

Role of Artificial Intelligence, Telemedicine & Electronic Health Records in re-shaping healthcare in Primary Health Centers in India

Dissertation submitted to



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Masters of Business Administration (MBA)

In

Hospital and Health Management

by

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DECLARATION

I hereby declare that this dissertation titled Role of Artificial Intelligence, Telemedicine & Electronic Health Records in re-shaping healthcare in Primary Health Centers in India is the bonafide record of my original researchwork. I declare that it has not been submitted to any other university or institution for the award of any degree or diploma. Information derived from the published or unpublished workof others has been duly acknowledged in the text.

Malini Nair

Name of Student

Date: **2nd July 2021**

CERTIFICATE

This is to certify that **Malini Nair** in partial fulfillment of the requirements for the award of the degree of MBA (Hospital and Health Management) from the IIHMR University, Jaipur has successfully completed her internship at MarketsandMarkets during March 22, 2021 to June 19, 2021.

Place: **Pune HQ (WFH)**

Date: **2nd July, 2021**

Preceptor/Head of the Organization:

Name of the Organization:

CERTIFICATE

This is to certify that dissertation titled **Role of Artificial Intelligence, Telemedicine & Electronic Health Records in re-shaping healthcare in Primary Health Centers in India** is a record of the research work undertaken by **Malini Nair** in partial fulfillment of the requirements for the award of the degree of MBA (Hospital and Health Management) from the IIHMR University, Jaipur under my guidance and supervision and her approach to the research study has been sincere, scientific, and analytical.

Faculty Guide
IIHMR University, Jaipur
Date

School Dean
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Date

ABSTRACT

INTRODUCTION

Primary healthcare is the initial block of attaining healthcare service. Primary healthcare in India is achieved from its three building blocks, namely Sub-centers (SC), Primary health Centers (PHC) and Community Health centers (CHC).

Primary Health Centers (PHC) are the initial building block of primary healthcare. PHCs have a major role in providing primary health care to the population or community they cater to. Primary Health Centers (PHC) is envisaged as social models of healthcare service delivery for all. However, there exists a major drawback in providing the care necessary for all.

Technologies like Artificial Intelligence, Electronic Health records and Telemedicine have been adopted globally to improve and make the for primary healthcare practice more effective. Technology has been seen to have many advantages in making the primary healthcare delivery more efficient and effective. Technological innovations and its adoption by the public healthcare system has evolved over the years. This report aims to understand the role of healthcare technology such as Electronic Health Record, Artificial intelligence and Telemedicine in improving and reshaping the primary healthcare services in India provided by Primary Health Centers in India and the current of such technology adoption in Primary Healthcare Centers.

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OBJECTIVES

Specific Objective:

To understand how Electronic Health Records, Artificial Intelligence and Telemedicine will help in improving the challenges in primary care in India

General Objectives:

1. To understand the application of healthcare technology in primary healthcare for filling the existing gaps in the Primary Healthcare Centers.
2. To understand the present gaps in Artificial Intelligence, Electronic Health Record and Telemedicine at the level of PHC.

METHODOLOGY

Study design – Descriptive study

Data source – Research articles (using Google scholar & PubMed), Government Websites (for secondary data)

Data Collection and Analysis- This study is based on review of past studies, reports, and other refereed articles. The primary information on which the researched report is premised is sourced from various studies and Government website. The information from such sources have been assessed, structured and analyzed to device possible solutions that may prove useful in tackling the primary challenges.

DISCUSSION & CONCLUSION

Primary Healthcare centers are one of the major pillars of attaining primary healthcare in India. The study reveals the present scenario of the Primary health Centers in India.

Artificial Intelligence, Electronic Health Records and Telemedicine have proven advantage in making the primary healthcare more effective and thus improving the functioning of Primary Health Centers service functions, making the services more achievable and effective. These technologies can be a link to the different departments and units of healthcare, at the same time can also serve as first point of access for primary care in the form of teleconsultations . And even has the potential to support the healthcare providers in making effective decision making.

Although Artificial Intelligence, EHR and Telemedicine can improve the existing the state of primary healthcare in India, but this technology cannot replace or could be an alternative to a doctor, other care provider or the required infrastructure to treat a critically ill patients. Moreover, the technologies in the scope of this study require a stronger infrastructure to operate, hence they can only be a solution to the micro challenges existing in the primary health centers in India. Whereas, the macro challenges will have to be dealt from the grass root level by policy makers and regulatory bodies.

Thus, these technologies can be used to improve the present scenario of the primary health centers in India by making the primary care system more effective and is not the end solution.

Acknowledgement

True inspiration and motivation are the key to true success of any new venture.

I wish to express my sincere gratitude to my university guide, Prof. Veena Nair Sarkar, Assistant Professor IIHMR University, for her guidance and invaluable help in preparing this project.

I extend my gratitude towards The IIHMR University, Jaipur to encouraging me to the highest peak and to provide me the opportunity to embark on this project.

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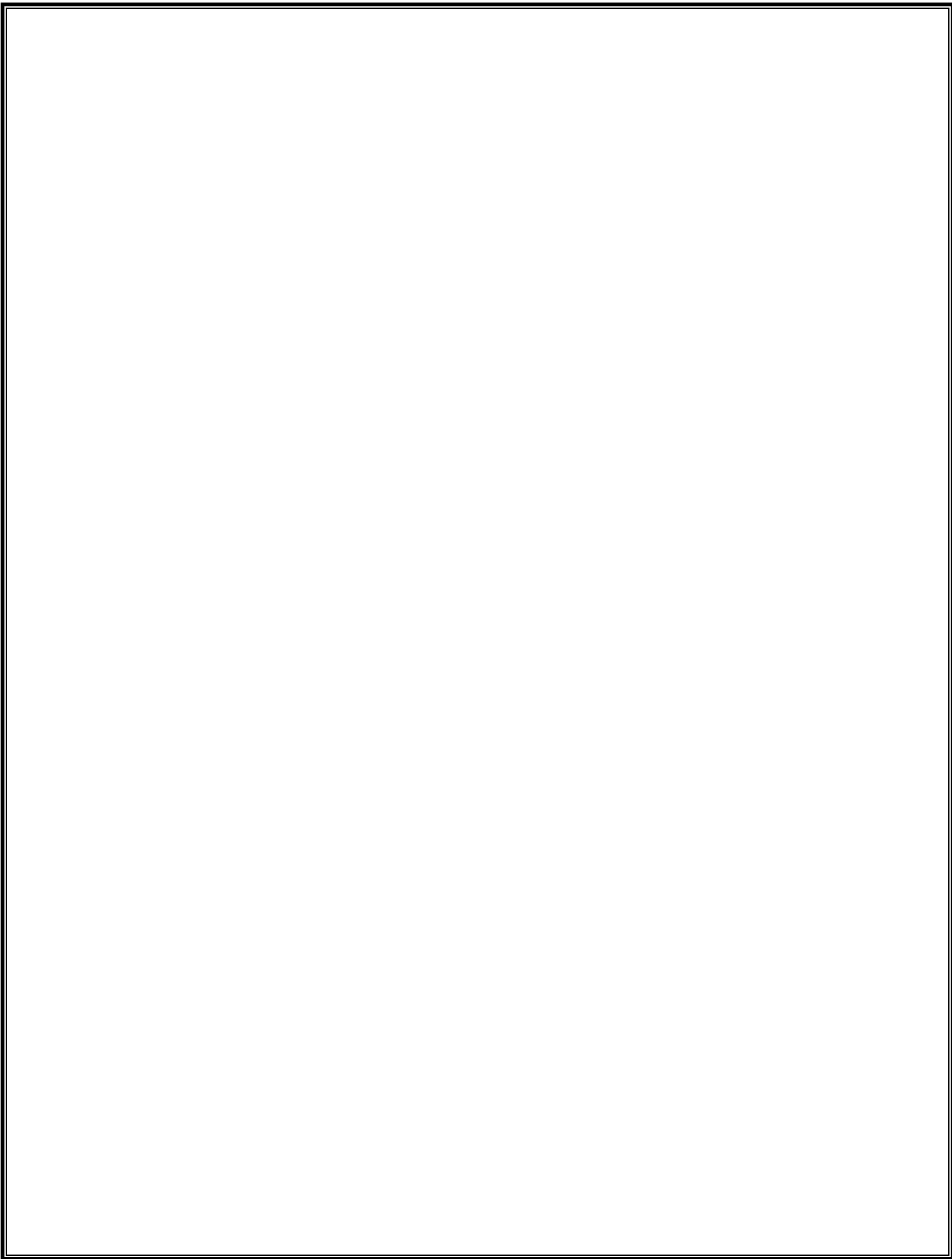
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ABBREVIATIONS

AI	Artificial Intelligence
BD	Big Data
CTQ	Critical to Quality
CDF	Cumulative Distribution Function
EHR	Electronic Health Records
EMR	Electronic Medical Records
HTI	Healthcare Technology Innovation
IT	Information Technology
IOT	Internet of Things
IPHS	Indian Public Health Standards
ML	Machine learning
MOHFW	Ministry of Health & Family Welfare
PHC	Primary Health Centers
RHS	Rural Health Statistics



INTRODUCTION

Primary healthcare is the most important and the first point of healthcare. It is defined as “the essential healthcare based on practical, scientifically sound and socially acceptable methods and technology made universally accessible to individuals and families in their community through their full participation at a cost that community and country can afford to maintain at every stages of their development in the spirit of self-reliance and self-determination.”

Primary Health Centers (PHC) are the initial building block of primary healthcare. PHCs have a major role play in providing primary health care to the population or community they cater to. Primary Health Centers (PHC) is envisaged as social models of healthcare service delivery for all. Front line institutions that deliver integrated care at the nearest to people's homes. However, there exists a major drawback in providing the care necessary for all. These drawbacks are, un awareness among the present availability of healthcare among population in various regions, poor infrastructure, lack of healthcare manpower, doctor's lack of interest in providing primary healthcare, disregard to outpatient care, preference for private healthcare facilities due to lack of provisions.

