

A Research Paper on Impact of Digital Health Initiative Under Viksit Bharat Mission 2047 in India

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Received: 20 April 2026, Accepted & Reviewed: 25 April 2026, Published: 30 April 2026

Abstract

The study titled “Impact of digital health initiative under viksit bharat mission 2047 in india” explores how India’s digital health transformation aligns with the national vision of Viksit Bharat 2047, which aims to achieve equitable and technology-driven healthcare for all. The research assesses the implementation and outcomes of key e-health programmes such as the Ayushman Bharat Digital Mission (ABDM), e-Sanjeevani Telemedicine, CoWIN, U-WIN, and Tele-MANAS across urban and rural areas of india. The study evaluates the accessibility, affordability, and quality of digital healthcare services while identifying disparities in adoption based on gender, income, and digital literacy. Findings are expected to reveal how digital platforms have enhanced healthcare delivery, reduced geographical and economic barriers, and contributed to universal health coverage. However, challenges related to infrastructure, digital literacy, and privacy persist. The study contributes policy insights to strengthen India’s digital health ecosystem and supports the realization of the “Health for All” goal under the Viksit Bharat 2047 framework.

Keywords: Viksit Bharat 2047, Digital Health, Ayushman Bharat Digital Mission (ABDM), Telemedicine, e-Health Services, Healthcare Accessibility

Introduction

Viksit Bharat means “Developed India” – it’s a dream and plan of our country to become strong, modern, and developed by the year 2047 (when India completes 100 years of independence).

□ Now, when we say “Health for All” in Viksit Bharat, it simply means:

□ Every single person in India – whether rich or poor city or village – should have good healthcare facilities.

□ No one should suffer or die just because they don’t have resources or a hospital nearby.

□ Healthy people represent a Strong nation.

To make this happen, the government and society are focusing on:

1. Better Hospitals & Clinics – so that even small towns and villages get proper treatment.

2. Affordable Medicine – so common people can buy medicines without worrying about high cost.

3. Digital Health Services – like online doctor consultations, health apps, and digital health cards, so that healthcare reaches everyone faster.

4. Preventive Care – focus on clean water, vaccination, healthy food, and exercise, so people don’t fall sick often.

5. Health Insurance for All – so families don’t become poor because of hospital bills. In short, Viksit Bharat’s Health for All is about creating a future India where everyone can live a long, healthy, and happy life without

worrying about money or distance for treatment. The Viksit Bharat Vision in healthcare aims to transform India into a developed nation by 2047 with a robust, inclusive, and technologically advanced healthcare ecosystem. The vision prioritizes universal health coverage ensuring accessible and affordable healthcare services to all citizens, emphasizing prevention, wellness, and treatment without financial hardship. It focuses on building an integrated digital health infrastructure leveraging innovations like telemedicine, digital health records, and AI—to connect patients, providers, and policymakers seamlessly across the country. The vision also highlights strengthening healthcare infrastructure by expanding hospitals, medical colleges, and skilled workforce development, alongside India's emergence as a global pharmaceutical and vaccine manufacturing hub. Ultimately, Viksit Bharat strives for equitable, patient-centered care and innovation-driven growth to achieve better health outcomes for every Indian by 2047.

The healthcare pillars of Viksit Bharat Vision 2047 focus on building a future-ready, inclusive, and technology-driven health ecosystem in India.

Key pillars include:

Universal Health Coverage (UHC): Ensuring every citizen has access to quality, affordable healthcare services, including prevention, treatment, rehabilitation, and palliation, without financial hardship, with schemes like Ayushman Bharat PM-JAY driving this goal.

Advanced Technology: Leveraging digital health innovations such as AI, telemedicine (eSanjeevani), digital health records, and healthcare AI tools to transform healthcare delivery, improve accessibility, and promote continuous care.

Robust and Scalable Infrastructure: Expanding health facilities across urban, rural, and remote areas, particularly strengthening primary healthcare centers, and ensuring availability of skilled human resources and medical technology.

Highly Skilled Healthcare Workforce: Emphasis on capacity building and training to address shortages in medical professionals and allied health workers to meet growing demand.

Patient-Centered Care: Empowering individuals with health data access and awareness to become active partners in their health management.

Integrated and Interoperable Systems: Seamless digital integration across healthcare providers and pharmaceutical supply chains to deliver evidence-based, preventive, and personalized care.

These pillars collectively aim to ensure quality, accessible, affordable, and sustainable healthcare for all Indians by 2047, supporting India's transition to a developed nation with global leadership in healthcare innovation and service delivery. Key healthcare goals of Viksit Bharat Vision 2047 focus on creating a robust, accessible, and equitable health system in India by the nation's centenary of independence. The main goals include:

Universal Healthcare Coverage: Achieve 100% health coverage ensuring no one is left behind, with comprehensive services for prevention, wellness, treatment, and rehabilitation accessible to every citizen across urban and rural areas [4][1].

The Viksit Bharat Mission 2047, a national endeavor aiming for a developed India by its centenary of independence, places significant emphasis on robust healthcare infrastructure and accessible services, with digital health initiatives serving as a cornerstone of this vision (Kar & Ram, 2024).

The Viksit Bharat Mission 2047, a nationwide effort to achieve a developed India by its hundredth anniversary of independence, prioritizes strong healthcare systems and readily available services, with digital health initiatives forming the foundation of this ambition (Kar & Ram, 2024).

Healthcare systems in developing countries face significant challenges, including timely disease detection, inadequate facilities, and poor monitoring, often leading to high mortality and economic losses. The advent of digital technologies offers a pathway to overcome these issues by leveraging IT, ICT, and ETs to enhance access, quality, and efficiency. This paper examines the transformative role of digital health initiatives, such as e-Health, telemedicine, m-Health, eRM, and Smart Health, in addressing healthcare disparities. With rapid urbanization and events like the COVID-19 pandemic accelerating adoption, digital health is poised to shift from curative to preventive care models. The study draws on global reports and expert analyses to illustrate how these technologies can bridge gaps in resource-constrained settings, fostering innovation and equity.

Objectives:

- 1) To analyze the challenges faced by healthcare sectors in developing countries.
- 2) To explore the role of digital technologies in overcoming these challenges.
- 3) To evaluate the benefits and limitations of key digital health components like e-Health, telemedicine, m-Health, eRM, and Smart Health.
- 4) To assess the impact of emerging technologies on healthcare delivery and patient outcomes.

