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Short Review

Internet of Medical Things

Narendra Kumar Jain*

Ex-Professor and Head, Department of Pharmaceutical Sciences, Dr. H. S. Gour University, Sagar, Madhya Pradesh, INDIA.

ABSTRACT

Quality healthcare has been universally recognized as a fundamental human right, but sadly, this right is not sufficiently fulfilled globally. The goal of healthcare 4.0 is to completely revolutionize the healthcare delivery system and part of its bigger framework includes the Internet of Medical Things, or IoMT. IoMT devices are changing patient care and the healthcare industry. IoMT is being used by a number of hospitals and clinics to run their healthcare IT systems more profitably and efficiently. On one side these new technologies connect patients and providers much closer, on the other hand they are making feasible new forms of treatments and boosting consumers' quality of life.

Keywords: Healthcare 4.0, Internet of Medical Things, Internet of Things, Medical devices, Patient monitoring.

Correspondence:
Prof. Narendra Kumar Jain
Ex-Professor and Head, Department of Pharmaceutical Sciences, Dr. H. S. Gour University, Sagar-470003, Madhya Pradesh, INDIA.
Email: dr.jnarendr@gmail.com

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INTRODUCTION

The Internet of Medical Things (IoMT),[1] a subset of the Internet of Things (IoT)[2] that leverages the Internet, is a highly promising scientific advancement that the pharmaceutical domain, specifically the manufacturing industry and the health care technologies as well as systems, are quickly adapting to. Hence our understanding of the IoMT would be improved by a brief introduction to IoT and the Internet itself.

Internet

The Internet is widely used by people of all ages worldwide. The Internet is a massive global network that links computers worldwide. These days, a highly connected global computer network known as the Internet is credited with facilitating faster and easier communication across borders. The Internet, also referred to as a "network of networks," first appeared in the US in the 1970s but was not widely accessible until the early 1990s. Approximately half of all people on the planet had access to the Internet by 2020. Approximately 67% of people worldwide accessed the internet in 2023, compared to 55% of Indian users. The rise of "smart" technology and the "Internet of Things" may be credited for the faster-than-expected growth in the number of internet users.

Internet of Things

Internet of Things (IoT) represents a sophisticated network of computer-like devices that engage with the internet through wireless connections.[3] This interconnected system possesses distinctive characteristics, enabling the transmission of information across a network. These 'things' encompass smartphones, appliances and security cameras etc.,

The Internet of Things pertains to the interconnectedness of various physical devices embedded with transducers such as sensors, detectors, actuators, electronic components and associated web links, facilitating seamless data exchange in real-time contexts.

In the realm of pharmaceuticals, IoT holds the potential to fundamentally reshape the industry by enhancing and automating the individualized care of patients, the development of various drug types, their accessibility and beyond.

IoT is potentially transforming the pharmaceutical industry by offering and automating drug research, pharmaceutical production, remote patient monitoring and more. Furthermore, digitization has a lot of potential to support pharmaceutical companies in overcoming several obstacles. In the field of information technology, IoT is also a buzzword!

Internet of Medical Things

One unique application of IoT is IoMT. It is the combination of medical equipment with the IoT. IoMT, a subset of IoT technologies, includes applications and equipment that are networked together and are utilized in medical and healthcare IT applications.[4] The Internet of Medical Things (IoMT)[5] is essentially a grouping of medical apps and devices that are

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connected to online computer networks that house healthcare IT systems.[6] IoMT devices connect to cloud platforms so that collected data can be processed and saved there. The IoT is a massive universe that is being used for innovation by the healthcare industry, which is remarkably quick to adopt new technology. The foundation of IoMT, machine-to-machine communication, is made possible by medical devices that have Wi-Fi.[7] IoMT is of special interest to pharma world.

Medical equipment can connect with each other independently across a network, thanks to a sort of IoT technology called IoMT devices. IoMT networks are used to gather and send patient data to healthcare professionals, often without the patient's or a doctor's consent.

