Navigating India's Digital Health: Unveiling Progress, Challenges, and Prospects

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Abstract:

The computerization of healthcare records started in the 1960s and later evolved into "digital health." In India, the momentum gained from the success of digital health initiatives led to the launch of the Ayushman Bharat Digital Mission. It aimed to overcome systemic barriers by acting as a single source of truth. Since its inception, the mission has achieved notable progress due to various government initiatives to expedite the implementation; however, challenges like limited saturation, low healthcare provider adoption etc still persist. User-driven, need-based targeted efforts are essential for improving digital literacy, providing affordable devices, strengthening data security measures, and building capacity to improve the overall output, outcome, and impact on health service delivery. This article has attempted to depict the journey of digital health in India while highlighting achievements, challenges, and anticipated opportunities like AI, IoT, and blockchain technology in the Indian digital health sector. Through synthesis of information from various sources, this article aims to contribute to the discourse on digital health in India, offering insights that may inform policy decisions.

Keywords: Digital Health, eHealth, mHealth, India, ABDM, NDHM

1. Relevance to public health

Digital health has the potential to improve the delivery of healthcare services and the management of the public health system. Digital tools can be leveraged for efficient healthcare delivery, extend healthcare to rural areas, and provide better quality at low cost.

2. Implications for clinical practice

The integration of digital health solutions may improve clinical practices by making healthcare more patient-centric, data-driven, and adaptable to the evolving needs of medical science and technology in India. It empowers healthcare professionals with tools for better diagnostics, treatment planning, and overall patient management.

Abbreviations:

ABDM	: Ayushman Bharat Digital Mission
ABHA	: Ayushman Bharat Health Account
AYUSH	: Ayurveda, Yoga, Naturopathy, Unani, Siddha and Homeopathy
DHIS	: Digital Health Incentives Scheme
DISHA	: Digital Information Security in Healthcare Act

EHR	: Electronic Health Records
HFR	: Health Facility Registry
HPR	: Healthcare Professionals Registry
IHIP	: Integrated Health Information Portal
LMIC	: Low and Middle income country
MDDS	: Metadata and Data Standards
MoU	: Memorandums of Understanding
NDHM	: National Digital Health Mission
NHP	: National Health Policy
UHI	: Unified Health Interface
WHA	: World Health Assembly

1. Introduction:

The computerisation of healthcare records has evolved since the early 1960s when hospitals started using computers.[1] The phrase "digital health" was first mentioned in 2000 by Seth R Frank, denoting the use of the Internet to enhance medical information, connectivity, and business transactions.[2] Later, at the global level during the World Health Assembly (WHA) 2018, digital health was introduced as "…a term encompassing eHealth and mHealth, including emerging fields like ''big data', genomics and artificial intelligence.[3] Since then, it has gained significant prominence, especially with the experience of the pandemic underscoring its relevance in the current healthcare scenario. In low and middle-income countries like India having demand-supply gaps in healthcare services, digital health can act as a catalyst to provide affordable, accessible, and equitable healthcare services. Understanding this government of India embarked on the journey of digital healthcare with its resolution for digital health which was later adopted during the 71st WHA [4]. India's interest in this direction were evident in its National Health Policy (NHP), National eHealth Authority (NeHA),the National Digital Health Blueprint (NDHB), and most recent launch of flagship program National Digital Health Mission (NDHM) on August 15, 2020 [5] [4]. Hence it is important to understand the journey of digital health in India, through this review we have tried a comprehensive search on digital health in India. The objective is to document the progress of digital health in India, emphasizing key milestones, challenges, and future possibilities. By combining information from different sources, this review may play a crucial role in discussing digital health in India, providing valuable insights for policy-making, strategic planning, and guiding future research in the dynamic healthcare landscape.

Materials and methods:

The methodological approach employed in this desk review involved an extensive exploration of online as well as grey literature, primarily sourced from government websites and reports. Data extraction and interpretation were conducted using information available on government dashboards. Additionally, reports published by various organizations and articles on related topics were incorporated to identify challenges, shortcomings, and anticipated outcomes associated with digital health in India.

