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# The Internet of Medical Things (loMT): Recent Advances and Future Applications

Amhimmid Q. Almabrouk[1], Ahmed Salem Daw Alarga[2], Fatimah Husayn Amir Aldeeb[3], Aisha Douma[4*]

[1]Mechatronics Department, Higher Institute of Engineering Technology, Bani Walid, Libya
[2]Department of Computer science, Elmergib University, Khums, Libya
[3]College of Computer Technology, Benghazi/ Libya
[4]Department of Computer Engineering, Atilim University, Ankara, Turkey

[*]*Corresponding author: aishaalwerfally@yahoo.com*

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**Abstract:** The evolution and digitalisation of the world have brought an innovative machine-to-machine (M2M) communication system that is called the Internet of Things (IoT). Internet of Things refers to the idea that everything is machine operated and one machine communicates with the other machine to carry out the basic functions. After the success of the Internet of Things (IoT), it started spreading its branches in different fields. Similarly, the Internet of Medical Things (IoMT) is also one of its most successful branches. It aids in the monitoring of chronic and critical diseases remotely. Internet of Medical Things (IoMT) is playing a huge role in the medical department by not only diagnosing the disease but also saving the lives of people by providing treatments and urgent care at the time of casualties and emergencies. It has provided dozens of benefits to the medical department yet it needs to overcome a few challenges that create blockage in the way of IOMT. This paper will discuss the recent advances and future applications of the Internet of Medical Things (IoMT) in terms of the success and progress along with the challenges it faced as these factors have a vital role in the field.

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## Introduction

Internet of Things (IoT) has been emerging in our lives and has become a necessity [1]. In addition to this, the Internet of Medical Things (IoMT) is incorporated into the healthcare department to create efficiency. It also works on cost reduction in the department with effective innovations and is said to be saving $300 billion for the healthcare department annually [2]. The devices Internet of Things (IoT) in the healthcare department are used for treatments and diagnosis with less power consumption. The Internet of Medical Things (IoMT) has improved health care activities in recent years. Internet of Medical Things (IoMT) has also helped during the times of the Covid-19 pandemic. It has provided a brief insight into the benefits of the Internet of Things in the diagnosis and treatment of diseases. This paper ahead will talk about the advancements, future predictions, and challenges faced by the Internet of Things (IoT) in the medical department.

**Advancements of Internet of Medical Things (IoMT)**

Medicine and healthcare are the most complex fields across the globe. Internet of Medical Things (IoMT) let healthcare become effective by transforming physical options into virtual ones. Internet of Medical Things (IoMT) is evolving at every step to provide solutions to the healthcare path by staying connected to the solutions. For instance, the Apple watch series 6 is a smartwatch device but it also works for healthcare matters as it monitors the blood pressure, heart rate, blood sugar, etc. [3]. These are the unique selling points of Apple now, as they provide the benefits of health care monitoring features too. Apple has also introduced a tagline for the watch, it states "The future of health is in your wrist". The biggest advancements to take place in the Internet of Medical Things (IoMT) made health care assistance easily accessible with a high level of efficiency, such as high-speed wireless technologies, for instance, 5G, enhancements of data compression, and computing power, and portability of the digital devices. IOMT applications help in analysing the data with the help of the data collection through sensors. Some major Internet of Medical Things (IoMT) devices is baby monitors, endoscopic instruments which improve the scope [4], and the tele-health KIOSKS (video streaming systems). Moreover, the technological advancements of IOMT are; robotic surgical instruments used for endoscopic and laparoscopic surgeries, non-surgical robots that are used to disinfect routines and transfer the specimen, remote monitoring solutions for chronic diseases and monitoring blood pressure, oxygen level, blood sugar, etc. then comes data automation devices, these can help in making the process of data collection faster. Last but not the least; tele-health is the most important invention, as going to the doctor for an appointment does not need a physical meeting or trip to the hospital. It is because it has now become virtual due to video streaming by KIKOS. KIOSKS have solved all the issues regarding physical appointments for instance, waiting. These advancements have not only played a role in the progress of the healthcare department but also provided ultimate guides to the healthcare officers, patients, and practitioners. Figure 1 below shows the dynamic collaboration of the Internet of Medical Things system:

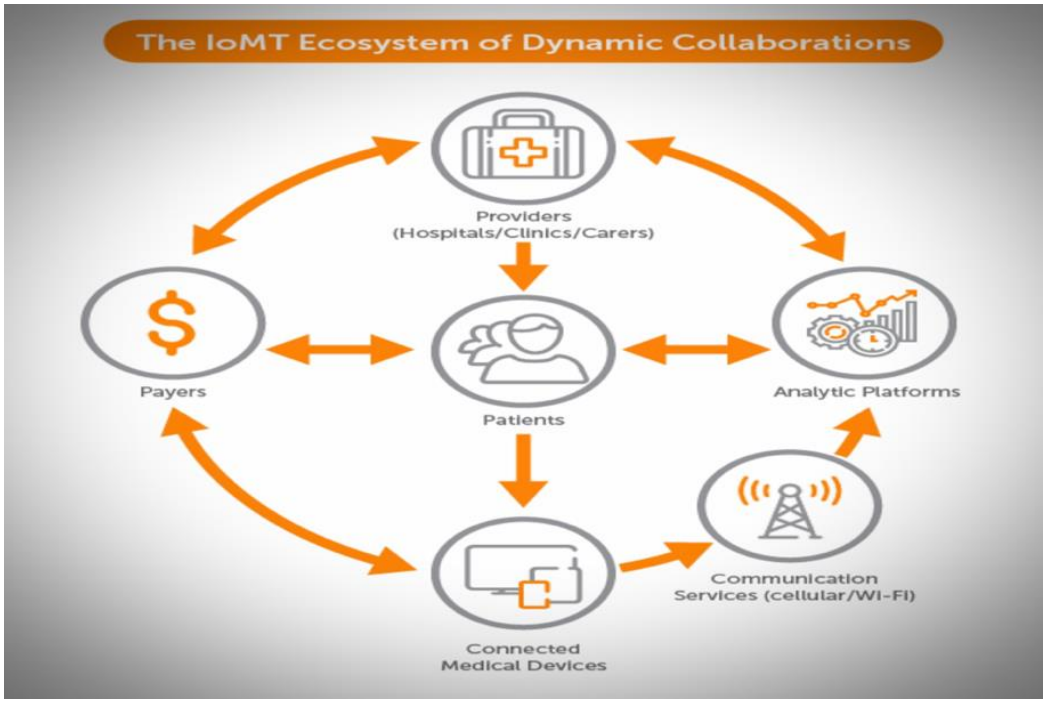


**Figure1** The system of the Internet of medical things in the dynamic collaborations. Source: Deloitte LLP, 2018

**Working on the Internet of Medical Things (IoMT)**

The incorporation of the internet into the daily lives of individuals has created a way for the IoMT systems into the lives of healthcare practitioners and patients. Many Internet of Medical Things (IoMT) is running in the form of layers that execute several devices, technologies, sensors, systems, and devices through electronic and wireless systems. These layers help in the efficient operations of these devices and increase the accuracy of the functions step by step. All the layers of the Internet of Medical Things (IoMT) are shown in the figure below:

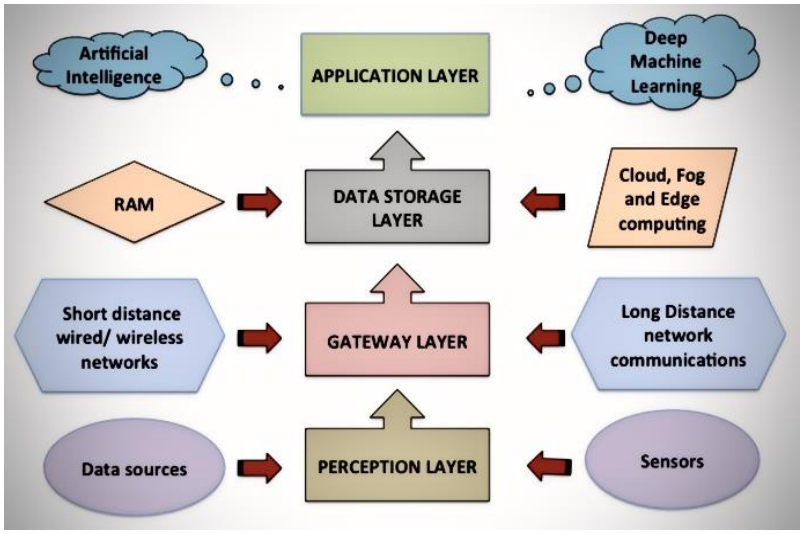


**Figure 2.**Different layers are involved in the Internet of Medical Things (IoMT) Framework.

**Challenges in Internet of Medical Things**

Despite having enormous success and dozens of benefits, Internet of Medical Things (IoMT) faced various challenges that are discussed ahead. Firstly, the biggest challenge faced by the Internet of Medical Things (IoMT) is the security of data, it is considered to be the most crucial challenge for the systems of the Internet of Things (IoT) because the quality of the data is affected due to this challenge, hence, creating the uncertainty of data. The aspect and effects of this challenge are shown in figure 3 below. The second challenge faced by the Internet of Medical Things (IoMT) is interoperability, IOMT is useful in several ways but it lacks interoperability, so it is difficult to get access when required in case of urgency. As a consequence of this, the transformation cost gets increased, and building new networks from the start is also a costly function. Hence, the lack of interoperability is the most costly challenge faced by the Internet of Medical Things (IoMT). The second issue that occurs in the path of the Internet of Medical Things is the mobility of the devices. The devices are ought to be kept in one spot for the usage of treatment and diagnostic. This lack of movement reduces the efficiency of the device. Therefore, it is important to have mobility in the Internet of Medical Things (IoMT) devices so that they can move from one place to the other so that the efficiency of the functions is increased. In addition to this, at the start of the IoMT execution, the biggest challenge that the medical field faced was the issue of getting a license. It is illegal to have IoMT devices without getting a license. But the license approval was the process that takes longer than any other process on the Internet of Medical Things (IoMT). Last but not the least, the Internet of Medical Things (IoMT) requires advanced and innovative analysis skills. It is because critical medical conditions require critical analytical skills to diagnose diseases at the early stage and fix them before they become fatal. These challenges have played a huge role in hindrances on the path of improving the quality of the healthcare departments with the help of the Internet of Medical Things (IoMT). IOMT skills are required to be efficient and proficient. Therefore, the concerned individuals need to work on these challenges so that these issues are brought into consideration and further solutions are provided. In addition to this, the can be avoided.

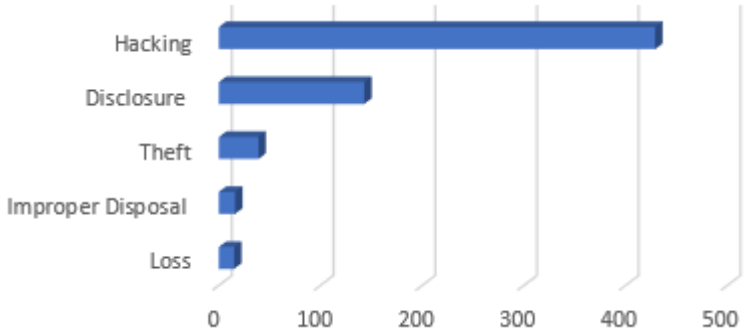


**Figure3** Causes of Healthcare Data Breaches [HIPPA JOURNAL]

**Future Applications of the Internet of Medical Things (IoMT)**

The Internet of Medical Things (IoMT) is said to be one of the biggest markets across the globe, according to the forecast predicted by expert engineers, medical things will exceed $136.8 billion in the coming years. It is also said that in future around 20.4 billion things will be connected ti Internet with the factors of dependency [5]. The applications of Internet of Medical Things will help in hospitals and clinics in the future for the use of X ray machines, CT scanners and MRI machines. This is just the basic usage. It is also said to be used for the test and tracing of diseases. It would test the disease and trace the patient's location to check its probability of spreading around. Secondly, it would be applied on the execution of smart hospitals where the whole environment is based on the Inter of Things. Thirdly, there will be smart operating rooms where everything will be connected to Internet in a hybrid manner and would allow surgeons to carry out the least invasive surgery that is guided through pictures. Another great invention would be of the biomarkers that would be attached on the human body to conduct self-diagnosis by the fluids of the body such as blood or sweats. In addition to this, I Robots will be incorporated in the IoMT systems of the hospitals that would help in the automation of the whole department. There will be many other applications in regard to the Inter of Medical Things that are shown below in figure 4.

