Digital Health Revolution in India: Transforming Health and Medicine

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Abstract

Digital innovation and its integration in various parts of lifestyle are inevitable as humans have started to evolve over time. Its integration in our health and various systems is irrefutable. In this position paper, we explore the various aspects of this important component of technology, discuss its evolution over time, discuss the various existing modalities, highlight the regulatory frameworks in India, and elaborate on the different ways it can be integrated in our country's future health plans. We believe digital health is here to stay and play important role in shaping our lives in terms of our accessibility and other interactions related to health.

Keywords: Ayushman Bharat Digital Mission, digital health, digital health regulatory framework, smart health devices, universal health care

INTRODUCTION

"*Now that digital technologies have provided almost full interconnectivity among all humans, they should be used to meet key challenges to ensure that health is created and that it spreads to reach every person on earth*"—*Jimenez-Marroquin, Deber, and Jadad**[1]

Digital health is a labile medical domain significantly improving the healthcare quality, and its effectiveness, while reducing costs for both healthcare system and patients as well as clinical research. The rapid spread of digital innovation for data collection and communication technologies has changed the way of collecting, sharing, and analysis of health information for improved clinical decision-making and healthcare delivery.[2] In face of the coronavirus disease 2019 (COVID-19), globally, we saw a swathe of new innovations amalgamating digital tools in looking for solutions for containing the pandemic with success in various facets of disease control.[3] Its evolution also saw remarkable barrier being transcended in terms of digital divide which has been pointed out in pre-COVID-19 era.[4] A vital part of a modern, accessible healthcare system is digital innovation and connection.[5] Digital health technology (DHT) can substantially attain optimal and universal health coverage (UHC) by empowering patients and advocates, promoting UHCs, and enhancing prospective patient outcomes and care experiences along with decreasing expenses related to health care.[6]

HISTORY

The progression of digital health is not a sudden occurrence happening overnight. The origins of digital health can be traced to the 1970s, a period marked by the emergence of health telematics. Health telematics aims to focus on disease and improving diagnostics and treating diseases and is now "Telemedicine" a renowned domain of digital health. Beginning of the twenty-first century integrated extensive use of desktop personal computer and Internet, ushered "eHealth" focused on health, instead of disease. Emerging mobile phone use in the 2010s gave birth to mHealth (mobile health). eHealth and mHealth are different in terms of adherence only, as having a device which is always with people provides the community to access healthcare services anytime, wherever required.[2] As smartphones, tablets, and robotics in 2015 became more common, "Digital health" emerged

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as a broader phrase eschewing eHealth and mHealth in the last 5 years (notably in the COVID-19 pandemic years of 2020–2022) to extend the reach of care and achieve higher healthcare standards using DHT.[2] DHT was effectively utilized for enhancing contact tracing, managing isolation, primary care strengthening, and connections between citizens and decision-makers in the COVID-19 pandemic. As of now, more than 120 countries globally prioritize health-related digital advances, driven by the increased necessity for the systematic implementation of standardized cross-cutting answers.[2]

Domains of digital health

Intersection of health care and latest digital technologies fairly represents digital health, encompassing a wide array of applications aimed at transforming and enhancing the healthcare service delivery. The term "digital health" describes technologies comprising mobile health and applications, electronic health records (EHRs), telemedicine services, mHealth, wearable devices and biosensors, robotics and artificial intelligence (AI), cloud computing, Internet of Things (IoT), and deep learning. Other domains of digital health are augmented reality (AR) and virtual reality (VR). These technologies have multiple uses, such as disease identification, helping patients' treatment, providing seamless health care, and handling patient data responsibly.[2,3]

Why Digital Health?