Research Methodology: The research employs a qualitative approach, synthesizing secondary data from scholarly articles, industry reports, and reputable sources. A review of 20 relevant papers was conducted from an initial pool of 50, focusing on digital health applications in developing countries. The methodology integrates qualitative and quantitative elements, including case studies and statistical insights from organizations like the World Health Organization (WHO) and the World Economic Forum. Data analysis emphasizes thematic categorization of challenges, technological interventions, and outcomes, ensuring a comprehensive overview of digital health's potential.

1.1 MEANING OF E HEALTH

e-Health, is broadly defined as the application of digital technologies (Information and Communication Technologies -ICTs) in health. e-Health covers application of broad range of data processing and computer networking applications (including Internet) in healthcare. It covers various aspects including online medical consultation, online medical records, online medicine supply management and country-wide (or may be world-wide) exchange for

patient information but not limited to the said services. The most notable attribute of e-health is that transforms the health system from curing diseases in hospitals by health professionals, to a better system that is focused on keeping citizens healthy by providing them with information to take care of their health whenever the need arises, and wherever they may be.

The scope of these initiatives are to make all medical facilities available for the patients and their care givers at all time, from any part of the world. e-Health initiatives have a vision to delivery better health outcomes in terms of access, quality, affordability, lowering of disease burden and efficient monitoring of health entitlements to citizens. Let us learn more about these benefits.

1.2 Benefits of e-Health

e-Health has the potential to improve the quality of healthcare and reach the unreached. The concept is based on using technology to improve the quality of healthcare. The advances have allowed both patients and medical professionals to gain access to a variety of resources to make healthcare more efficient and cost-effective. e-Health empowers patients to take an active role in their treatment, allowing them to gain a deeper understanding of their conditions and how to effectively manage them.

□**Efficiency:** One of the promises of e-Health is to increase efficiency in health care, thereby decreasing costs. One possible way of decreasing costs would be avoiding duplicative or unnecessary diagnostic or therapeutic interventions, through enhanced communication possibilities between health care establishments, and through patient involvement.

□**Enhancing Quality:** Increasing efficiency involves not only reducing costs, but at the same time improving quality. e-Health may enhance the quality of health care by allowing comparisons between different providers, involving consumers as additional power for quality assurance, and directing patient streams to the best quality providers.

□**Evidence based:** e-Health interventions should be evidence based in a sense that their effectiveness and efficiency should not be assumed but proven by rigorous evaluation.

□**Empowerment of consumers and patients:** By making the knowledge bases of medicine and personal electronic records accessible to consumers over the internet, e-Health opens new avenues for patient centered medicine and enables evidence based patient choice.

□**Encouragement:** A new relationship between the patient and health professional, towards a true partnership, where decisions are made in a shared manner is developed.

□**Education:** The physicians are educated through online resources like medical education and consumers like health education, preventive information etc.

□Enabling information exchange and communication in a standardized way between health care establishments..

□**Extending:** The scope of health care is extended beyond its conventional boundaries. It means both in geographical and conceptual sense, e-Health enables consumers to easily obtain health services online from global providers.

□**Ethics:** e-Health involves new forms of patient-physician interaction and poses new challenges and threats to ethical issues such as online professional practice, informed consent, privacy and equity issues.

□**Equity:** To make health more equitable is one of the promises of eHealth. People who do not have money, skills, and access to computers and networks cannot use computers effectively. As a result, these patient populations are those who are least likely to benefit from advances in information technology, unless political measures ensure equitable access for all.

Digital healthcare is not just about technology—it is about people. It is about bringing doctors closer to patients, medicines closer to families, and health records closer to every citizen. In India, this movement has grown rapidly under the Digital India programme and the Viksit Bharat 2047 vision, where Health for All is a central goal. A good healthcare system is very important for everyone. However, due to several issues such as lack of adequate infrastructure, shortage of medical professionals, and the rising cost of healthcare, the present healthcare systems are unable to accommodate everyone's needs, particularly those who are in rural

and remote areas of developing countries. Some of the common issues that confront healthcare domain in such countries are listed in the next section. It is these set of issues that are expected to be resolved by application of emerging technologies / new age technologies.

2.1 Why Digital Healthcare Matters

For decades, India's healthcare system faced challenges: lack of hospitals in rural areas, shortage of specialists, high medical costs, and the struggle of patients to maintain records or travel long distances for treatment. Digital healthcare tries to solve these problems. With the use of smartphones, internet, cloud services, and artificial intelligence, healthcare is shifting from being hospital-centric to being patient-centric. Now, healthcare can reach homes, villages, and even the most remote parts of the country.

2.2 The Key Pillars of Digital Healthcare

1. Ayushman Bharat Digital Mission (ABDM): This is the backbone of India's digital health ecosystem. Citizens can create their Ayushman Bharat Health Account (ABHA ID) to safely store and share medical records. It ensures privacy, portability, and accessibility of health information.

2. E-Sanjeevani Telemedicine: India now runs the world's largest telemedicine service, providing free video consultations. Over 36 crore consultations have already been completed, making it possible for patients in villages to talk to specialists sitting in big hospitals.

3. CoWIN Platform: During COVID-19, India's vaccination drive became a global example through the CoWIN portal, which registered more than 110 crore people and issued vaccination certificates seamlessly.

4. Digital Health Records & Smart Health: Electronic Medical Records (eMRs) and Electronic Health Records (eHRs) replace piles of paper files. They help avoid duplication, improve accuracy, and make healthcare more efficient.

5. Mobile Health (m-Health): Mobile apps like Aarogya Setu and other wellness apps have empowered people to monitor blood pressure, sugar levels, fitness, and even mental health from their phones.

6. Other Services: e-Hospital system for online appointments and lab reports, **e-BloodBank** to check availability of blood in real-time, **U-WIN** platform for immunization tracking, and **Tele-MANAS** for mental health support. Whether in Agra or a remote village in Ladakh—should have equal access to doctors, medicines, and medical knowledge.

One significant area of focus is the evaluation of **telemedicine** systems through a multi-criteria framework that accounts for various stakeholders, including healthcare providers, patients, and policy-makers. Telemedicine initiatives in India often reflect the concerns of providers rather than the needs of patients, making it vital to establish frameworks that incorporate patient perspectives into design decisions (Chandwani & Dwivedi, 2015). This approach could enhance user acceptance and the effectiveness of telemedicine services. The ongoing COVID-19 pandemic has highlighted the necessity of such systems, where digital health solutions have become crucial for maintaining service accessibility and quality (Ahmad & Azeez, 2023).