69 % of the population in India resides in villages, whereas 26 % of the doctors serving the patients are mostly in the private healthcare sector. Private healthcare facilities and hospitals are generally not accessible to many, especially the ones living in rural India. The accessibility to private healthcare service for people living in rural India becomes a challenge due to its cost. More than 833 million population in India are completely dependent on 44,000 doctors (S Angrish, 2020) . This shows the severe lack of adequate healthcare provision and human resource scarcity catering to healthcare needs. Accessibility to healthcare provision affects also due to the hampered availability of healthcare providers due to them residing majorly in urban locations/ locations far from the rural areas. This major proportion of the healthcare force include specialists, physicians and paramedical staffs, this leads to a major maldistribution of the healthcare work force required in the areas when in need. Moreover, these reasons stated above are responsible for the increasing out of pocket expenditure on healthcare. This is in turn responsible for the impoverishment of 3.3 percent of India's population (Furtado, 2014). All these issues are responsible for the inadequate and poor primary healthcare delivery to patients in India.

In order to address the present challenges existing in Primary healthcare centers in India, various measures have been taken by the government and India is seeing technological advances in its healthcare sector to make its healthcare sector more stringer and efficient. There has been an increasing trend in the adoption of technological advancements in the healthcare system of various countries across the world. Technology has been seen to have many advantages in making the healthcare delivery more efficient and effective.

Technology has impacted human lives in myriad ways. Its expanse today, stretches from the hitherto “conventional” sectors like “brick and mortar” businesses, to even the most advanced of financial markets. By essentially blurring the line between human capabilities and that of its limitations, it has played a pivotal role in development of the whole of human race. Healthcare sector is no different, and the rapidly evolving technology innovations, have thrown up huge opportunities which until now didn’t exist. Among many other factors, the primary ones fueling the technology adoption are viz. change in life style, climate change, increase in life expectancy and demographic transitions.

Technological innovations and its adoption by the healthcare industry has evolved over the years. It has helped in easier collection and archiving of critical patient information (data). “Data is the new oil” – as the saying goes, the availability of such macros to healthcare professionals, has revised the whole perspective and approach towards understanding of critical illness and the quality of treatment meted out to their patients. Hence, technology solutions such as Electronic Health Records, Artificial Intelligence and Telemedicine has the potential to strengthen the primary healthcare in India.

This study aims to understand the role of healthcare technology such as Telemedicine, EHR and AI in reshaping healthcare system, and primary focuses on their role in reshaping the Primary Health Centers in India.

OBJECTIVES

Specific Objective:

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General Objectives:

1. To understand the application of healthcare technology in primary healthcare for filling the existing gaps in the Primary Healthcare Centers.
2. To understand the present gaps in Artificial Intelligence, Electronic Health Record and Telemedicine at the level of PHC.

STUDY FRAMEWORK

S.no.	OBJECTIVE	INDICATORS	CONCLUSIONS
1.	To understand the application of EHR, AI & Telemedicine in primary healthcare services.		Healthcare technology such as AI, Telemedicine and EHR systems have a broader role in improving the present primary care delivery.
a.	Applications of EHR in primary Healthcare	• Training on EHR • Storing patient data • Study disease pattern	
b.	Applications of AI in primary healthcare	• Predictive modelling • Decision making • Learning Disease pattern	
c.	Applications of Telemedicine in primary healthcare	• Access to primary care (consultation)	

2.	To understand how EHR, AI and Telemedicine will help improve the challenges in primary care in India	• Percentage of human resource working • Accessibility to PHC • Referral system in PHC • Trained staff working • Effective Decision making	EHR, AI and telemedicine has the potential to improve the primary care challenges by enhancing the proper functioning and increasing the efficiency of Primary Health Centers in India.
3.	To understand the present scenario of Technology implementation in Primary Healthcare Centers in India	• Implementation gaps	The study suggests there are various gaps and challenges in the present use and implementation of AI, EHR and Telemedicine in the Public healthcare centers.

LITERATURE REVIEW

Authors (Year)	Study location	Sample size	Sampling Techniques	Salient Features
<u>(2019)</u> Harshana Liyanaga, Siaw-Teng Liaw, Jitendra, et al	Europe	Round 1: n= 20, Round2: n=12, Round 3: n= 8	Three round Delfi study, Round 1: AI used in PHC, Round 2 : appropriateness of the statements checked, Round 3: Online panel discussion finding	The study suggests that AI has the potential to enhance healthcare deliver by improving managerial and clinical decisions and processes. The study also talks about various limitations in the implementation of AI in India.
<u>(2019)</u> Vinoth G Chellian, A.Y. Nirupama & Neha Taneja	India	<u>NA</u>	Literature Review	The study suggests that Telemedicine can be a potential solution to many healthcare problems. Telemedicine is used in the field of healthcare as tele- education, tele-home and tele-health. The study also talks about the use of Telemedicine in Indian scenario. Telemedicine is used in healthcare for training of healthcare staffs, healthcare delivery even in remote access conditions, Also used for healthcare management.

<u>(2018)</u> Harry Hemingway, Flkert W Asselberg, et al	India	NA	Literature review	The study concludes about the potential use of EHR systems in early identification of diseases. With the availability of huge data available EHR systems can be used as an analyzing tool to understand various disease patterns which contribute to effective healthcare delivery.
<u>2017</u> Hongbo Lin, Xun , Peng Shen, et al.	China	n= 10,53,565 (adults >18 yrs)	Longitudinal population cohort study	The researchers in this study used big data alongside EHR to analyze and understand Cardiovascular disease pattern. Their result suggest that linking of Big data with EHR is a powerful tool for investigating quality of care and improving the disease outcome.
<u>2020</u> Tyler Wagner, FNU Shweta, Karthik, Murugadoss, et al.	India	n= 77,167	Experimental	In the study the researchers leverage the application of EHR to analyze the disease pattern of COVID 19 in patients. By contrasting EHR data, the researchers were able to compare the infection symptoms among positive tested and negative.

<u>2020</u> Raju Vaishya, Mohd Javaid, Ibrahim Haleem Khan, et al.	India	NA	Literature review	The study talks about the urgent need and application of healthcare technology in the field of healthcare. The review studies the application of Artificial Intelligence (AI) in the field of healthcare to track and combat COVID 19. The researcher also concludes from their study that AI in healthcare has multiple applications. In the time of COVID 19 it could not only help in tracing the infected patients but can also help in prompt delivery of vaccine across the country. AI altogether can be used as a result driven technology and can be used for screening of patients, analyzing, disease prediction and for tracking.
<u>2019</u> Monika Pathania, Vyas Kumar Rathaur	India	NA	Descriptive study : literature review	The study talks about various advantages and applications of AI in healthcare. The researchers also talk about the limitations in the research of AI use in practical.

<u>2020</u>				
Christine A Sinsky	US	NA	Literature Review	The author talks about the various use of telemedicine in primary healthcare. Telemedicine has the potential to combat the challenges existing in primary healthcare practice. The author also compares the adoption of telemedicine with the adoption of EHR. The study also elaborates about the various ways to effectively implement telemedicine in primary health care.
<u>2017</u>				
Tina Lien Barken , Elin Thygesen & Ulrika			N=60 Participatory observation & focus group interview	The researchers conducted the study in a telemedicine center. The telemedicine center. The study was focused on the nurses working in the telemedicine center. The results of this study suggest the advantage of EHR systems used by healthcare providers. The nurses in the study were able to make more efficient decisions with the use of EHR.

<u>2021</u> Sonu Bhaskar, Sian Bradley, et al.	India	NA	Literature review	In the study, the authors explore the use of telemedicine in the time of COVID 19. Their authors identify various applications of telemedicine during the time of COVID 19, such as: Telemedicine used for specialties like telecardiology, Tele acute neurology, telemedicine used for COVID 19 patients with acute respiratory syndrome , and the broad use of telemedicine in other chronic diseases, for primary care. Telemedicine was also identified as being used for palliative care and for Elderly. The study also highlights various challenges and limitations associated with the use and implementation of telemedicine.
<u>2019</u> Magdala de Arujo, Novaes, et al.	Brazil	N= 9 students N= 396 patients		In the study, the 9 participants, medical students experimented with the use of EHR systems to learn the patient disease patterns. The researchers could conclude by the feedback of the medical students that EHR can be used as a tool for better understanding of Diseases. Thus, EHR device can be used as a training to for the upskilling of the healthcare providers.

<u>2017</u> Brian G Arndt, John W Beasley, et al	US	N= 142 (family medicine physicians)	Retrospective Cohort study	The study was conducted on 142 primary care physicians where they used the EHR system as a part of their work each day. Their daily working hours were recorded into these EHR device. The researchers from this study were able to establish the application of EHR in maintaining proper work flow and decision making in regards to managing the staff. The researchers suggest that EHR systems are useful in healthcare management decision such as in this case, where delegations of staff according to work flow was made possible due to regular usage of EHR device in the health setting.
<u>2019</u> Pablo Buitron dela vega, Stephanie Losi, et al.	US	N= 1696 (patients)	Observational study design.	The researchers study EHR automation in clinical primary care setup to facilitate screening of primary care patients and to implement EHR based “social-determinant health” screening and referral. In total 1696 patients were screened for SDOH . The researchers concluded that EHR implementation in primary care work flow turned out be successful.

METHODOLOGY

- Study design – Descriptive study
- Data source – Research articles (using Google scholar & PubMed), Government Websites (for secondary data)

Data Collection and Analysis- This study is based on review of past studies, reports, and other refereed articles. The primary information on which the researched report is premised is sourced from numerous studies and Government website. The information from such sources have been assessed, structured and analyzed to understand the role and gaps. in Artificial Intelligence, Telemedicine and Electronic Health Records used for primary healthcare in Public Health Centers.

To plug the gaps in information needed to base this study upon, a comprehensive survey literature was done using tools like – pub med, google scholar, Research Gate, data from government organization websites. Further references were obtained by cross referencing the articles.

Key words such as: Telemedicine in primary healthcare, Artificial intelligence in primary healthcare and EHR for primary healthcare, Primary health center, Quality of care, electronic health records, primary healthcare were used to obtain an overview of healthcare technology applications currently in use and how they can be used in combatting the primary healthcare challenges in India.

