# Healthcare Services Using IoT: Opportunities and Challenges

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***Abstract*—** Internet of things (IoT) is becoming most demanding, dynamic and rapid technology which is not only bringing radical changes in health treatment ways but is changing patient life through technology controlled medication management. Advanced healthcare organizations, hospitals are looking into IoT as next gen technology to enable better health prospects for people. In this paper we are outlining potential IoT applications through which IoT contribution is giving benefits to human being. One of the areas of focus of this paper is to present key opportunities and challenges in IoT while forming statistical hypothesis and validations as per collected data by following various research methodologies.

***Keywords*—** *IoT (Internet of Things); healthcare; Opportunities; Challenges; benefits, IoT healthcare applications*

## I. INTRODUCTION

The IoT is fastest emerging network which enable communication between physical and digital environment through connectivity medium i.e. internet. IoT play an incredible role in improving the quality of life. The IoT change the traditional healthcare care into the modern health care with promising technology.

Paschou et al. [19] focused on Health Internet of Things (HIoT). The related technologies identified for realization of HIoT include wrist-worn devices, heart rate monitors, pulse oximeters, glucose monitors, and stethoscopes. All these devices have integration with Bluetooth, Wi-Fi, and RFID. They also provided observations on data transfer costs involved with healthcare IoT integration.Ahmed et al. [1] provided an overview of IoT integrated with health infrastructure for monitoring. Gyrard et al. [8] stated the significance of semantic web to realize the needs of IoT and WoT. They said that semantic technologies provide benefits like ease of interconnection, deducing new knowledge, interoperability. Mettler el al. [16] on the other hand provides challenges in such integrated systems. The challenges include knowledge empowerment, security and privacy, digital divide, and inter-operability. Shunj et al. [25] explored that Green Internet of thing is a set of action to attain energy efficiency with the espousal by the Internet of things in the form of software or hardware efficiency technique.

Stergiou et al. [27] explored the importance of MCC in the context of IoT and healthcare integration. Mobile cloud computing (MCC) has its limitations pertaining to security, connectivity, performance, latency, and privacy. Fernandez et al.[6] studied opportunities and challenges of IoT integrated with healthcare units and found that IoT paves way for improving QoS in healthcare services provided it overcomes challenges related heterogeneity in data and devices and inadequate global standards. Similar kind of work is done by Hassanaliergh et al. [9] with respect to highlighting opportunities and challenges in IoT based healthcare systems.

Wan et al. [28] stated the use of mobile cloud computing in healthcare services. The integration of mobile cloud computing with wearable sensors finds health details of patient in real time. When MCC is integrated with wearable device network, it provides many advantages such as rich user experience and functionalities, efficient performance, patient-centric services, and reinforced reliability. Body sensor nodes used by patients form network along with mobile devices in the hospital premises. In turn such network is connecting to Internet through access points or base station. Afterwards, the healthcare network can gain access to cloud and mobile application servers through Internet. The servers where data is stored can have patients' vital signs and process them with suitable algorithms for diagnosis. Then physicians gain the information pertaining to their patients for attending patients in real time

Hiremath et al. [10] presented architecture for WIoT. The Wearable IoT (WIoT) is made up of three major components. They are body sensor network, big data, gateways and cloud. Body worn devices are connected to medical infrastructure. Body area sensors are categorized into therapeutic sensors, on-body contact sensors, fitness and wellness sensors, behavioral sensors, and rehabilitation sensors. Rehabilitation sensors promote language development and technology for blinds. Behavior sensors monitor activities such as fall, sleep and exercise, emotions such as anxiety, depression and stress, diet such as eating habits, and calorie Intake. Fitness and wellness

sensors monitor motion such as calorie count and physical activity and location such as GPS information, and indoor localization. Therapeutic sensors monitor medication such as drug delivery, stimulation such as chronic pain relief, and emergency such as defibrillator. Monitoring sensors take care of sensing physiological things such as ECG, EMG, and EEG, chemical monitoring such as saliva, glucose, and sweat, and optical sensors monitor tissue properties and oximetry.