2.3 Challenges Faced by HealthCare Sector in Developing Countries

In developing countries, there are several challenges at every stage of healthcare sector. These challenges start from the first stage of disease diagnosis to the final stage of monitoring the patient. Some of the related challenges in disease lifecycle of a patient of a developing country are listed herewith:

• **Lack of Timely Disease Detection:** Unnecessary loss of lives and resources is often reported when certain diseases like seasonal diseases, lifestyle diseases, cancer, are not detected at an early stage. A recent outbreak of COVID-19 has taught the world that when timely detection of certain types of diseases is not done, it could easily become a mass outbreak/pandemic, leading to wastage of not just individuals but of the nation as a whole.

• **Lack of Adequate Facilities for Diagnosis of The Disease:** Early disease diagnosis requires proper and timely analysis of the family's medical history, specialized routine checkups, and the right types of medical equipment and much more. However, lack of availability of

appropriate equipment and also lack of data are some of the main reasons that proper and early diagnosis of diseases cannot be undertaken and hence leading to loss of lives and money.

• **Lack of Adequate Analysis during Preparation of Patients for the Treatment:** When patients come for any treatment, they must receive a procedure-specific preparation for a successful intervention. For instance, health and related needs of the patient must be properly understood and analysed before complicated procedures like a surgery is advised. However, it has been observed that in certain cases, patients get operated even when there was no need. This leads to unnecessary expenditure and related complications too. Such situations could have been avoided if patient's medical history and also appropriate medical expertise was easily available.

Deficiency of Appropriate Medical Intervention: Intervention can occur with drugs and/or with a procedure/surgery and should be handled only by trained specialists. However, due to inadequate number of specialists, this is tough to achieve. In several situations, even the cases of emergency referrals get ruined due to lack of collaboration amongst hospitals and specialists.

• **Inadequate Recovery and Rehabilitation Medical Facilities:** Post intervention period is also a deciding factor in a patient's healthcare. Many hospitals neglect the importance of smooth patient recovery and rehabilitation and end up sending them home, earlier than required. This could lead to re-occurrence of medical emergencies, especially in critical cases. In other cases, some patients are compelled to seek 'early hospital discharge' because of high medical costs.

• **Lack of Regular Monitoring and Managing:** Regular patient follow-ups are essential, after the hospital discharge or required treatment. This requires maintaining a track record of the patients and also regular follow-ups of the patient. All this is usually neglected due to lack of adequate specialists and healthcare infrastructure.

2.3.1 Employing Digital Technologies to Overcome Health Care Challenges

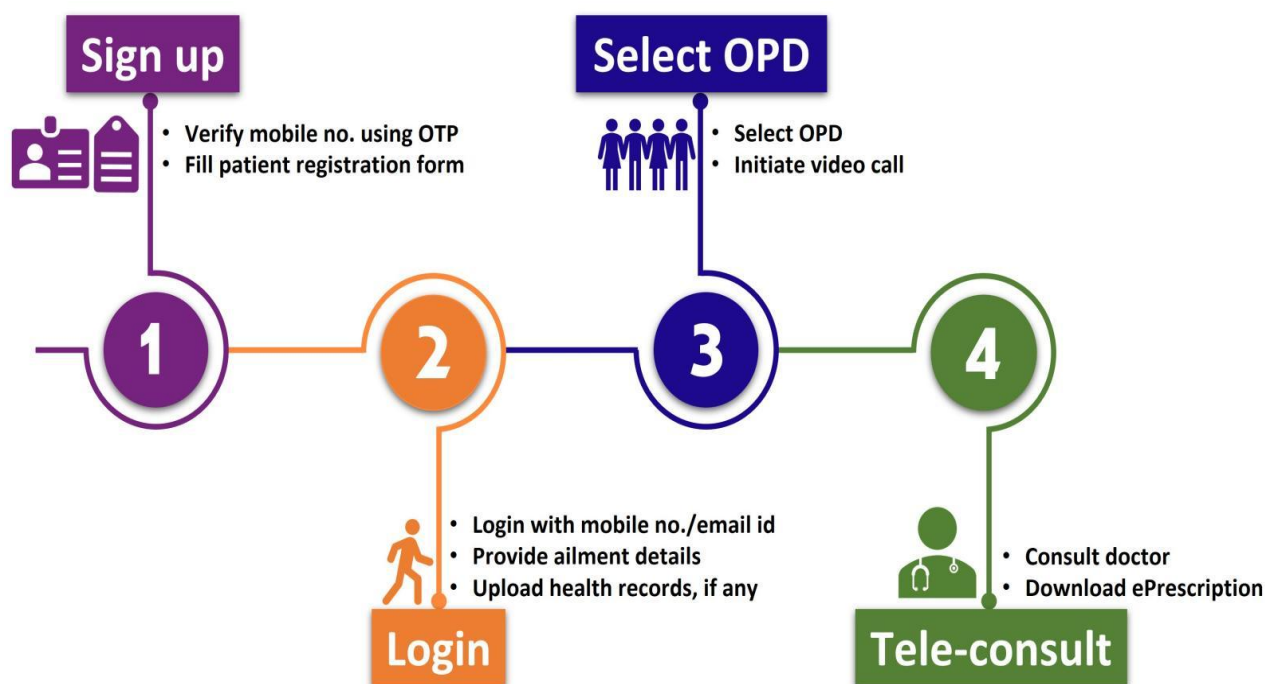
Before we proceed to understand the ways and means to overcome challenges of health sector, certain terms such as Information Technology (IT), Information Communications Technology (ICT), Emerging technologies (ETs) have to be revised .

A. Information Technology (IT) : IT is the use of electronic devices like computers to create, process, store, retrieve, and exchange all kinds of electronic data and information.

B. Information Communications Technology (ICT): ICT is an extended term to Information Technology (IT) to specifically include the presence and role of digital communications using telecommunications and computers. Therefore , apart from computers, it typically includes Local Area Networking(LAN), Wide Area Networking (WAN), wireless networking , mobile connectivity, Internet, Intranet technologies too.

C. Emerging technologies (ETs): as those that have the potential to gain commercial and social validity in the next 10 to 15 years; with reference to digital technologies, these are also referred as New Age Technologies (NATs). These technologies include Artificial Intelligence, Immersive Technologies and Digital platforms.

