“LEVERAGING ARTIFICIAL INTELLIGENCE TO ACCELERATE PATIENT DIAGNOSTICS EFFICIENCY IN RURAL INDIA”

Research Paper

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Abstract

India has made significant advancement in healthcare and has reduced the gap between urban and rural or rich and poor. The doctor to population ratio is almost near to what is prescribed by World Health Organization. However, there are still some disparities that remain when it comes to access to healthcare and doctors in rural areas. Artificial Intelligence can bridge the gap here. Artificial Intelligence can play a major role by augmenting the capabilities of the doctors in performing efficient and quick diagnostics in rural India. Artificial Intelligence uses rich algorithms, neural networks, deep learning, and advanced analytics to triage critical findings in medical imaging and radiology, diagnose cancer and other life-threatening diseases, predict heart strokes, and many such scenarios. Satellite hospitals and diagnostic centres can be set up in remote villages and towns where there are limited healthcare facilities and using remote sensor devices, patient health data can be collected, Artificial Intelligence can analyse the patient health data, diagnose health issues, and suggest a course of treatment. Artificial Intelligence can greatly reduce the workload of doctors in rural India.

Keywords: Artificial Intelligence in Healthcare, Artificial Intelligence based Diagnostics

1 Introduction

Artificial Intelligence has been widely adopted by major industry sectors and the Healthcare industry is no exception to it. It has been widely adopted for various use cases in the Healthcare segment. Artificial Intelligence facilitates computational mechanism involving human intelligence, deep learning adaptations, sensory understanding and human like engagement using various software algorithms using Deep Learning, Machine Learning, Neural Networks, and advanced analytics to bring in human intelligence to computational systems. These techniques have an interdisciplinary approach and can be applied to different fields, such as medicine and health. AI has been involved in medicine since as early as the 1950s, when physicians made the first attempts to improve their diagnoses using computer-aided programs (Secinaro *et al.*, 2021).

Healthcare industry comprises of Providers, Payers, MedTech and Life science verticals. Providers comprise of healthcare givers like hospitals and clinics. Payers are healthcare insurers that insure patients for healthcare treatments. MedTech companies manufacture healthcare devices and Life science companies perform drug discoveries and manufacture drugs. Artificial Intelligence is predominant in all these sectors. Artificial Intelligence technologies have the potential to transform many aspects of patient care, as well as administrative processes within provider, payer and pharmaceutical organisations. There are already a number of research studies suggesting that AI can perform as well as or better than humans at key healthcare tasks, such as diagnosing disease. Today, algorithms are already outperforming radiologists at spotting malignant tumours, and guiding researchers in how to construct cohorts for costly

clinical trials. Several types of AI are already being employed by payers and providers of care, and life sciences companies. The key categories of applications involve diagnosis and treatment recommendations, patient engagement and adherence, and administrative activities (Davenport and Kalakota, 2019).

India has made significant advancement in healthcare. There are healthcare providers in both public and private sectors that are providing excellent care to patients. As per Indian Government sources, India is very near to the 1 to 1000 doctor population ratio as prescribed by the World Health Organizations. Even the health care facilities and Indian Government health programs like National Rural Health Mission have reached the rural India. National rural health mission (NRHM) was initiated in the year 2005 in eleventh five-year plan, with the objective of providing quality health care services to the rural population. The mission brought out salient strategies by involving various sectors and forging partnerships with various organizations to unify health and family welfare services into a single window (Gopalakrishnan and Immanuel, 2018). However, there remains a shortage of doctors and healthcare providers in Rural India. The healthcare infrastructure remains a challenge in some rural parts of India. Artificial Intelligence can play a major role here when it comes to rural India and offload tasks from the overburdened doctors and care givers in the rural India.

The use of Artificial Intelligence in healthcare in India is increasing with new startups and large software companies offering Artificial Intelligence solutions for healthcare challenges in the country. Such challenges and solutions include addressing the uneven ratio of skilled doctors to patients and making doctors more efficient at their jobs, the delivery of personalized healthcare and high-quality healthcare to rural areas, and training doctors and nurses in complex procedures. Companies are offering a range of solutions including automation of medical diagnosis, automated analysis of medical tests, detection and screening of diseases, wearable sensor based medical devices and monitoring equipment, patient management systems, predictive healthcare diagnosis and disease prevention (Paul *et al.*, 2018). Artificial Intelligence software can be used in rural India to ease healthcare providers workloads and compensate for lack of infrastructure in these remote areas.

