

# A Review on Internet of Medical Things (IoMT) in COVID-19

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**Abstract.** The Internet of Medical Things (IoMT) is an emerging technology that integrates medical devices, software applications, and healthcare systems through the Internet of Things (IoT) infrastructure. It facilitates real-time monitoring, diagnosis, and remote healthcare services, significantly transforming traditional healthcare practices. This paper presents a comprehensive review of IoMT, highlighting its evolution from IoT, key components, major applications, and its pivotal role during the COVID-19 pandemic. It explores various use cases such as wearable health monitors, ingestible sensors, virtual home assistance, and personal emergency response systems. Furthermore, it discusses the benefits of IoMT in enabling remote patient care, reducing hospital visits, and ensuring timely interventions. The paper also examines the major challenges associated with IoMT implementation, including cybersecurity, interoperability, data accuracy, device mobility, and cost. By addressing these challenges, IoMT has the potential to revolutionize the healthcare industry, making medical services more accessible, efficient, and patient-centered.

**Keywords:** Internet of Medical Things (IoMT) · COVID-19 · Health Informatics · Remote Health Monitoring.

## 1 Introduction

The term IoT refers to “Internet of Things”. It is a dynamic global network infrastructure with self-configuring capabilities. Generally, IoT comprises of things that have unique identities through which they are connected to the internet. The focus of IoT is in configuration, control and networking via internet of devices or things that are traditionally not associated with the internet. IoT is driven by the advancements in capabilities in combinations with low cost sensor networks, mobile devices, wireless communications, networking and cloud technologies. Generally, IoT is a group of technologies/devices such as Sensors, Embedded systems, Data Analytics, Mobile and Mobile internet, Security aspects Protocols and Cloud storage. There are 4 main pillars of IoT. They are: Data, Device, Analytics and Connectivity. The term “Internet of Things” was coined by “Kevin Ashton”, MIT’s executive Director of Auto-ID Labs in 1999. Besides being an

innovator he was also a consumer sensor expert too. He was the first one to describe the network connecting objects and he authored many new books such as “How to Fly a Horse”. Early i.e; in twentieth century, computers are just made to work without any capability of sensing of objects. But later on, in twenty-first century, computers can sense objects for themselves and the best example for this is GPS-based location sensing. Although Kevin Ashton termed the definition of Internet of Things, the first IoT device “Smart Toaster” was invented by John Romkey” in 1990 which can be controlled and monitored automatically through the internet. John’s invention was showcased at the INTEROP conference. [1]

These days, IoT is gradually expanding its features mainly in health-care sector and termed as “IoMT” (Internet of Medical Things). IoMT is an emerging technology that helps us to connect medical devices, hardware infrastructure and software applications to healthcare information technology through online computer networks. The basis of IoMT is to allow machine-to-machine communication. Research analysts expects that over 7.4 million IoMT devices to be deployed globally. Some of the example of IoMT devices include remote patient monitoring system for chronic diseases and also tracking the location of patients. Not only these, it also includes various smart wearable devices to remotely monitor oxygen, sugar, blood pressure levels to corresponding doctors that are connected to the internet.

This IoMT approach is more beneficial in pandemic situations as it allows only virtual connection between doctors and patients and there is no risk of spreading of chronic diseases. By this approach, we can reduce the hospital visits and also the cost. The main difference between IoT and IoMT is that IoMT devices are medical devices that are connected to healthcare IT systems where as IoT devices are designed in such a way that it provides more flexibility to use by the people by connecting to the internet and also helps in improving efficiency..It allows wireless and remote devices to firmly communicate the data over the internet which allows flexible and rapid analysis of medical data.

This Wearable technology has been found since 1500. The first IoMT device was invented by Peter Henlein. He was a locksmith as well as clockmaker from Nuremberg in Germany. He invented small and portable watches which are worn as necklaces or attached to clothing. The best modern example is Apple Watch. This technology is used to track individual’s health such as heart-beat rate, glucose levels, oxygen and blood pressure levels in order to maintain a healthy life and it also makes alters to doctors or clinical staff in case of any emergencies. Especially health apps that works only when there are sensors embedded in smart devices to collect a patient’s data and transmits, which helps doctor to remotely monitor the patient’s health without any regular check ups. This app also reminds patients to take medicines at a in-time as directed by the doctor. According to the report, which was released by IMS Institute for Healthcare Informatics in 2015, it was found that there are more than 165,000 health-related apps that are available throughout the world. In the United States, experts of ABI Research states that digital wearable medical devices sales will top 55 billion dollars in 2022.