D. Digital Technologies : To avoid confusion, usually an umbrella term - “digital technologies” is used to refer to various digital/electronic technologies represented by the terms IT, ICT and ET / NATs. To overcome all common challenges confronted by majority of the citizens in developing countries (particularly in rural and remote areas), digital technologies (Information Technologies-Its, Information Communication Technologies-ICTs , Emerging Technologies-ETs) are required to improve the healthcare sector. Application of digital technologies in health, is essential to achieve health priorities such as ‘universal health coverage (UHC)’ and the Sustainable Development Goals (SDGs).



3.1 The implementation of digital technologies, is generally referred by the term as ‘digital health’ . This field has become very popular and has undergone huge development in last few decades. Broadly, it is important to know that the digital health field includes the concepts of ‘electronics record management’(eRM), ‘m-health’ , ‘telemedicine’ and ‘Smart Health’, all which would be explained in subsequent sections.

we shall cover the application of emerging technologies in the area of health, referred as ‘Smart Health

3.2 Telemedicine Services

Telemedicine: refers to the application of various telecommunication and networking systems in the delivery of appropriate health care to individuals without limitations of time or distance. It involves the speedy transmission of patient data related to consultations, diagnostic and therapeutic services, patient education and rehabilitative services among the providers, the Consumers, the planners and researchers.

The World Health Organization has adopted the following broad description of Telemedicine:

“The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies

for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing

education of health care providers, all in the interests of advancing the health of individuals and their communities”.

Therefore telemedicine refers specifically to remote clinical service and aims to increase the accessibility of quality healthcare to a larger population and can be particularly helpful in disease prevention and health promotion in remote/isolated areas. Telemedicine applications, such as audiovisual aids, video conferencing, and healthcare-related conversations with

paediatricians/general physicians can be used to inform and motivate people.

There are three main types of telemedicine, which include store-and-forward, remote monitoring, and real-time interactive services. Each of these types has a beneficial role to play in overall health care and, when utilized properly, can offer tangible benefits for both healthcare workers and patients. More specifically, during the pandemic, telemedicine has provided remote access to healthcare to patients without putting doctors/health caregivers at the risk of infection. It is expected that telemedicine would become more popular in the coming days.

3.3 Tele-consultation : It is one of the specific applications of telemedicine. It uses digital technologies to facilitate communications between a patient and a doctor who are otherwise geographically separated.

Telemedicine allows scaling up of healthcare systems to meet a rising population, especially in remote, rural and low-income areas, by employing technologies such as tele-consultation and surgery. Surgeons using telemedicine will have access to haptic (3D touch) feedback, which will allow for the feeling of touch to be transmitted. As the applications of telemedicine widened, the term ‘telehealth’ was introduced to reflect a broader scope of IT enabled health-related functions such as education and administration too. Therefore the terms ‘Telemedicine’, ‘Tele-consultation and ‘Tele-health’ are closely interlinked and get covered by the generic term ‘tele-health’. Tele-health, is therefore a very general term that also includes remote provision of administrative support and/or awareness-building etc. using digital technologies, whereas tele-medicine and tele-consultation are specific terms that respectively focus on ‘complete treatment’ remotely and ‘only consultation remotely’.

In general all these advancements using digital technologies have been able to transform the healthcare system from one that is narrowly focused on curing

diseases in hospitals by health professionals to a system focused on keeping citizens healthy by providing them with information to take care of their health

whenever the need arises, and wherever they may be.

Benefits of Telemedicine Using telemedicine as an alternative to in-person visits has several benefits for patients and health care providers as summarised below:

Patients enjoy telemedicine in the following ways:

- ☐ No travel expenses or time.

- ☐ More knowledge about their own diseases.
- ☐ No exposure to other potentially contagious patients.
- ☐ Access to medical experts despite geographical distances.
- Improved work efficiency.
- ☐ Better patient follow-ups and improved health outcomes.
- ☐ Fewer missed appointments and cancellations.
- ☐ Better collaboration.

Limitations of Telemedicine

However, it is not that telemedicine does not have certain limitations. Some of the limitations of telemedicine are written below:

1. Telemedicine programs mainly depend on optimum internet network, therefore interrupted and poor connection can lead to program failure.
2. Lack of expensive instruments and lack of service engineers in rural area pose major hindrances to the implementation of tele medicine services in rural areas.
3. Lack of capacity building of staff and community is being a hurdle for full utilization of telemedicine services. As a result, expansion of telemedicine centres in rural areas is not easy due to lack of well trained staff in some identified areas where public health facilities still not exist.
4. Due to lack of orientation of use of tele instruments, people in villages can not handle tele equipment independently and when some other operator/ third party company is employed to operate these sophisticated equipment then several privacy issues can arise.

m-Health Services

One of the components of e-Health is m-Health (also written as 'mHealth' or 'mobile health'). Mobile devices are designed to be portable and easy to carry. The proliferation of mobile communication devices and associated wireless technologies has stimulated various innovative health interventions for personalized care. As a result, almost all the hospitals and healthcare professionals have become dependent on the ease of access provided by

mobile phones.

As already said earlier, m-Health is a shortening for mobile health and mHealth refers to use of mobile phones, mobile communication and various mobile utilities and apps for healthcare sector. The Global Observatory for eHealth (GOe) defines mHealth as 'medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices'.

The various utilities of a mobile phone are voice calls, short messaging service (SMS), mobile applications (apps), Internet, global positioning system (GPS), Bluetooth technology, etc. Also, there are several mobile based information systems/ applications that have been designed and customised to improve the efficiency of specific hospitals /practitioners etc. These apps are helpful to medical experts to track the recuperation of patients of a particular hospital. Even m-health apps that provide doctor consultations are becoming very popular, and have huge potential. These apps generic , off-the-shelf , commercial health applications , that

help to make doctor appointments, or seek expert advice on health related queries and so on , such as ‘GoogleFit’ and ‘Apple Heart Study’.

In general, one can easily sum up discussions on m-Health by stating that since mobile is becoming such a popular and affordable device, therefore m-Health services are also becoming very popular.

Especially, with urbanization and the emergence of COVID-19, the demand for m-Health-related services have increased and that m-health is becoming a very well-accepted mode of healthcare delivery even in developing countries.

