RESEARCH ARTICLE OPEN ACCESS

Sympto Predict: Unlocking Health Insights Through Predictive Symptom Analysis

Prabha R*, Dineshkumar Munikrishnan, N. R. Dhineshbabu*****

*(Department of Computer Science and Engineering, T John Institute of Technology, Gottigere, Bangalore, India
Email: research.prabha.r@gmail.com)
** (Global Digital Platforms & Portals Director, Boehringer Ingelheim Vetmedica GmbH
Email: munidinesh@gmail.com)
*** (Department of Electronics and Communication Engineering, T John Institute of Technology, Gottigere, Bangalore, India
Email: babudhinesh2009@gmail.com)

----------**********----------

Abstract:

Good health and well-being are the foundation of the quality of human resources, which determines the development strategy of any country. Public healthcare is an important aspect of the country. Healthy living and well-being of citizens are important concepts for economic growth and international human resource development. Adequate medical facilities and diagnostic infrastructure have been developed for urban people, but inadequate access to medical facilities for most backward rural people of the country. Today, there are many new inventions in the field of healthcare and treatment in various countries and even organ transplants have been successful, but the reality is that there is hardly any progress in advanced treatment and diagnostics for the people living in the hilly and rural areas of the world. In the growing era of technology, artificial intelligence and data science are realizing various achievements in the medical field and this should extend to government health domains and everyone should work together to protect the welfare of public. This present work encapsulates feasible projects and their feasibility.

Keywords — **Artificial Intelligence, Data Science, Health Policies, Health, mission, Public Health, Machine Learning, Socio-Economic Development.**

----------**********----------

I. INTRODUCTION

Indian healthcare uses a range of contemporary technologies. In the meantime, government hospitals' technological advancements are progressing slowly, which makes it challenging for patients to get the right care and enhance their quality of life. Our research examines how data science and artificial intelligence are revolutionizing healthcare and how this will impact socioeconomic development.

India is currently the second most populous country, with 18% of the world's population (United Nations, 2021). Large human resource bases do, however, provide a number of unique difficulties. India is dealing with a dual burden of diseases: non-diagnostic diseases are on the higher end of the spectrum, while Malnutrition, sanitation, vaccines, hygiene and infectious diseases are at low levels.The Indian economy is currently the fourth largest in the world and is growing rapidly. India made great strides in other areas as well, such as life expectancy rising and sharp declines in the infant, maternal, and death rates. These advancements were made in the economic sphere. [1].

Compared to developed countries and other densely populated developing countries, India's spending on healthcare is notably lower. In 2019, India's healthcare financial allocation accounted for 3.01% of the country's GDP (Global Health Expenditure Database, 2022).Nonetheless, it is noteworthy that India's healthcare sector is broadening due to the country's growing population, anticipated increase in the older population, diseases related to a change in lifestyle, higher literacy levels, and spendable money that lower the cost of healthcare [2].

The digital healthcare sector is expanding and is projected to reach INR 882.79 billion at a compound annual growth rate (CAGR) of 21.36 percent by 2027, according to Research and industry. The increased use of technology in the treatment regimen, which enables early disease detection and lowers costs for fund providers, is the cause of the increase. The study also highlights how the healthcare industry is currently flourishing as a result of its increased focus on patients. Improved patient awareness, improved patient engagement, and data access in healthcare apps are what they are offering. It has encouraged people to use the digital healthcare resources offered by clinics, hospitals, and other healthcare facilities. Moreover, the adoption of new trends has emerged as the driving force after bringing about significant changes in the healthcare sector. This development makes it possible for medical professionals to diagnose, assess, and counsel patients using telecommunication technologies [3].

Big data analytics and artificial intelligence (AI) have recently been used in m-health to provide an efficient healthcare system [4]. NLP programs that can comprehend and categorize clinical documents are a popular use of artificial intelligence in the healthcare sector. Unstructured patient clinical notes can be analyzed by NLP systems, providing amazing insight to understand quality, optimize procedures, and improve patient's outcome [5], [6], [7].