IoMT is sometimes referred to as healthcare IoT[5] or Internet of Medical things (IoM). The term "telemedicine" refers to the use of IoMT devices to remotely monitor patients in their homes. This type of care relieves patients of the need to visit a hospital or doctor's office if they have a medical concern or notice a change in their condition.[8]

IoMT is a key paradigm projected to alter the healthcare sector and bring unique healthcare services. With developments in sensor technology, communication and data analytics,[9] it is anticipated to keep growing. An increase in the number of linked medical equipment will facilitate remote patient care, real-time monitoring and early health concern detection. By facilitating remote care, customized therapies and ongoing monitoring, it can enhance patient outcomes. Transmission of data in real-time can help with early intervention, which lowers complications and readmissions to the hospital.

Healthcare systems may become more efficient, individualized and proactive by utilizing technology. To optimize the advantages of these developments, however, implementation issues, privacy concerns and data security must also be addressed.

IoMT expands the quantity, diversity and speed at which health data is gathered, transferred and analysed, making it more readily available to caregivers. Greater communicated data improves the decision-making capacities of both patients and providers.

The networks and devices made possible by IoMT allow for virtual and telemedicine care. During the height of the COVID-19 pandemic, remote healthcare skills gained popularity as a technique to reduce the number of patients who had to travel to medical facilities and to ease the pressure on already overworked hospitals and other medical facilities.[8]

ADVANTAGES OF IOMT

Following are the salient advantages of IoMT, particularly in the health care sector.

Remote Patient Monitoring (RPM)

When an IoT device gathers patient data, it transmits the information to a software program[10] so that patients and/or medical professionals can access the same. One of the biggest challenges with RPM devices is protecting the extremely personal information that these IoT devices gather. People with long-term illnesses and chronic ailments will particularly benefit from this.

Patient monitoring systems

patients with chronic diseases can get round-the-clock health monitoring; thanks to IoMT. Better information on the patient's living situation is also provided to clinicians, which may have an impact on treatment.

Monitoring of Glucose

IoT-enabled glucose monitoring devices can aid in addressing these issues by continuously and automatically monitoring patients' blood glucose levels.[11] With glucose monitoring devices, patients can be alerted when their blood sugar levels are troublesome and manual record-keeping is eliminated.

Monitoring of Heart-rate

With the availability of numerous tiny Internet of Things (IoT) devices for heart rate monitoring, patients can roam about as they want with the assurance that their hearts are being continually monitored with approximately 90% accuracy.

Monitoring of Hand hygiene

In order to reduce the danger of infection, healthcare providers and patients inside a healthcare facility must wash their hands thoroughly.[10] IoT devices are used by hospitals and other healthcare facilities in the modern era to remind patients to wash their hands before entering a room. The devices can even give instructions on how best to sanitize to mitigate a particular risk for a particular patient.[12]

Tracking depression and emotional state

"Mood-aware" IoT devices have the ability to gather and evaluate data, including blood pressure and heart rate and can also deduce details about a patient's mental health. Even the movement of a patient's eyes can be tracked by sophisticated IoT devices for mood monitoring.

Monitoring of Parkinson's disease

Healthcare professionals can use IoT devices to continuously gather data about Parkinson's patients' symptoms and determine how the severity of their patients' symptoms varies throughout the day.[10]

Accessibility

Patients have greater access to health services and education, thanks to IoMT. Through a telehealth application, patients have

additional alternatives for services and can access them whenever needed.

Better outcomes for patients

IoMT makes it possible to employ cutting-edge technology that promotes patient self-care and reduces the need for in-person appointments.[8] Patients can now obtain data that they might have previously needed to see a doctor for thanks to consumer-grade wearables. IoMT devices free doctors from the need for human caretakers by enabling remote patient monitoring and instantaneous alerts in the event of an issue.

Accuracy

More data is made available by IoMT, which helps medical professionals understand patients' health status more precisely. For instance, data from multiple days' worth of blood pressure and heart rate measurements from an IoMT-enabled blood pressure monitor can produce a diagnosis that is more reliable than information from a single doctor's appointment.

Economy

Part of the expense of an in-person patient visit to a healthcare facility can be avoided with RPM and telehealth. In addition to saving providers money and time, faster processing of health data allows them to focus their resources where they are most needed.