Popescul et al. [20] Investigated security issues like as, loss of boundary, hyper connectivity, and, hacking when of internet of things incorporated with healthcare. They also identified some problems such as inadequate configuration of smart devices, unattended devices, and non protection to sensitive data, spam, and social engineering. Diega [4] discussed data protection and consumer laws in the wake of IoT, cloud and emerging integration of them with healthcare. The intersection of both IoT and cloud are known as Clouds of Things (CoT) that reflect M2M communications. Liang et al. [11] proposed a framework known as Health Share which is meant for sharing healthcare data through social media related to healthcare domain or Health Social Networks (HSNs). Their architecture has an attribute trusted authority that provides relevant access permissions to doctors and patients in healthcare units.

## II. POTENTIAL APPLICATIONS OF IoT IN HEALTHCARE UNITS

Healthcare units can have different applications that can serve patients in an elegant fashion when IoT is integrated with health infrastructure. Dlodlo [5] threw light into potential applications of IoT its related technologies in healthcare systems of South Africa. The applications include diabetes management, heart disease management, environmental health, occupational health, mental health, home and community based healthcare, emergency services, sports and fitness, baby care, oral health, disease surveillance, telemedicine, chronic medical management, and ambient-assisted living for aged people.

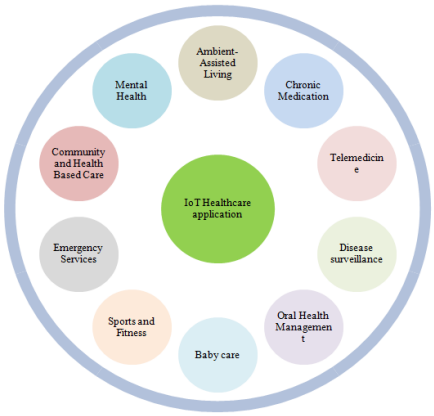


Fig. 1, Potential Applications of IoT Healthcare

### A. Ambient-Assisted Living

Elderly people are more in many countries due to increased life expectancy. They need special care in their adult life to live autonomous and independent life. IoT technology used in healthcare units can achieve ambient-assisted living. Especially for elder people IoT along with healthcare infrastructure provides services that can improve quality of life of adults. Caalyx-MV is one of the platforms for ambient assisted living. It has provision to provide healthcare services to adult population. To achieve this, the home system has different devices involved in computations. The ambient-assisted living platform has different devices or elements for elderly people. They include smart T-shirt, Weight Bridge, blood pressure cuff, video camera, TV, data logger, WiFi, set top box, Modem for Internet, UMTS, and surveillance. The care services provided to elders include healthcare services, professional care services, and services to family and friends. The services are provided through Internet [24]. CONFIDENCE is another system for supporting ambient-assisted living. As per this, radio tags connect with human body. The system is able to monitor patients and reconstruct patients' posture and find any abnormalities. It can identify falling and being left unattended. It targets elderly people above 65 years age. With CONFIDENCE in place, elderly people can live with confidence and comfort [13].

### B. Chronic Medication Management

Patients with chronic ailments need to follow medication long time. Lack of patient's compliance in this regard can lead to fatal consequences. It also results in increasing cost of further healthcare services and medication. With IoT integration it is possible to track chronic medication. It is possible to associate Radio-frequency identification (RFID) with medical devices and track the movement. Both RFID and Electronic Product Code (EPC) are used in this case for automatic information acquisition. With the usage of these technologies as part of IoT, it is possible to help patients with chronic diseases to have ideal medication as prescribed by physicians. Visualizing supply chain of medicine and monitoring can help improve quality of services with respect to chronic medication management [5]. Some of the services existing in this area include CorrectoSpecto [26] and Philips Medication Dispensing Service [3].

### C. Telemedicine

According to WHO [18] telemedicine is the practice of medical care using audio visual interactions and data communications that include finding cause of problem, education, transfer of medical data, diagnosis and treatment. Telemedicine is provided by different departments from healthcare units. Usually patients from home make calls through Internet. These calls are attended by service providers. Then service providers take initiation to let a competent doctor involve in understanding, diagnosing and solving problems of

patients. Voice based communication is prevailing in this kind of application where patients can interact with service providers and get advice from experts without leaving the comfort of home. This can leverage their morale and confidence besides saving time and money.