## 2 Literature Survey

RaviPratap Singh et al. in his research explained about the potential for using the IoMT strategy to treat orthopedic patients while battling the ongoing COVID-19 outbreak. The IoMT idea offers the treatments and solutions to the concerns related to orthopedic patients by utilizing the advanced technology and intelligent machine learning based methods. [2]

Azana Hafizah Mohd Aman et al. author proposed a new framework in terms of technology advancement, adoption and potential within the context of the COVID-19 pandemic and highlights security concerns specific to IoMT in general. [3]

Gulraiz J. Joyia et al. in his research provided an overview of the Internet of Things, the various uses it has adopted, and how it is resolving issues that the global health care sector is facing. The researchers will also benefit from this effort in their understanding of IoT applications in the healthcare domain. [4]

Shikha Jain et al. in her research explained about the Synergetic approaches using IoMT and POCT-based biosensing systems that provide benefits to a wide range of communities including microbiology, immunology etc. The research is done to explore new and smart biosensing technology employing novel nanosystems, bioactive chemicals and computer analytics. [5]

Anand Nayyar et al. researcher key objective in this research is to design biosensor-based smart health monitoring system—BioSen Health 1.0. This system helps in measuring heart beat, pulse rate and oxygen level of patients. The way people manage their health will change dramatically as a result of systems like this, which also help doctors accurately predict patients pre-health. [6]

## 3 Applications of IOMT

As IoMT is a new emerging technology, several applications are developed using this emerging technology [7].

### 3.1 IoMT as a Movement Detector

Movement Detector is the latest application or invention associated with IoMT technology. This system is used to detect the motion of immobile patients. So, in order to monitor the movements of patients, we embed smart monitors and sensors on clothing, bed or skin of patients. By this type of implementation, we can track the movements of immobile patients for providing better insights about their condition. Here, we use Wi-Fi motion sensor that actually sends the notification about patient condition through mobile app.

### 3.2 Real-time Patient Health Monitoring

This system includes various wearable sensors that track health status of a particular patient in order to maintain a healthy and peaceful life. Here, we use different

sensors in order to collect medical information such as heart-beat rate, glucose levels, blood pressure, oxygen levels and also temperature of the body. This system is mainly used for those patients, who need consistent monitoring of their health and this is a cost effective process. The data received by these sensors is used to determine the seriousness of the situation. In case of emergency, this system raises alerts through notifications.

### **3.3 Fitness Tracking and Diagnostics**

Fitness Tracking is a booming technology in the present world as the people are more conscious about their health. Fitness Tracker is an electronic wearable device that is designed in such a way that it records all the information about your physical fitness, heart rate, calories burned per day and step counts. Self fitness tracking allows us to maintain a healthier diet, sleep better and also exercise more [8]. Regular usage of this fitness tracker allows us to reach our daily goals and also increase the speed of daily workouts too. Basically there are 3 types of fitness trackers. They are: Heart rate monitoring trackers, Basic fitness trackers, Heart rate monitoring trackers with GPS.

### **3.4 Ingestible sensors and Cameras**

These ingestible sensors allow us to monitor whether a patient has taken the medicine or not and also for measuring pH, pressure and temperature. These sensors are pill-sized electronics that send data to your smartphone immediately when you pop and swallow. Researchers are using these sensors to detect medical molecules and also diagnose other gastrointestinal ailments. These are used for screening of diseases and are cost-effective.

### **3.5 Smart Continuous Glucose Monitoring**

This system is mainly used for diabetic patients, which helps them to monitor their glucose levels in order to reduce health risks. Continuous Glucose Monitor consists of a tiny sensor which is usually fixed on the belly or arm. This sensor is used to measure the glucose found in the fluid between cells and this process proceeds to continue for every few minutes. A wireless transmitter is used to pass the collected information to the monitor. So, this monitor is used to analyze the collected data and also takes the necessary action in case of any risks. There are some CGM's that directly transmit the information to the patient's smartphone/tablet. CGM data receiver is a separate device that collects the data from the tiny sensor [10].

### **3.6 Virtual Home System**

This Virtual Home assistance is mainly used for senior citizens who cannot travel from one place to another easily. Especially during the COVID-19 pandemic, this

technology gained relevance. It provides virtual assistance to patients to ensure appropriate treatment at home. This system uses smart sensors integrated with AI for greater connectivity. It is particularly helpful for patients suffering from chronic diseases. One example is Lenovo Health, in partnership with Orbita Health, which developed a voice-command-based system to connect patients seamlessly with doctors.

### 3.7 Personal Emergency Response Systems

Currently, there is a lack of systems that provide immediate response during emergencies, such as when an accident occurs. IoMT plays a crucial role by enabling devices to send real-time help alerts. These devices track patient conditions and ensure prompt action during emergencies. A notable example is the ActiveProtective smart belt, which uses Bluetooth and AI to send real-time information to caregivers or emergency responders. This system helps save lives by ensuring timely action during medical crises.