Access to advanced diagnostics centres remain a challenge in rural India. The doctors at the diagnostics centres are overburdened with a very high footfall of patients. Also, the availability of diagnostics infrastructure and facilities is a challenge in rural India. This poses a threat to detection and cure of patients in rural India. Around 75% of villages have at least one health care provider and 64% of care is sought in villages with 3 or more providers. Most providers are in the private sector (86%) and, within the private sector, the majority are ‘informal providers’ without any formal medical training. Our estimates suggest that such informal providers account for 68% of the total provider population in rural India. Second, there is considerable variation in quality across states and formal qualifications are a poor predictor of quality (Das *et al.*, 2022). Artificial Intelligence can help bridging this gap along with ensuring quality diagnostics and better healthcare. Artificial Intelligence can be used to diagnose patients suffering from complex diseases like cancer. Sensor-based wearable devices can be used to record patient vitals. These vitals can be analysed to monitor health conditions of the patients and notify health risks in advance. Samples can be collected from the patients and Artificial Intelligence based MedTech devices can be used to cure the patients. Instead of Doctor manually performing the test, Artificial Intelligence enabled devices can help in early detection and cure of such life-threatening diseases.

There are various government schemes that support and streamline use of digital technologies in rural India, and this will help incorporate artificial Intelligence diagnostics and cure in India. Government of India has taken various initiatives related to AI such as establishment of Artificial Intelligence Task Force, formulation of NITI Aayog's National Strategy for Artificial Intelligence, setting up of four Committees for AI under Ministry of Electronics and Information technology (Bajpai and Wadhwa, 2021).

This article focuses on the following areas.

- Challenges faced in healthcare diagnostics in Rural India
- Use of Artificial Intelligence to bridge the gap and accelerate diagnostics in Rural India

- Government policies and frameworks for use of Artificial Intelligence in healthcare diagnostics in Rural India

2 Healthcare Diagnostics Challenges in Rural India

The Primary health care in rural India is delivered through a vibrant, dense, and competitive marketplace that includes few qualified providers with an MBBS degree (the equivalent of an MD in the United States), but a wide variety of non-MBBS providers including AYUSH providers (alternative medical practitioners with degrees in Ayurveda, Yoga, Unani, Siddhi and Homeopathy) as well as those with other or no medical qualifications (Das *et al.*, 2022). These factors have an impact on healthcare diagnostics centre in rural India. The doctors and healthcare providers are overburdened in the diagnostic centres. This has an impact on the quality of healthcare diagnostics done in rural India owing to availability of limited healthcare practitioners and most of the practitioners have limited skills and competencies needed for healthcare diagnostics.

There are limited healthcare diagnostic centres in rural India as compared to urban areas. There are limited ICUs having state of art of facilities. Proper diagnostics remains a distant dream for people in rural India. The patients from rural India need to travel to healthcare diagnostics centres in nearby towns and cities and if the patient is from a remote village, then accessing a diagnostic centre gets challenging. Triaging complex diseases like cancer gets difficult in rural India. Even though a healthcare diagnostic centre will have state art of art devices to diagnose patients' healthcare issues, there are lack of quality doctors to interpret the diagnosis reports. Even the quality doctors available in rural India are overburdened.

There is disparity in health care availability between various socio-economic groups and it becomes prominent in case of major illnesses like hypertension, heart diseases, diabetes etc. Major illnesses are long term in nature and subject to several diagnostic tests. A sizeable proportion of major illnesses in rural areas remain untreated mainly due to unavailability of diagnostic facilities in the local vicinity. Only 3% of the major illnesses in metro areas remain untreated, whereas 12% of the same remain untreated in the less developed villages. Again, one-fifth of the diagnosed major illness among the scheduled tribes remain untreated. The tribal households are usually located in places, which have fewer health facilities and still rely on the traditional healers. Most of these long-term major illnesses also remain undiagnosed amongst them. They need to go out of the villages, which are often isolated to avail treatment (Barik and Thorat, 2015). The current healthcare delivery system in rural India has many problems impeding the delivery of quality care for chronic health conditions. In both the public and private facilities studied, the care processes are very doctor-centred, with little room for other health centre staff. Doctors face very high workloads, especially in the public sector, jeopardising proper communication with patients and adequate counselling. In addition, the health information system is fragmented and provides little or no support for patient follow-up and self-management. The patient is largely left on their own in trying to make sense of their condition and in finding their way in a complex and scattered health care landscape (Lall *et al.*, 2019).

