International Journal of Applied Pharmaceutics

ISSN- 0975-7058 Vol 12, Issue 5, 2020

Review Article

PHARMA 4.0–IMPACT OF THE INTERNET OF THINGS ON HEALTH CARE

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Received: 05 Jun 2020, Revised and Accepted: 10 Aug 2020

ABSTRACT

The IoT in health care is currently booming in the world of health care in particular. Industry has risen from generation 1.0 to 4.0 during the Internet of things period. As we remember, we came across the exact submission of the traditional health care system. Each time the patient has needed to visit the clinic/hospitals, even for small complications that may affect the patient's medical costs along with time and energy. One more significant factor is also an emergency; otherwise, she/he/older population was unable to demand urgent assistance from the older system of healthcare. And yet somehow, the situation has changed with the use of the cyber-physical world; we are heading out of the 4th phase of the health care industry means smart health care network. This paper offers an insight into different facets of how healthcare systems such as doctors, hospitals, and of course, patients are powered by the internet of things and how can it track and ensure fast, quality, and efficient use of less time also in a smart way. Here, a patient knows how to track patients by using a collection of different wearable sensor nodes for real-time monitoring and examination of specific patient criteria. One of the most boosting subjects characterizes the development of medical technology within their own homes, enabling older or physically weak people to stay as long as possible at home while being medically cared for and monitored.

We searched literature and guidelines in Pubmed, Web of Science, Google Scholar, Scopus, CNKI, and Embase databases up to 2019. The following search terms alone or matched with the Boolean operators 'AND' or 'OR' were used: "Nanoparticles", "Anticancer treatment", 'Bioflavonoids', 'Plant origin drugs', 'Nano formulations', 'Cancer' and 'Novel drug delivery systems'. We focused on full-text articles, but abstracts were considered if relevant.

Keywords: IoT, Pharma 4.0, Hospital management, Physician, BP monitoring, Smart clothing, ECG monitoring, Glucose monitoring, Health care

DOI: http://dx.doi.org/10.22159/ijap.2020v12i5.38633. Journal homepage: https://innovareacademics.in/journals/index.php/ijap

INTRODUCTION

History–background of the industrial revolution

Over the last couple of decades, we have seen various movements in the Pharmaceutical industry and it's very important to readers know the background of the industry. The first revolution to till here means the 4th revolution [1]. The 1st industrial revolution initiated with Steam Power on mechanization. The 2nd resolution was brought electricity oriented by the end of the result, means the evolution of this 2nd is Mass Production. Then we were moved to the next-generation, considered as Pharma 3.0, nothing but 3rd generation of the industry. This 3.0 is completely focused on Automation with the help of computer electronics'. After moved into Pharma 4.0. This is the current form of the industry by using IoT [2]. Fig. 1 shows an overview of the industrial revolution.

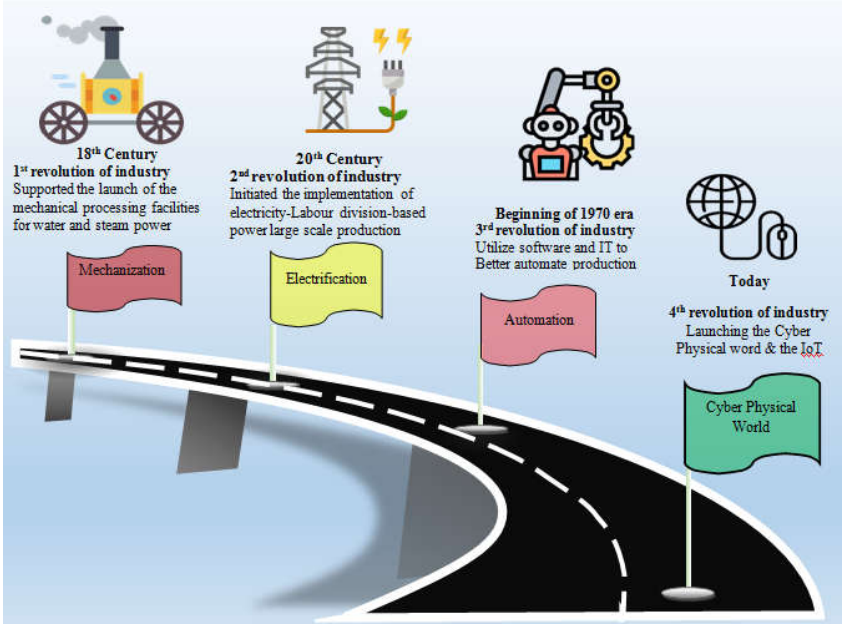

Fig. 1: Overview of the industrial revolution

Pharma 4.0

Pharma 4.0 is nothing but Industry 4.0 is the 4th revolution of the pharmaceutical industry Pharma 4.0 originated from German Concept and 4.0 was first published in November 2011 by Kargermann *et al.* [1]. Pharma 4.0, involving advanced delivery tools and explicitly tailored drug treatments. The related methods, i.e. auto-ID tags, smart cars, patient-centered exchange of details, internet of things, Big Data analytics, etc.