The World Health Organization (WHO) states that "digital health can help make health systems more efficient and sustainable, enabling them to deliver good quality, affordable, and equitable care."[6]

Current Landscape of Digital Health in India

Overview of Health Information Technology (HIT) infrastructure

Health information technology (HIT) processes, manages, and securely stores healthcare data, knowledge, and information using computer hardware and software. It entails storing, retrieving, sharing, and using these data for communication, decision-making, and research.[7] HIT has impacted almost every element of health care, from electronic charting to advanced decision support systems and medical device integration. It improves healthcare quality, efficiency, and accessibility in many ways including but not limited to automating repetitive operations, reducing transcription errors, notifying and warning doctors, minimizing human error, and enhancing patient safety.[8] HIT is being transformed by AI and ML, which enable predictive analytics, personalized treatment, and automated decision support systems. IoT devices connect healthcare systems to a broad network of sensors, wearable devices, and medical equipment, generating real-time data for patient health monitoring and remote treatment.[9] Digital healthcare tools are simplifying access to health for people in remote areas in their privacy, while for the underserved communities, it is breaking barriers.[8] HIT empowers patients to actively participate in health care via portals, apps, and online tools. Health care's future will increasingly depend on HIT. HIT will power healthcare systems' efforts to provide more personalized, efficient, and accessible care. HIT will alter healthcare delivery, improve patient outcomes, and improve public health by using data, AI, and emerging technology.

Adoption and utilization of digital health technologies (DHT)

India's healthcare scene has changed as a response by the government to rising mobile phone use, Internet connectivity, the advent of 5G and AI, and the COVID-19 pandemic. DHT adoption leapfrogged post-COVID-19 and even the government adopted technology to improve healthcare accessibility, quality, and affordability.

In March 2020, India issued Telemedicine Guidelines to regulate and practice telemedicine and promote its acceptance and excellence.[10]

India's vaccination program relied on the Ministry of Health and Family Welfare's CoWIN platform for online registration, appointment scheduling, and vaccine certificate issuance.[11]

DHT use in India increased during the COVID-19 pandemic as healthcare providers and patients explored other communication and care delivery mechanisms. Telemedicine saved the day by minimizing infection risk, enabling remote consultations, and closing the healthcare access gap, especially in underserved areas.

Ayushman Bharat Digital Mission (ABDM)

Ayushman Bharat Digital Mission (ABDM), led by the National Health Authority (NHA), is a flagship Indian government initiative to improve healthcare delivery and accessibility. It aims "To create a national digital health ecosystem that supports universal health coverage in an efficient, accessible, inclusive, affordable, timely and safe manner, that provides a wide range of data, information and infrastructure services, duly leveraging open, interoperable, standards-based digital systems, and ensures the security, confidentiality and privacy of health-related personal information."[12] ABDM aims to digitize the whole health ecosystem. It has five main components viz. Health Care Professional Registry, ABHA number (Unique Health Id), Health Facility Registry, ABHA Mobile app (PHR), and United Health Interface (UHI).[12]

Significance of digital health in public health

DHT plays a crucial role in public health by improving access to health information, enhancing the quality of care, reducing errors, and promoting healthy behavior.[13] Various tools available help public health official in enhancing communication and disease surveillance, along with rapid outbreak tracking, effective public health education, and engagement for feedbacks and improvements.[14] During the COVID-19 pandemic, Aarogya Setu app helped trace contacts. Over 200 million people downloaded the app to self-report symptoms and exposures, helping to limit the infection.[15] Similarly, M-sakhi app in India has helped improve the nutrition status of children in remote settings by providing correct education and resources to mothers when in need.[16]

Social medicine and community health in the digital era

Digital health has changed social medicine and community health by allowing healthcare providers to connect with patients and communities in new ways. The Indian government's e-Sanjeevani telemedicine platform has offered over 10 million teleconsultations in underserved areas. Remote residents have better healthcare access thanks to the platform.[17] Globally, the worldwide non-profit mHealth Alliance created has developed a platform called Frontline SMS to empower frontline healthcare personnel in resource-limited countries. The technology lets health workers collect and transmit health indicator data for real-time community health monitoring.[18]

WHAT ARE THE OPPORTUNITIES AND INNOVATIONS?