Data Science and Analytics can provide practical insights and facilitate strategic decision-making in the health system. They help create a holistic view of patients, consumers, and healthcare professionals. Data-driven decision-making opens up new possibilities for improving the quality of healthcare [8], [9].

In Section 2 we discuss the structure of the Indian Healthcare Structure and its responsibilities, Digital Healthcare Infrastructure and Growth of Digital Healthcare. In Section 3 we described the Digital Initiatives and Implemented Technologies in Healthcare sector of India. Some of the Digital Health Mission being implemented by the central and state governments.

II LITERATURE REVIEW

2.1. Healthcare Infrastructure in India

In India, the health industry can be classified as public, government, private, or person owned. Private healthcare providers are those that are owned and operated by people or groups of individuals and are recognized under the Clinical Establishment Act. These include pharmacies, doctors' offices, assisted living facilities, and hospitals that can provide care using Allopathic, Ayurvedic, Homeopathic or Unani systems of medicine. In contrast, the Ministry of Health and Family Welfare, on the other hand, oversees the public sector. All networks of public health facilities in India are included, including sub-centers, primary health centers, community health centers, rural hospitals, urban health centers, municipal hospitals, and government hospitals. Many of these are also owned by charities, religious institutions such as churches and NGOs, and public sector entities including the armed forces, reserve bank, railways, the port trust, and nuclear power. The health sector also includes pharmaceutical companies, pharmacies, research groups, medical schools, and other public or private institutions that do health-related training research [10], [11], [12].

[10] According to Tarun Stephen et al., a more extensive use of spatial information could facilitate and expedite the process of health reform. They also discussed the driving forces behind the transformation of the health system, the latest advancements in spatial analytics and information, and the state of Australasian spatial health research today.

[11] Data on all resources used for health service delivery in specific health services in three northern Indian states was gathered by Shankar Prinja et al. Following study, they calculated the total yearly cost of providing services through the public sector and came to the conclusion that these costs might be utilized to plan the finances for the expansion of comparable health services under the National Health Mission to metropolitan regions.

[12] Hamad Dailah collected data from four public and private hospitals and concluded that private hospitals have a flat structure and high levels of employee empowerment. It also highlighted the challenges faced by public hospitals that negatively

influence advanced healthcare marketing practices and performance outcomes.

The public and private sectors have different roles and duties. Though public sector institutions are more focused on curative components than private sector institutions are, the public sector has a more comprehensive strategy that encompasses research, disease prevention and control, sanitation and cleaning, and other activities.[13]. The federal structure of the Constitution allows for the coexistence of two levels of government: the Union and the States. The three lists - Union, State, and Concurrent, that define the duties and obligations of each level are described in the seventh schedule to the constitution.

The Union government offers a more comprehensive framework and guidance for all initiatives, including those addressing malaria, tuberculosis, and other diseases. These initiatives are implemented consistently throughout the country. It is responsible for providing the state government with the funds needed to carry out each initiative [14].

2.2 Digital Health care Infrastructure in India

"*Harnessing the potential of digital technologies is essential for achieving universal health coverage. Ultimately, digital technologies are not an end in themselves; they are essential tools to promoting health, ensuring global security, and caring for the vulnerable."*

-Dr. Tedros Adhanom Ghebreyes us, WHO Director General

The Indian healthcare system is undergoing a transformation because to new health technologies like wearables, telemedicine, genomics, virtual reality (VR), robotics, and artificial intelligence (AI). In India, the use of digital health technology is essential to providing value-based treatment throughout the healthcare system. In Indian metropolitan areas, adaptive smart solutions can help reduce barriers between healthcare facilities and patients, facilitating better access to services and increasing overall patient satisfaction [15].

2.2.1 Growth of Digital Healthcare

The Indian Brand Equity Foundation (IBF) forecasts that the healthcare sector would triple at a compound annual growth rate (CAGR) of 22% between 2016 and 2022, reaching USD 372 billion by 2022. In 2016, the US dollar was worth 110 billion. Similarly, the Indian hospital sector was valued at $61.79 billion in 2017 and is expected to grow at a CAGR of 16-17% to reach $132.84 billion by 2022. Telemedicine is a rapidly growing sector in India. The market is expected to grow at a 20% CAGR between 2016 and 2020, reaching US$ 32 million by 2020. Meanwhile, the share of digital healthcare is predicted to drive the market with a CAGR of 23% by 2020[15].