Pharma 4.0 symbolize by the cyber-physical world. The new revolution brought by the Additive Manufacturing, the Internet of Things, Blockchain, Advanced Robotics, Artificial Intelligence (AI), Machine learning, 3D printing, auto-ID tags, Cloud Computing, Smart vehicle, Patient-centered exchange of information and other related technologies,

The new concept of 4.0 is to reduce human intervention related activates and also promise of reducing cost effect, increase speed, enhancing flexibility.

- From an educational point of view, we need to educate our students with the help of knowledge and skills required to take over new operations, challenges.
- From a research perspective, we need to hunt whether and how the technologies are lacking. We need to find innovative ideas and important operations questions that will emerge from the advancement and adoption of these technologies [3–5].

An internet of things (IoT)

An IoT is a concept founded in 1999, it helps to characterize objects fitted with digital technology that can interact through the Internet [6, 7]. The Internet of Things has delivered tremendous benefits to a wide variety of business activities because of its ability to offer greater cost and time savings. Few numbers of application scenarios where the IoT may play a crucial role, such as home automation, light and temperature control, traffic signal, surveillance cameras, health care, and also are of smart manufactures containing employee safety, tracking assets, and real-time inventory [8]. Digitization isn't just about improving performance but also about offering new services or delivering them differently [9]. Fig. 2 showing major components of the healthcare program in the internet of things.

Health care

The global population is currently rising rapidly and the demand for remote and continuous tracking of healthcare is also gradually increasing. Interaction between both the patient and the doctor can be carried out through various technology boards focused on IoT ex: Arduino, Intel Galileo, Raspberry respectively [11]. The Indian healthcare system, one of the fastest-growing sectors, is expected to grow to reach US$ 280 billion at a CAGR of 17 percent in 2011-2020. Hospitals account for 71%, pharmaceuticals for 13%, and medical materials and services for 9% of health care revenues in the country [12]. The most important things as we are facing a shortage of hospital resources like beds, surgical instruments, doctors, and nurses are imminent worldwide [10]. Some percentage of patients with chronic illnesses and the expense of delivering medical care are growing in the 21st century, the life expectancy is increasing and the World Health Organisation reports that about 4.3 million health professionals worldwide are in short supply [13]. As we know our country began with the magnificent tradition of public health, as we see in the references to the description of the Indus Valley Civilization (5500-1300 BCE), which was mention “Arogya” as reflecting “Holistic well-being and today we are around 1,296,667,068 people in this country [14].

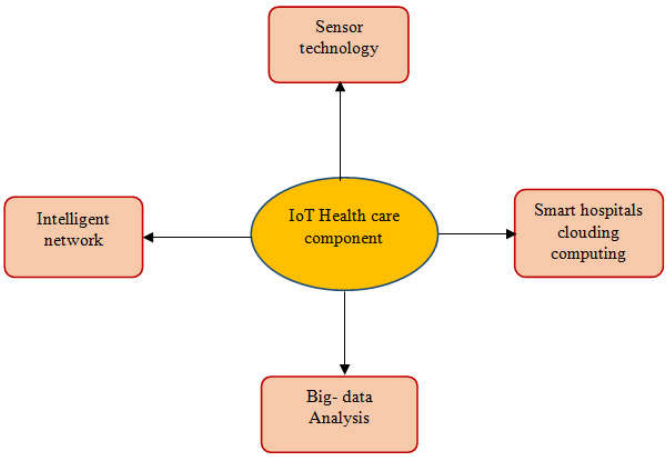

Fig. 2: IoT healthcare components program [10]