Emerging technologies in digital health

Digital health is rapidly evolving, driven by advancements in technology that aim to revolutionize healthcare delivery and patient outcomes. Two notable emerging technologies at the forefront of this transformation are large language models (LLMs), such as ChatGPT and blockchain. LLMs, such as ChatGPT, have made significant strides in enhancing communication and interaction within the healthcare sector. These models leverage natural language processing to understand and generate human-like text, enabling improved patient engagement, virtual assistance, and information dissemination. ChatGPT and similar models have the potential to empower patients with accessible health information, improve communication with their providers, and automate routine healthcare checkups.[19]

Blockchain, known for its secure and decentralized nature, is being highlighted in health care to address issues related to data security, interoperability, and transparency. By creating a tamper-proof and distributed ledger of health information, blockchain ensures the integrity of medical records, enhances data sharing among stakeholders, and provides patients with enhanced control for their health data. This technology holds promise in areas, such as medical record management, clinical trials, and supply chain optimization.[20,21]

Potential impact on preventive medicine

DHTs are revolutionizing preventive medicine with new methods for illness prevention, early detection, and personalized therapy. Smartwatches and fitness trackers, wearable tech, are crucial for preventive medicine. They offer comprehensive health tracking capturing heart rate data, activity levels, sleep pattern, and vital signs. The real-time data generated by wearables enable individuals to track their health status continuously, promoting a proactive approach to preventive care.[22,23]

Mobile health apps are transforming preventive health care. These apps provide users with personalized health information, reminders for vaccinations and screenings, and lifestyle recommendations. They empower users to make healthy choices and adhere to recommended interventions.[24,25]

Another important area of interest is advanced analytics and predictive modeling techniques, which leverage large datasets to identify patterns and predict health risks. By analyzing patient data, these technologies empower health care for predicting outcomes, shifting from active to proactive approach, thus prioritizing preventing action toward high-risk individuals.[26,27]

What are the various challenges and why are there concerns?

Digital health presents various ethical and policy challenges. Overall, such challenges and concerns faced in empowering digital health care can be categorized as either technical or nontechnical.[28] Technical challenges include adapting evidence-based standards, privacy and data governance issues, and the potential to manage health inequities.[29] Nontechnical challenges mainly include privacy and security issues, accessibility and inclusivity, health inequality, and the digital divide, followed by ethical issues. Often sensitive and personal, patient data face unauthorized access, breaches, or misuse risks. Collecting and sharing sensitive health information require robust privacy safeguards to protect individuals. Additionally, they must follow accountability and transparency to establish a fairer and more ethical health system.[30] Another major problem in promoting digital health is disparities in access to technology, creating potential disparities in healthcare delivery. This underutilization of digital health due to socio-cultural disparities leads to a digital divide.[31] The digital divide exacerbates health inequalities among rural residents, the elderly, and low-income groups.[32] This divide is influenced by social, cultural, and economic factors and is a key area for future research.[33]

Why the partnerships and collaborations?

Collaborations between industry players and academic institutions have become increasingly prevalent in the digital health space. These partnerships leverage the research capabilities of academic institutions and the industry's practical know-how to develop cutting-edge technologies and solutions. Such collaborations often result in groundbreaking innovations that bridge the gap between theory and real-world application.[34,35] Public and private sector collaborations play a crucial role in advancing digital health initiatives. Governments, healthcare organizations, and technology companies often join forces through PPPs to address healthcare challenges, improve infrastructure, and implement large-scale digital health projects. These partnerships foster shared responsibility and bring together diverse perspectives to create sustainable solutions.[36,37]

Global Digital Health Partnership (GDHP) was formed in 2019 across different nations to promote digital health maturity.[38]

Why there should be a regulatory framework and need for capacity building?

Digital health care is still nascent in many resource-limited settings and requires further investment to fully leverage its potential. Medical practitioners and policymakers are the key stakeholders