PRIMARY HEALTH CARE

According to WHO, Primary health care is a combined effort and approach to the health at aims at providing and ensuring the highest level of health. Primary healthcare also ensures equal distribution of healthcare with focus on the needs of the community. Primary healthcare focuses on continuum of care via health promotion and treatment for disease prevention, rehabilitation and palliative care. Provided in an environment that is feasible to the community. Primary healthcare system has three pillars, namely: Sub-centers, Primary Healthcare Centers and Community Health Centers.

THE PRESENT SCENARIO OF THE PHCS IN INDIA

Bhore committee in 1946 first introduced the concept of Primary Healthcare Centers (PHC) in India and defined them as the basic health units to provide close to the people as possible. PHCs were built to provide integrative, curative and preventive health care especially for the rural population emphasizing on their preventive and promotive healthcare. Thus, Primary Healthcare Centers are known to be the cornerstones of rural health services.

The primary objectives of PHC were focused on providing comprehensive primary health care to the community, PHCs must achieve and also maintain acceptable standards of quality of care and to the services more sensitive to cater to the needs of the community.

According to MoHFW, PHC is the first contact point for primary healthcare access between the village communities and the medical officers. The PHCs are maintained by the State Governments under the minimum needs program (MNP).

According to the state government mandates a PHC consists of:

- Medical Officer- 1
- Paramedical and other staffs- 14
- PHC must involve curative, preventive, primitive and family welfare services

Being said, Primary Health Centers are the initial building blocks for rural healthcare services. According to IPHC guidelines on PHC, it is the first point of contact with a doctor in a public sector in rural areas for the sick and for those who either directly visit the PHC or are referred to a PHC from a Sub center.

According to National Urban Health Mission (NUHM), Primary health centers are built to provide comprehensive primary healthcare services. Built for preventive, promotive and basic curative healthcare for the population it caters to.

According to MoHFW, UPHC varies from 30,000 to 50, 000 population. The Urban PHC is to be located closer to the slum or similar inhabiting areas. Urban PHCs are based on urban locations with population of 50.000 or more. According to RHS data (2019- 2020),there are 5895 Urban PHCs that are functional in the country as of March 31st 2020.

Provisions by Urban PHCs include:

1. Laboratory services
2. OPD Services
3. Reproductive and Child Health (RCH) services
4. Dispensing contraceptives and other prescription drugs
5. Providing preventive, promotive and curative care - communicable and non-communicable diseases.
6. Minor surgical procedures
7. Health counselling for all
8. Population based screening.

Activity	Delivery unit	Nature of work	Role of primary care specialist
Primordial prevention	Populations likely to be at risk	Screening Health education and promotion	Active engagement with training of grassroots workers
Primary prevention	Population at risk	Health promotion and specific protection	Surveillance, monitoring, and Evaluation
Secondary prevention*	Individuals	Early diagnosis and treatment by both field-based active surveillance and outpatient clinics at the center	Consultancy - prescribing both treatment and prophylaxis. Stabilization and referral
Tertiary prevention	Individuals	Prevention of complications, disability limitation, and rehabilitation	Disability limitation Supervisory role for rehabilitation
Epidemic control	Population	Epidemic prediction and preparedness	Epidemic indicator analysis, sentinel surveillance, and epidemic control
Health programs: Development and delivery	Population	Specific community needs assessment Evaluation of program efficiency, gaps in the program, and interventions to fill the gaps	Development of intervention strategy Monitoring and supervision of delivery of the program at the primary care level

*Secondary prevention in an individual should be coupled with primary prevention at the family level, wherever applicable

Figure 1: Areas of primary care specialization (Nafis Faizi, 2016)

Figure 1 describes the various activities performed in primary care units, the role of primary care specialist in each unit and the nature of primary care delivered by each. According to the study (Nafis Faizi, 2016), various activities performed by the primary care specializations are primordial prevention of diseases, primary, secondary & tertiary prevention of diseases, among others. The diagram also summarizes the role of primary care specialist in each unit for every activity.

HUMAN RESOURCE

Healthcare providers are the major building blocks of Primary Healthcare service provision. The unavailability of the medical staffs and care providers is what effects the timely delivery of healthcare. There is a huge gap in the availability of manpower to provide primary healthcare in many parts of India. Poor manpower in PHCs in India are majorly seen due to many driving factors such as poor living and working conditions, low wages as compared to private players (Pavithra Mohan, 2019).

Primary Health Centre - Rural

- The availability of manpower is one of the major aspects and prerequisites for an efficient functioning of health services. According to RHS report 2019-2020, as of

31st March, 2020 the post of the Healthcare worker (HW)/ ANM is 3.9 % of the actual required as per the guidelines for Sub center and PHC (Gujarat, Himachal Pradesh, Rajasthan, Tripura and Kerala).

- Out of the posts sanctioned by the government, a huge difference was seen when compared with the number of vacancies. According to the RHS 2020 data, out of 14.1 % of the sanctioned posts of the / ANM - 37 % vacancies of the healthcare workers were observed (male) in the year 2020.
- 37.6 % of the sanctioned posts for male and female health assistant and 24.1 % of doctors posts were vacant.

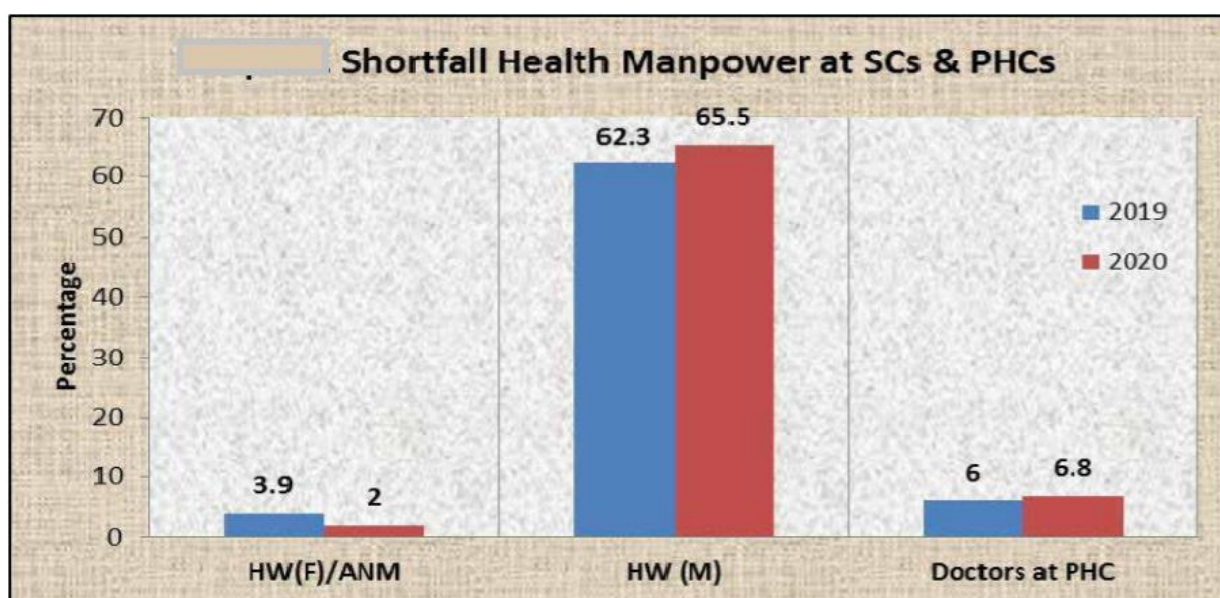


FIGURE 2: Shortfall Health Manpower in SCs and PHCs (Source: Rural Health Statistics 2019-2020)

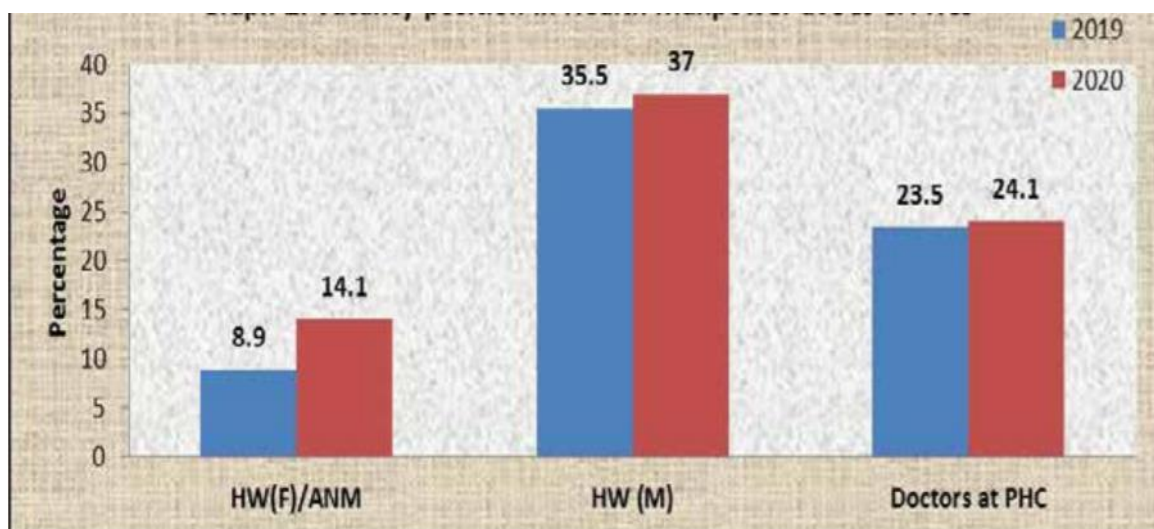


FIGURE 3 : Vacancy position in health manpower at SCs and PHCs (Source: Rural Health Statistics 2019-2020)

According to Figure 2 and Figure 3, the number of doctors at the PHCs have been still less in number as compared to the previous year (2019). The graph clearly shows the inadequate staff population in PHCs in India. Also, it shows the existing number of vacancies in the PHCs as compared to the sanctioned posts by the government.