1. India's Digital Health: Journey so far

In India, while digital health was officially acknowledged in the NHP of 2017 and subsequently marked by the National Digital Health Mission launch in September 2021, the integration of information

technology in healthcare dates back to 1996. Some of the major milestones from 1996 to 2023 are depicted in Figure 1.[6–10] The NHP 2017 emphasised creating a district-level health database, strengthening surveillance, and establishing integrated health information systems by 2025. The policy endorsed digital tools in Ayurveda, Yoga, Naturopathy, Unani, Siddha and Homeopathy (AYUSH) medicine and advocated for information databases to support research.[11] In 2018, the Ministry of Health and Family Welfare (MoHFW) drafted the "Digital Information Security in Healthcare Act (DISHA Act)" to ensure data privacy, confidentiality, reliability, and security of digital health data. However, it was subsequently incorporated into the "Data Protection Framework on Digital Information Privacy, Security & Confidentiality Act" to avoid redundancy. The National Digital Health Blueprint (NDHB) was released in 2019. It envisions establishing a layered, federated national health information architecture system consistent with Metadata and Data Standards (MDDS) and Electronic Health Records (EHR). This architecture also advocated linking systems across public and private health providers at the state and national levels and across different healthcare systems like modern medicine and AYUSH systems.[7]

The Aarogya Setu mobile application launched during the COVID-19 pandemic achieved the remarkable milestone of reaching 50 million downloads in just 13 days, making it the fastest-growing app globally.[12] Aarogya Setu and CoWin stand as exemplary case of successful adoption and implementation, serving as a blessing and a boost for advancing digital health ecosystem. On August 15, 2020, NDHM was launched as pilot project by Prime Minister of India. It was followed by the nationwide rollout on September 27, 2021, and renamed as "Ayushman Bharat Digital Mission" (ABDM).

In addition to the achievements above, over the past two decades, the Indian government has launched and implemented various digital health initiatives, including applications and online platforms in different health program verticals and disease management. Examples include RCH portal, IDSP portal, Nikshay, DVDMS, e-Raktkosh, RBSK portal, Mera Aspataal, Arogya Setu, CoWIN, AB-HWC, HRMIS, NP_NCD app.[13] These initiatives aimed to improve the accessibility, availability, and quality of healthcare services. However, they were working in silos. This lack of interoperability led to duplication of data and resources and quality errors[14]. Albeit, the government has acknowledged it and is developing an Integrated Health Information Portal (IHIP) and creating a Unique Health Identification Number i.e. Ayushman Bharat Health Account (ABHA) ID under ABDM Bridging realms in digitalisation of healthcare: The ABDM way

2.1 ABDM: Program strengths and Advancements The NDHM was initiated to establish a comprehensive digital healthcare ecosystem at the national level. It aims to provide a wide range of data, information, and infrastructure services, by leveraging open, interoperable, standards-based digital systems while ensuring personal health information's security, confidentiality, and privacy. An Empowered Committee headed by the Secretary of Health and Family Welfare was established to oversee the nationwide rollout of the Mission in all regions and diverse population segments.[7] Salient feature of ABDM and how it aims to address the existing are provided in Table 1 and Table 2 respectively.[15] The ABDM comprises four key components, including the a) Health Facility Registry (HFR), b) ABHA mobile App (PHR), ABHA IDs, c) Unified Health Interface (UHI), and d) Healthcare Professionals Registry (HPR). Box 1 illustrates the notable progress achieved in these components.[7] Significant milestones include issuing state guidelines on March 8, 2022, and facilitating ABDM implementation. Also, their grievance portal addressed 4,000

concerns between August 2021 and July 2022. Over one lakh government and private healthcare facilities were successfully onboarded in the HFR of ABDM by June 2022. Moreover, more than 50 digital health services/applications, including 20 government and 32 private ones, had been integrated with ABDM by July 2022. Within 75 days of its launch, the Scan and Scare (QR code for OPD) service in the tertiary care system has already helped more than one lakh patients by availing faster OPD registration.[16] India's efforts in the digital health mission have gained recognition on international platforms, including the World Health Organization (WHO), and during India's G20 Presidency for the global digital health initiative.

As of October 7, 2023:

A. 46,88,19,223 ABHA IDs have been created.
B. 31,22,82,776 health records linked.
C. Around 2,20,633 Health facilities- verified on ABDM.
D. 2,31,606 Healthcare Professionals' registration -verified.
E. Around 54,632 partners use ABHA-enabled software, and 108 facilities (including 56 private) are creating ABHA IDs.
F. Box 1: Progress of ABDM components till October 7, 2023