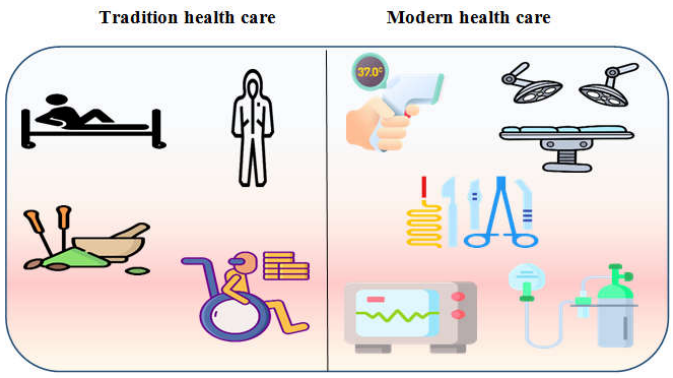

Fig. 3: Tradition and modern health care

IoT in health care

A collection of medical tools and applications for linking computer networks to the health sector is called as an Internet of medical things (IoMT) [(15)]. Our digital channels should play a big role in this, and we are working hard to build them. From May 2015, the then Minister of Health declared the development of a Digital Health Authority to mark the beginning of a new era for digital healthcare across Australia [16]. Master requires physicians, nurses, and patients with unique end-user devices (e. g. smartphone, Laptop, or tablet) authorization to access a program. This is responsible for prescription processing, database management, data collection, creation of subsystems, and management of knowledge base [17, 18]. IoT Facilities will be used for application advancement that is directly used between users and patients and not based on scenarios for BP Monitors, Pulse medical equipment, Glucose oximeters, ECG monitors, Wheelchairs, Oxygen pumps, Nebulizers, Brain waves, Surgical robots, Dispensing implants and Cloth with sensing monitoring [19]. This Paper [going] to divide into three parts, such as Patient's Hospitals and Physicians.

Using the internet of things to support patients

1. BP monitoring

Approximately one-third of all adults worldwide are suffering from hypertension, which induces high blood pressure (BP) levels. It is the leading cause of cardiac disease, myocardial stroke, or heart failure, killing about 7.5 million people annually. Monitoring BP values regularly allows these diseases to be avoided, providing a better quality of life [20]. The BP monitoring procedure is assisted throughout the following steps: a user-requested order for a general medicine appointment; a vital sign and BP assessment is reviewed by the usual doctor at the appointment. Arindam Ghosh has started the method [21]. Wireless technologies Blood Pressure Monitoring System (BMPS) makes home tracking of patients' BP simpler and strengthens doctor-patient relationships [22]. The method will go like this fig. 4 at regular intervals, the smartwatch on the expectant patient hand collects BP measurements and sends them to the phone through Bluetooth. The BP reading is received by a mobile app on the mobile phone as well as data is sent to the cloud server, which records it and generates notifications. The alerts produced will be sent to the caretaker for action, as required [23].

2. Cloth with sensing monitoring

"Smart clothing" was produced since the 1990s to help the people or older people a more friendly way to interact with the help of IoT. Smart clothing provides convenient, interactive, real-time and reliable tracking of your health and fitness [24]. Smart clothing may be extended to a wide variety of application settings, in which either physiological signals or psychological data from the human body are collected [25]. One of the most encouraging subjects characterize the implementation of medical technology within own homes, enabling older or physically weak people to stay as long as possible at home while being medically cared and monitored [26]. As a patient is usually not a medical expert; however, certain solutions need to be built to be user-friendly and smart enough to determine if the patient is using them correctly. Few medical devices are now providing such features. For example, A small multi-therapy pump for ambulatory application developed by Baxter to use for pain and also it is wireless communication and user friendly [27]. And also Philips was developed smart clothing sport wear while playing sports it can measure several biosensors like BP, body temperature, Heartbeat, and other vital signals [24)], ECG monitoring [28]. The amount of Smart Clothing available in the market has drastically increased during the third era, from 2001 to 2004, e. g. MET5TM jacket from The North Face (Ward, 2001), smart shoes from Adidas (Momphard, 2004) and sweatshirts from GapKid with embedded FM radio (CNN, 2004) [29].

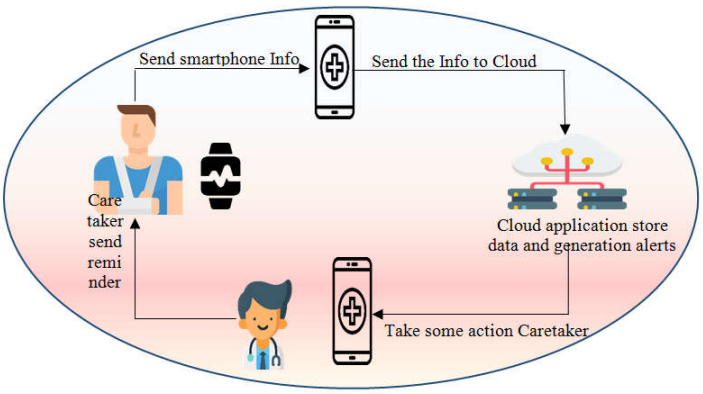

Fig. 4: An IoT software-based framework for monitoring preeclampsia [23]