*D. Disease surveillance*

Disease surveillance is made possible with wearable body sensors. Though it is applicable to certain diseases only as of now, it is very important understanding about the improvement in healthcare. With this, patients can stay at home and lead normal life while their healthcare is being monitored, diagnosed and treated by physicians without losing quality of life. As disease surveillance can get rid of moving places and waiting time, it is one of the factors that can have impact on patients positively. The real time surveillance needs technology integration and seamless communication among different devices and wireless technologies.

*E. Oral Health Management*

This is related oral health including dental diseases. Preventive dental care is essential as there is relationship between diseases like diabetes, respiratory illness, cardiovascular disease, and pregnancy complications. With technologies in place and IoT integration with healthcare infrastructure, oral health management becomes easier [5].

*F. Baby care*

Baby care is very important in any society as the baby grows into adult. Efforts are needed in order to protect babies from diseases. Immunization and vaccination are important for various diseases such as measles, tuberculosis, and polio to mention few. RFID tags and sensors can help to improve quality of baby care. It is important to keep track of body temperature and other vital signs for real time care of babies. Location based transport and location based services can help improve quality of life of babies. This is leveraged with IoT used in healthcare units [5].

G. *Sports and Fitness*

Health and life style monitoring is possible with IoT enabled healthcare services. As explored in [5], mobile applications such as EndoMondo Sports Tracker can help athletes to have mobile applications associated with sensors to monitor their activities. The applications can keep track of not only activities but also time taken, speed, and so on. The application also has integration with Google Maps. CardioTrainer is another application that runs in Android smart phones to have Global Positioning System (GPS) for recording fitness events of athletes. Athletes who use IoT related devices and applications are alerted about time, cycles, and so on with real time voice messages.

*H. Emergency Services*

Medical services are delayed generally due to distance between healthcare unit and living place of patients. There is time delay in reaching hospital. Moreover money and time are involved. In case of emergencies also, the same thing may occur unless there is alternative in place. To overcome this problem, IoT application associated with healthcare can be adapted in order to have real time observations of patients either from home or when the patient is in transit. It is possible to start treating patients even the patient reaches hospital. The mobile nodes involved in IoT, sensor devices, and healthcare infrastructure work together to have real time communication among different stakeholders. Machine to machine interaction is made possible to deliver patient's vital signs in real time. This has tremendous impact on healthcare services [5]

*I. Community and Health Based Care*

Community based healthcare services improve quality of life of people who are associated with communities. These services are provided at home when patients are not advised to move places for any reason. For instance, physically impaired patients and people with chronic diseases can avail such services. With the invent of technologies and NFS-enabled devices provide intuitive interface between devices and patients. Since Network File System (NFS) is compatible with RFID; these technologies can be used to ensure better healthcare services [5].

*J. Mental Health*

Mental health is often not taken care of. In other words it is overlooked without having diagnosis. Integration of IoT applications with healthcare can mitigate this problem as explored in [5]. There are some mental health disorders such as Generalized Anxiety Disorder (GAD) cause long-term issues to people. Behavioral, cognitive and physical strategies are needed to treat such diseases. Biofeedback and making the patients aware of their own reactions to situations and educating them through different programs lead to solving problem to great extent.

## III. METHODOLOGIES

The research methodology includes secondary research, case study and primary research methods like structured survey and interview. The outcome of these exercises is interpreted to derive conclusions on the application of IoT in healthcare. The review of literature provides valuable insights to determine the most recent stage of development and gain information to frame research questions or hypothesis for the completion of the study. Besides it leads to survey questions and interview questions that are used in the primary research. The secondary research is made on wide variety of technologies such as EPC, Wireless sensor network (WSN), RFID, and Near-field communication (NFC) and so on those are essential for the

apprehension of IoT and leverage of quality services in healthcare units.

In this research two types of data collection method are used. First one is Questionnaire method as structured survey using online survey tool Surveymonkey.com. Second is Interview as a qualitative method using GoTo Meeting as video conferencing medium.

The sample size for structured survey is 150. It does mean that around 150 people participate in the survey. Respondents industry association with medical industry is in the range of >1 year to more than 10 years. Respondent's age is in the range of 25 to 60 years. Random sampling method has been used to collect sample data. Responses have been gathered from healthcare experts such as technicians, physicians and other stakeholders from various representative healthcare units. Sample size for Interview method is 25.