AI is radically transforming the Indian healthcare market. According to Research & Markets, AI applications in the Indian healthcare sector are expected to be worth $6 billion (INR 431.97 billion) by 2021, growing at a CAGR of 40%. The National Association of Software and Services Companies (NASSCOM) estimates that the Indian healthcare information and communication technology (ICT) market will be valued at $1 billion in 2014. The industry is expected to double in size by 2022, according to the research. Digital health start-ups are predicted to fuel a large share of the forecasted growth [16].

According to the 2019, Future Health Index (FHI) research, India is at the forefront of digital health technology adoption, with 76% of healthcare professionals adopting digital health records (EMR, EHR) in their practices. The FHI is based on primary research conducted in fifteen countries. The study examines the experience of healthcare professionals and individuals. In India, 46% of health sectors are using artificial intelligence(AI), which is in line with the 15-country average [17], [18], [19].

2.2.2 Technologies and Digital Tools

New Technologies are already beginning to impact India's healthcare system and promise to transform healthcare delivery in the future by improving efficiency and improving coverage.

Figure 1: Illustrates the technology and digital tools that are integral part of the Health System to monitor, capture, store, analyze, predict, prescribe and manage data.(Source from Gemini.google.com)

1. Telemedicine can reduce medical consultation time to10-15minboth rural and urban areas, by reducing wait times through optimal utilisation of doctors and avoiding the trips to a clinic or hospital, at a fraction of the cost of current healthcare systems.
2. Electronic Health Records and Electronic Medicine Records (EHR & EMR) allow patient's information from various sources to be digitalized in one place, helping the doctor make an accurate prognosis in a shorter time.
3. AI will play a big part in improving clinical outcomes as health data becomes increasingly accessible and analysis technique improve. From the automation of clinical tasks to virtual nursing assistants. AI has the potential to transform daily health management.
4. Smart health monitors can collect personalized vital signs and real-time test results, facilitating early diagnosis and appropriate treatment.
5. Human DNA analysis enabled by increased computer processing will enable truly personalized genomic testing and offer treatment options for certain genetic diseases.
6. Mobile health apps can help prevent serious diseases by increasing patient engagement, providing health education and providing expert guidance from healthcare professionals.
7. VR has the potential to transform the way we approach pain management, stress management and rehabilitation, as we see services moving beyond the walls of a doctor office to mobiles, headsets and headphones. Patients are immersed in a multi-sensory world.

3 *3. Digital Health Initiatives in India*

"In future, world's largest health care provider won't be a hospital. It will be a software company"
-Dr. Devi Shetty, Chairman of Narayana Hospitals

3.1 By Government

The Scheme of Telemedicine / e-Health was extended to "National Program for Strengthening of e-Health and Telemedicine Services" after end of the 12th plan and was integrated into the framework scheme of "Tertiary Care Programs" under NHM. It includes primarily following projects

- Integrated Health information plat form for interoperable HER (Electronic Health Record)'s
- National Resource Centre of HER (Electronic health record)Standard
- National Medical College Network for Telemedicine
- National Health Portal (by Centre for Health Informatics)
- Setting Up of National Digital Health Authority of India
- National Health Helpline: Doctor on Call

Figure 2: Illustrates the interconnected / integrated health information system. (Source from Gemini.google.com)

Interoperable Electronic Health Records (HER)

The Ministry of Health & Family Welfare has planned to establish a system for creation, availability, and online access of interoperable

Electronic Health Records (EHR) of Citizens. This will facilitate continuity of care, improve affordability and better health outcomes and have decision support system.