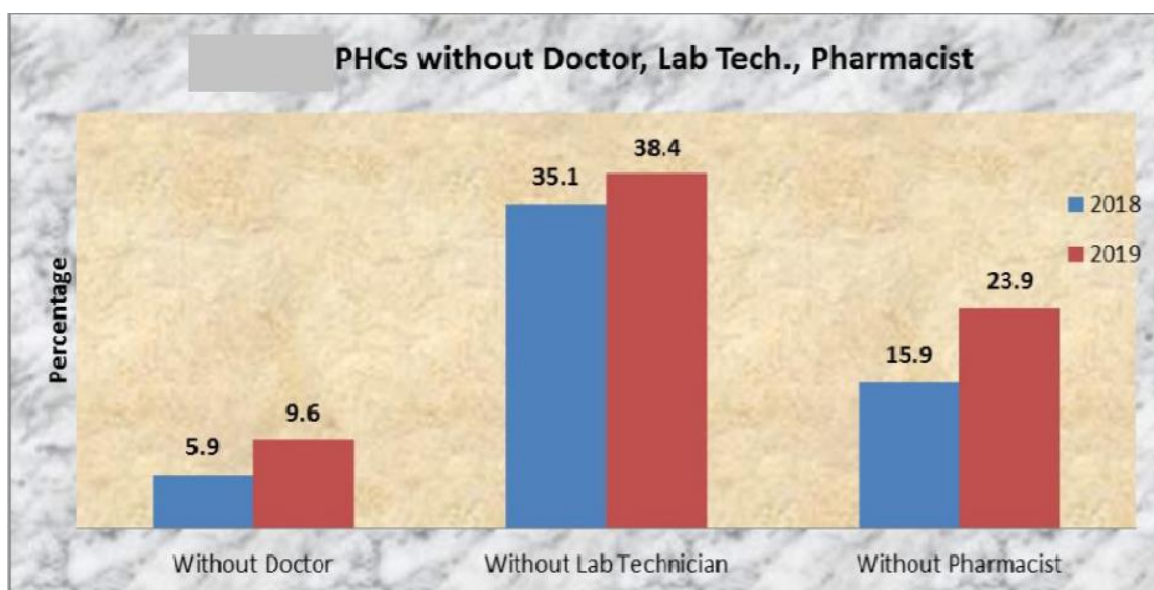


Figure 4: PHCs without Doctor, Lab Tech., Pharmacist (Source: Rural Health Statistics 20118-2019)

REFERRAL SYSTEM IN PRIMARY HEALTH CENTER

Referrals in healthcare system is a key component in providing the right healthcare to the community. Every unit in the healthcare system is a link to the other.



FIGURE 5. THE REFFEREAL SYSTEM IN HEALTHCARE IN INDIA (MD Abu Bhaskar, 2019)

Figure 5 explains the referral system in Indian healthcare system. The primary care begins with the Sub-centres. Sub-centers are the first point of contact for the community. Primary Health Centers act as the referral units for 6 sub-centers. The patients requiring specialized treatment are referred by the primary care physician to the community health centers. Hence, Primary Health Centers are an important link for primary care provision and treatment for the community. The healthcare system may fail if the

There exist various challenges in the referral system in the current scenario of Primary Health Centers in India. Doctors and other health care givers working in the PHCs face challenges of accessibility and inadequate facilities to provide proper service to the population they cater to. In a study by (Angrish, 2020) , the results suggest that doctors in their study population perceived themselves as isolated from their work professionally at the PHCs and they felt delinked from the referral tiers. They expressed concerns about dealing with medical

conditions at times without any peer support. This situation was sometimes worse when such situation piled on with lack of adequate drugs, supplies and diagnostic equipment. This situation lead to a risk averse situation resulting in higher number of referrals from Primary Health Centers than that was necessary from a clinical perspective.

INFRASTRUCTURE

According to IPHS guidelines for PHCs, all functions must be available in their own buildings. There are many states in India that lack a proper infrastructure in terms of PHC building facilities, the equipment and unavailability of required drugs in them. According to a study (Sriram, 2018) conducted in Andhra Pradesh, the results suggest the status of the improper infrastructure of PHC building in Nellore district. The unavailability of the required conditions as per IPHS guidelines.

Lack of adequate infrastructure and required choice and treatment of care leads to inadequate utilization of the facilities in the PHCs. This encourages the people to rather choose private healthcare facilities as a point of care rather than opting for the public health centers. With a long run inadequate facility is unable to provide adequate care to the patient, the patient gradually becomes disconnected to the public facilities and tends to seek care from private healthcare facilities. This in turn is the major reason that increasing out of pocket expenditure, as the patient spends more while acquiring healthcare services from a private hospital by not spending on Primary care centers thus by bypassing it. This leads to a higher burden, especially on the poor even while seeking for primary care. According to a study by (Krishna D., 2018), patients that visited the local PHC spent less money for healthcare service as compared to those who took treatment from private healthcare facilities. The study suggests that there needs to be more focus relevant to healthcare needs of the community the PHC is catering to, in terms of both the infrastructure, care provider and facilities available adequate to treat the patient needs.

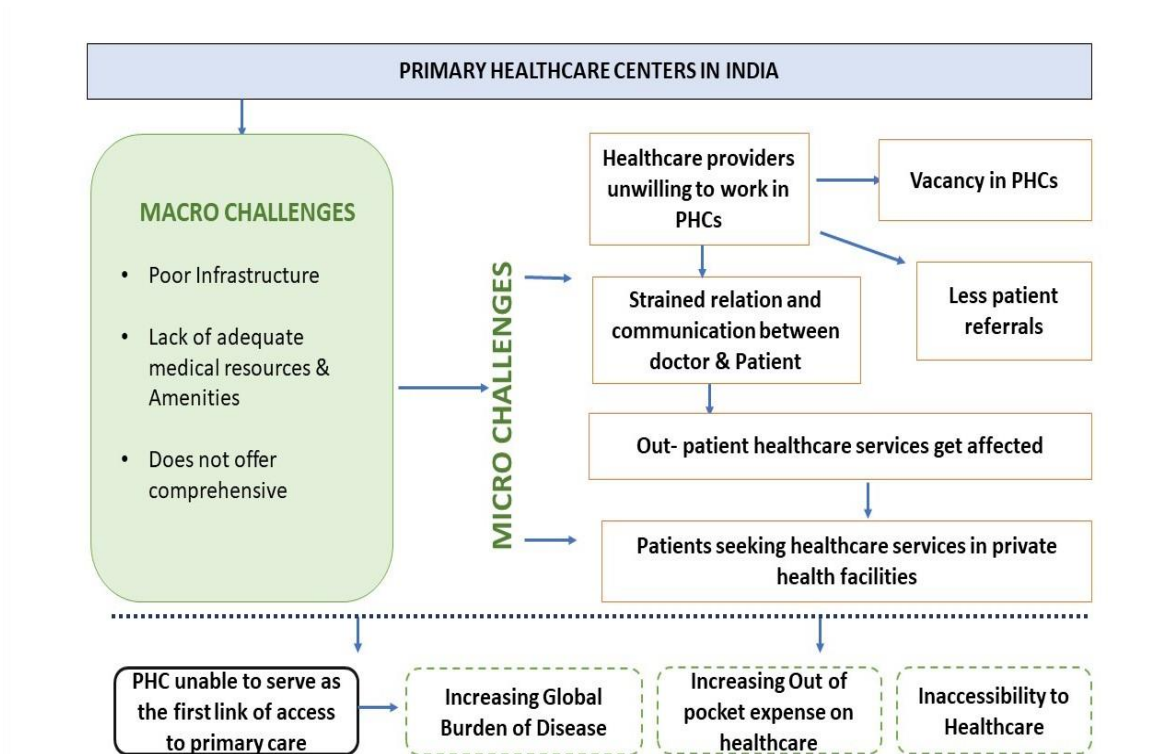


Figure 6 : Summarizing the existing challenges in PHC in India from the study

Figure 4 summarizes the existing challenges in the PHC in India based on the above literature. There are certain challenges and gaps in the primary care provided by the PHCs in India. Based on the scope of the study the challenges are segmented into macro challenges and micro challenges.

1. HEALTHCARE TECHNOLOGY INNOVATION FILLING THE EXISTING GAP

1. ARTIFICIAL INTELLIGENCE (AI)

Artificial intelligence based on deep learning is a property of computer programs and systems, that has the capability to perform certain functions with intellect, creativity and with independence just like a human being does. Most artificial systems have the ability to think and learn while giving possible solutions and making decisions for a given problem. AI has the potential to work with 90-96 percent accuracy and reliability (Jahanzaib Shabbir, 2018)

AI technology is being used widely across the world in different industries for its known capabilities and potential. Healthcare industry has also adopted this technology to provide high quality services and to use its tools to figure out solutions to healthcare problems/ issues, with speed and accuracy, and to come up with possible solutions for the same.

AI and Machine learning (ML) has the potential to provide real time wisdom to the front-line workers in every decision that needs to be made. Along with Decision support, image analysis and patient triage AI and ML help physicians in making smarter choices. Machine learning can graphically represent data to further analyze problems and illness, much faster than any physician. This may help healthcare workers to have a better understanding of illness and its treatment. Robotics in the domain of surgery (Ahmed, 2019) (Andonian S, 2018) help surgeons to perform high precision surgeries, and help serve better outcome to patients. This may further reduce cost due to post- operative complications. Improving outcomes with the help of technology can help make “Smart hospitals” more patient centric.

Machine learning is a form of AI (Kalakota, 2019). In healthcare, ML is commonly used for predicting the treatment protocols, which is most likely to succeed on a patient diagnoses based with many attributes. This is commonly known as Precision medicine (Lee SI, 2018). The potential uses of AI and Robotics is vast in healthcare industry. **Figure 7** explains how AI and robotics together can transform the world of healthcare in eight different ways.

There is a large number of healthcare data being generated daily by various healthcare facilities. These data are in large quantity and are complex to store and be analyzed. With the

rise of complexity in data, the importance of adopting artificial intelligence into the field of healthcare becomes more important (Kalakota T. D.).