In this research data analysis is done using two approaches as quantitative and qualitative. Quantitative analysis is computed using SPSS tool and Minitab (Chi-square test) which is meant for statistical analysis. Qualitative analysis is made to interpret the results of interview.

## IV. RESULT and DISCUSSION

Minitab software tool has been used to run statistical test. Minitab gives the chance to run various Hypothesis tests.

Case Processing Summary

Number of cases:
Valid = 150, Excluded = 0, Total=150

Industry association or Experience of respondents having medical industry revealed that, 38% have 1-5 years of experience and 38% have less than 1 year of experience and 10 % people got rich experience (higher than 10 years). Respondents age group indicating that, 38% of respondents fall in the range of 25-30 which indicate young generation, and 40 % are 31-40 years group followed by 10 % & 11% each in ranges 41- 50 and 51-60 years.

Chi-square test for association,

Pearson Chi square statistic:

$$\chi^2 = \sum_{i=1}^{r}\sum_{j=1}^{c}\frac{(O_{ij}-E_{ij})^2}{E_{ij}} \quad (1)$$

Likelihood ratio Chi square statistic:

$$G^2 = 2\sum_{i=1}^{r}\sum_{j=1}^{c} O_{ij}\ln\left(\frac{O_{ij}}{E_{ij}}\right) \quad (2)$$

In this formula, observed frequency in cell (i, j) shown as $O_{ij}$, expected frequency for cell (i, j) shown as Eij, number of rows shown as r, number of column shown as c, degrees of freedom as $\{(r-1)\times(c-1)\}$

Expected cell count:

$$E_{ij} = \frac{n_{i+}\, n_{+j}}{n_{++}} \quad (3)$$

In this formula, number of observations in the ith row shown as *ni+*, number of observations in the jth column shown as *n+j*, Total number of observations shown as n++

Contribution to Chi-square statistic:

$$\frac{(O_{ij}-E_{ij})^2}{E_{ij}} \quad (4)$$

In this formula, *O*ij is Observed frequency in cell (i,j), *E*ij is Expected frequency in cell (i,j)

Summary of Hypothesis Tested

Chi-square analysis has been used to test the null hypotheses defined for the present study. Test gives opportunity to analyze Contribution to Chi-square, Expected value, observed value, Likelihood ratio, Pearson, degree of freedom. Test throws significance value. The standard significance value (0.05 as P-Value) and computed significant value is shown in Table 1 Result.

$H_{01}$: There is no significant relation between Industry association and their opinion of Wearable sensor devices associated with IoT can help for real time monitoring of patients.
Pearson Chi-Square Value =144.458, DF=1, P Value = 0.000
Likelihood Ratio Value =151.483, DF=1, P Value = 0.000

$H_{02}$: There is no significant association between Age of respondents and their opinion of IoT can throw sensitive data handling, threats to data security.
Pearson Chi-Square Value =138.784, DF=1, P Value = 0.000
Likelihood Ratio Value =140.289, DF=1, P Value = 0.000

$H_{03}$: There is no significant relation between industry association and their opinion of IoT remote healthcare service help physicians to monitor patient even if there is difference in geography and time zone
Pearson Chi-Square Value =150.000, DF=1, P Value = 0.000
Likelihood Ratio Value =160.565 , DF=1, P Value = 0.000

$H_{04}$: There is no significant association between Age of respondents and their opinion of Patients health records are to be handled, accessed with high level security, with IoT in place
Pearson Chi-Square Value =138.784, DF=1, P Value = 0.000
Likelihood Ratio Value =140.289, DF=1, P Value = 0.000

$H_{05}$: There is no significant relation between age of Respondents and their opinion of IoT integration with healthcare services improve quality of life of patient with Disease surveillance
Pearson Chi-Square Value =150.000, DF=1, P Value = 0.000
Likelihood Ratio Value =155.502, DF=1, P Value = 0.000

$H_{06}$: There is no significant relation between Industry association and their opinion of Mobility based healthcare IoT with end-to-end security and automated reconfiguration can help in improving quality of services in healthcare centers.
Pearson Chi-Square Value =138.784, DF=1, P Value = 0.000
Likelihood Ratio Value =140.289, DF=1, P Value = 0.000