Continuous monitoring and early detection of health issues is an important aspect today. With improved income and education, the expectations of the people also increased. It was not merely the financial and physical access that are important but the manner of delivery, the availability of various facilities and the interpersonal and diagnostic aspect of care as well that mattered to the people with enhanced economic earnings (Sharma and Narang, 2011). Due to limited infrastructure and lack of healthcare staff in rural India. Continuous monitoring of health by conducting diagnostic tests in regular interval gets difficult in rural India.

The Government of India has come up with various schemes like National Rural Health Mission, Ayushman Bharat, ABHA ID generation for Indian citizens and many more. However, due to lack of healthcare infrastructure and enough trained healthcare providers in rural India makes it challenging for the healthcare providers to implement these schemes. Outpatient Departments of all government

hospitals, in rural India, are overcrowded. There are queues for registration, consultation with the doctor, undergoing diagnostic tests, meeting the doctor with test results, and buying medicines. As is often the case, these take more than one visit, and each visit is a loss of a workday for the patient and/or the attendant (Bhandari and Dutta, 2007).

3 Artificial Intelligence to Accelerate Healthcare Diagnosis in Rural India

Artificial Intelligence is the science of making machines act like human. It refers to the ability of machines to perform cognitive tasks like thinking, perceiving, learning, problem solving and decision making (Bajpai and Wadhwa, 2021). Artificial Intelligence works on existing large datasets. These systems get trained on these datasets and learn from these datasets to perform cognitive activities. Recent days, a large amount of health data has been generated by all sections of the healthcare industry. These data can be used to train Artificial Intelligence based healthcare software that can perform various tasks like health diagnostics, drug discovery or suggesting the right course of treatment based on patient characteristics.

Artificial Intelligence can play a major role in enhancing healthcare facilities in rural India. It can augment healthcare providers in rural India to facilitate fast and reliable healthcare offerings. Artificial Intelligence can assist healthcare providers with diagnosis, rehabilitation, patient outreach, and mental health support. It can help healthcare providers with early detection of diseases, finding out treatment path, discovering new drugs and help in vaccine development (Pradhan et al., 2021).

Doctors and patient care givers can use artificial intelligence software to diagnose patient illness. This will ensure that the healthcare providers are not overburdened in rural India, considering the fact that there is a shortage of doctors and healthcare providers in rural India. Artificial Intelligence based healthcare software will not only address the healthcare providers shortage issues but will also augment to capability of doctors to perform accurate diagnostics and suggest the right course of treatment. This will ensure that the patients in rural India get the right and timely health diagnostics and treatment in rural India.

Diagnosing critical diseases like cancer is an important aspect in rural India. There are not enough trained doctors or specialist staffs who can diagnose critical diseases. Artificial intelligence can help in such cases with the help of rich Deep Learning algorithms. Artificial intelligence software can analyze videos of colonoscopies and find out polyps in real time and that too with a very high accuracy rate. Pathologists spend lot of time in checking the patient samples under microscope to diagnose cancer (Elemento *et al.*, 2021). However, Artificial Intelligence software can use rich algorithms to figure out anomalies in a matter of time. This increases the throughput of the diagnostics centres. Diseases like cancer should be detected early. Rural India lacks manpower and infrastructure to monitor patients for early detection of life-threatening diseases cancer. However, a lot of data related to cancer patients is getting generated using Electronics Health Records systems. Deep Learning and Artificial Intelligence techniques can use these data to build Cancer detection software that can detect patient's chances of getting cancer early using the prediction models built using these technologies (Hunter, Hindocha and Lee, 2022).

Rural India lacks good radiologists who can make the right sense of the scanned images. Artificial Intelligence can fill in this gap. Deep Learning and convolutional neural networks can be used to study the scanned radiology images. There is a lot of dependency on imaging data in ophthalmology, radiology, pathology, and dermatology. Artificial intelligence software can analyse the image data collected from the patient and make critical insights pertaining to diagnostics from it. Radiomics tools are used in Oncology to detect cancers. Radiomic Tools are based on radiographic images coupled with clinical outcomes data (Hosny *et al.*, 2018). Deep Learning can be used with these Radiomic Tools to make more specific interpretations for cancer diseases from the image data collected from the patients.