In terms of the corporate additions, some of the biggest companies such as Siemens and GE also use Internet of Medical Things (IoMT) for the diagnosis of the medical conditions. The applications of Internet of Things (IoT) can also be carried out in homes, in future, as it gives the essence of medical connectivity without actually going to the hospital. The biggest example of Internet of Medical Things (IoMT) in hospital is the usage of remote patient monitoring which make sure that the patients suffering from chronic diseases are getting 24/7 check up on them without making hustling efforts. Along with all these future applications, the innovative technology of Internet of Medical Things (IoMT) is also concerned to bring automative innovations in the journey of data of Internet of Medical Things (IoMT) by bringing several softwares and implementation of those softwares in the daily lives of healthcare practitioners and patients. They also do it by making the lives of people connected with the health care departments easier.

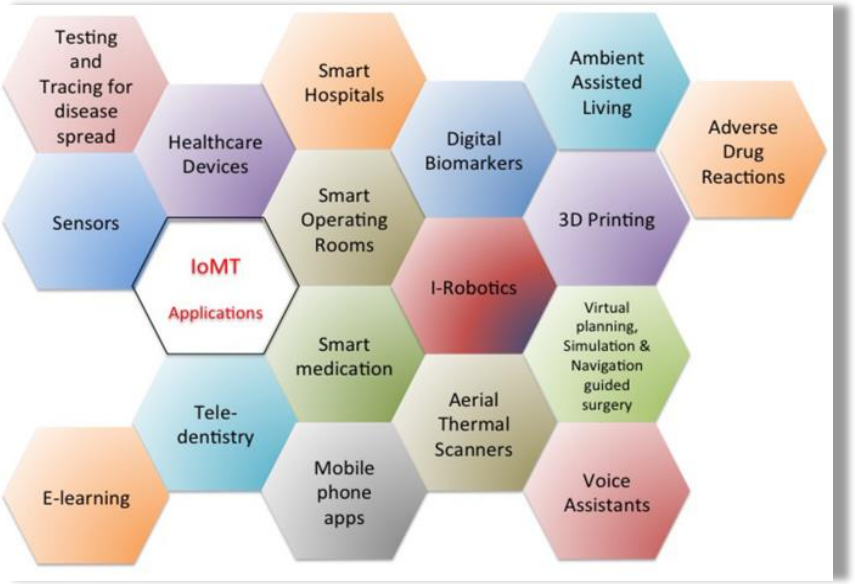


**Figure 4** Schematic representation of applications of IoMT in healthcare

The special approaches are used to deal with patients in regard to IOMT [6]. The wellbeing business is changing radically in created nations as the future has unexpectedly raised during the twentieth century. Ongoing infections are additionally progressively compelling these nations' medical services frameworks. For sure, the future in created nations has been raised by around 30 years during the twentieth 100 years [7]. Thus, the number of inhabitants in more established grown-ups has quickly expanded. Furthermore, the heightening of constant illnesses have forced medical services frameworks all over the planet because of the absence of assets.

Significant difficulties emerge from the increment of ongoing lack of facilities issues and maturing populace, as medical services frameworks need to deal with a wide assortment of infections and therapies, yet in addition a rising number of patients [8]. To keep away from over-burdens of medical care foundations and to decrease medical care costs, in-home telemedicine frameworks have been shown to be effective arrangements.

In any case, telemedicine frameworks are very heterogeneous, and are likewise commonly intended to answer a solitary remedial objective, for example, distant cardiovascular observing, stroke rehabilitation, and so on. This

quality of telemedicine frameworks makes them proficient in diminishing expenses and medical care foundation over-burden, yet addresses a downside as the quantity of patients and assortment of illnesses increment. The requirement for better generically and versatility can be handled by the Internet of Medical Things (IoMT). In the recent years IOMT has changes the perspective of medical field completely, be it; economically, socially and technologically [9]. It has become the most advanced phase of technology [10].

**Conclusion**

To wrap up, it is safe to say that having Internet of Medical Things (IoMT) is highly important because we need to reduce cost of healthcare and provide an effective and better way of diagnostic and treatment for the patients. With the help of the Internet of Medical Things (IoMT) devices, it would not be wrong to say, that Internet of medical things has become one of the best additions in the healthcare department. In the times of pandemic Internet of Medical Things (IoMT) also helped a lot in order to save thousands of lives of people suffering from the corona virus. IoMT has given a major boost to the technology, which was made possible by the development. For instance, remote health monitoring systems, telemedicine, robotics and smart devices. The paper also discussed about challenges faced by Internet of Medical Things (IoMT) which created hindrances in the way of success towards the IoMT. Therefore, it is important for the healthcare practitioners and other individuals to have flexibility with machines so that these challenges could be overcome and have the optimum results from the Internet of Medical Things (IoMT).

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