The following initiatives have been implemented [20]:

a. Electronic Health Record (EHR) Standard of December 2016 for disease classification, medicine and clinical terminology, laboratory data exchange, digital image communication, etc. There are 35 standards available.

b. Metadata & Data Standard (MDDS) has included more than 1000 data elements for use in healthcare application and is aligned with global Health IT Standard [20]

c. National Identification Number (NIN) for Health Facilities in order to facilitate interoperability and information exchange between complex health IT systems. NIN has been assigned to more than 2 public institutions that lack to information to be used as a unique identifier in IT Systems [20].

d. Hospital Information System (HIS) are currently being implemented for the computerized registration and capturing EHR/EMR of patients in public Health Facilities, upto the Primary Health Care (PHC) level. To date, financial assistance has been provided to 14 states/Union Territories (UT)'s for HIS Implementation, namely e-Hospital (NIC), e- Sushrut (C-DAC Noida) [20].

e. Integrated Health Information Platform (IHIP) is designed to prevent health data from becoming trapped in multiple silos and to enable the creation, provision and access of Electronic Health Records (EHR's) to citizens nationwide through Health Information Exchange by: Avoidance of duplication of investigation; Improving decision making by providing access to patient data; achieving efficiency and improving professionalism in service delivery and ultimately strengthening the Health care System; and providing useful macroeconomic information on health to policy makers [20].

f. Personal Health Record Management System (PHRMS) provides Indian citizens with a single electronic platform for storing their personal health records. This allows them to centrally manage their medical records, making it much easier to store, access, and share their personal health data. Patients can access the PHRMS from anywhere, anytime [20].

3.1 *State Tele - medicine Network (STN)*

Development of existing Healthcare facilities (MC, DH, SDH, PHC, and CHC), selected PHC's will be spoke and spokes and a hub of doctors. So far Ten state financially supported Under National Health Mission (NHM). STN implemented hub and spoke model [20].

3.2 *SATCOM based Telemedicine nodes at Pilgrim sites*

Pilgrimage sites have been planned using Space Technology Tools for telemedicine facility between identified remote health facility and multi-speciality hospital in collaboration with Department of space. Kasi, Mirzapur, Amarnath etc., Bay of Bengal initiatives for Multi Sectoral Technical and Economic Co- operation (BIMSTEC) – patients care services [20].

3.3 *Digital Health ID*

Unique Digital Unique ID for each citizen. The government had launched Ayushman Bharat (Healthy India) [21].

3.4 *Notable MoU's*

Improving public health outcomes through big data analytics. The Maharashtra State government has also signed memorandum of understanding with NITI Ayog and the Wadhwani AI group to launch International Center for Transformational Artificial Intelligence (ICTAI) in 2018focusing on rural health care. In 2018-2019 budget speech, the Hon'ble Finance Minister of India mandated NITI Ayog to establish a national program on Artificial Intelligence to guide research and development in Healthcare [21].

4. Application of AIin Healthcare

"For India, a country with more than 1.3 billion people and a severe shortage of doctors, artificial Intelligence cannot be just a novelty; it is likely to prove essential".

"Artificial Intelligence (AI) has the potential to transform healthcare in several ways. It can turn large amounts of patient data in to actionable insights, improve public health surveillance, accelerate health responses, and generate faster and more precise research and development".

The uses of AI in Healthcare can be divided into three main categories:

Descriptive: This involves identifying events that have already occurred and using this data to discover trends and gain further insights;

Predictive: This involves making predictions about the future using descriptive data;

Prescriptive: This not only discovers trends and predicts the future, but also suggests potential treatment options in public health or clinical trials in research and development.

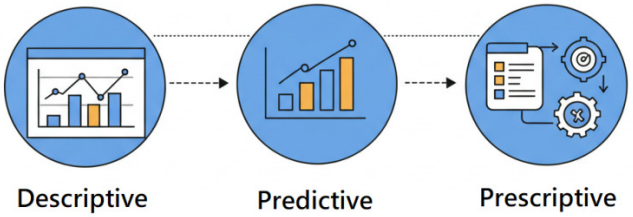

Figure3: Illustrates three major data analysis methodology. (Source from Gemini.google.com)

One of the most significant advantages of AI in healthcare is that it has the potential to be extremely beneficial in locations where human resources are few, particularly in rural and distant regions. AI can help create electronic health data repositories containing high-quality, annotated health data for machine learning applications. Developing a national clinical decision support system would enable less skilled healthcare providers to manage routine clinical cases more effectively; Develop self-learning digital systems in fields such as radiology, genetics, and pathology to improve the future of healthcare.