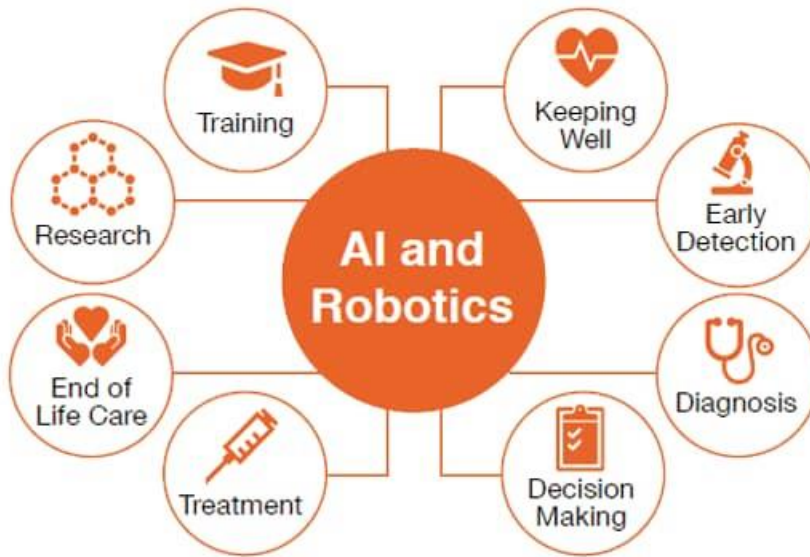


Figure 7. Improving patient outcomes using AI in Healthcare (*source: PWC report*)

Big Data and analytics

Big Data refers to large & varying data sets, that can be collected, stored and later analyzed to provide insights to an organization (Knight, 2018). Healthcare industry is one of the most promising industry where Big Data is used. It is most often used for healthcare analytics. Big Data helps in collection and structuring of large complex data sets collected from various departments of the hospitals, patients, devices, etc. (figure 8) and is analyzed for improving the services and efficiency of the organization. Large unstructured data sets are easily collected with the help of various digital tools from different departments of the hospital, and are converted in a structured manner to be analyzed further. A few of such data sets are:

- Nursing Diagnosis, interventions and outcomes extracted from the Electronic Medical Records (EMR) (Jane Englebright, 14 (4) (2016)).
- Medical and clinical data from Imaging and Laboratory examination.

- Also, data sets like, electronic health records (EHR), Pharmacy Prescription, Insurance records, etc.

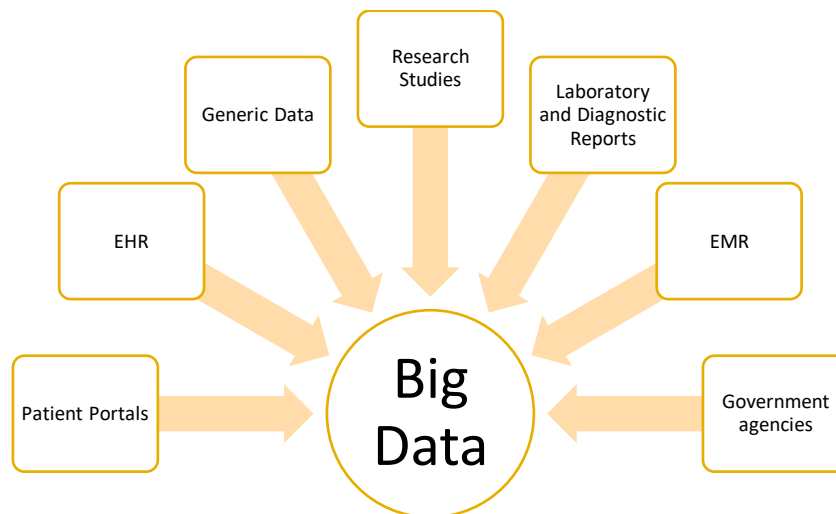


Figure 8. *Role of Big Data in Healthcare*

Big Data in collaboration with deep learning and the use of EHR, can help in the making of prediction models at hospitals, for diagnosing many health problems (Maragatham G, 2019)

Role of AI in PHC

Artificial intelligence is now widely being adopted in providing effective primary healthcare services across the world. AI is used for predictive modelling, which is useful in early detection and diseases. One of the main focus of PHCs is on preventive care model and early detection of diseases. Thus, AI is used as a tool to detect early symptoms of diseases. AI based Deep Learning (DL) is also booming. DL is being widely adopted in many countries to detect diseases like diabetic retinopathy, tuberculosis and more (Ting DSW, 2019) . It has mostly been used in medical imaging and analysis. DL has shown to have successful in detecting diseases like Tuberculosis from Chest x-ray (Lakhani P, 2017). A study (Liyanage, 2019) suggests the following benefits of AI in primary healthcare system, AI helps the physician in decision support to improve primary care process, it is used for pattern recognition in Imaging, AI is useful in performing predictive modelling of primary care data and used for analytics for better management.

Artificial Intelligence is used across the world by general physicians for multiple applications. Its adoption by the general physician is increasing as the prevalence of infectious cases is rising in this new era. A very such case is of COVID 19, where with the rising number of covid patients, after a certain period it became a challenge for the providers to trace the infected patients. AI was adopted as a tool to combat this disease by the primary care physicians to understand the disease pattern and improve the surveillance. In a very recent study (Raju Vaishya, 2020), the researchers study the application of AI during Covid across general physicians. The study illustrates how the primary care general physicians are using AI as a tool to combat the disease by improving the surveillance and understanding the disease pattern in patients with the help of analysis.

2.ELECTRONIC HEALTH RECORD SYSTEM (EHR)

Electronic Health Records are developed initially for the purpose of recording patient information. EHR is the real time record of a patient charted digitally. It is a technology innovation that has led to a reliable and safer storage of patient records. It safely maintains information of the patient health data and makes it available only to the authorized person. EHR is useful for the storage of data. This stored data can be used by the healthcare practitioners to analyze **(Figure 9)**, by leveraging other technological tools like AI & Big Data, and understand the disease patterns, improve efficiency and effectiveness of the care delivered to their patients (Electronic Health Record, 2019 updated). EHR standards were first notified in 2013 in India by MoHFW, and its revised version in 2016. Most of the corporate hospitals in India like Max Hospitals, Apollo Hospital, Shankara Netralaya Hospital, Fortis Hospital, etc. has implemented EHR (Srivastava, 2016).

Apart from these EHR is also used in order and entry prescribing. The healthcare provider may enter the required details of the patients into an EHR and can even accept prescription orders, it can also be used to capture dose, site and manage referral orders as well with details of the provider and the provider referred-to. This method helps in improving the reporting and the right use of health information.

Moreover, EHR systems are also used to exchange health information of the patients by an authorized person to an authorized user. EHR systems are digitally connected to other devices (especially patient monitoring devices) in a healthcare system via medical device connectivity solutions.

According to the advisory report e-health in zicht, it is said that electronic healthcare is able to combat various healthcare challenges such as accessibility, proving the correct information, improving the efficiency and effectiveness of the healthcare delivery systems.

Role of EHR in Primary healthcare

Effective communication between the healthcare provider and the patient plays an integral part in providing the most effective care to the patients. Electronic health records are not only seen as an effective method for providing the best healthcare to the patients but also an effective method of communication between the provider and patient (Wang, 2017). In promoting and sharing of patient's health status and information among other providers, EHR is helpful in creating a smooth care and coordination between healthcare providers and different healthcare departments. This enables the provision of providing safe and effective patient care with minimal medical errors and reduces the changes of adverse events (P, 2015).

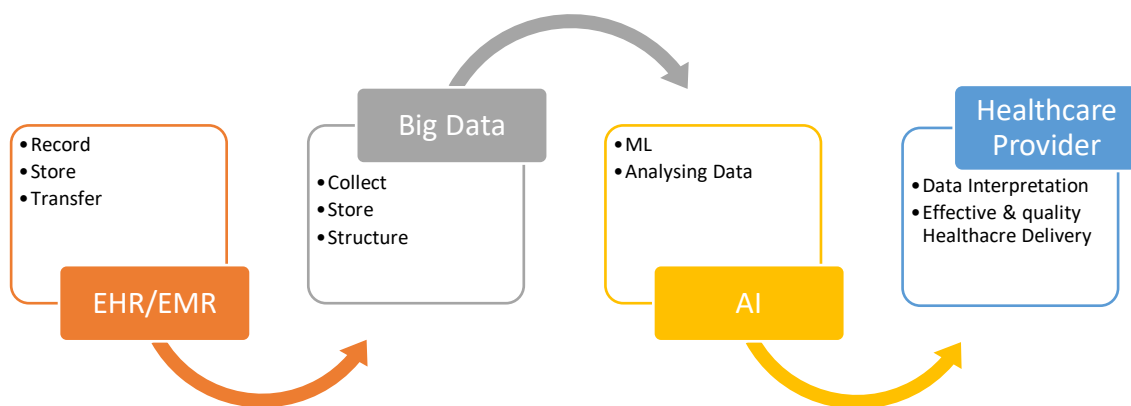


Figure 9. Process of an effective Health care delivery system using HTI

Stage 1 Data Capture & Sharing	Stage 2 Advance Clinical Process	Stage 3 Improved outcomes
Electronically Capture health information in standardized format	More rigorous HIE	Improve, quality safety and efficiency leading to improved health outcomes
Use of information to track clinical conditions	Increased requirements for E prescribing and incorporating lab results	Decision support for national high – priority conditions
Communicate that information for care coordination processes	Electronic transmission of patient care summaries across multiple settings	Patient access to self management tools
Initiate the reporting of clinical quality measures and public health information	More patient controlled data	Access to comprehensive patient data through patient centered HIE
Use information to engage patients and their families in their care		Improve population health

Figure 10. *EHR : to attain the meaningful use (Information)*

Figure 10. elaborates the meaning full use of EHR in healthcare systems. The source talks about the three stages that can be attained by utilizing the various applications of EHR in the healthcare processes. The very initial and primordial use of EHR is data capture and sharing. If stage 1 can be achieved effectively then this captured data can be used for advanced clinical process as mentioned in the stage 2. The final stage is achieved once the EHR data is analyzed and used for decision support of the healthcare units. And later can even be utilized for not only the community but for also to improve the population health. Such stages can be followed in primary care centers will reduce the global burden of diseases and improve the work flow efficiency of these centers.