$H_{07}$: There is no significant relation between Industry association and their opinion of big data analytics improve healthcare units for analyzing medical data to extract latent trends
Pearson Chi-Square Value =150.000, DF=1, P Value = 0.000
Likelihood Ratio Value =160.565, DF=1, P Value = 0.000

$H_{08}$: There is no significant relation between Industry association and their opinion as IoT and 5G technologies, robotics play a very important role in rendering improved healthcare service
Pearson Chi-Square Value =150.000, DF=1, P Value = 0.000
Likelihood Ratio Value =160.565, DF=1, P Value = 0.000

Table 1 Explain hypothesis, result and derived interpretation of chi-square test

TABLE 1. Chi square analysis results

| Hypothesis | Result | Interpretation |
|---|---|---|
| $H_{01}$: There is no significant relation between Industry association and their opinion of Wearable sensor devices associated with IoT can help for real time monitoring of patients. | Computed significant value 0.000. i.e. <0.05 (Standard sig. value) *Reject null hypothesis* | As per expert's opinion, Wearable sensor devices associated with IoT can help for real time monitoring of patients, diagnosis and treatment |
| $H_{02}$: There is no significant association between Age of respondents and their opinion of IoT can throw sensitive data handling, threats to data security. | Computed significant value 0.000. i.e. <0.05 (Standard sig. value) *Reject null hypothesis* | As per expert's opinion, health data is very sensitive, IoT can throw many challenges such as disclosure of sensitive data, threats to data security, and increased cyber attacks. |
| $H_{03}$: There is no significant relation between industry association and their opinion of IoT remote healthcare service help physicians to monitor patient even if there is difference in geography and time zone | Computed significant value 0.000. i.e. <0.05 (Standard sig. value) *Reject null hypothesis* | As per medical experts opinion, IoT remote healthcare service help patients to leave hospital early as physicians as monitor their health with geographical and time restriction |
| $H_{04}$: There is no significant association between Age of respondents and their opinion of Patients health records are to be handled, accessed with high level security, with IoT in place | Computed significant value 0.000. i.e. <0.05 (Standard sig. value) *Reject null hypothesis* | As per expert's opinion, opinion of Patients health records are to be handled, accessed with high level security, with IoT in place |
| $H_{05}$: There is no significant relation between age of respondents and their opinion of IoT integration with healthcare services improve quality of life of patient with disease surveillance | Computed significant value 0.000. i.e. <0.05 (Standard sig. value) *Reject null hypothesis* | As per medical expert's opinion, IoT Integration with healthcare services improve quality of life of patient with disease surveillance equipment in place |
| $H_{06}$: There is no significant relation between Industry association and their opinion of Mobility based healthcare IoT with end-to-end security and automated reconfiguration can help in improving quality of services in healthcare centers. | Computed significant value 0.000. i.e. <0.05 (Standard sig. value) *Reject null hypothesis* | As per medical expert's opinion, Mobility based healthcare IoT help in improving QoS in healthcare center. |
| $H_{07}$: There is no significant relation between Industry association and their opinion of big data analytics improve healthcare units for analyzing medical data to extract latent trends | Computed significant value 0.000. i.e. <0.05 (Standard sig. value) *Reject null hypothesis* | As per medical expert's opinion, big data analytics improve healthcare units for analyzing medical data to extract latent trends |
| $H_{08}$: There is no significant relation between Industry association and their opinion as IoT and 5G technologies, robotics play a very important role in rendering improved healthcare service. | Computed significant value 0.000. i.e. <0.05 (Standard sig. value) *Reject null hypothesis* | As per medical expert's opinion ,IoT and 5G technologies, robotics play a very important role in rendering friendly healthcare service with high care service with high quality. |

Table 2. A Holistic representations of Healthcare IoT opportunities & Challenges

| Opportunities & Challenges | Description |
|---|---|
| Positive aspects of IoT in healthcare | Wearable sensor, remote healthcare service, disease surveillance, Mobility based healthcare, early detection of chronic diseases, Digitized channel of information, automated process |
| Opportunities for improvement | Electricity supply, high speed Internet connectivity, lack of interoperability |
| Opportunities for growth | Improve patient care, green technology and minimum paper work, high potential to reduce medical errors. Predictive data analytics on healthcare data, technology architecture, infra and platform solutions (data storage and data integration through multiple information sources) and data analysis applications. |
| Challenges | scalability, standardization, data privacy, energy limitation, memory and computation limitation in IoT smart devices and patient information security |