With the advancement of technology and artificial intelligence, healthcare will eventually become less expensive, with increased efficiency and diagnostic accuracy. We can use data to predict who is more likely to develop health problems. We can obtain a structural picture, as a robot measures every muscle in the body and advises patients on the necessary preventative measures to avoid further health complications.

Role of AI in Public Health

Compared to human, artificial intelligence – based virtual medical support can execute numerous activities with more precision, fewer error and less man power AI promises to make healthcare more practical in the following ways: Health Protection; Health Promotion; using Machine Learning to detect abnormalities; Machine Learning aided automated evidence synthesis and public health surveillance [22]. Always utilized in the following process

- Disease detection and Diagnostics
- Process optimization
- Patient-facing Application
- Medical R&D and training

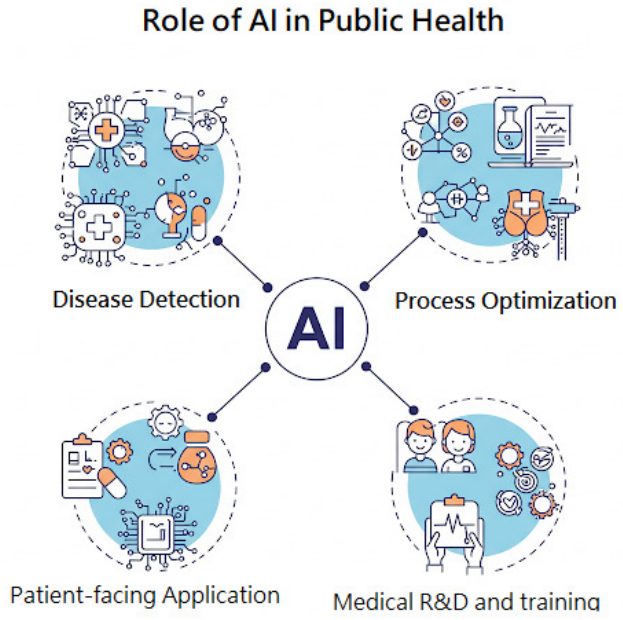

Figure 4: Illustrates important roles of AI in Health Management Echo System. (Source from Gemini.google.com)

Challenges faced in using AI like ethical, legal and other

The availability of massive amounts of data is critical to the functioning of artificial intelligence(AI) systems. AI requires longitudinal data. Digitization practices are insufficient, uneven, and non-standardized, and there is no central

database for health records in India. The Indian Health Services Regulatory Authority (DISHA) prohibits the use of digital health data for commercial purposes, particularly by insurance companies, human resource consultants, and pharmaceutical companies.

Increasing the availability of health and patient data and the use of AI to analyze them for medical purposes requires addressing ethical, technical, and resource issues. Challenges remain related to quality, security, governance, privacy, consent, and ownership. Governance is a challenge in this area. Health technology and data protection policies vary widely across countries and states, and many state governments lack the resources and technological capabilities to develop consistent population health policies. Health-related AI applications will require robust infrastructure and legal and ethical frameworks. The Indian government recently released its AI strategy, and healthcare is a priority sector for its implementation in India (NITI Ayog2018). [23], [24], [25].

Risk in implementation

While AI has the potential to revolutionize healthcare in India, it will not offer a simple solution or fix in an already complex healthcare landscape, which includes multiple actors, competing agendas, constantly evolving incentive systems, and corporate cultures. Additional and complex concerns will arise regarding data use, privacy, and security. Front-line healthcare professionals in India record patient histories in notebooks, each with its unique annotation method. As a result, the data provided to AI businesses is likely to be inaccurate for a large portion of the population. Insufficient or unrepresentative data can lead to poor quality and consistency, which can result in flawed algorithms and possibly misdiagnoses. [24].

Findings in Literature Survey

Various research articles and study results based on the general practice of different data collection, and the lack of a centralized data base structure are causing a lot of problems in the delivery of medical services.

Following difficulties found in literature survey:

Reports of first-time non-traditional disease cannot be shared, making difficult to find treatments for the same disease in another part of the country.