3. TELEMEDICINE

Telemedicine enables the remote delivery of healthcare and allows the exchange of healthcare information by telecommunication. The role and function of telemedicine are:

- It makes the geographical distance shorter, by helping patients to access to healthcare from anywhere.
- The major function of telemedicine is to provide prompt healthcare reach for all
- Its aim is to provide healthcare for all

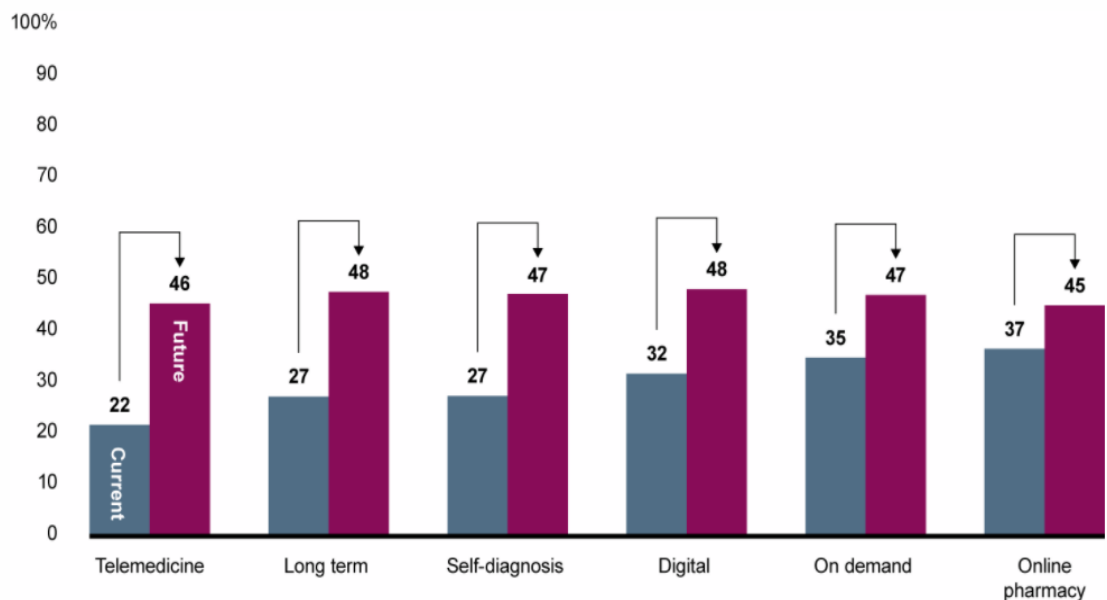


Figure 11: Covid-19 accelerating the adoption of Telemedicine in Asia-Pacific
(Source: Bain & Company Front line of Healthcare Asia Pacific Survey, 2019)

Global adoption of telemedicine has increased, especially since the onset of Covid-19 (figure 3). Telemedicine has helped many attain healthcare and reach out to healthcare providers via telemedicine from the comfort of their home. Many other factors that are driving the adoption of telemedicine in various countries is the ongoing focus towards digitalization of health. Many countries are focusing on increased funding in digital health, in order to reshape and to provide healthcare for all. Telemedicine can be used for various disease management such as asthma, diabetes mellitus, hypertension and when accessibility to healthcare service is challenge. Individuals with infection such as COVID 19 requires social distancing, such patients can easily access healthcare consulting through telemedicine. Telemedicine can serve as a timely and effective alternative to in person medical care. In a study, telemedicine was

application in treating chronic diseases was studied. And the results of the study suggest both approaches to healthcare service had an equal impact on patient care and treatment (J Portnoy, 2020).

As seen in figure 11, countries are focusing more on funding telemedicine, this has led to its increased adoption worldwide. The funding on telemedicine rose as the demand for the same increased. This new era has led to an increased adoption of healthcare technology to all over the world. Healthcare technology is visualized to be playing a very crucial role in delivering healthcare service to all. This requires government and private players to focus on the current trend. As seen in the figure, funding is provided for faster adoption of all types of healthcare technologies available. Telemedicine has the major share, followed by Data analytics and mobile- healthcare apps, among others.

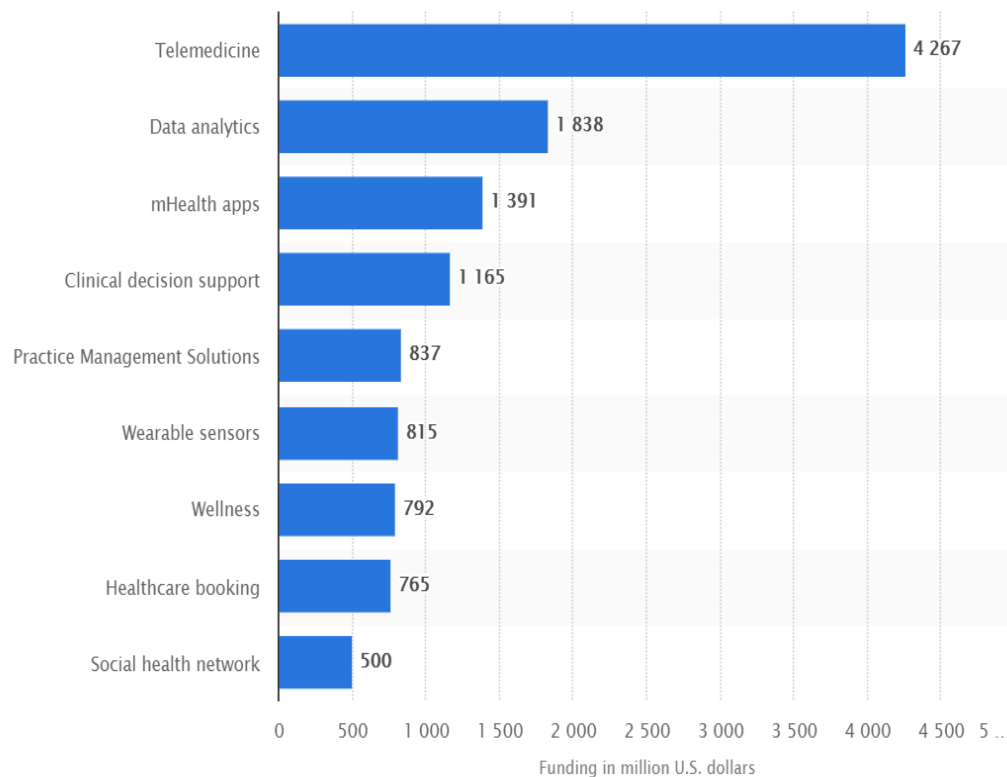


Figure 12: Top funded digital health categories worldwide in 2020 (Source: Statista)

Telemedicine in India has steadily gained its acknowledgement. There are many initiatives taken by Indian government, ISRO, Ministry of External Affairs that has led to the adoption and increased use of telemedicine in India. Telemedicine is widely being adopted by hospitals

and private practitioners in India to make healthcare services more accessible. In recent years, the government has initiated projects such as, National Cancer Network (ONCONET), Integrated Disease surveillance Project and Digital Medical Library Network (Affairs) . Standardized telemedicine practice guidelines by the DIT of Government of India. In this the National Telemedicine Task force was deployed by The Ministry of health for adoption of telemedicine in India. External Affairs Ministry also launched Telemedicine Network Projects in India, which lead to the prompt adoption of Telemedicine.

Telemedicine in Primary healthcare center

Telemedicine services in India is monitored by Ministry of Health and family Welfare (MoHFW). MoHFW has created a National Telemedicine Portal (Ministry of health and family welfare, 2018) for the Telemedicine device for implementing green field e- health project and to establish a National Medical College Network (NMCM) for connecting Medical colleges across the country with the s purpose of providing e-education and National Rural Telemedicine Network was provided for e- Healthcare delivery.

Telemedicine has three major application methods, namely, tele-health, Telehome healthcare and tele-education . Telemedicine public health care application are (Vinoth G. Chellaiyan, 2019) :

- As an educational tool for training of medical staffs, teleconferencing and for tele-Proctoring.
- Telemedicine used for tele clinics and mobile health clinics. It enables the patients to get quick access to the physicians.
- Used in Healthcare management, where telemedicine is used where telemedicine is used to monitor patients from a central station.
- Telemedicine used for specialties in healthcare, for example, telemedicine is used as tele-cardiology, tele- psychiatry, tele-cardiology and tele surgery.
- Telemedicine used for diagnostics (tele-radiology and tele- endoscopy)

Many people are unable to have access for primary healthcare services. Telemedicine is being widely adopted as a solution to cater to the basic primary healthcare needs of the population. Telemedicine is a way to tackle the growing burden of diseases such as diabetes, obesity, hypertension, where early treatment can help avoid future complications and risk from the disease. Primary care physicians can only provide the first line of treatment for patients with such diseases. Hence, unavailability of the primary physicians in PHCs is a huge challenge that needs to have a solution. Telemedicine is seen to have been used to tackle various diseases better at an earlier stage, and was found to be promising for families living in rural regions who has limited access to treatment.

Telemedicine is also being widely adopted for wellness treatment in primary healthcare centers. There are various initiatives being taken by the government and other affiliated bodies to tackle the primary care challenges in India using telemedicine as a solution. National Institute of Mental Health and Neurosciences (NIMHANS), India among its recent efforts integrated mental health care program into a general healthcare program. This program is digital innovation which is driven by four primary care psychiatry programs (PCPPs). This program incorporates the involvement of primary care doctors, where they monitor at their working clinical from a hospital using digital technology (N Manjunath, 2018) . This module was used by many in different parts of the country. One such example is of a Primary care doctor working in a Primary health center in Uttarakhand, where three patients with tobacco addiction were treated with the help of two modules of PCPP (K.T Santosh, 2019).