Benefits of m-Health

m-Health has many benefits like patients can log, store, and monitor their health records on their personal devices. Some of these benefits are:

Ease of Communication: m-Health has proven to be an effective means of communication between doctors and patients. Doctor consultations via mobile health apps are beneficial to both doctors and patients since they save time and money. For example, mobile health services enable patients to rapidly send secure messages, schedule appointments and connect to healthcare providers’ day in and day out for telemedicine visits. Even doctors / clinicians can ensure that patients are regularly taking the desired prescriptions etc. Apart from doctors and patients, there also stays a regular connect between all other stakeholders of the health system – the referring physicians , office staff through secure messaging and texting etc. They can also exchange health records of the patients for consultation , mutual coordination and other reasons. This surely results in huge improvements in overall health outcomes of the patient.

Ease of correct and regular medication adherence by patients: mHealth apps improve medication adherence as several m-health apps give features such as automated medication and refill reminders to the patients. Such facilities surely improve the chance that patients would take their Medications properly and regularly.

Ease of Health Service Delivery: This method has been found to be effective in overcoming common healthcare system challenges such as healthcare professional shortages, reliance on untrained and/or informal providers, cost of service, transportation, and a lack of credible information sources.

Health Data Captured at Source: The advanced connectivity of mobile services (like mobile phones, tablets, laptops, EHRs, sensors, PDAs, etc.) and applications provide enough health-related information that can be excellently utilized by big data and AI to provide Predictive Decision Making and other smart healthcare solutions

e- Records Management (eRM)

Usually, patients possess paper records on the history and status of their diseases, which are very tough to maintain and assess over a long period of time. eRM tools and techniques, help to digitally store patients’ records/documents related to health and procedures performed, for reference by medical experts, insurance companies and for patients themselves. It maintains all files and documents of the patients as ‘electronic records’ and hence smoothens the record-keeping process from the point of its creation to disposition. Many health care giving organizations, particularly in developing countries still have a deep fear of eRM due to the anticipated cost and infrastructure overheads to the setup. However, it is a commonplace fact that if e-RM forms a part of information management efforts, anyone can realize greater gains for their business.

e-Medical Records (eMR) and e-Health Records (eHR)

e-Records can be either e-Medical Records (eMR) or e-Health Records (eHR) .

To understand the difference between EMRs and EHRs, we must know how to differentiate between terms “medical” and “health.” In general, the term “medical” represents to all the clinical aspects of the patient whereas the term “health” refers to overall wellbeing of an individual. Similarly, the term eMR represents the narrower view of a patient's medical history, while the term eHR is indicative of a more comprehensive report of the patient's overall health. eHRs are created after collecting overall health information from all health

care providers and related organizations including diagnostic laboratories, medical specialists, medical imaging facilities, pharmacies, emergency facilities, and school and workplace clinics – so that these records contain information from all stakeholders involved in a patient's care. Once combined then this integrated information is shared with all these stakeholders to get an overall integrated view of a patient's health.

Further, eMRs help the doctors to track specific patient data over time and also help them create patient-specific health plans. On the other hand, since eHRs provide a complete overview of patient care therefore more advance hospitals and larger health enterprises opt to create overall comprehensive eHRs for their patients.

Therefore, whether those are eMR or eHR , electronic record management is a very beneficial process for the patients. Some of the obvious benefits of eRM, in general, are shared herewith.

Benefits of eRM

Easy Record Retrieval: It provides quick access to patient records and information for efficient healthcare. By storing records electronically, e-RM becomes very useful in ease of identifying, categorizing and facilitating easy retrieval of records by the hospital, caregivers, and by patients themselves.

Ease of Removal of Duplications: Even all duplications can be easily noted and removed by digital records management. Even the outdated versions could be ignored and the latest correct information could be saved. This also reduces the chances of medical errors and improves clinical decision-making.

Ease of Record Maintenance: e-RM helps in easing the burden of cumbersome record maintenance task. It reduces paperwork and thus, helps to reduce the cost of healthcare.

Ease of Compliance: With electronic storage of records, there are tighter controls on the files. eRM helps to quickly achieve the required governance compliances with internal policies as well external requirements.

Need and Definition of Smart Health

- **What is Smart Health:** Smart healthcare systems integrated systems that use emerging technologies such as Artificial Intelligence, wearable devices, cloud computing and so on, to regularly access medical information, to connect all the stakeholders involved in patient-care, materials, and institutions related to healthcare. Therefore, Smart Health systems are a combination of Information system management software and application of emerging technology based apps (AI/ML etc), Hardware such as sensor-based medical devices, block-chain, IoTs and Networking/ connectivity technologies – all combined together as one unit , to achieve the objective of preventive and precise healthcare for the patients.

- For example, a combination of surgical robots (AI) and Immersive technologies (mixed reality technologies that combine both VR and AR) are used to perform precise surgery.

- Similarly AI and radio-frequency identification (RFID) technologies can be used to manage the supply chain and the hospital resources including manpower, machines and material.

· There are also integrated management platforms / health stacks that are used to collect information from all the stakeholders of health value chain and to assist decision-making.

• **Need for SmartHealth** : It is well known that a healthcare system is an interconnected system comprising of complete medical setup that works together for illness inference, treatment, medical aid, hospital management, and clinical analysis to meet needs of a patient. It also includes several stakeholders including doctors, care-givers, patients and related institutes such as hospitals, clinics, and analysis institutions. It has been clearly understood that healthcare organizations must effectively manage information obtained from both patients and the external environment. Even the patients must be made aware about their medical history, course of treatment and related medical procedures. Patient's compliance with the treatment also has to be followed up.

Role of Emerging Technologies : Emerging technologies (also called new-age technologies), including the Internet of Things (IoT), mobile technologies, cloud computing, big data, 5G, microelectronics, and Artificial Intelligence, alongside modern biotechnology, constitute the cornerstone of smart healthcare systems. As already indicated above, healthcare systems comprise doctors, patients, hospitals, research institutes, etc. Smart healthcare technologies are widely utilized in all aspects of the healthcare system by the patients and the doctors as well as by the hospitals and medical researchers' community. The introduction of emerging technologies in healthcare is among the most important factor in transforming healthcare. In this section, we would explain some of the emerging technologies (such as AI, IoT based wearable and so on) that have improved the health care services a lot.