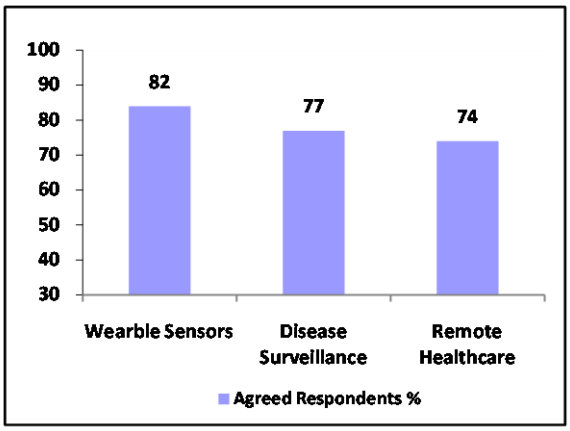


Fig. 2, Graphical representation of % Respondents agreed that the wearable sensor, remote healthcare service; disease surveillance can improve the healthcare services.

Hiremath et al. [10] explored those wearable body area sensors monitoring real time sensing physiological things such as Electrocardiography (ECG), Electromyography (EMG), and electroencephalogram (EEG). This preposition has 82% support. It reflects that Wearable sensor devices associated with IoT can help for real time monitoring of patients, diagnosis and treatment.

Boric-Lubecke et al. [12] studied privacy and security issues in such IoT applications employed for e-Healthcare. Privacy refers to non-disclosure of sensitive data pertaining to patient while security refers to allowing access to healthcare data with authentication. This preposition has 81% supports, it reflects that the security and privacy challenges of IoT integration with healthcare units. This is true as the disclosure of sensitive information can spoil careers of people; make them bad, results in security threats and cyber attacks. Roman et al. [23] opined that distributed nature of IoT and related technologies throws privacy and security challenges. This proposition has 81% supports. That reveals privacy challenges.

Chen et al. [2] explored the impact of big data analytics on health organizations to improve quality of life of people. This proposition has 77% supports. That reveals that big data analytics on health organizations to improve healthcare units. Moosavi et al. [17] focused on mobility enabled healthcare IoT for providing a scheme to enable end-to-end security. This preposition has 77% support. It shows that Mobility based healthcare IoT help in improving QoS in healthcare center. Ma et al. [14] explored that robotics is suitable for bandwidth intensive applications to promote Quality of Experience and Service in IoT healthcare center. Zheng et al.[29]Explored that 5G is more user centric and improve networking capability and increase throughput .This preposition has 77% support which reflect that 5G technologies, robotics play a very important role in rendering improved healthcare service. Ghosh et al.[7] Remote healthcare means monitoring patient from remote place at real time and fast detection of disease. This preposition has 74% supports. It reveals that IoT remote healthcare service help patients to leave hospital early as physicians as monitor their health with geographical and time restriction.

The research provides insight that remote surveillance facility and promotes real time health monitoring. Disease surveillance is made possible with wearable body sensors. Though it is applicable to certain diseases only as of now, it is very important understanding about the improvement in healthcare. With this, patients can stay at home and lead normal life while their healthcare is being monitored, diagnosed and treated by physicians without losing quality of life. As disease surveillance can get rid of moving places and waiting time, it is one of the factors that can have impact on patients positively

Wearable devices are connected to healthcare digital infrastructure; it is possible to have live observation of vital signs of patients. This can help physicians to make well informed decisions. Moreover, that kind of integration can lead to real time response from healthcare service providers. When physicians are able to view a dashboard containing their patients' health information, they can easily cater to the needs of patients in real time and take most accurate decisions. This can improve quality of service in healthcare sector besides improving customer satisfaction.

Remote healthcare service means the service given to patients from a remote place. In this concept, patients do not move places but healthcare services are provided. . IoT remote healthcare service helps physicians to monitor patient even if there is difference in geography and time zone.

