Review article

The role of IOT in transforming community pharmacy

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ABSTRACT

During Covid-19 Pandemic the entire world experiences the role and importance of Internet of Things (IoT) in healthcare system and especially in Community Pharmacy. Internet of Things can be described as a network architecture incorporating an abundance of sensors software hardware, computing devices, technologies, machines and many more utilities, assisting us in our relevant domains as per the needful. Over the yesteryears it has been observed that the footprints of Internet of Things over the healthcare sector have increased eloquently. This observation leads us to the fact that with the escalating population and the healthcare plight Internet of Things can really prove itself to be serious breakthrough in the community pharmacy. By revising the current healthcare system in the community pharmacies in a more socio-economic fashion. This paper reviews the technological advancements in Internet of Things, for the medical management of public health so that it can be vitally made use of in the domain of community pharmacy. There is a demand of efficient Internet of Things framework that would seriously be able to challenge the abysmal state of community pharmacy mostly in the remote areas and the distant regions.

INTRODUCTION

IoT can be enunciated as a very encouraging and eminent technology. With the evolving vogue in IoT it can be articulated that IoT has pretty well surfaced up, to proclaim itself as the modus-operandi of the coming era for the smooth streaming of innumerous operations around us. As we know that since the ages, the public health has played a very crucial role in the development a society and further a nation. In the recent declarations by W.H.O it was stated that the world is facing even more health issues than the last decade. It is quite evident in the developing countries that the rising global medical appearances has proved themselves to arise as a hindrance in the path of their development. To combat such a situation of medical fatigue we need to strengthen our community pharmacies. So that they are capable of handling such a situation of medical catastrophe at it's very beginning and eliminate the risks of any future calamity. This is where IoT can help the community pharmacies to medically aid their patients and people of critical health. Whereas a trend has been observed from the past few years that an enormous count of IoT applications have been instigated to assist healthcare professionals and doctors in the better medical management of Patients via the use of Mobile-Health/M-health [1-4]. IoT might revamp the running/classical systems of management for the patients, their medical records their treatment and the facilities provided to them against the healthcare services at the community pharmacies.

Table 1: Application of IoT framework in Community Pharmacy

Medical Management	Treatment Management	Patient Convenience
Instantaneous patient Diagnostics	Use of IoT framework to regulate and organize patient's diagnostic tests along with therapies	Smartphone access of the wearable e-devices
Smart e-devices for health monitoring	Sensors and Computing devices to oversee and organize patient's treatment records	Tele-medicine

IoT can assist us with the real-time data on the entities on which it is exercised, in this way the community pharmacies can use it to oversee the patients at any given time to help them with the adequate health management. In this scenario the community pharmacy may track the pulse, blood pressure and other vital information of the patient, to whom varying sensors have been allocated, so that they may even be aided with appropriate telemedicine, at the time of requirement. Nowadays as the wearable technology is gaining spirit among the peoples, so as of this varying smart e-devices can also be put on by the patients for the real time tracking of their spO_2 levels, blood pressure, heart rate, ECG, blood-glucose level, etcetera. And further on this data can be shared with the community pharmacy, so that they may get a better idea of the medical condition of their patient and could direct their treatment appropriately. The technology of IoT-framework and its application is still of very Avant-grade. So, it's pretty obvious that such a new technology also has many hurdles along with it, and these may comprise of its decentralized mode of operation, it's free spiritedness, privacy-issues, security-flaws [5,6]. technological hindrances and many more. Even though IoT can be coined as a very new notion for the medical management of patients, but if it is used on a full-fledged level and with modern day SOP's, then it may result in paramount advantages. This paper is engrossed on the encouraging advancements in IoT. Here it was analysed that how IoT can precisely transmogrify the resistance faced by the healthcare professionals in the medical management of the patients and the people of critical health at the community pharmacies.

LITERATURE REVIEW

The Internet of Things (IoT) can register its dominance in the domain of Community Pharmacy in the forth-coming future and it can turn out to be explicitly compelling. It even has the potential to rewrite the way we see community pharmacy these days. But to evidence such a scrumptious turnout in the fate of Community Pharmacy we need to put in the right efforts, along with an appropriate network architecture, data security [7-8], capital investment, conglomerate association and many more. Few of the recent enhancements in the field of IoT, which has the potential to revamp the current scenario of community pharmacy in the context of healthcare have been tabulated below, in table 2.