Logistics

Healthcare facilities employ IoMT devices to monitor their equipment and give notifications when maintenance needs to be done or other problems occur. In order to reduce confusion and errors, they are also utilized as trackers to follow patients and medication throughout the campuses of medical facilities.[1]

Patient empowerment

IoMT devices give patients the ability to take charge of their health by providing them with information that would otherwise require a visit to the doctor, such as wearables and smart scales. Patients can now monitor their health in real-time instead of waiting for an annual check-up.

Upgraded operations

IoMT facilitates easier, more centralized control of hospital facilities for administrators and physicians, which enhances hospital operations. IoMT devices can give doctors new technology like robotic surgical instruments and high-resolution digital imaging systems, as well as more vision into their surroundings.

Tracking patient medication orders

This can significantly reduce the risk of probable drug errors.

Monitoring the whereabouts of hospitalized patients.

Big hospitals can really benefit from this.

Gathering information from wearable mobile health devices owned by patients.[7]

Establishing connections between medical personnel and ambulances traveling to hospitals.

TYPES OF IOMT DEVICES

The types of IoMT devices are often categorized based on their environment.[1]

Mobile IoMT

Near-field communication and Radio Frequency Identification (RFID) tags are used by many consumers' mobile devices that people carry around, such as cell phones, to allow devices to communicate data with other IT systems. For instance, medical staff can access data from their organization's network and patients can operate glucose monitors that are networked using their smartphones.

Community IoMT

These devices, also known as Public IoMT, are scattered throughout a certain area. Point-of-care kiosks, for instance, link patients and healthcare professionals and provide medicinal supplies. They provide access to healthcare and healthcare systems for patients living in rural locations without access to conventional medical institutions.

Wearable IoMT

These devices, which are attached to a person's body and capture medical data, are also referred to as on-body IoMT. Wearable tech might be of the consumer or medical markets. For instance, consumer-grade on-body IoMT that collects health information like blood pressure and heart rate is called a smartwatch. It is possible to track health metrics and promote wellness with consumer-grade smart gadgets without a doctor's supervision. On-body, medical-grade IoMT is utilized under a physician's supervision. As an illustration, consider a neuromodulation tool that modifies a patient's neurological system to reduce pain. One kind of wearable IoMT is the smart pill, which is an edible sensor that gathers data from the patient's internal organs.

In-home IoMT

Devices are positioned or used within a patient's residence. Personal emergency response systems, for instance, make use of household appliances to notify a hospital in the event of a patient emergency. Patients with long-term medical issues are monitored in their homes with RPM devices.

In-hospital IoMT

Internet access is used by hospitals to improve patient care. Examples include hospital beds equipped with sensors to monitor patients' vital signs and infusion pumps that link to analytics dashboards.[13] IoMT devices are also used by hospitals for inventory and asset management. Hospital employees receive updates on the number of medical supplies and equipment they have on hand as well as their location when RFID tags are affixed to these items. Tracking patients as they move through institutions is likewise done using similar devices.

AVAILABILITY

IoMT devices are available in a wide range of categories, including.

In-clinic monitors

They are comparable to point-of-care devices, with the exception that they can be controlled remotely and do not require an on-site professional care practitioner.

In-hospital devices

A wide range of equipment, such as MRI machines, are used to manage various hospital resources, track inventories (such as medications), track assets in the hospital and keep an eye on patient flow.

Point-of-care devices and kiosks

Without a complete laboratory, mobile devices that can gather diagnostic data and other health information can be used in a doctor's office or on the go. Examples of these equipment are blood glucose meters and ultrasound machines.

Consumer-grade wearables

Activity trackers, Apple watches, Fitbits and other fitness trackers are examples of smart devices.

Medical-grade wearables

Products at the clinical level that are regulated and used under a doctor's supervision, such as tools for pain management, enhancing physical performance and addressing other health concerns.

Devices for Remote Patient Monitoring (RPM)

Devices that assist in the management of chronic illnesses are typically installed in long-term care patients' homes.

Personal Emergency Response Systems (PERS)

These wearable devices enable a patient-typically an elderly person-to promptly summon assistance from a caregiver in an emergency.

Smart pills

A newly developing class of devices that patients can ingest and swallow, electronically sending information about their internal organs to healthcare professionals.

CHALLENGES OF IOMT

Up-front expenses

IoMT technology can have large upfront implementation costs and it may take some time to prove a profit.