Categories of Smart Health

Based on the context and range of technology implementation in healthcare systems, the World Economic Forum report on healthcare services (2016), classifies Smart Healthcare in four digital categories (described below):

- i) Smart care will improve patient outcomes and lower the cost of healthcare through the use of precision medicine, robotics, and medical printing. For instance, surgeons can achieve precise surgery using surgical robots and mixed reality technologies.
- ii) Care anywhere will see healthcare move closer to the home, through advances in the connected home and virtual care, which will also help broaden access, especially in mature economies. For instance 'telemedicine' and 'teleconsultation' are the techniques that help to achieve the possibility of 'care anywhere'.
- iii) Empowered care, through the development of 'living services', will enable citizens to take a more active role in managing their own well-being and healthcare. For instance, patients use IoT-based wearable devices/ on-body sensors to keep a regular watch on their health parameters. They could also seek medical assistance by using AI-based virtual assistants that can 'talk' to them and advise them on healthcare basics using natural language processing techniques (NLP). In certain, very sophisticated instances, patients use smart IoT-based smart homes to avail health services remotely.
- iv) Intelligent health enterprises will provide data-driven solutions that enable healthcare workers and their enterprises to maximize their efficiency and allow patient health to be monitored more effectively in real-time. There are many examples of health enterprise systems For example :
 - Intelligent clinical decision support systems (DSS) or expert systems (ES) would assist doctors to improve their diagnosis of diseases in the patients.

- To manage the supply chain, integrated management platforms are designed to gather information and assist decision-making for all aspects of the supply chain.
- Doctors could also manage medical information through an integrated information platform that has Laboratory Information Management System, Picture Archiving and Communication Systems (PACS), Electronic medical history, and many more.

Characteristics of Smart Healthcare

Smart healthcare systems must possess several vital characteristics that are very critical to assure accurate and timely medical inputs. These systems should be customized to the context of the patient, should be sensitive to respond immediately to the concerns of the patient, and should be tailor made and must adapt to the specific needs of each patient.

Apart from these, it is essential that smart healthcare systems should have low power consumption and have high machine reliability. These systems should be able to deliver exceptional or improved consumer experiences. The devices that are deployed must exhibit better efficiency and have the ability to interoperate on different kinds of platforms. These systems should also be easy to use and maintain. It is also very important that these health devices must have constant support available for ease of implementation. These technologies must be easy to upgrade to newer technologies and variations. In higher applications, along with these needs, the machine also has ambient intelligence to enhance itself to the needs of the patient.

Benefits of Smart Health

The application of emerging technologies particularly help patients to be prepared in advance to address their anticipated health emergencies. These systems also support doctors to deliver more customized healthcare to each and every patient, as per the need, on real time basis. Indeed, there are several advantages of smart health systems, as summarised herewith :

(i) Always Connected to the Doctors: Such systems also help patients stay connected with the doctors and help to provide a remote diagnosis of patients, irrespective of the distances. So it also helps in bringing down the cost of the treatment for the patient.

(ii) Advance Information to Patients: The main focus of Smart healthcare has been to provide diagnosis and treatment in a preventive and not curative manner. Therefore, the main advantage of smart healthcare systems is to support people to be more prepared to tackle health emergency issues, by providing them with advanced knowledge about their health parameters so that they could either self-manage some emergencies or be prepared with medical assistance in advance. Therefore, mobile devices and in particular, wearable devices such as watches, fitness trackers, and wristbands help to track patients' progress in-between their visits, and also help to notify a healthcare provider when the patient seems to be high risk.

(iii) Individual Specific Care to Each Patient: Further, as already indicated in the beginning of this topic, smart health helps to deliver 'precision health'. Such health care systems provide easy access to patients' medical history and therefore support doctors in providing customized and personalized care to each and every patient

PRECISION HEALTH FOR PERSONALISED HEALTHCARE

While covering the basics of smart healthcare systems, it is very important to know how science and technology are shaping the health sector to be more personalized, contextualized. . This brings us to the very

important concept of 'Precision health', which means the customization of medical interventions to make disease treatment explicit to individuals. Smart Health systems help to manage and respond to patients in real-time, precise and connected manner as per their needs, also referred as "Precision Health". It helps in planning the treatment individual-driven instead of following the one-size-fits-all methodology, where individual contrasts are not considered at all. Precision health refers to the customization of medical interventions to make disease treatment explicit to individuals. Such health care systems provide easy access to patients' medical history and therefore support doctors in providing customized and personalized care to each and every patient. Precision treatment focuses on a patient's genes, environment, and lifestyle. Technological advancements have indeed paved the way for precision health. It is an intervention that employs both medical and digital technologies to improve the performance, appearance, or capability of each and every individual, and thus increases their chances of leading a good life, without any discrimination. Precision Health also focuses on identifying at-risk groups within the population and finding ways of providing them suitable medical intervention, to help them in living longer by living healthier lives. The precision health method is presently utilized by different medical health facilities, to develop targeted and cost-effective ways. This aids in the early diagnosis of disease, alongside developing suitable treatments. For instance, specialists at Stanford Medicine are working with Apple to create an application called "My Heart Counts." The application can accumulate information concerning a person's active work and factors inferring their risk of cardiovascular issues to propel the comprehension of the human cardiovascular frameworks and issues.

In the United States, Precision Medicine Initiative (PMI) was established in 2015, to study cancer and its cures based on precision healthcare. For cancer treatment, there is a drug called imatinib (Gleevec). This precise medication tries to treat leukemia, only if the cancer cells have a specific genetic makeup. This is an apt example of Precision medicine, where only a small population of the diseased are treated. Along with developing cancer cures.

HEALTH PLATFORMS /STACK

Stack is defined as shared digital infrastructure/platform created for a specific vertical/domain. It is a sophisticated knowledge management system on

Internet, that could be accessed by all the stakeholders (both private and public)

using Application Programme Interface (APIs).

APIs are a set of software functions and procedures that access the features or

data of an operating system, application, or service by other computer

programs. Since these software utilities act as a bridge / linkage between

different computer-programmes- hence are referred as "programme interfaces".