2.2 Government initiatives promoting Digital Health/ABDM:

Since its inception, the government has been actively working to expedite the implementation of ABDM, with various initiatives such as the Digital Health Incentives Scheme (DHIS), the 100 Microsites Project, Scan & Share OPD, ABDM sandbox for integrating PHR webs under ABDM, the development of a Drug Registry, Engaging with developing partners through MoUs to leverage expertise and resources for implementing ABDM. Several consultation papers were launched in 2021-22, covering topics such as Universal Health Insurance (UHI), proposed health data retention policy, drug registry, and revised health data management policy. Further, interactive sessions and mentorship programs have been organized to provide guidance and support. [17] NHA issued "state guidelines" on March 8, 2022, outlining the setup of state-level teams for ABDM implementation. To expedite the implementation and address the identified challenge government has increased proposed allocation for ABDM by 144% from revised estimates of 2022-23 to Rs 341 crore in 2023-24.[18] Similarly, Initiatives such as the Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA) and the National Optical Fibre Network (NOFN) or BharatNet further emphasise the commitment to improving digital literacy and connectivity, especially in rural areas. [19,20] Significant software advancements like repurposing of Aarogya Setu as India's health and wellness application and CoWin apps for maintaining records of immunisation and as health management information systems for small doctor's clinics and nursing homes is being done. It aim to enhance citizens' and healthcare professionals' access to digital health solutions. [21] NHA has developed platforms like DeVforum where developers can raise their issues and concerns and get responses. NHA is building up a health exchange platform to aid the filing of health insurance claims. It also released a beta version of lightweight HMIS, focusing on private healthcare providers and small health facilities.[17] These multifaceted initiatives collectively contribute to the robust progression of ABDM in India.

2.3 Weakness or shortcomings of ABDM:

In assessing the implementation of the Ayushman Bharat Digital Mission (ABDM), it is imperative to acknowledge existing weaknesses and shortcomings that necessitate attention and resolution. Firstly ABHA numbers cannot currently distinguish between adults and children, which is a necessity for

effective consent management, especially concerning minors. While certain states like Uttar Pradesh, Madhya Pradesh, and Maharashtra are leaders in numbers of ABHA ID generated, they still account for only a fraction of their estimated populations, i.e., 22.2%, 49%, and 29%, respectively. Over 50% saturation has been achieved in only a handful of states like Uttarakhand, Odisha, Chhattisgarh, Gujrat, Andhra Pradesh and a few union territories.[22] The challenges still persist with poor adoption rate among healthcare providers and limited private sector engagement. Less than 7% of healthcare professionals registering (13,08,009 allopathic doctors were registered with National Medical Commission (NMC) till June 2022[23], and only 99,549 doctors have been verified on ABDM HPR registry as on October 7, 2023).[7] And only 28% of the registered health facilities belong to the private sector, indicating the need for increased participation from this segment. The private sector engagement has been seen majorly in health-tech startups/companies.[7] Furthermore, despite the creation of a substantial 40 crore ABHA IDs, there is a need for heightened awareness among end-users regarding the utilization, benefits, and security risks associated with their data.[24] Lastly, ambiguity prevails regarding the accessibility and extent of an individual's health data across different levels of the health system, ranging from community-based screenings to inpatient admissions in tertiary care facilities. Addressing these issues is vital for the comprehensive success of ABDM and the realization of its objectives in the evolving healthcare landscape of India.

3. Challenges ahead for Digital health in India:

Ensuring the compatibility of software and mobile devices is crucial for the widespread adoption of digital health services. The main challenges of healthcare software include inadequate functionality, lack of accessibility to basic infrastructure at end-user sites, poor user interface and design, and hardware issues that may hinder its sustainability and scalability.[25] According to the FICCI 2020 "Leaping into Digital Healthcare" report, it is estimated that EHR adoption in India is less than 10% characterized by fragmentation and low digital penetration. According to different surveys, Internet penetration is 48-58% of the population. Most public hospitals and dispensaries need more ICT infrastructure. Only a few major public hospitals have connectivity and computers.[26] Similarly, The increasing number of cyber threats and scams has led to data security and safety concerns. In 2021, the healthcare sector in India experienced the second-highest number of cyberattacks worldwide, accounting for seven (7.7) per cent of the total cyber-attacks.[27] Additionally, in terms of using and accessing the Internet and digital services significant gender, geographic, and socio-economic divide exist in India. As per a report released in 2022, women constitute only 1/3rd of internet users, and only 31% of the rural population uses the Internet.[28] As per NFHS 5 data, only 33.3 % of women use the Internet, against 57% of males. Another survey showed that only 34% of internet users accessed internet to research health issues and healthcare products. [29] There is a high prevalence of local superstitious healers and quacks, especially in rural areas.[30] It can hinder the adoption and utilisation of digital health services, especially among underserved and vulnerable populations. Resistance to change and distrust in digital systems can impede the acceptance of digital health services. Cultural beliefs, diversity, and linguistic barriers will also hinder better adoption and utilisation. [31] Switching to ABDM means doctors need to start writing prescriptions on their laptops, computers, or tablets. This is a significant behavioural change in practice. Convincing them to use these devices, especially with their already busy schedules, is a big challenge.[15] Aged medical practitioners and front-line workers may not be comfortable with digital technology to provide care.