in establishing comprehensive regulations to protect patient data, highlighting apparent loopholes in the data management systems, and helping outline clear guidelines for data collection, storage, and sharing within the digital health ecosystem. Legal frameworks, such as policy recommendations, can act as a critical factor in hindering or facilitating the growth of digital health.[29] For this, the treatment of any personal data should be compatible with several privacy laws, such as the Patients Data Act and Personal Data Act.[39] Hence, defining and enforcing standards that facilitate seamless interoperability between different digital health platforms and promoting data exchange and collaboration among healthcare systems can be proven to be a great initiative toward this. The ISO/IEC 29100:2011standard "Information technology, security techniques, privacy framework" focuses on the protection of personally identifiable information (PII) (ISO/IEC, 2011). It aligns with Global Privacy Standard, and incorporate efforts from the International Telecommunication Union (ITU) Focus Group on Data Processing and Management (FG-DPM). This includes contributions from Working Group 3 including "Data sharing, interoperability, and blockchain" and Working Group 4 focusing on "Security, privacy and trust including Governance."[40] Information of patients is highly confidential, in India its protected by various relevant provisions as per Bharatiya Nyaya Sanhita (BNS) and specifically by *Information Technology Act, 2000 ("the IT Act"),* Information Technology Rules, 2011 from India. Also, the Indian *Digital Data Protection Bill 2023* applies to any personal data in India that's been converted to a digital format, regardless of whether it was originally collected from online sources, for example, websites or offline sources (paper forms).

To enhance the digital literacy of healthcare professionals ensuring they are proficient in using tools for digital health and technologies, capacity enhancement is needed. The government should provide specialized training programs for healthcare professionals engaging in telehealth services, addressing the unique skills required for virtual patient care and communication. It is recommended to involve experts from data sciences and legal matters to look into such aspects while making necessary decisions concerning AI. Healthcare AI adoption needs vast amounts of patient-related data that firms can use for purposes other than intended. Ministry of Electronics and Information Technology (MeitY) formed the *Indian Computer Emergency Response Team* ("CERT"), nodal agency for notification, and response to all breach notifications.[41]

Future Roadmap and Way Forward

Use of digital technologies in developed countries has been always progressing; at the same time, developing countries are no less. India is progressing at a very high speed to attain its establishment in digital platforms. Rashtriya Swasthya Bima Yojana (RBSY) was India's initial digital-based health coverage program for promoting digital health.[42] It focused on providing good quality health care at affordable and accessible costs. Biometric-based identification acts as a gateway to healthcare access in India. Other notable health system-strengthening interventions include the National Digital Health Mission,

Ayushman Bharat.[43] In the long term, the main objective of all these interventions is to scale up digital health infrastructure in the country and capacity building to promote the same. As the development scale is increasing at a very high-speed day by day, there is a need for monitoring and evaluating the direction of development in the field of digital literacy. These initial steps taken toward the same will be the defining future of upscaling or downgrading digital health in India.[44] A strong evidence base helps to reduce the perceived risk for investors and governments making them more likely to fund digital health solutions.[45]

Conclusion

In conclusion, adopting DHTs in India holds vast potential to revolutionize the landscape of preventive and social medicine, aligning with the mission. The multifaceted benefits encompass improved disease surveillance, enhanced preventive interventions, and strengthened community health initiatives. As we navigate the ever-evolving field of digital health, it is crucial to acknowledge the strides made in technology integration within our healthcare system. The data-driven insights, real-time monitoring capabilities, and innovative solutions showcased in various case studies underscore the transformative power of digital health. However, our journey is not without challenges. Privacy and security concerns, the digital divide, and the imperative need for a robust regulatory framework necessitate careful consideration and strategic planning. Public Health Practitioners, in collaboration with relevant stakeholders, must actively contribute to shaping policies that balance innovation with ethical and equitable healthcare delivery. The future of digital health in India is contingent on our ability to address these challenges collectively. The IAPSM, IPHA and other recognised public health associations must champion initiatives that bridge the gap between technology and public health, ensuring that the benefits of digital health reach all strata of society. Furthermore, the association should advocate for comprehensive capacity-building programs to create skilled healthcare professionals for navigating the digital landscape adeptly. All concerned stakeholders must actively collaborate with Government of India (GoI) to promote an appropriate regulatory framework that ensures data privacy, security and interoperability standards are maintained.

In conclusion, this paper aims to catalyze dialog and action. By embracing digital health strategically and responsibly, we can propel India toward a future where preventive and social medicine is fortified by cutting-edge technologies, ultimately leading to a healthier and more resilient nation. The IAPSM remains committed to fostering this transformation and invites collaboration from all stakeholders in this collective endeavor for a digitally empowered, inclusive, and healthier India.

Conflicts of interest
There are no conflicts of interest.

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