Table 2: Recent advancements in the application of IoT in the genre of Medical Management

| Author	Problem Specification	Proposed Approach	Advantage
Lei Yu [10]	Inter-departmental collusion deficits, medical data record management, treatment record management	Digitisation based on IoT framework along with RFID tagging, sensor technology	information sharing, wireless communication and data transmission, smart recognition
Haleem m A [11]	Inability of the patient to assess the medical consultation after orthopaedic treatment	Use of sensor technology in collusion with IoT, monitor the patient condition after orthopaedic treatment	Accurate diagnosis of fracture, bone damage, bone, pain levels; Progress monitoring
Diaa salama Abdul minaam [12]	Patients who forget to take the medicines at the specified time or time durations	Smart-pill box system, medicine reminder	Administration of the correct medicine at right on time
M Abo Zahhad [13]	Inability in accessing the appropriate medical treatment in case of backward/distant regions	IoT network architecture, with sensor technology, assess medical treatment on mobile	Ease in availing the medical treatment, no requirement of travel charges
Chao Lia. [14]	Incapacity to speculate treatment requirement prior a heart attack	Use of remote monitoring system, three technical layers assess the vital signs	Alerts acquaintances before arousal of such a medical condition
K J Cho. [15]	Incompetency to speculate and receive medical aid in case of Asthma	Wearable stethoscope, linked to IoT framework	Helps in wireless remote monitoring of patient's health at any time
J P Dieffenderfer [16]	Patient can't speculate his/her vital signs and reach for the medical aid for Respiratory breakdown	IoT in compliance with the wearable wireless sensor technology, monitoring chronic respiratory diseases	The sensors constantly monitor the pulmonary condition, alerts the concerned instantaneously
Deepika Mathuvanthi P [1]	People suffering from depression or mental illnesses can't assess doctors, on their own, or because of a hesitation	A wrist band accoupling sensors, linked to IoT framework, senses the vital physical signs of the patient	Any disruption in vital signs alerts the acquaintances; plays music, alters temp. to help the person calm down
W Hyuma [18]	Incapability of the patients to assess their heart health by ECG monitoring by themselves, an reaching the medical aid accordingly	Use of a wireless sensor and a smartphone, in compliance with a discrete ECG device	iHeart oversees patient's ECG in real-time, alerts the user/patient if it detects any abnormality in the behaviour of heart

Medical management by community pharmacy in accordance with IOT

At this point in time, it is pretty much clear that, if we start to focus on the better medical management of the people lying at the root of healthcare accessibility via the help of the Community Pharmacies, predominantly in the remote areas. Then this step would lead us to a better medical condition of the global population and would eventually lead us to a better life-expectancy rate. Different applications of IOT in healthcare is shown in figure 1.

We know that the community pharmacies can keep up with the medical management records of their patients at a satisfactory level. But even then, there are certain shortcomings in it such as inter-departmental collusion deficits, manual data entry, and professional

involved patient diagnostic tests. Few of the measures that could be taken to get us a leap ahead in this direction are following.

Figure 1: IOT application in healthcare monitoring
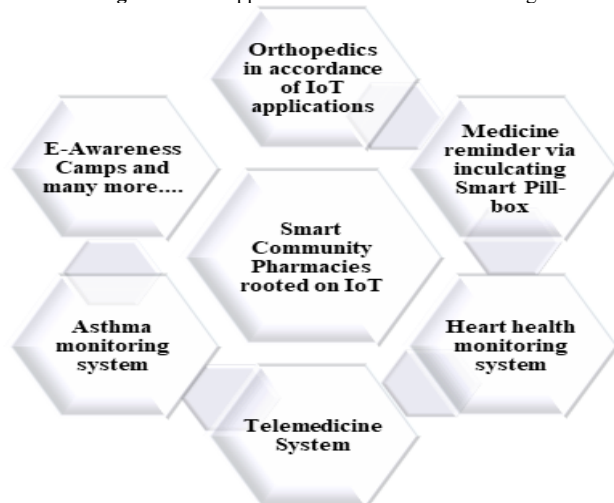
The IoT framework which can rectify these shortcomings involves the use of Internet, Sensor network technology, RFID tags, Infrared tags, Wi-Fi, etc. The architecture thus formed by accoupling these helps us in various aspects such as ease of information sharing; wireless communication and data transmission; smart-recognition; instantaneous tracking, positioning, monitoring [9-12]. Checking the real-time temperature, location and movements of the patient; automated zero-contact identification.

This whole framework also includes the involvement of the mobile network. Hence it becomes convenient for the patients to connect to the Community Pharmacy digitally. Further on after being digitally connected the patients can have a fine acquaintance at the community pharmacy and it even becomes convenient to manage the varying medical records.