When medical records are maintained by humans again there is a need to depend on a third party to investigate the particular person's reports or to carry out practical treatment on them.

While moving from one city to another city in the country for medical treatments, one has to depend on paper based reports to know about the treatment already given and to continue the same treatment, which causes problems in understanding and sometimes life is at risk at the moment of changing the treatment.

Hospital management software currently in practice is neither government- defined nor universal, some hospital software collects a large amount of information which many harm to public in the future and there are insufficient legal norms to control such collection of information

Electronic Medical Record (EMR) and Electronic Health Record (EHR) procedures which are practiced only in a few select hospitals in primary and secondary cities of the country and even in Government District head hospitals in major cities of the country these modern technologies are not yet to be implemented.

The operation of basic electronic devices as defined in the Tele medicine scheme implemented by the Government of India. Requires electricity and consistent internet connection, but still there is insufficient electricity infrastructure in various villages of the country, so despite the implementation of the Tele medicine scheme, it has not been able to bring clinical equity to all. [21]

A Personal Health Record Management System allows an individual to store and manage their health information online. But there is a huge problem in using this facility because the literate people in rural India do not have sufficient knowledge of English.

There is insufficient awareness among the public about the scheme of providing Personal Identification Number and there is lack of transparency about how the scheme works and information is exchanged.

The medical field lacks adequate technical frameworks to use artificial intelligence and data

science technologies in the treatment segment. And since these technologies are used only in few private hospitals so consulting fee is very high, poor and middle-class people can't get the high-quality treatment.

III Proposed Model

Based on the studies carried out we can suggest a new methodology with practical possibilities. The purpose, objective and working methods for proposed model are given below

Scope of the model

The proposed strategy intends to transform healthcare delivery by solving the issues associated with fragmented patient data management. At its core, it aspires to develop a centralized ecosystem that facilitates the gathering, processing, and exchange of patient information. By upgrading existing electronic medical information systems, the model envisions a comprehensive database where patient records may be stored uniformly, minimizing inefficiencies caused by numerous identification numbers across various healthcare facilities. Furthermore, the model focuses on the development of innovative algorithms for real-time data analytics and transfer, allowing healthcare providers to get accurate information quickly.

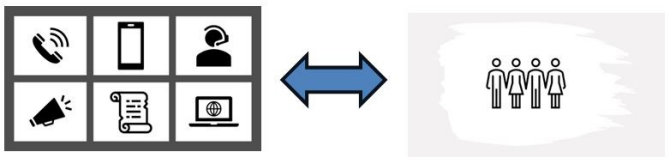

Figure 5: Illustrates the Traditional and Digital Channels used to communicate to the health care stakeholder on time. (Source from Gemini.google.com)

Through better communication channels and collaboration among healthcare stakeholders, the approach promotes proactive disease management and data-driven decision-making. The suggested strategy intends to improve patient care outcomes by making relevant medical information more accessible to those who need it, while also increasing efficiency and scalability in healthcare delivery. It envisions a future in which correct patient data is easily accessible, allowing for informed treatment decisions and eventually improving the quality of healthcare services delivered.

Implementation

Initially, each individual will be assigned a unique health identification created by the disease prediction model. This identity will act as a universal reference point, allowing medical records to be seamlessly integrated across several healthcare providers and facilities. This centralized system allows authorized healthcare practitioners to securely store and accessing data, such as medical history, diagnosis, and treatment outcomes.

Furthermore, the illness prediction model's algorithm will continuously monitor incoming patient data in order to find trends and patterns in disease prevalence, symptomatology, and treatment outcome. Using machine learning and predictive analytics, the system may forecast and reduce potential health risks for individuals based on their medical profiles and demographic information.

Furthermore, the installation includes real-time data analytics and communication channels, allowing healthcare providers to make timely decisions and intervene. The system ensures ongoing improvement and adaptation to changing healthcare demands and emerging disease concerns by providing regular updates and feedback channels.

Overall, the suggested implementation of the illness prediction model within a centralized healthcare information system has the capability to improve patient care, optimizing allocation of resource, that would contribute to population-level health management techniques.