ANALYSIS

OBJECTIVE	CONCLUSION	REFERENCE
To understand the role of EHR in primary healthcare	Electronic referral system used along with EMR can improve the information management. EMR can also improve the workflow and thus can be useful in improving efficiency. EMR referral provides a better link and coordination between two levels of care, primary and secondary care. However, barriers such as high cost and extensive planning for effective implementation, data privacy and interoperability of data still remains a challenge.	<i>Greenwood-Lee, J., Jewett, L., Woodhouse, L., & Marshall, D. A. (2018). A categorization of problems and solutions to improve patient referrals from primary to specialty care. BMC health services research, 18(1), 986.</i>
	EHR implementation for effective use can be done in three phases. EHR is used in healthcare for capturing health data, sharing the data. EHR systems are also used for advanced processes in a clinical setting such as for e-prescribing and storing patient lab results. The final phase of the EHR use is when it is used for decision support of the healthcare providers and for national priority. The authorized providers and policy makers can access the stored data for making effective decisions and policies to improve the present healthcare scenario of the nation. The proper storage and analysis of the EHR data allows the providers to reduce the global burden of disease by early interventions. EHR adoption is widely adopted by the healthcare providers believing it would help in accurate decision making and reducing the healthcare cost. However, the adoption is still limited in many regions. The regulatory bodies and policy makers	<i>EHRs: The Challenge of Making Electronic Data Usable and Interoperable. P & T : a peer-reviewed journal for formulary management</i>

	initiatives to improve and strengthen the infrastructure and promote interoperability will increase the adoption.	
To understand the role of Telemedicine in Primary healthcare	Telemedicine will further grow in the coming years. Telemedicine can be used for primary care treatment and diagnosis of diseases such as hypertension, bronchial asthma, etc. However, telemedicine cannot address all the primary care problems such that it cannot replace a human touch during a medical emergency, hence there needs to be a doctor available physically as well.	Agarwal, N., Jain, P., Pathak, R., & Gupta, R. (2020). <i>Telemedicine in India: A tool for transforming health care in the era of COVID-19 pandemic. Journal of education and health promotion</i> , 9, 190.
	The virtual consultations primary healthcare is becoming effecting in the rural regions in India. Telemedicine is effective in building patient - provider communication. However, it is necessary to evaluate the quality of care and health outcomes provided by telemedicine	Angrish, Siddharth et al. "How effective is the virtual primary healthcare centers? An experience from rural India." <i>Journal of family medicine and primary care</i> vol. 9,2 465-469. 28 Feb. 2020, doi:10.4103/jfmpc.jfmpc_1124_19

	Nurses when supported by computerized decision Support systems. Telemedicine was useful in making effective decisions.	<i>Barken, T.L., Thygesen, E. & Söderhamn, U. Advancing beyond the system: telemedicine nurses' clinical reasoning using a computerised decision support system for patients with COPD – an ethnographic study. BMC Med Inform Decis Mak 17, 181 (2017).</i>
	Telemedicine services have a broader application in Primary healthcare Centers. Telemedicine is currently used for services like tele-health, tele-education. Telemedicine is being currently in use with the help of various government and non-government initiatives. However, there the adopting is limited due to lack of awareness among people and the reluctance among the professionals to use. Government initiatives are encouraging the adoption of telemedicine in the public healthcare sector.	<i>Chellaiyan, V. G., Nirupama, A. Y., & Taneja, N. (2019). Telemedicine in India: Where do we stand? Journal of family medicine and primary care, 8(6), 1872–1876.</i>
	Telemedicine can help mildly ill patient get early diagnosis and treatment on time. Telemedicine has its uses especially in patients requiring remote monitoring during the onset of infectious diseases such as COVID 19 with mild symptoms. Telemedicine use increased during COVID 19. But it can further be utilized in the coming years due to the potential benefits. However, Telemedicine implementation requires a strong infrastructure including a good internet connectivity especially in areas hard to reach, such as the rural areas.	<i>Telemedicine in the Era of COVID-19. The journal of allergy and clinical immunology</i>

Role of AI in reshaping PHCs in India	AI based E-referral system is effective in reducing the distance between the healthcare units. This also allows smooth workflow between departments and timely management of cases.	<i>Bashar MA, Bhattacharya S, Tripathi S, Sharma N, Singh A. Strengthening primary health care through e-referral system. J Family Med Pri Care. 2019;8:1511–3.</i>
	AI along with Machine learning is used for precision medicine. Although early efforts in diagnosis proves to be challenging. The major challenge of using AI is the acceptance by the users and effective adoption. AI used along with EHR requires regulatory approvals. Thus, effective implementation of AI will require funding, acceptance and regulatory nod. AI will not replace a doctor but will be helpful in making the doctors decision more effective.	<i>Davenport, T. Kalakota, R. (2019). The potential for artificial intelligence in healthcare. Future Healthcare journal, 6(2), 94-98</i>
	AI has a promising role in decision making. The main AI tool is a part of the routine medical practice. However, there are various concerns regarding the use of AI in clinical practice. AI has become the part of many business models and is a key component in decision making. Implementation of AI requires a deep understanding of factors associated with professional's acceptance.	<i>Esmailzadeh, P. Use of AI-based tools for healthcare purposes: a survey study from consumers' perspectives. BMC Med Inform Decis Mak 20, 170 (2020).</i>
	Big data generations from the EHR systems are leveraged for meaningful use to understand various disease dynamics. The data provided by EHR consists of both structured and unstructured data, which can be used is structured using Big data analytics to understand various disease at their early onset. This helps in early detection of disease.	<i>Big data from electronic health records for early and late translational cardiovascular research: challenges and potential.</i>

	Big data also provides opportunities to understand cost effectiveness and thus improving the work flow. Big data can be used to evaluate population impact of healthcare or for various public health interventions.	
	AI in primary care can be used for decision support to improve the processes in primary health care centers. Used for early detection of diseases. AI used for predictive modelling to understand disease patterns and early diagnosis of patients in primary care. AI can be leveraged utilizing EHR/ administrative data to improve the business and work flow in primary care centers. However, analytics and machine learning is not adequately supervised in the current scenario. Hence, standard protocols for the use of AI needs to be at place for effective implementation.	Artificial Intelligence in Primary Health Care: Perceptions, Issues, and Challenges.
	Deep learning used as a tool to identify and detect early phases of diseases. Deep learning in AI combined with diagnostics imaging makes the test more reliable and precise. Deep learning can be early phases of detecting diseases. And hence, can be used as a tool for early detection of various lethal diseases such as TB when used along with diagnostic imaging.	<i>Deep learning at chest radiography : automated classification of pulmonary tuberculosis by using convolutional neural networks</i>
	AI used along with Long short- term model (LSTM) for predicting health failure has been proven to be effective. Big data used along with AI can be used to detect the early stages of heart failure. AI used along with diagnostics, has proven to give better and precise results. Hence, AI used along with diagnostic tools can be utilized for early detection of diseases as complicated as heart failure.	<i>LSTM Model for Prediction of Heart Failure in Big Data.</i>

	Early and accurate results of the findings will be useful in combating the disease burden and is useful in analysis the early intervention which will also diminish the cost by reducing expenditure on a later complicated phase of the disease.	
	Although AI is known for its potential benefits in primary healthcare, but still the implementation of AI requires to follow regulatory standards for its proper implementation. The adoption of AI in healthcare also depends of the perception of the users regarding the accuracy of it. Therefore, a continuous quality check needs to be at place for effective implementation of AI.	<i>Artificial Intelligence in Primary Health Care: Perceptions, Issues, and Challenges.</i>

Table 1: STATUS OF AI, EHR AND TELEMEDICINE IN PHC

Role In PHC	Technology	CONCLUSION
1. Decision Making	Artificial Intelligence	• AI used in healthcare for analysis of data • Helps in decision making • AI has high speed accuracy • Decision support, image analysis and patient triage. • Big Data used alongside AI, helps in collection and structuring of large complex data sets collected from various departments of the hospitals, patients, devices, and more. Large complex health data can be stored & analyzed using AI. • Helps with the understanding of disease pattern and surveillance
	EHR	EHR allows an efficient work flow: • Accept orders, enters prescriptions faster and allows to store the data for future follow ups. • Enables exchange of patient data • Exchange of data provides smooth care and coordination among each department of the primary care.

	Telemedicine	• Disease management • Telemedicine can be used for various disease management such as asthma, diabetes mellitus, hypertension and when accessibility to healthcare service is challenge. • Telemedicine used for upskilling of staff by providing e- education. • As an educational tool for training of medical staffs, teleconferencing and for tele-Proctoring • Used in Healthcare management, where telemedicine is used where telemedicine is used to monitor patients from a central station •
2. Early diagnosis	EHR	EHR is useful for storage of data • To understand the disease pattern. • Disease surveillance • Analysis of the stored data for efficient decision making. • EHR used for efficient work flow.
	AI	• Decision support, image analysis and patient triage. • Graphical representation of data-enabling better understanding of the disease. • Predictive modelling for early detection of disease

	Telemedicine	• Telemedicine can be used for various disease management such as asthma, diabetes mellitus, hypertension and when accessibility to healthcare service is challenge. • Telemedicine used for tele clinics and mobile health clinics. It enables the patients to get quick access to the physicians • Telemedicine used for specialties in healthcare, for example, telemedicine is used as tele-cardiology, tele- psychiatry, tele-cardiology and tele surgery. • Telemedicine is also used for diagnostic services like tele-radiology and tele-endoscopy. • A way to tackle global burden of diseases such as diabetes, obesity, hypertension, where early treatment can help avoid future complications and risk from the disease. • Telemedicine used for wellness treatment and other primary care treatment by teleconsultation.
3. Patient Referrals	EHR	• EHR allows timely and faster exchange of data between authorized healthcare providers. • EHR systems can be digitally connected with other medical devices, enables remote monitoring of the patients.

4. Human resource management	Telemedicine	• Telemedicine enables remote monitoring of patients. • Enables patients to access healthcare from anywhere in the world •
	EHR	• EHR systems used to increase the referral system. • EHR used as a link between departments and other level health centers.