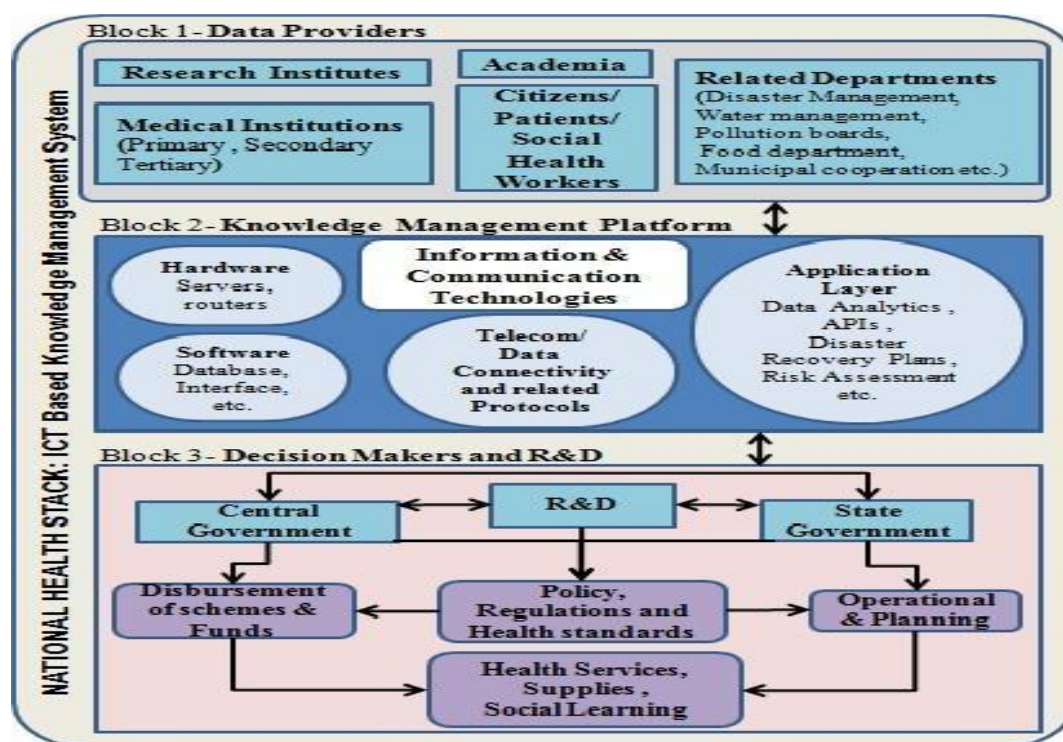
Stacks could be built up for any domain. Therefore, there could be a Health Stack for health domain, Education Stack for education domain and so on. Creation of a stack allows various stakeholders of that vertical, to utilize a common digital infrastructure towards achievement of their respective goals. It is a service delivery innovation that permits paperless, cashless and presenceless secure access to the system. In the same spirit, design and creation of Health Stacks have become very popular.

Need for Health Stack : In most of the cases, despite rapid use of digital technologies, the digital health initiatives remain decentralised and segregated. There are several isolated health related websites, by both private and public players and they do not link up facts of each other and remain advisory in nature.

6.3 Proposed Conceptual Framework of National Health Stack

National Health Stack : Health Stack could be understood as converged digital platform for all stakeholders of health, to improve access and affordability of healthcare, facilitate national health programmes, monitor insurance policies and claims, and boost medical research and health analysis. Since aggregation of values must happen at national level, therefore, it is always most correct to create a National level Public Health stack, that would also reflect state/ local values for each of the components .

Aim of National Health Stack : The main aim of the proposed health stack is to achieve transformation of the public health system - from the one that is narrowly focused on curing diseases in hospitals by health professionals, to the one that is interconnected, integrated and is focused on keeping citizens healthy by providing them with information to take care of their health whenever the need arises, and wherever they may be.



Components of National Health Stack : National health stack would primarily be aggregation of related digital databases such as Registries, Public Health Records (PHR), national analytics and so on, which would be accessible through open APIs (Application Programming Interfaces) by various stakeholders of the public health care system. Usually Health Stacks have four key components – electronic health registries of health service providers and beneficiaries, a coverage and claims platform, a federated personal health records framework and a national health analytics platform. It will also have other components like digital health IDs, health data dictionaries, supply chain management for drugs, payment gateways and more.

Designing a National Health Stack :

Step 1 :To design a health stack the first step is data collection from different sources comprising of local data stacks (from Block level to the State to Capital, in a federal structure of governance). It should also get data from other public sources that impact public health including environmental pollution monitoring agencies, disease surveillance programmes, targeted disease control initiatives like vector borne diseases, control of Tuberculosis, anaemia etc, public health databases with various research institutes,

meteorological data, incidences of food borne disease outbreaks, nutrition and consumption of food related studies as well data on per capita consumption. External data points from outside the country also need to be collected to keep a check on communicable diseases

like Pandemic, Ebola, Swine flu etc.

Step 2: The second step is to analyze the data collected based on predictive methods. Examples include near-repeat theory, regression models using risk factors, text analytics, neural networking.

The next step is to utilise that data using summarization tools to aid health related knowledge discovery through integrated data mining and. It is important to note that the very act of predictive policy making is enabled through a stack. Attractive visualization of output

through user friendly apps/dasboards is available to all the stakeholders (of course, only after due authentications) through smartphones and hand-held devices

Benefits of National Health Stack

1.First and foremost, National Health stack is the need of the hour to remove siloation of various health information data systems that are being maintained by both public and private sectors, in health domain.

2. A national health stack can also systematically permit active profiling of past diseases, systematic monitoring of non-communicable diseases. Through aggregation of different data bases, it could predict which of these are on the rise and in which location.

3. Based on detailed e-health records, it could also predict who all are more vulnerable than others. The problem of suboptimal / inaccurate treatment due to incomplete knowledge of patients' health and the personal biases of clinicians can also be addressed. Continuous monitoring with early detection has the potential to provide patients with an increased level of confidence, which in turn may improve quality of life All such data driven predictions are best possible by deployment of such a national health stack. Summing up, design of a national health stack is based on core principles of Knowledge Management. It employs digital technologies to collect, aggregate and analyse real-time health data from various sources and eventually permits health efforts to be focussed at various levels – viz. individual / community / region / country, depending on respective needs.

Impact:

✧ India's Progress in Maternal and Child Health

● Maternal Mortality

□MMR (Maternal Mortality Ratio) in India dropped from 130 (2014-16) to 97 (2018-20) per 1,00,000 live births – a decline of 33 points.

□Over the last 30 years (1990–2020), MMR declined by 83% in India.

Global comparison: Global MMR reduced by 42% in the same period.

- Infant & Child Mortality
 - IMR (Infant Mortality Rate) dropped from 39 (2014) to 28 (2020) per 1,000 live births.
- □NMR(Neonatal Mortality Rate) reduced from 26 (2014) to 20 (2020) per 1,000 live births.
- □U5MR(Under-5 Mortality Rate) declined from 45 (2014) to 32 (2020) per 1,000 live births.