Artificial Intelligence (AI) and Data Science in Proposed Model

In proposed paradigm, Data Science and Artificial Intelligence technologies play critical roles in analyzing the massive amount of patient data kept in the centralized database. The system creates personalized illness profiles for each individual based on their medical history, genetic predispositions, lifestyle factors, and demographic information using advanced data analytics approaches such as machine learning algorithms and predictive modeling. Using this personalized

illness table, healthcare providers can tailor preventative treatment programs and measures to reduce the risk of future disorders. Furthermore, the system uses a variety of diagnostic algorithms to precisely diagnose and classify diseases based on specific risk factors, allowing for early and targeted healthcare interventions.

IV CONCLUSION

The present healthcare landscape is heavily reliant on Health Information Exchange & Consent Manager (HIE-CM) systems, which largely analyze and exchange patient data for treatment purposes [26]. However, advanced data analytics and preventive healthcare interventions are only available at a few specialized private hospitals, leaving a large percentage of the population without necessary healthcare resources. This disparity in healthcare access disproportionately affects low-income individuals, resulting in higher rates of disease and mortality. The introduction of artificial intelligence and data science technology in public hospitals has the potential to democratize access to quality healthcare for all. By utilizing machine learning technologies, these hospitals can effectively forecast future disease trends, allowing for proactive disease prevention and treatment planning. Sharing predicted data across sectors such as immunology, pharmaceuticals, and medical equipment manufacture can help to alleviate treatment resource shortages while also driving local production of critical medical supplies. The proposed integration of artificial intelligence and data science technologies in government hospitals not only promises to transform the healthcare industry, but it also has enormous potential for socioeconomic development and human resource advancement.

REFERENCES

[1] G. Andrea and B. N. Martina, Improving Primary School Learning Trough Teaching at the Right Level and Community Engagement: Evidence from Assam, India, AEA RCT Registry, 2018. https://doi.org/10.1257/Frct.2817-2.0

[2] Anonymous, India - India needs to spend more on healthcare, International Journal of Health Care Quality Assurance, 24(4), 2011. https://doi.org/10.1108/ijhcqa.2011.06224dab.006

[3] K. Ashley, Working smarter, not harder, to improve healthcare transparency, Institute for Operations Research and the Management Sciences (INFORMS). 2020. https://doi.org/10.1287/orms.2020.01.11p

[4] Z F Khan, and S R Alotaibi, Applications of Artificial Intelligence and Big Data Analytics in m-Health: A Healthcare System Perspective, Journal of Healthcare Engineering. 1-15, 2020. https://doi.org/10.1155/2020/8894694.

[5] S. B. Partha and B Jaya, Handbook of Research on Advancements of Artificial Intelligence in Healthcare Engineering, 2020, https://doi.org/10.4018/978-1-7998-2120-5.ch018

[6] A. Choudhary, A. Choudhary, S. Suman, NLP Applications for Big Data Analytics Within Healthcare. In: Mishra, S., Tripathy, H.K., Mallick, P., Shaalan, K. (eds) Augmented Intelligence in Healthcare: A Pragmatic and Integrated Analysis. Studies in Computational Intelligence, vol 1024. Springer, Singapore, 2022. https://doi.org/10.1007/978-981-19-1076-0_13

[7] M A. Kazancigil, Big medical data, cloud computing, and artificial intelligence for improving diagnosis in healthcare, Big Data Analytics for Healthcare, 139-150, 2022. https://doi.org/10.1016/B978-0-323-91907-4.00021-2

[8] S V G Subrahmanya, D K Shetty, V Patil, B M Z Hameed, R Paul, K Smriti, N Naik, B K Somani, The role of data science in healthcare advancements: applications, benefits, and future prospects. *Ir J Med Sci* **191**, 1473–1483, 2022. https://doi.org/10.1007/s11845-021-02730-z

[9] B. Ashay and S B. Ankur AI and Healthcare, Data Driven Decision Making Using Analytics. 1st Edition, CRC press, 2021. https://doi.org/10.1201/9781003199403-9

[10] S. W. Tarun and W. Peter, Spatially Enabling the Health Sector, Front. Public Health, 4, 2016. https://doi.org/10.3389/fpubh.2016.00243