4   Anticipated Trends and Opportunities in India's Digital Health Sector:

The existing digital systems of India like Aadhaar, Unified Payments Interface, use of mobiles (JAM trinity), has created a sound foundation for setting up the basic elements of NDHM.[15] According to a report from Statista Market Insights, the revenue in India's digital health market is projected to reach US $7,373.00 million in 2023. This revenue is expected to exhibit a noteworthy annual growth rate (CAGR 2023-2028) of 18.35. The predominant segment within this market is poised to be Digital Fitness and well-being. [32] Industrywired.com data indicates the presence of approximately 3,225 health-focused startups in India in 2022, with numerous others in various stages of development. Around 80% of health systems plan to increase their investment levels in digital healthcare over the next five years, according to the HIMSS report published in 2021.

Notably, the 'Outpatient Healthcare Market in India' study by Praxis Global Alliance highlighted that in 2021, India recorded over four billion outpatient consultations, with a staggering expenditure of $26 billion on outpatient prescriptions. The COVID-19 pandemic expedited the adoption of telemedicine, with users increasingly embracing this platform for remote healthcare consultations.[33] Additionally, Telemedicine may boost India's medical tourism by providing efficient remote healthcare services. Integration of drones with telemedicine holds potential for delivering vital health services in remote regions.[34]

Artificial intelligence (AI) is set to revolutionize healthcare in India by improving disease detection, treatment outcomes, and patient care through diagnostic algorithms, ,evidence-based decision support and personalized health applications. Additionally, AI-driven robotics can facilitate remote surgeries, drug delivery, and physical therapy, reducing the need for patient travel and on-site medical care.[35] The Internet of Things (IoT) is reshaping healthcare with smart devices like wireless inhalers, ECG monitors, and intelligent beds, offering real-time monitoring for high-risk patients. Additionally, integrating remote 3D interactive models via virtual reality is promising for medical education and research. The application as well as adoption of IoT in healthcare is growing both in high and low income countries. Blockchain technology, with its distributed ledger system ensures secure and safe transfer of patient records, fortifying data systems and aiding pharmaceutical supply chain management. It was also used during Covid-19 pandemic for pandemic control and surveillance, vaccine passport monitoring, and contact tracing.[36]

5   Way forward:

While India has made substantial progress in implementing digital health through initiatives like the ABDM, there is still room for improvement. Digital technology should complement existing healthcare services rather than serve as a replacement. India should observe as well as learn from past success and failure stories encountered by other nations in the domain of digital health. There is a need to further improve digital literacy through targeted initiatives, providing citizens with information on data use and decision-making choices to empower them. Ensuring equitable internet connectivity across all regions is essential for seamless access to digital health services. Simultaneously, efforts should be made to make digital devices and broadband more affordable and accessible in public health facilities. To fortify the digital health infrastructure, resources should be allocated for high-capacity servers, advanced data storage, and efficient retrieval systems. Robust security frameworks must be established to protect against cyber threats, with regular regulatory checks and supervision visits to monitor functionality and address data breaches. Capacity building initiatives for healthcare workers and user-driven approach while designing applications are crucial for effective use of digital technology. Also, there should be clear and