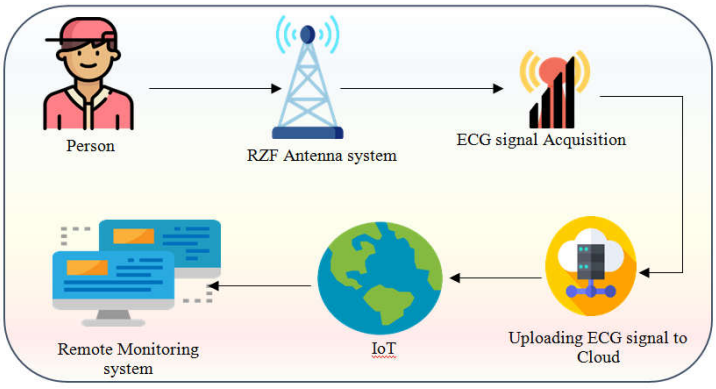

Fig. 5: Block diagram of the electrocardiogram monitoring system by using the Internet of things [34]

3. ECG monitoring

As we know day by day the number of death increasing caused by chronic and cardiovascular diseases (CVDs) throughout the society. According to WHO, 17.9 million death every year caused by CVDs [30]. IoT-driven Electrocardiogram monitoring can play a significant role in improving safety and well-being along with quality medical care. Apart from this, it can knowingly reduce the cost, travel, and also time in the remote and Electrocardiogram monitoring [31]. Moreover, data acquired will be sent to the remote doctors with low cost, and also ensure the physical status continuously and real-time [32]. Example-a planner inductive sensing component (flat spiral) that is installed to the clothes to detect parameters like heart-rate and respiration [33]. And more example using RZF (Rectangular Zig Fractional) antenna to monitoring ECG with the help of IoT, as shown in fig. 5.

4. Glucose monitoring

Millions of people are being infected by an epidemic disease known as diabetes. When the sugar level increase in the blood it may lead to serious consequence such as heart attack and kidney failure etc. As we already know, the IoT is one of the big communications developments linking daily sensors and all devices [35]. Owing to different conditions, patients with diabetes have typically monitored blood glucose levels by Blood Glucose Self-Monitoring (SMBG) methods, such as pricking their fingers multiple times a day. These methods entail a range of disadvantages that can be overcome by using a system called the Continuous Glucose Monitor (CGM) that can constantly track blood glucose levels without having to poke the patient while performing any test. This strengthens commercial CGMs by adding the IoT and also helps remotely track patients in a risky situation [36]. Another example: a non-invasive blood glucose monitoring system based on the IoT is presented. Non-invasive tracking data is collected using the camera of the Raspberry Pi Zero (RPi), capturing an image of the user's fingertip, then information is processed via a neural network built using Tensorflow libraries in a Flask microservice. The calculated glucose levels can be collected for tracking purposes by an end user such as a mobile, or by some other end device that allows the opportunity for different potential uses [37].

IoT for hospital management

The rapidly increasing amount of hospitals and clinical centers, need a rapid fault/mistake detection and also withdraw the technical drawback as well as decrease of the medical instrument downtime and efficient reliable feedback of the patients as we know the medical instrument used in different sections in the hospitals such as diagnosis, general ward, ICU, medical laboratory, operational room and storage of medicine [38, 39].

Presently, 3.7 million medical devices are being used, attached to different parts of the body, and tracked to notify health care decisions [40]. The demand for IoT medical devices is projected to rise nearly $69.7 billion by 2023, hitting a value of approximately $18.8 billion in 2018. Such instruments are recording vital signs such as heart information, levels of insulin and glucose, and other body measurements. The data moves from the medical system to a mobile phone, laptop or computer and is processed and analyzed by the patient. Patients, health-care providers, or doctors can be the recipient [40]. For example; Dexcom and Verily Life Sciences worked together to develop miniature, continuous glucose monitoring (CGM) systems for patients with type 2 diabetes. IoT Allowed Competitive Countryside Healthcare.

Major competitors are:

- Medtronic plc
- General Electric Company
- Koninklijke Philips N. V
- Siemens Healthineers AG
- Fujifilm Holding Corporation [41]

And also, one major thing by using IoT in a medical device it can helps to the security issues that should be overcome to allow the IoT-based medical system widely recognized. Furthermore, access to dangerous medical devices or toxic drugs must be monitored so that illegal users cannot abuse them [42]. The Internet of things can help to find critical medical data, which eliminates the crucial of treatment data from one person to another one [43].