[11] P. Shankar, G. Aditi, V. Ramesh, B. Pankaj, K. Dinesh, K. Manmeet, K. Rajesh, Cost of Delivering Health Care Services in Public Sector Primary and Community Health Centres in North India, . PLoS ONE, 11(8): e0160986, 2016. https://doi.org/10.1371/journal.pone.0160986

[12] H. Dailah, Understanding the determinants of digital health marketing strategies: a comparison of private and public sector hospitals, JMR Prints, 27844, 2021 https://doi.org/10.2196/preprints.27844

[13] OECD, Gender Equality in a Changing World: Taking Stock and Moving Forward, Gender Equality at Work, OECD Publishing, Paris, 2025. https://doi.org/10.1787/e808086f-en.

[14] Riha, Johanna, Ravindran, Sundari, T K, Atiim, A. George, Remme, Michelle, Khanna, Renu, What Works in Gender and Health in the United Nations: Lessons Learned from Cases of Successful Gender Mainstreaming across Five UN Agencies. United Nations University International Institute for Global Health. 2021. 10.37941/RR/2021/4

[15] K R Rishabh, K Neelesh, K Dewesh, V. Madhur, T. Gunjan, Digital Health Revolution in India: Transforming

Health and Medicine, Indian J Community Med . 30;49 (Suppl 2):S205–S209, 2024. https://doi.org/10.4103/ijcm.ijcm_803_24

[16] Anonymous, Ceresana predicts fillers market to be worth US$31.76 billion by 2023", Additives for polymers, 2016, Additives for Polymers Volume 2016 (7), 11, 2023. https://doi.org/10.1016/S03063747(16)30096-3

[17] A. L. Robin, Country Spotlight: India. In: Olivier, M., Croteau-Chonka, C. (eds) Global Health and Volunteering Beyond Borders. Springer, Cham. 2019. https://doi.org/10.1007/978-3-319-98660-9_15

[18] N. Tom, M. Oliver, C. Aimee, R. Damien R, Acceptability of artificial intelligence (AI)-led chatbot services in healthcare: A mixed-methods study, Digital Health, 5, 2019. https://doi.org/10.1177/2055207619871808

[19] E. Slevin, Healthcare in the Digital Age - The Future of Health Records. Open Access Te Herenga Waka-Victoria University of Wellington. Thesis. 2017 https://doi.org/10.26686/wgtn.17067950

[20] Chapter 20, E-Governance & Telemedicine https://mohfw.gov.in/sites/default/files/20%20ChapterAN 2018-19.pdf

[21] Claire Muñoz Parry, U. Aneja, Artificial Intelligence for Healthcare Insights from India, Centre for Universal Health & Asia-Pacific Programme, 2020.

[22] T. Sahrish, G. Nidhi, G. Preety, S. Aditi, Artificial Intelligence in Public Health Dentistry, International Healthcare Research Journal 5(9): RV1-RV5, 2021. https://doi.org/10.26440/IHRJ/0509.12489

[23] J. Albert, E R Muhammad, InsurFit - Client Health Monitoring System for Health Insurance Companies Using Smart Wearable Devices and Data Visualization, Internat. J. Pharm. Res. 12(2), 2020. http://dx.doi.org/10.31838/ijpr/2020.12.02.0136

[24] C. Albo, Alternative Data for Configurable and Personalized Commercial Insurance Products. In: Soldatos, J., Kyriazis, D. (eds) Big Data and Artificial Intelligence in Digital Finance. Springer, Cham., 2020. https://doi.org/10.1007/978-3-030-94590-9_18

[25] M. Perier, G. Bourel, B. de Neuville, O. Floch, PMU111 Use in Research of French Snds Real-World DATA By Pharmaceutical Companies: Evolution from DATA Access Opening to Pharmaceutical Companies in 2017, Value in Health, 23 (supplement 2), S622, 2020. http://dx.doi.org/10.1016/j.jval.2020.08.1323

[26] Ayushman Bharath Mission, Draft Health Data Management Policy, version 02, National Health Authority, India, 2022