standardised guidelines on role and responsibilities of healthcare providers at each level and scope of data integration at micro-level health units. State-level adoption of Electronic Health Records (EHR) should be encouraged. Operational revalidation, user-centric research, and understanding the implications of digital technology access on health determinants should be prioritized for a comprehensive and effective digital health ecosystem in India. Emerging technologies though have potential to reduce health expenditure, improve quality and access to healthcare have their limitations and associated risk. India should have a forward approach to adopt these technologies supported by the meticulously developed regulatory frameworks.
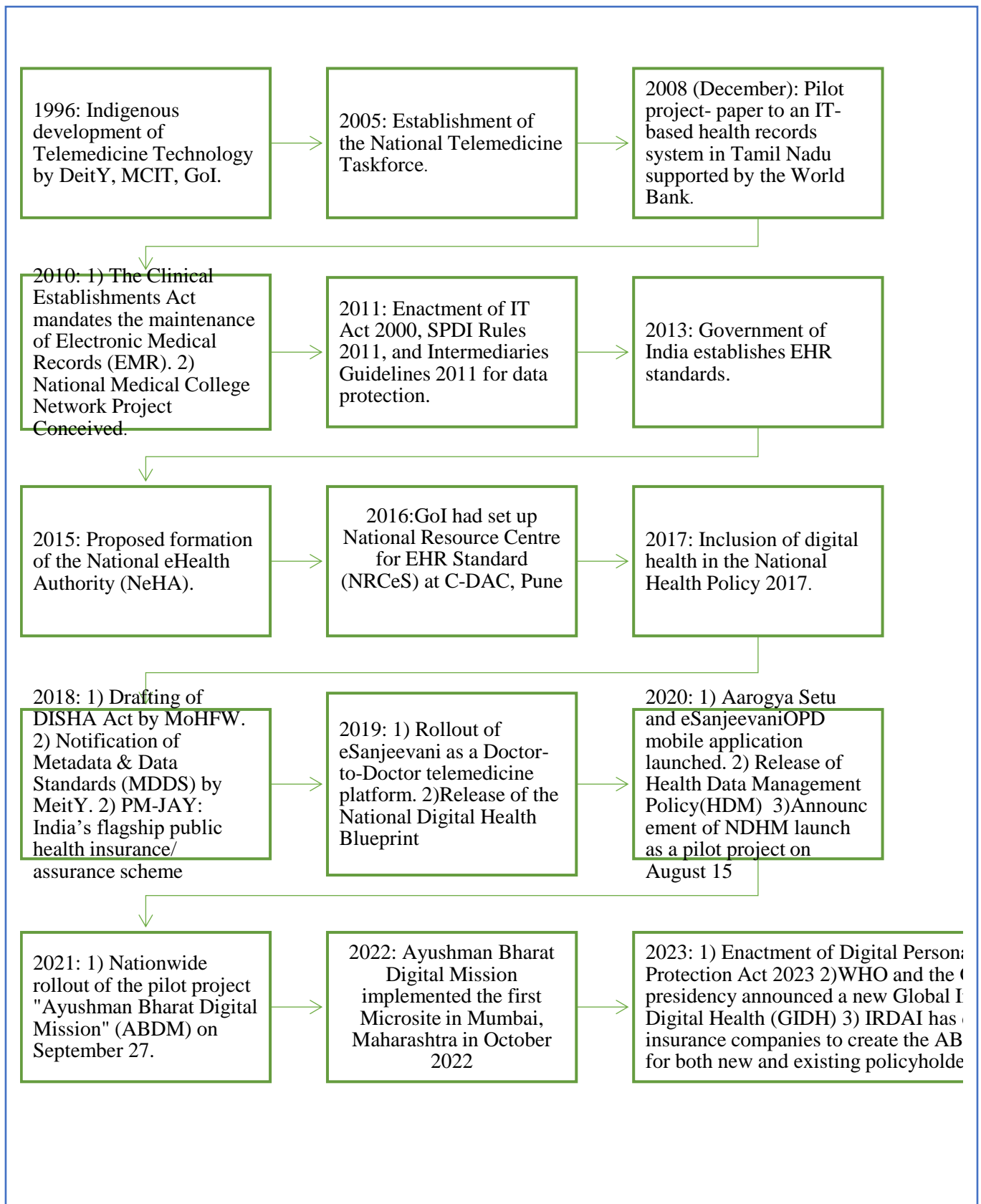
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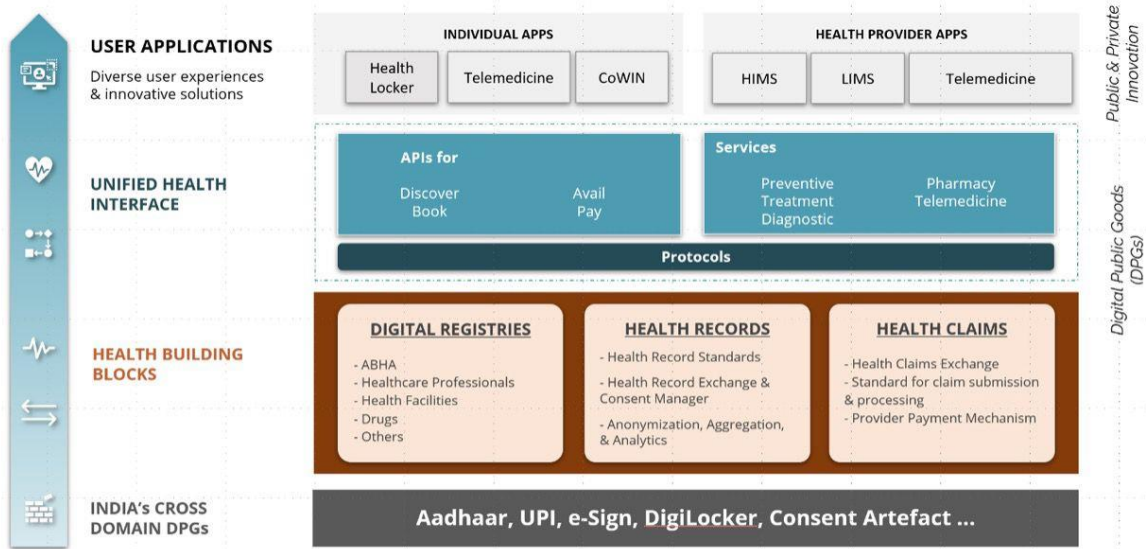
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2011: Enactment of IT Act 2000, SPDI Rules 2011, and Intermediaries Guidelines 2011 for data protection.