Table 2. GAPS IN AI, EHR & TELEMEDICINE IMPLEMENTATION IN PHC

TECHNOLOGY	GAPS
Artificial Intelligence	Cannot replace the physical Presence of a Doctor
	Requires constant quality checks to avoid inaccuracy and errors.
	Unskilled staff
	Requires constant supervision and rechecks
	Poor infrastructure of the Public Healthcare centers in India
	Unavailability of human resource in public health centers in India- AI requires
	Interoperability issues

	Unavailability of effective Regulatory standards for Interoperability and data security
Telemedicine	Telemedicine adoption in Indian Public healthcare system is limited.
	Telemedicine consultations can only be used for mild treatment of patient.
	Telemedicine cannot replace the physical presence of a doctor during
	Lower adoption in Public Health Centers due to initial cost of implementation.
	Infrastructural challenges
	Poor network connectivity and internet connections in Rural India.
	Lack of awareness among patients and sometimes the healthcare staff
Electronic Health Records	Poor infrastructure of PHCs in India
	High cost of initial implementation
	Requires regular supervision and checks
	Training of staff
	Lack of awareness among healthcare staff
	Interoperability of data
	Data privacy and security

DISCUSSION

Technological advances in healthcare such as AI, Telemedicine and EHR are widely being adopted across the world for providing effective primary care to the patients. Big data analytics has proven to have disrupting the public healthcare system by providing major analytical platform for early detection of diseases. These technologies are being adopted widely into primary healthcare practices across the world. AI, Telemedicine and EHR has a wider application in the Public Health Centers. Thus, the study was aimed at understanding the role of these technologies and their application in the PHCs in India, and how these technologies can improve the existing conditions of the PHC.

In Primary Health Centers, EHR systems are used for E-referrals, capturing and sharing of health data, used for advanced processes in clinical settings such as e- prescribing and storing of lab and other diagnostic results. The data sharing and interoperability is done by the authorized users in order to make better decision and to form a link of information among various units and departments of primary healthcare system. Since, one of the primary roles of the Primary Health Center is to be a link between the sub-centers and Community Health Centers, EHR is a useful tool in doing so. However, the adoption of these systems is still limited in India, especially in the Public Health sector. EHR implementation is subjected to high initial implementation costs, hence are not much adopted in the in public sectors. In order to make the data interoperable and share among other users, it requires continuous internet connection and more band width. Internet and a strong infrastructure being a limitation in the present Primary Care Centers in India possess a huge challenge in EHR implementation. Also, looking at the present scenario of PHCs in India that lack adequate human resource is again a challenge for EHR adoption.

Artificial Intelligence is also used for primary healthcare for precision medicine, a software to analyze the data captured via EMR systems. AI used along with ML has been used by primary care physicians for diagnosing and as an early disease detection tool. AI is also used along with Deep Learning especially in diagnostic imaging in primary care for early detection of diseases like Tuberculosis. Early stages of heart failure have also been detected using AI by primary care physicians. AI if incorporated in the Public Health Centers in India will help

the primary care physicians in detecting early signs of diseases. Many patients can be treated on time at the primary healthcare level, thus also by avoiding the healthcare expenditure on a later stage by the patients in private hospitals and will also reduce the global burden of diseases in India. AI incorporation into a healthcare system requires continuous training and monitoring, and also needs to be checked for quality and accuracy. The implementation of AI is seen to be limited in the Public Healthcare system in India as it requires training and continuous quality checks. With the limited availability of resources such as computers, continuous power supply and human resource in most of the Primary Health Centers in India, it becomes a little challenging to implement AI in regular primary care practice in India.

Telemedicine applications in primary healthcare is mostly in the teleconsultation platform. Tele-consolation was widely adopted across primary health centers in the recent years. Telemedicine is used by primary care physicians for disease surveillance and remote monitoring of patients. For instance, tele-consolation was used by primary care physicians across public healthcare domain for remote monitoring of Covid 19 patients. Remote monitoring of patients prevents the spread of infectious diseases. Telemedicine has also been useful in filling the doctor patient ratio gap in the PHCs. It was used by various primary care physicians in disease surveillance that led to early detection of diseases which further reduces the disease burden. The use of Teleconsultations in rural areas was also shown to be effective in a study, which was found to be useful in building the patient -provider relationship by improving the communication link. Therefore, Telemedicine can bridge the gap of doctor unavailability in most PHCs in India, where the patients are unable to access to healthcare services due to availability of doctors. Telemedicine is also used in in training and upskilling of healthcare staffs through tele-conferencing and tele-education. This will help in bridging the knowledge gap in the present public health system and thus has shown to improve the decision-making capabilities and improve the workflow in the primary care units when studies its effectiveness on nurses in a PHC. However, the effective adoption of Telemedicine requires regulatory mandates in public healthcare system and also infrastructure and resources for its implantation. Also, a limitation that exists is that Telemedicine cannot replace the physical presence of a doctor or other healthcare staff during a situation where a patient requires an emergency medical attention. Hence, the macro challenge of doctor availability needs to be addressed in the PHCs in India.

The studies showing the implementation of EHR and telemedicine and AI in public health centers were limited. The application of such healthcare technology will certainly deliver great benefits in the overall primary healthcare system.

Implementation of healthcare technologies requires initial funding, acceptability of caregivers & patients and a strong infrastructure. There remains a huge gap in the existing challenges in the primary healthcare setting and the adoption of healthcare technology.

RESULTS & CONCLUSION

EHR implementation in care for effective use can be done in three phases. EHR is used in healthcare for capturing health data, sharing the data. EHR systems are also used for advanced processes in a clinical setting such as for e-prescribing and storing patient lab results. The final phase of the EHR use is when it is used for decision support of the healthcare providers and for national priority. The authorized providers and policy makers can access the stored data for making effective decisions and policies to improve the present healthcare scenario of the nation. The proper storage and analysis of the EHR data allows the providers to reduce the global burden of disease by early interventions. Moreover, EHR can also improve the workflow and thus can be useful in improving efficiency. Electronic referral system used along with EHR can improve the information management. EHR referral provides a better link and coordination between two levels of care, primary and secondary care. EHR is widely adopted by the healthcare providers believing it would help in accurate decision making and reducing the healthcare cost. However, the adoption is still limited in many regions. The regulatory bodies and policy makers initiatives to improve and strengthen the infrastructure and promote interoperability will increase the adoption. And, barriers such as high cost and extensive planning for effective implementation, data privacy and interoperability of data still remains a challenge.

Telemedicine will further grow in the coming years. Telemedicine can be used for primary care treatment and diagnosis of diseases such as hypertension, bronchial asthma, etc. Studies show the advantage of Telemedicine in building effective patient-provider communication. This can have a positive impact in fighting the communication barriers between the primary care providers and the patients. Telemedicine services have a broader application in Primary healthcare Centers. Telemedicine is currently used for services like tele-health, tele-education which is also useful for upskilling of the healthcare staff and for effective decision making. Moreover, these studies suggest virtual consultations for primary healthcare is proven to be effective in the rural regions in India, it can help mildly ill patient get early diagnosis and treatment on time. Telemedicine has its uses especially in patients requiring remote monitoring during the onset of infectious diseases such as COVID 19 with mild symptoms. Telemedicine use increased during COVID 19. But it can further be utilized in the coming years due to the potential benefits. However, Telemedicine implementation requires a strong infrastructure including a good internet connectivity especially in areas hard to reach, such as the rural areas. Hence this can be proven effective to combat the patient provider communication Gap and distance. However, it is necessary to evaluate the quality of care and health outcomes provided by telemedicine. Also, telemedicine cannot address all the primary care problems such that it cannot replace a human touch during a medical emergency, hence there needs to be a doctor available physically as well. Many studies have also suggested lack of awareness among people and reluctance towards the usage of technology by professionals could also be challenging.

AI and big data is another such healthcare technology innovation which has been widely adopted in healthcare system and has its potential impact on providing effective primary health care since, AI has a promising role in decision making. The main AI tool is a part of the routine medical practice. AI along with Machine learning is used for precision medicine. Artificial Intelligence can be used along with other healthcare technology system such as EHR. When used along with EHR, AI based E-referral system is effective in reducing the distance between the healthcare units. This also allows smooth workflow between departments and timely management of cases. Big data generations from the EHR systems are also leveraged for meaningful use to understand various disease dynamics. The data provided by EHR consists of both structured and unstructured data, which can be used is structured using big data analytics to understand various disease at their early onset. Such data analysis

could be proven useful for early detection of diseases. Thus, can be useful for making it a part of primary healthcare system. AI in primary care can be used for decision support to improve the processes in primary health care centers. Findings suggest AI use for early detection of diseases and used for predictive modelling to understand disease patterns and early diagnosis of patients in primary care. AI is also leveraged utilizing EHR/ administrative data to improve the business and work flow in primary care centers. Deep learning along with AI is also adopted in various centers for early phases of detecting diseases. And hence, can be used as a tool for early detection of various lethal diseases such as TB when used along with diagnostic imaging. Early and accurate results of the findings will be useful in combating the disease burden and is useful in analysis the early intervention which will also diminish the cost by reducing expenditure on a later complicated phase of the disease. Thus, AI has a potential in reshaping the Primary Health Centers in India by helping the primary healthcare providers make better decisions. However, finding from the studies also suggest various concerns regarding the use of AI in clinical practice. AI will not replace a doctor but will be helpful in making the doctors decision more effective. analytics and machine learning are not adequately supervised in the current scenario. Hence, standard protocols for the use of AI needs to be at place for effective implementation.

Artificial Intelligence, Electronic Health records and telemedicine has the potential to fill the existing gap in PHCs in India. But these technologies are not the end solutions to the existing challenges in Primary care in India, these technologies would serve as an alternative to the present situation. Healthcare technology is used to address many challenges but it is moreover used for improving the current healthcare system rather than replacing them. Healthcare technology is the future of an effective and efficient primary healthcare system in India.

Although Artificial Intelligence, EHR and Telemedicine can improve the existing the state of primary healthcare in India, but this technology cannot replace or could be an alternative to a doctor, other care provider or the required infrastructure to treat a critically ill patient. Moreover, the technologies in the scope of this study require a stronger infrastructure to operate, hence they can only be a solution to the micro challenges existing in the primary health centers in India. Whereas, the macro challenges will have to be dealt from the grass root level by policy makers and regulatory bodies.

Thus, these technologies can be used to improve the present scenario of the primary health centers in India by making the primary care system more effective and is not the end solution.

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