Security

More security dangers and laws, such as Health Insurance, Mediclaim etc, apply to protected health information. Providers are exposed to several cybersecurity risks, such as fraud and data breaches, when they transmit medical data. Theft of credentials might be used by attackers to get prescription medicines or medical care. Should a data breach occur, providers risk severe fines and penalties for noncompliance.

Execution

Implementing IoMT infrastructure is made more difficult by device compliance with industry standards and interoperability.

Classification of data

It may become more difficult to classify medical data as technology advances and IoMT gathers a wider range of data.[8] Emergent medical data, for instance, is health information deduced from non-health-related data using Artificial Intelligence (AI) applications. AI can turn consumer traces and other data into medical information. Tracking the transmission of infectious diseases can be done using non-medical data, such as user location monitoring.

Ownership of data

When IoMT data is created, its ownership isn't always evident. During the course of its lifetime, the data may be generated or touched by the patient, software provider and other healthcare practitioners. The specific circumstances will determine how complicated each party's data rights are.

User experience

Creating software and medical devices that are simple for people to use might be difficult. When patients remove or misuse poorly designed devices, data collection is either limited or compromised.

Regulatory aspects

Since IoMT is developing at an alarming pace, standardization protocols pertaining to design, manufacturing, patentability, off-patenting, relevant parties' rights, international trade, cybercrime concerns, etc. must also be developed and made available quickly.

FUTURE OF IOMT

A basic human right is access to quality healthcare; however, it is not always sufficiently provided.

The usage of telehealth and associated technologies and practices, such as IoMT devices, increased during the COVID-19 epidemic. It is anticipated that the number of medical devices that are connected will keep rising.

Providers will incorporate new developments in IoT technology into IoMT devices and networks. For instance, it is anticipated that sensor technology would develop to deliver more and better real-time data. Predictive healthcare will also be enhanced by AI-enabled data analytics and machine learning.

IoMT-generated healthcare data will also open up possibilities for new therapy developments and more, better research. IoMT devices can save expenses, streamline medical administration and enhance data exchange and cooperation between healthcare institutions.

IoMT is a fact of the present era; neither elusive nor IoMT technologies exist yet, but they are increasing communications with healthcare practitioners and improving health care for millions of people. In the meanwhile, IoMT is emerging as a crucial piece of equipment for medical professionals, allowing them to diagnose patients more accurately and quickly-even when a face-to-face consultation is not possible. IoMT has significant financial advantages as well; in the years to come, unthinkable financial savings should be realized.

IoT is enabling healthcare professionals to monitor patients who are at risk while also speeding up and enhancing the accuracy of diagnosis. Furthermore, IoMT and healthcare IoT are reaching patients who might not otherwise be reachable by caregivers while also lowering total service costs. Additionally, IoMT is being used by clinics and hospitals to run healthcare IT systems more profitably and efficiently.

The fourth industrial revolution in healthcare, known as "Healthcare 4.0" or "Health 4.0," involves combining cutting-edge digital technology, like Artificial Intelligence (AI) and Internet of Things (IoT) devices to improve healthcare delivery systems.[14] It is a cutting-edge approach to healthcare that improves patient care by utilizing networking and digital technologies.

The next phase of the healthcare industry, known as "Healthcare 4.0," has the potential to completely transform the way healthcare is provided and make it more widely available, efficient and effective. Healthcare 4.0 aims to change the entire healthcare delivery system, not simply technology.[9] IoMT is rightly included in Healthcare 4.0 as part of its broader framework!

As members of healthcare team, the modern day pharmacists are required to be thoroughly aware of the 'sine qua non' of the IoMT, briefly explained hereinabove.

CONCLUSION

Internet of Medical Things, or IoMT is part of Healthcare 4.0. IoMT devices are changing patient care and the healthcare industry. IoMT devices are changing patient care and the healthcare industry. IoMT is being used by a number of hospitals and clinics to run their healthcare IT systems more profitably and efficiently. These new technologies are making feasible new forms of treatments and significantly boosting consumers' quality of life.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

IoMT: Internet of Medical Things; **IoT:** Internet of Things; **Rpm:** Remote Patient Monitoring; **RFID:** Radio frequency identification; **PERS:** Personal emergency response systems; **AI:** Artificial intelligence.

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