2013: Government of India establishes EHR standards.

2015: Proposed formation of the National eHealth Authority (NeHA).

2016:GoI had set up National Resource Centre for EHR Standard (NRCeS) at C-DAC, Pune

2017: Inclusion of digital health in the National Health Policy 2017.

2018: 1) Drafting of DISHA Act by MoHFW. 2) Notification of Metadata & Data Standards (MDDS) by MeitY. 2) PM-JAY: India's flagship public health insurance/ assurance scheme

2019: 1) Rollout of eSanjeevani as a Doctor-to-Doctor telemedicine platform. 2)Release of the National Digital Health Blueprint

2020: 1) Aarogya Setu and eSanjeevaniOPD mobile application launched. 2) Release of Health Data Management Policy(HDM) 3)Announcement of NDHM launch as a pilot project on August 15

2021: 1) Nationwide rollout of the pilot project "Ayushman Bharat Digital Mission" (ABDM) on September 27.

2022: Ayushman Bharat Digital Mission implemented the first Microsite in Mumbai, Maharashtra in October 2022

2023: 1) Enactment of Digital Personal Protection Act 2023 2)WHO and the G presidency announced a new Global I Digital Health (GIDH) 3) IRDAI has insurance companies to create the AB for both new and existing policyholde

Figure 2: ABDM architecture

Source 1https://abdm.gov.in:8081/uploads/Architecture_db6e165997.jpg

Table 1 Salient Features of ABDM

Salient Feature	Description
1) Single source of truth	Data validated by authorized entities
2) Federated architecture	No central storage of data
3) Open API interoperability	Any compliant healthcare entity can integrate
4) Standard frameworks	Widely accepted industry standards can be used
5) Privacy & Security	Consent-based information exchange
6) User inclusivity	All Indian citizens can participate
7) Voluntary participation	End-users have the option to opt-out at any point
8) Wellness Centric	Enhances healthcare system efficiency with real-time records

Source 2: ABDM website

Table 2 Key challanges ABDM intends to address

Stakeholder	Challenges	ABDM Solutions
Citizens	1. Limited access to medical records	- Allow consumers to choose any UHI app to reach any participating health care provider for these services -Informed consent before sharing data with healthcare provider
	2. Lack of information about doctors, hospitals, and labs	- Discover health services, doctors and products online and book health services -Allow consumers to choose any UHI app to reach any participating

		health care provider for these services
	3. Accessibility, affordability of health services	- Inclusive access to the Digital Health ecosystem. People with smartphones, feature phones, and even no phones can enroll
Hospitals/Labs/Doctors	- No access to patient's medical history - Inability to ensure follow-up after treatment	- Access and view patient's health history by enabling inter-operable health data via health information exchanges. Single point of discovery of Health Information and seamless health information exchange ensuring continuity of care
	- Lack of feature for remote consultations	- Provide tele health consultations to patients and primary care
	- Challenges in ease of doing business	Standardize the interchange of information between payers and providers
	-Prescription and clinical errors	-Reduced prescription and clinical errors due to robust ID creation
Policy-makers and Program Managers	- Insufficient information about emerging diseases	- View and analyze public health at a national level
	- Lack of complete monitoring and control in a unified manner	- Implement policies effectively at a local level