Cardiac diseases are impacting masses in India. Rural India has witnessed a considerable volume of Cardiac patients. There is a lack of good diagnostic centres and healthcare staff that can do efficient

diagnostics of heart diseases in Rural India. Artificial Intelligence can contribute here by diagnosing heart-based diseases. Electrocardiogram (ECG) sensors and Photoplethysmography (PPG) sensors can ingest patient health data to hospital systems. Artificial Intelligence software can analyse these data and predict heart attacks and other cardiac diseases (Lakkamraju, Anumukonda and Chowdhury, 2020). Patients in Rural India can wear these sensors as wearable devices. These sensors can send the patient data to systems located at urban areas or anywhere and need not be in the village from where the patient is based out of. This process reduces the dependency of having a healthcare staff diagnosing the patient at his location.

Mental diseases like autism can also be diagnosed using Artificial Intelligence. Genetic studies can be performed and appropriate triaging can be done to detect Autism early. Early detection of Autism can help faster treatment and cure of this disorder (Joudar, Albahri and Hamid, 2022). Rural India lacks infrastructure and healthcare staff that can deal with such mental diseases. Artificial Intelligence can be a great help here.

Health monitoring is an important aspect for patients. Rural India does not have enough healthcare staff to monitor patient vitals regularly. The sensor based wearable technologies like smart watch or health band or other Internet of Things based devices can be provided to the rural patients. These devices will ingest health vitals of the patients to the data servers kept at hospital premises. Artificial Intelligence based healthcare software will analyse the ingested patient data and get insights on patient daily health status thus enabling continuous monitoring of health. If there will be any health anomalies for the patient, both the patient and the doctor will be notified. This entire process of automating monitoring patient health data eases the workload of healthcare staff in rural India and also fills in staff shortage scenarios in rural India. An Indian start-up company, Thalamus Irwine has developed a similar Artificial Intelligence and Internet of Things based software platform named Garuda to remotely monitor patients during Covid 19 pandemic (Bajpai & Wadhwa, 2021). Such automated health monitoring systems come handy during pandemic where there can be a health risk for the healthcare staff when they directly encounter the patients. Using such health monitoring systems can be a boon in such scenarios by ensuring fast, accurate and time monitoring of patient vitals and ensuring minimal interaction of healthcare professionals during pandemic. The huge impact of the COVID-19 pandemic on global healthcare systems has prompted search for novel tools to stem the tide. Attention has turned to the digital health community to provide possible health solutions in this time of unprecedented medical crisis to mitigate the impact of this pandemic (Kapoor *et al.*, 2020).

The patients in rural India face a major challenge when it comes to Intensive Care Units (ICU). There is a lack of ICU facilities in rural India. Artificial Intelligence can play a major role in setting up remote ICUs in rural India. Remote ICUs can be set up where patients can wear sensor-based devices. Patient vitals will get ingested to servers at the primary hospital that can be in an urban area. Doctors in the primary hospital will continuously monitor patient vitals. Limited number of healthcare staff who can carry out instructions given by experts can be appointed at the remote ICU. Doctors at primary hospital can pass on instructions to the healthcare experts at remote ICU as and when needed. The Artificial Intelligence Technologies and Internet of Things (IoT) is changing the way the remote patients are monitored efficiently and in a timely manner. Both Artificial Intelligence and AI work hand in hand to make remote monitoring of patients possible. IoT based sensors ingest patient vitals to the monitoring software system and Artificial Intelligence analyses and monitors the ingested patient health data using neural networks and deep learning (Vaisshalli *et al.*, 2021). The Telehealth is becoming the new normal in India and enables setting up Smart Hospitals where patients can be monitored remotely. Another advantage with remote monitoring is that any bed in a hospital can be converted into a ICU bed thus reducing a shortage of the ICU beds. Healthcare experts can virtually monitor the patients in these virtual beds. Artificial Intelligence based technologies like Computer Vision can help doctors study the patient reports remotely and suggest actions (Ganapathy *et al.*, 2022).

Figure 1 demonstrates a remote ICU implementation. Remote ICUs have limited healthcare professionals as in Figure 1. Patients using sensor-based Internet of Things (IoT) devices ingest health data into the Data Server in the primary hospital. The primary hospital has good number of highly trained

doctors as in Figure 1 and they use Artificial Intelligence to analyse patient vitals. They can instruct the doctors at remote ICUs can pass on instructions in case of emergency to the doctor at remote ICUs.