India vs Global Progress (1990–2020)

<u>Indicators</u>	<u>India Reduction (%)</u>	<u>Global Reduction (%)</u>
Maternal Mortality Ratio (MMR)	83%	42%
Neonatal Mortality Rate (NMR)	65%	51%
Infant Mortality Rate (IMR)	69%	55%
Under-5 Mortality Rate (U5MR)	75%	58%

Other Interventions for Maternal Health and Pregnant Women

- Maternal Death Surveillance and Response (MDSR): Conducted at facility and community levels to identify causes of maternal deaths and implement corrective actions for improving obstetric care.
- Mother and Child Protection (MCP) Card & Safe Motherhood Booklet: Distributed to educate pregnant women on nutrition, rest, pregnancy danger signs, government schemes, and benefits of institutional deliveries.
- Reproductive and Child Health (RCH) Portal: A name-based digital platform to track pregnant women and newborns, ensuring timely antenatal, delivery, and postnatal care.
- **Anaemia Mukd Bharat (AMB)**: Part of POSHAN Abhiyan; focuses on testing, treatment, and prevention of anaemia in adolescents and pregnant women through nutrition, awareness, and addressing non-nutritional causes.
- Birth Waiting Homes (BWH): Set up in remote and tribal areas to improve access and promote institutional deliveries.
- Village Health, Sanitation & Nutrition Day (VHSND): Monthly outreach at Anganwadi Centres for maternal and child care services in collaboration with MoWCD.
- Outreach Camps: Organized in tribal and difficult areas to deliver maternal healthcare, raise awareness, mobilize communities, and monitor high-risk pregnancies.

Wider Access to Quality Health Services

- As of 5th April 2025, there are over 1.76 lakh active Ayushman Arogya Mandirs (Health & Wellness Centres) in India, providing comprehensive primary health care.
- According to the portal, 107.10 crore screenings for hypertension and 94.56 crore screenings for diabetes have been conducted at the Ayushman Arogya Mandirs (AAMs).
- Wellness-related activities, such as yoga, cycling, and meditation, are conducted in AAMs. As of 28th February 2025, a total of 5.06 crore wellness sessions, including Yoga, have been undertaken at AAMs.
- As of 30th November 2024, there are 17,000+ government health facilities certified under the National Quality Assurance Standards (NQAS), a framework by the Ministry to ensure continuous quality improvement and patient-centric care in public health facilities.

Digital Health Interventions

The Ayushman Bharat Digital Mission (ABDM) is a unified digital health ecosystem to securely connect patients, healthcare providers, and systems through an interoperable digital infrastructure. As of April 5, 2025, over 76 crore Ayushman Bharat Health Accounts (ABHA) have been created under the ABDM.

- There are over 5.95 lakh verified healthcare professionals registered under the ABDM Scheme, with over 3.86 lakh verified health facilities. Under ABDM, more than 52 crore health records are linked.
- U-WIN is a digital platform that streamlines and tracks immunization for pregnant women and children (0–16 years), enabling flexible, anytime-anywhere vaccine access under the Universal Immunization Programme (UIP).
- As of 15th December 2024, 7.90 crore beneficiaries have been registered, 1.32 crore vaccination sessions have been held, and 29.22 crore administered vaccine doses have been recorded on U-WIN.
- eSanjeevani, India's National Telemedicine Service, bridges gaps in healthcare access by providing free, equitable, and remote medical consultations, emerging as the world's largest telemedicine platform for primary care.
- As of April 6, 2025, e-Sanjeevani has served over 36 crore patients through teleconsultations since its launch in 2020, making healthcare accessible remotely with 232,291 providers onboarded to date. There are 131,793 spokes operationalized and 17,051 hubs established, with 130 specialities under e-Sanjeevani.

Disease Elimination & Control

- The WHO World Malaria Report 2024 highlights India's major strides in malaria elimination, with a 69% drop in cases and 68% reduction in deaths between 2017 and 2023. Contributing just 0.8% of global cases in 2023, India's exit from WHO's High Burden to High Impact (HBHI) group in 2024 marks a significant public health achievement.
- The Government of India has eliminated Trachoma as a public health problem in 2024, a feat recognised by the WHO.
- The Government of India's proactive Measles-Rubella vaccination drive, strong surveillance, and public awareness efforts have greatly improved public health. As of March 6, 2024, 50 districts reported no measles cases and 226 districts saw no rubella cases in the past year.

- According to WHO's Global TB Report, India has made strong progress in tuberculosis control. Under the National Tuberculosis Elimination Programme (NTEP), TB incidence fell by 17.7%, from 237 to 195 cases per lakh population between 2015 and 2023. TB-related deaths also declined from 28 to 22 per lakh. Notably, missing TB cases dropped by 83%, from 15 lakh in 2015 to 2.5 lakh in 2023.
- As of 6th April, 2025 the Pradhan Mantri TB Mukta Bharat Abhiyaan, launched in September 2022, has registered over 2.5 lakh Ni-kshay Mitra volunteers supporting over 15 lakh TB patients. This initiative has further been expanded to include family members of TB patients.
- Kala-azar Elimination: India has successfully achieved Kala-azar elimination as of October 2024, with 100% of endemic blocks reaching the target of less than one case per 10,000 population by the end of 2023.

Affordable Health Coverage for All

Under Ayushman Bharat - PM Jan Arogya Yojana (AB-PMJAY):

- As of December 20, 2024, over 55 crore beneficiaries from India's economically vulnerable population in the bottom 40% are covered with ₹5 lakh health insurance per family.
- Over 40 crore Ayushman Cards have been issued as of 3rd April 2025.
- Over 8.50 crore authorised hospital admissions throughout the country.
- Overall, 31,846 hospitals (17,434 public and 14,412 private) have been officially empanelled under the scheme as of 3rd April 2025.
- ASHA and Anganwadi workers are now included as beneficiaries.
- Over 25 lakh+ enrollments for Ayushman Vay Vandana Cards under the scheme as of December 9th, 2024.

Mental Wellness Health Interventions

- Tele-MANAS (National Tele-Mental Health Programme) now operates 53 cells across 36 States/UTs, offering 24x7 mental health support in 20 languages.
- □ As of 5th April 2025, over 20 lakh calls have been handled, with more than 230 crores allocated to NTMHP in the past three years.

Conclusion:

Digital technologies hold immense potential to address healthcare challenges in developing countries, fostering equitable, efficient systems. While barriers like infrastructure persist, investments in e-Health, telemedicine, and Smart Health can drive preventive care and better outcomes. Future research should focus on ethical implementations and scalability to ensure sustainable transformations.

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