In orthopedics sensor technology can be equipped in with IoT to accurately diagnose the fracture, bone damage, bone, pain levels etc. [13]. It can even be brought in use by the patients for their speedy recovery by helping them to exercise appropriately. After the crucial surgical procedures. it can even signal the patient if there are any further complications. With this accoupling to the patient, he/she or even their acquaintances can monitor the recovery as well as the progress of the patient without actually having them to make a visit to the nearby community pharmacy.

It can even aid the patient in the following manner-

1. With the help of IoT tools and devices patients have virtual consultations.
2. Accumulate the precise data on the progress of the motion of the bone.
3. It can periodically surveil the condition of the bone and the health of the patient, which can ultimately help us in the progress report generation.

The proposition made in medicine reminder via inculcating Smart Pill-boxis regarding the forgetfulness of the patients to take the varying medications prescribed to them as per their medical conditions. Here to deal with such a dilemma, a technological device called as the Smart Pill-box, which is accoupled with the IoT framework is put forward to be used. This smart pill-box even accompanies varying distinctive features with it. Like this pill-box is highly programmable (prioritize), we can easily set it to daily periodic pill amount requirements and then it will signal alerts to the patients to take the pills at the required time. This technological device can even be connected via a mobile application that may eventually generalize the process of medicine administration, specifically in the elderly peoples [14].

The pill-box comprises of two varying modes-

1. In the Normal Mode, the device is in reserve condition. Where the user presses a button on the device and it instantly dispenses medications.
2. If the patient/user gets ignorant to the device and doesn't take the medications on time. Then it eventually signals an alert to their acquaintances.

Telemedicine System is an IoT based framework specifically designed for the people who are living in the remote areas/distant regions and it can really come up to be boon. Here in this form of telemedicine system a single unit chip is used, which comprises of the processing unit, communication unit and a sensor unit. The system comes into functional mode when the chip is attached to the patient's body. In the Store and Forward mode, the data previously stored by the care unit is later on transmitted to the connected server, if any irregularity is observed among the vital signs of the patient. And from there it is transferred to the end of the community pharmacy, so that they would be able to perform the righteous procedures in real-time [15].As from the earlier studies it became quite evident that most of the people who die due to heart failure, are not even able to reach the appropriate medical assistance, so they may be saved. Such an upsetting situation surfaces up as they can't reach the medical support. But in heart health monitoring system framework of IoT such instances can be reduced off. As here varying omnipresent remote monitoring system is used, which sends the data related to the patient's physical signs to community pharmacy at instant [16]. This system generally comprises of three varying layers which are….

1. The Sensing layers, usually comprised of the sensors, which senses the varying vital signs of the patient such as the spO2, pulse rate, ECG, heart rate, etc.
2. In the middle of the framework lies the Transport layer, which instantaneously sends the vital health data to the connected server.
3. The third layer is known as the Application layer, here the data

sent via the transport layer can easily be accessed by the assigned professionals at the community pharmacy so that they may be able to analyse it and assist the patients accordingly.

In E-Awareness Camps what can be done is, periodic awareness camps can be organised in the remote areas or the distant regions by the local community pharmacy. But the catch here is that the awareness camps/programs would be organised with the collaborative efforts of the huge conglomerate hospitals and the local community pharmacy on an e-portal/e-platform. Here the resource person who are to counsel the local public would be the highly qualified healthcare professionals. As the people in the rural areas don't possess a huge capital, which would help them to reach such highly qualified healthcare workers. So, in this manner it could be a great opportunity for them to get a health-related assistance from them. As we know that asthma is a very censorious medical condition, which can easily get triggered at any instant of time, without giving a prior symptom. In some cases, it has been observed that due to the inability of the patient to reach the appropriate medical assistance has led to fatal results. An uncomplicated discrete technological computing device has been introduced as a restorative for people fighting Asthma. Basically, a wearable stethoscope is used as an integral part in this device, which usually monitors the condition of asthma and varying other pulmonary diseases at each instant of time. This system even comprises of a chest-patch and a wristband for determining the effects of ozone on chronic asthma conditions. The wireless sensor technology which is equipped on the system and attached to the skin the patient transmits data signals. Finally, the data is sent to the connected server which can be righteously used by the concerned professional in the community pharmacy. And the required medical aid is processed for the patient instantaneously, by the concerned authority for his/her betterment [17]. Diabetes can seriously be perceived as a precarious and unabating disease, which usually brings further complications in the future and ultimately resorting into varying other illnesses. It also brings a major financial breakdown in the life of the patient. A discrete self-examining technological device can be used to monitor the periodic blood-glucose level, by the patient himself. Blood-glucose level monitoring system is a part of the IoT framework, and after assessing the result, it eventually sends the data to the concerned community pharmacy. Who can utilise the data adequately, to manage the medical records of the patient. For a greater good the renowned Swiss pharmaceutical company Novartis partnered with Google and came up with a smart contact lens that can assess the tears of a diabetic person and quantify his/her blood-glucose levels.