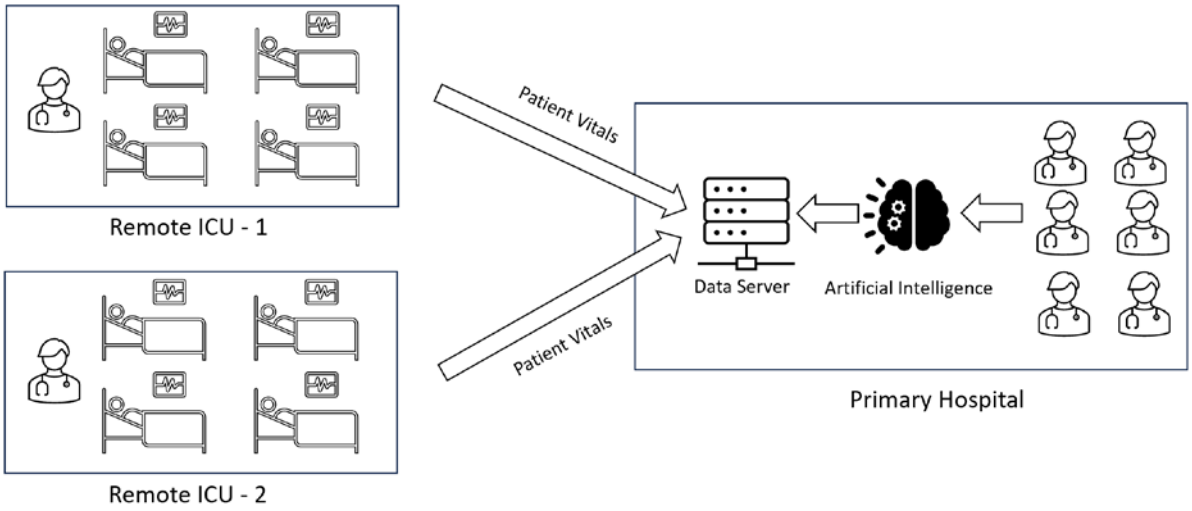

Figure 1 : Remote ICUs using Internet of Things and Artificial Intelligence

4 Government Policies and Frameworks

Indian Government has come up with policies to support digitalization of healthcare facilities in rural India and use of Artificial Intelligence based software. Some of the initiatives taken up by Government of India include incorporation of Artificial Intelligence Task Force, NITI Aayog's formation National Strategy for Artificial Intelligence, committees for Artificial Intelligence under Ministry of Electronics and Information Technology and many more. Even the State Governments in India have come up with initiatives like Center of Excellence for Data Science and Artificial Intelligence by Karnataka Government, Safe and Ethical Artificial Intelligence Policy 2020 by Tamil Nadu and many more (Bajpai and Wadhwa, 2021). These policies by central government and the state government will boost adoption of Artificial Intelligence in rural India in the field of healthcare.

Government of India and is funding startups in the healthcare and encouraging development of Artificial Intelligence based software for healthcare needs. Premier government institutes like Indian Institute of Technology have supported startups in the healthcare area when it comes to adoption of Artificial Intelligence and emerging technologies. Indian Institute of Technology, Mumbai has incubated an Artificial Intelligence based mobile application called Naima that monitors and reduces pregnancy risks (Pradhan, John and Sandhu, 2021).

All these government policies and frameworks will promote adoption of Artificial Intelligence in Healthcare in rural India.

5 Conclusion

Artificial Intelligence has the potential to revolutionize healthcare facilities in rural India. It can address the healthcare challenges faced in rural India like shortage of healthcare professionals, lack of trained healthcare professionals, lack of diagnostic centres and detection and cure of critical diseases like cancer. Artificial Intelligence along with Internet of Things (IoT) can help in setting up remote Intensive Care Units (ICUs). These remote ICUs can be monitored at primary hospitals in a urban area, thousands of miles away from the remote ICUs in the rural India. Artificial Intelligence can help general physicians in monitoring and diagnosing illness for their patients and suggesting the course of recovery and medications with a very high degree of accuracy. It can also help in early detection and diagnostics of mental illness related to genes and DNAs. Artificial Intelligence based diagnostics and monitoring

software was widely accepted during the COVID 19 pandemic by enabling remote monitoring of patients and telemedicine.

Government of India and State Governments have come up with policies and framework that will help Artificial Intelligence to be a part of healthcare in rural India. Government bodies like NITI Aayog has come up with strategies and methodologies to incorporate Artificial Intelligence in healthcare. Government agencies and educational institutions like Indian Institute of Technology are funding Artificial Intelligence based healthcare startups.

To sum up, Artificial Intelligence can make quality healthcare diagnostics facilities available across rural India and prevent diagnostics healthcare professionals get overburdened due to lack of staff in rural India.

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