
14. Shi F, Wang J, Shi J, Wu Z, Wang Q, Tang Z, He K, Shi Y, Shen D. Review of artificial intelligence techniques in imaging data acquisition, segmentation and diagnosis for covid-19. *IEEE reviews in biomedical engineering*, 2020.
15. Evolving role of AI, IoMT and Big Data analytics have redefined the shape of Indian healthcare market. [cited 2020 Aug 10]. Available from: <https://health.economictimes.indiatimes.com/news/health-it/evolving-role-of-ai-iomt-and-big-data-analytics-have-redefined-the-shape-of-indian-healthcare-market/77004049>.
16. A Detailed Guide ToIoMT Implementation in 2020. [cited 2020 Aug 10]. Available from: <https://arkenea.com/blog/iomt/>