*A. MERITS OF IoT USAGE IN HEALTHCARE*

*1) Patient treatment cost and time reduction*

Research findings indicate that it is possible to have real time patient monitoring. Wearable devices provided to patient

can facilitate in throwing real time data with the help of IoT in hospital centre. With the utilization of IoT innovation in healthcare services it will rebelliously decrease wastage of time and cost.

*2) Minimize human error*

IoT automate end to end patient treatment, care life cycle and enable smart wearable device use like RFID, Sensors and barcodes which result in reduction in medical errors. Smart IoT devices connected with patients, doctors, medication and medical equipment powered through internet help mobilize digital inputs, data and trends.

*3) Taking away geographical restriction, constraints*

IoT in healthcare is making patient and doctor/ physician interaction possible even in case of different geographical locations e.g. different countries, city etc. Physicians able to examine patient's health status and advise relevant medications, treatment in order to prevent/cure chronic diseases.

*4) Reduction in paper usage*

IoT integration with healthcare facilitates Patient data, test results, medical information in Digital form which minimizes paper work, document filling activities. Digital data/ information can be shared with medical experts as and when required to deal with medical situation of patient. It follow Green technology concept.

*5) Proactive alert of chronic diseases*

Big data analytics, cloud computing in healthcare IoT is providing opportunity to analyze patient data, health information in structured way trends, patters which help to detect severe chronic diseases at initial stage and help to cure in a timely manner.

*6) Boost effective medication*

IoT in healthcare provide effective and efficient medication to a patient. RFID, EPC are used to attach with medical devices which help to monitor patient medical compliance and report status. Secondly, it helps to track medication supply, procurement confirmation to ensure patients with chronic diseases equipped with required medicines as prescribed by medical expert.

*7) Enhance emergency support*

In emergency situations, it is feasible to treat patient even if patient not yet reached to hospital or at home. Technologies involved in IoT like mobile nodes, sensor devices help to get real time patient data and help to mobilize the information among several medical experts in case required. M2M interaction is possible to give alert about patient medical situation and status when patient needs immediate attention.

*B.* CHALLENGES AND ISSUE

- As IoT presence is growing, all smart devices & objects connected to the internet and delivering a humongous data which get transferred from IoT enabled smart devices and analyzed for relevant insights. Data storage, archival and retrieval is also a major concern given size of data. This issue brings IoT scalability as one of the key challenge.

- IoT facilitate integrated network of smart devices which run and operate with defined medical objective in order to measure and collect patient health data and information. Integration of these devices provides many useful insights. It also brings an issue of standardization and interoperability which is a major concern in achieving optimum output from connected device network.

- During remote monitoring, patient need to attach wearable or implanted devices to the body. Lack of attention may result in security threat to patients and may result in critical consequences. Hence this is one of the potential issues in remote monitoring process.

- IoT enabled healthcare mechanism deal with patient data in an open network which bring threat to security and privacy of the human. This issue needs to be managed with help of Robust IoT infrastructure which can ensure data integrity, security and confidentiality.

- IoT usage and applications are growing at a faster pace which brings basic design issues into our attention. Issues like energy limitation, computation limitation and memory limitations in smart devices. These issues need to be addressed with further improvement in design and development.

## V. CONCLUSION AND FUTURE WORK

IoT in healthcare bring patient centric functionalities and better health prospects. This research paper throws light on opportunities and challenges lies in IoT in healthcare services. Research revealed that Wearable sensor, remote healthcare service, disease surveillance, Mobility based healthcare, early detection of chronic diseases, Digitized channel of information, automated process bring enormous benefits in healthcare industry. These points provide clear view that IoT in healthcare services can bring digital revolution, effective and efficient patient care. On the other hand, there are challenges and issues which suggest further improvement

areas in IoT such as scalability, standardization, data privacy, patient information security, energy limitation, memory and computation limitation in IoT smart devices. As per responses received in interview process it has been suggested that if Electricity supply, high speed Internet connectivity, lack of interoperability is addressed than IoT may deliver more extensive results. In future, we recommend further research on key areas of IoT enablement and growth such as platform solutions (data storage and data integration through multiple information sources) and data analysis applications.

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