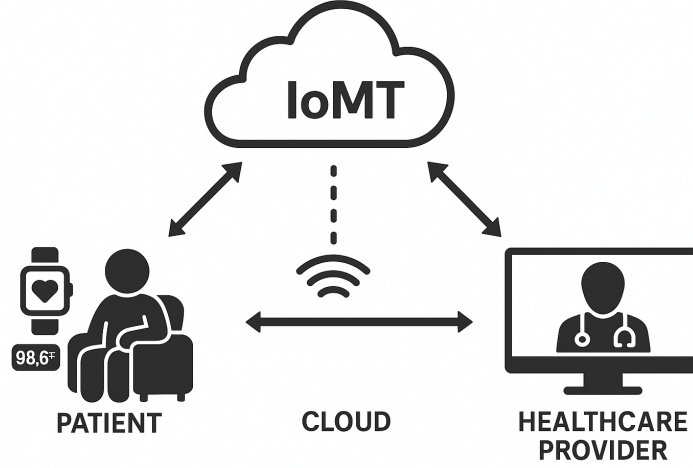
**Table 1.** Key Applications of IoMT and Their Functions

Application	Purpose	Examples
Movement Detection	Tracks immobile patient movement using sensors	Apple Movement Disorder API
Real-time Health Monitoring	Monitors vital signs remotely and alerts on abnormalities	DocBox, wearable ECG monitors
Fitness Tracking & Diagnostics	Tracks fitness levels, sleep, and daily activity	Fitbit, Apple Watch
Ingestible Sensors & Cameras	Swallowable devices for diagnostics and internal monitoring	PillCam, Digital pill sensors
Continuous Glucose Monitoring (CGM)	Monitors glucose levels continuously for diabetics	Medtronic Guardian Connect
Virtual Home Assistance	Provides care and connectivity to elderly patients at home	Lenovo Health + Orbita AI
Personal Emergency Response Systems	Sends real-time alerts during emergencies	ActiveProtective smart belt

## 4 Role of IOMT in COVID-19

IoMT played a crucial role in providing medical services during the COVID-19 pandemic, especially in remote and underserved areas. It allowed healthcare professionals to offer virtual assistance, particularly to orthopedic patients who required continuous care. IoMT-enabled systems used machine learning and connected devices to deliver timely diagnosis and treatment. This virtual approach reduced patient stress, minimized hospital visits, and prevented the spread of infection. Patients were able to consult doctors remotely, and medical data was

transmitted securely over the internet. This led to increased efficiency, better health outcomes, and optimized use of medical resources.



**Fig. 1.** IoMT-enabled virtual care model implemented during the COVID-19 pandemic

## 5 Challenges of IOMT

### 5.1 Cybersecurity

As we already know that data security is one of the major problem these days. The reason behind this is the quality of data transmitted or received through these medical devices and the advanced technology used. We can see few years back, lot of data breaches has takes place. It may be patient's personal or financial information such as date of birth, name bank account details, phone number etc. As hacking in these days is very easy, so inorder to provide more security to the patient's data, we should develop the product with HIPAA (Health Insurance Portability and accountability act) [13].

### 5.2 Interoperability

The data should be easy to access inorder to ensure perfect outcomes of the patient's condition. So, to ensure easy accessing of data, the data must be in sorted data. so that analysis of data becomes easier. Here, IoMT managing system lacks interoperability. So, it becomes easier to extend data interoperability if we use open platforms and open-data standards. As some departments in hospitals has no or little communication about using of network simultaneously designed by various companies.

### 5.3 Device Mobility

As device remains in stationary mode i.e; in only one spot at the time of treatment or data handling. By this, the performance of device also decreases. So, inorder to overcome this dual network should be used to allow the device configuration to interchangeable network use and therefore, performance also increases. IoT-enabled mobility provides greater medical assistance to patients. There is also a greater facility for patients to avail the medical prescriptions right at the home itself without any burden of approaching the hospitals.

### 5.4 Data Overload and Accuracy

As the data is not uniform, so it is difficult to aggregate the data and analyze in a proper manner. We already know that IoT device collects bulk amount of data and this data has to be segregated in a proper manner inorder to avail better results. If the data is overloaded, then decision making process is also affected. So, to overcome this, the data has to be separated into different chunks and this makes the decision making process very easier and the results are accurate enough inorder to come to a conclusion.

### 5.5 Cost

We already know that cost is one of the biggest challenge while planning such as app development for healthcare systems. But this will not become major issue if we spend significant amount of money on IoMT application development and this will return a huge amount of money than we invested and also saves the manpower and time too. We can increase the revenue by improving the business processes and by providing several business opportunities through IoMT [14].

## 6 Conclusion

This paper consists an overview of IOMT technology and how this technology works and how it is evolving in present system. This paper also discusses about the applications and uses of IOMT technology. From this paper, we can conclude that IOMT (Internet of Medical Things) technology consists of several sensors which helps in gathering/collecting the data from various IOT devices and also helps in analyzing the data which is collected from sensors. Also there are several remote applications developed which helps in easy access of data. It contains detailed review of IOMT technology and also it's role in the society. It also talks about the changes that occurred by implementing this technology. By introducing this new system, people have made their lives easier to live in this contemporary world. It also consists of challenges that will be facing by implementing this technology and also solutions to overcome those challenges. As IOMT is totally related to healthcare, it makes the lives of the patients to be treated in a better manner without any direct contact as this may leads to

spreadness of diseases. The security aspects are also taken in consideration in order to develop a safe and secure virtual connection between doctors and patients. Finally, we can conclude that IOMT helps in remote access of patients which is especially required in case of treating elderly people and also leads to live a better quality of life.

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