From the concurrent studies it has been found that a number of people in this global population is suffering from varying mental illnesses, specifically to say depression has laid a huge impact on our society. In depression monitoring system a technological computing device which can be wore on by the diseased person is proposed to be used. It has been observed that the patients suffering from these depression symptoms often find it tough to consult the doctors. In such a dilemma this wrist band can be worn by the patient. Where the sensors accompanying the device can constantly measure the physical signs of the patient. These physical signs can range from temperature, blood pressure, heart rate, spO_2 level to the galvanic skin response of the patient. Any abnormality if observed in these vital signs of the patient will immediately be alerted to the patient's acquaintances and the concerned authority AIDC program of the device. So that the precautionary measures can be taken in the real time, to prevent the patient from any further breakdown. Depression monitoring system is even accoupled with an actuator, when triggered, instantly plays music, and alters the lighting condition as well as temperature of the ambience around the patient [18].

In the community pharmacy a healthcare professional who works for the medical management of the patients, is often obliged to reach them in case of their inability to physically access the services of the local community pharmacy. It even comes under their moral duty to out-reach the patients of critical health. But sometimes it has been observed that in some scenarios, specifically in the distant/rural regions, that even the healthcare professional from the community pharmacy is in no control to reach the patient. In such a case, an IoT framework can be involved to connect them, which is easily accessible via the internet. It even involves an audio-visual telephonic device such as a laptop, tablet or even a smartphone at the end of the patient. By connecting via this medium, the patients and the people can access few services from the community pharmacy, which can be the online consultations, problem resolving and many more.

IOT in healthcare management

Here, some of the companies as shown in figure 2 related to the successful application and implementation of IoT in the medical management of concerned beings have been understated.

Systemone

This firm, a barcode and label systems specialist, utilises Vodafone's Managed IoT Connectivity Platform and global IoT network. Transmits medical diagnostic data to the concerned authority in real-time to manage the public health situations effectively and be in touch with the patients.

QUIO

Quio, a cloud platform, wirelessly connecting the diverse therapeutic devices for patients with chronic illnesses, specifically related to medications, activity and health conditions. The mobile and web tools assist the medical management professionals to monitor and oversee trends to assist the patient more effectively and efficiently.

PFIZER/IBM

Pfizer and IBM developed an IoT technology to track the

effectiveness of Parkinson's drugs administered to the concerned patient and to initiate the required dosage correction in real time for better medical management of the patient. They even emerged up with a "Parkinson's house" decked with sensors to detect the smallest variation in a patient's movements. The data hence collected is analysed to detect the patient's progress and medication responsiveness.

Figure.2: Different organizations in healthcare management

Adheretech

AdhereTech assist's the patients with a smart pill bottle with their specialty medications. The bottle provided issues reminders for missed doses via text or phone. It even assists the patients with personalized support for medication refills and health issues.

Aeris communications

It came up with a plug-and-play platform for medical device manufacturers and healthcare providers. Helping the professionals to remain in -contact with patients, to monitor that they comply with the frequency and dosage of medication administered. This remote vigilance is done via the help of the sensors and let the patients remain at home.

Stanley healthcare

It's a technological institution assisting with instantaneous patient location visibility over a wireless RFID, helping the medical management professionals to monitor patients in a more effective and personalized manner, based on individual needs.

Honeywell

They came up with a tech. named Genesis Touch (GT). It keeps the medical management professionals connected with remotely located patients. They receive biometrics data of a concerned patient via a patient dashboard. It can host video visits, give multiple providers access to a patient's vital statistics and be

Integrated with an oximeters, blood pressure monitors and precision health scale.

ENSA

This firm came up with a technological solution to sync the Biometric Sensor's and the medical history of the patient to assist the users with the suggestions for wellness and supplements. It can even sync Apple Health Kit and Dexcom CGM, update wellness advice

from reasonable sources and access to an online supplement dispensary.

CHALLENGES

IoT can really be of great benefit to Community-Pharmacy, but still there are major flaws/challenges to address before the broad-spectrum execution. The challenges that may rise up, on using this technology in Community Pharmacy are listed below-

Data security and privacy

The IoT devices and mobile applications capture and transmit data in real-time, hence it stimulates a risk of data security and privacy. The leak of sensitive information about the patient's medical condition and meddling with such sensitive information can have serious consequences.