How IoT helpful for physician

Healthcare systems based on IoT will help doctor's better control illnesses, track patients, and improve medical outcomes. Remote health monitoring based on IoT is becoming important due to aging and an unhealthy lifestyle [44]. Doctors in clinical centers can treat the patient with approved suitable medical equipment in a remote location and upload patient data to the medical server [42]. Different medical sensors are used to collect the patient data(Medical data) and the respective monitoring station for analysis; few examples are Body temperature, Blood pressure, Body position, 3-channel ECG, Pulse rate apart from this system has an advanced camera sensor it helps provide live images of the patient to respective caretaker or physician [45]. And also one more device is suggested that smart treatment adherence devices use RFID for medication type, sensors, and mobile notification. The program should verify patients are receiving the right medication at the right moment. Communication with doctors in case of taking the wrong medication is also an additional aspect of this program [46]. Such as, Micromedex: Reference app with services including correct dosage of the medication and instructions for medicines [47]. And fig. 6 demonstrates the device representation suggested where the various sensors are attached to the Arduino Fio receiver board [48].

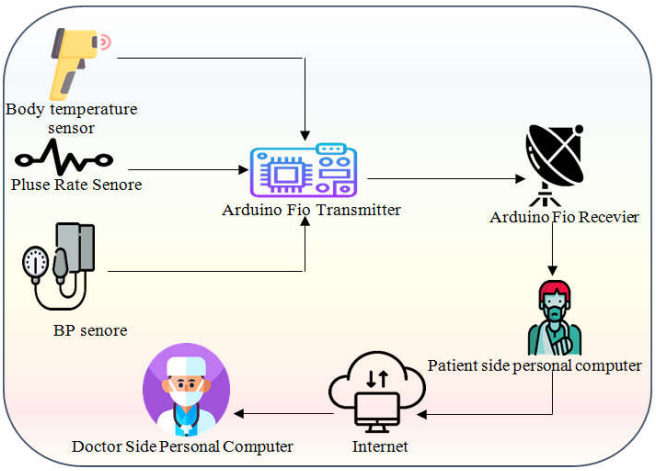

Fig. 6: Arduino fio receiver board [48]

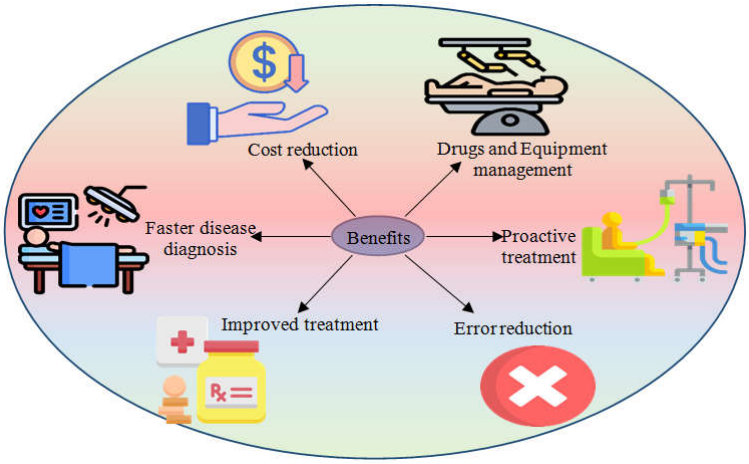

Fig. 7: Major benefits of IoT In health care [51]

Benefit of IoT in health care

The IoT is the great revolution of the healthcare area that allows a life-enhancing service throughout the world. IoT has bring a lot of benefits for citizens, government, end-user, no time lost, and businesses over advance and well accurate service delivery [49, 50].

To mainly decrease handbook data entry for the patient data allows medical staff to monitor their patients efficiently [48]. Fig. 7 has to demonstrate a major advantage of IoT in health care.

CONCLUSION

Healthcare management is one of the most important parts of society. The most important things as we were facing a shortage of hospital resources like beds, surgical instruments**,** doctors, and nurses are imminent worldwide. IoT in health care helps to reduce an item of expenditure, reduces time and effort, remote monitoring for patients to various physiological parameters. The majority of the system has to verify patients are receiving the right medication at the right moment and communication with doctors in case of taking the wrong medication is also an additional aspect of this program. The Internet of things isn't just about improving performance but also about offering new services or delivering them differently. By using IoT in health care, doctors/nurses can easily monitoring for patients along with the respective requirement.

FUNDING

Nil

AUTHORS CONTRIBUTIONS

All the authors have contributed equally.

CONFLICT OF INTERESTS

No conflict of interest

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