Integration

IoT framework utilises multiple devices involved in networks. It's quite intriguing that on connection whether they are compatible with each other. As there are numerous manufacturers and they do not manufacture these systems under a standard set of protocols.

24*7*365 Availability

In the medical management of a patient via IoT devices, operating 24*7*365 days, it becomes mandatory for the medical institutions to conduct their periodic maintenance, for their streamline operation. But in a condition of their inability to do so, it may ultimately result into a situation of chaos.

Internet connectivity

The internet availability is a necessity as most of these devices operate on the internet. When the patients are at remote locations and unable to access the internet in such a situation the use of IoT is of no benefit for patient's medical management.

Cost-Effectiveness

The use of IoT assisted medical management for the common people or those who are economically weak, is still not so much cost-effective or cheap. As it is still in its development stage and needs to evolve a lot. However, it promises to reduce the costs in a long-term run.

ADVANTAGES

The application of an IoT network architecture in medical management, is still an area of plethora of evolution. But we should not underestimate the abilities that it possesses to transform or streamline our classical modus-operandi in it's such early stage of development. Below are few of the advantages listed:

Medical-Data convenience

The availability of patient's medical history data electronically, to the healthcare professionals at any time can help them to make the right medical decisions and provide quality healthcare to the patient.

Economic-Feasibility

Use of such integrated technologies helps the patients to

reach the medical assistance virtually, reducing the costly visits, transportation charges, etc. Hence it becomes a more economical to access such a mode of treatment.

Instantaneous monitoring

The instantaneous visibility can make it really accessible for the healthcare professionals, to remotely diagnose the ill-patients and do the required treatment and even save lives in crucial cases of emergency.

Improved treatment quality

The respective data gathered from the IoT assisted wearable, helps the medical management professionals to come up with evidence-based treatment methods for the better treatment of patients.

Error minimisation

Data collected from the wearable and the integrated IoT devices assists the healthcare professionals to come up with a more efficient and precise treatment methods to ensure streamlined operations with an ultimate reduction in errors.

FUTURE ASPECTS

The future scope of the medical management of the patients with the application of IoT assisted technologies for patient treatment has got multiple benefits. As per a Business Insider report, the current market for the IoT assisted and integrated technologies for the medical management of patients will rise up to $400 billion by 2022. Such a growth will be a result of the increase in acceptance and the demand of IoT technologies, Health-care IoT software and internet connectivity. The tech giants such as *Samsung, Apple* and *Google* are also investing in abundance to minimise the gap between the actual precise medical care and the fitness tracking apps. Keeping aside the hindrances, the ongoing and the coming digital transformation and evolution in the medical management is quite inevitable and this postulation of IoT will evidently capture and scenario of the current healthcare services

DISCUSSION

After analysing this article it's pretty obvious that the application of IoT network architecture in the community pharmacies can turn out to be really constructive. But only if it's executed in a well précised manner with adequate capital investment, operational ability, obligatory infrastructure, etcetera. Its application at such a broad spectrum can't be left on its own as it's still a state-of-the-art abstraction. In a professional opinion there is still a few serious worriment regarding the data privacy of the patients at the community pharmacy. As the network architecture of operation is decentralised most of the times. Hence the system engineers must come up with data security alternative so that the integrity of the crucial medical data must not be compromised.

The insubstantial power supply that is used to support the numerous types of wearable devices at some point, may urge out as a serious problem. So, we must come up with a better alternative for the uninterrupted power supply. The smart monitoring e-devices

utilised in this network architecture even ask for a very high maintenance. As of this issue, it is not amongst the cheap alternatives, so we must come up with a more superior and a feasible alternative for the issue. The multiagent technologies that are being utilised to manoeuvre such a network may erupt with a situation of software/server breakdown and hardware incompatibility, leading to an unprecedented situation of hassle.

CONCLUSION

It's quite evident now, that it could undoubtedly forge the quality of medical management at community pharmacies, and help it to achieve novel forte. But it's still a novel concept, it has yet not achieved a state of plateau in terms of evolution/development. Implying it still has an ample scope to be worked upon and result into its better variants. The collusion of IoT network architecture with Community Pharmacy, would unquestionably help us to help us to come across varying hindrances. As the Community Pharmacies have a plethora of records and data to be managed. At this point the involvement of IoT could really streamline their workflow and assist them with a better operational ability. The collusion of IoT in community pharmacy would really bear great outcomes, but before their collusion it must be foreseen that whether their contemporary SOPs would go hand in hand along with the application of IoT network architecture or not.

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