

The Ayushman Bharat Digital Mission (ABDM): making of India's Digital Health Story

R. S. Sharma¹ · Aishwarya Rohatgi² · Sandeep Jain² · Dilip Singh²

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Abstract Technology is being leveraged worldwide to deliver services to citizens in all domains, including healthcare. The COVID-19 pandemic has pushed everyone to embrace digital transformation and reconsider current healthcare trends. In response to the emerging need for digitization of healthcare in India, the Ayushman Bharat Digital Mission was launched in September 2021. It creates and uses Digital Public Goods in increasing the availability, accessibility, affordability and acceptability of health care through different building blocks. The purpose of this mission is to establish a national digital health ecosystem that is integrated, effective and inclusive. The interoperable frameworks, open protocols and consent artefact enable citizens, public and private healthcare providers, digital innovations and other stakeholders to come together and drive equitable digitization of healthcare across the country.

Keywords Ayushman Bharat Digital Mission (ABDM) · Digital Health and India

1 Introduction

Healthcare is at an inflection point in India. Digital technology is emerging as an enabler to ensure accessible, affordable, and quality health services, supporting the goal of achieving of universal health coverage (UHC). Digitization across industries is rapidly increasing and is inevitably

being embraced. The intersection of technology and health around the world has exhibited the potential to augment current models of delivery of care, steer them toward patient centricity, and improve overall health outcomes.

2 Global Digital Health Practices

A broad overview of global best practices in digital health can lend an informed understanding of how the world implemented e-health initiatives. The NHS of the UK, one of the highest ranked health service models, adopted digitisation beginning with an NHS electronic care records which allowed sharing of patient records with their consent. This streamlined the process for general physicians and other staff working in primary care to schedule appointments with doctors at hospitals, providing a system for electronic transmission of prescriptions, exchange of patient data, and electronic referrals to higher centres. The NHS architecture represents an easily replicable model in designing digital architecture for health and social services [1].

Australia became the first country to develop a population-centric approach to implement My Health Record (MHR), a national repository of electronic health histories of patients, built with the goal of easing the patient's journey to seek care. To curb fears of data breaches and mistrust among people, MHR provided the flexibility to opt in or opt out as and when patients consider it appropriate, at any time point. This strategy imparts important lessons for India where personal data protection, consent, and health data privacy are critical issues [2].

South Korea's Ministry of Health developed a master plan for National Healthcare Information and Communication Technology about two decades ago. In Korea, healthcare institutions have become increasingly digitized, with almost

✉ Aishwarya Rohatgi
riya1774@gmail.com; yp1.ceooffice@nha.gov.in

¹ Former CEO, National Health Authority, MoHFW, New Delhi, India

² Young Professional National Health Authority, MoHFW, New Delhi, India

all hospitals adopting computerized provider order entry systems, patient management systems, electronic health record keeping, and insurance claim systems that use electronic data interchange, enabling better clinical decision support and access to healthcare. The promising ICT intervention in Korean healthcare institutions provides important lessons for our country, which is currently developing a digitally enabled health claims platform [1].

Estonia began its digital transformation of its healthcare system approximately 25 years ago with the unified health information system, which linked public and private medical records, granted patients access to their records, and linked them to public information systems and registries. E-health technologies, electronic health records (EHRs), digital imaging, digital registration, unique identifier allocation, and e-prescriptions were built on existing public IT infrastructure and previous experiences with many cross-institutional digital integrations, such as e-banking, e-taxation, and e-school. The Estonian digital health experience is similar to the path India is taking to build a comprehensive digitally enabled healthcare ecosystem [1].

3 Indian Digital Health Landscape

Many Indian states like Kerala, Tamil Nadu, and Rajasthan have made significant leaps towards launching digital health initiatives. Tamil Nadu was the one of first states in the country to implement a digital health program. A comprehensive state-wide Health Management Information System (HMIS) was developed with the assistance of the World Bank so that clinical, logistical, administrative processes are streamlined. This will help the state's public health system become operationally efficient [3].

Rajasthan has started e-Health initiatives in 2015 by incorporating digital initiatives under central level national health programs such as–, RMNCHA+, NIKSHAY, e-Aushadhi, Non-Communicable Disease programs. Health Information System for government, Computerized Human Resource Information System, E-mitra, ASHA Soft are some other digital applications rolled out to support community health workers [4]. On similar lines, Kerala had taken lead digitizing healthcare sector by launching e-Health Kerala scheme in 2017. It provides unique ID for each patient which help to create and link comprehensive medical history of the patient [5].

The private sector has evolved a lot in the last few years, and large and small players in health technology have benefitted from the wave of digitization in health. The rapid adoption of smartphones and the internet, combined with supportive government policies, has propelled the health market forward. In 2021, the digital healthcare market in India was estimated to be worth INR 524.97 billion. It is

expected to reach INR 2528.69 Bn by 2027, growing at a CAGR of 28.50% between 2022 and 2027 [6].

However, immense fragmentation, lack of dialogue, poor data portability, and interoperability have plagued the digital health domain, leading to siloed and incoherent efforts towards developing a digital health architecture for India [7]. Furthermore, the World Health Organisation (WHO) also laid down the Global Strategy on Digital Health 2020–2025 to create a better health experience for everyone, everywhere, for all ages [8] and the Indian Government, in its effort to achieve SDG 3, responded to the above-mentioned challenges by taking the initiative to build a National Digital Health Ecosystem that would complement global efforts to accelerate digital health and innovation [9].

4 Digital Public Goods and infrastructure

The adaptation of information technology across sectors reflects our digital prowess as a country. We have successfully established Digital Public Goods (DPGs), based on the principles of equity and access [10]. With nearly 1.2 billion wireless connections, 600 million smartphone users, 800 million internet connections [11], digitization is reaching the last mile. With more than 90% penetration of Aadhaar, it acts as the foundation of DPGs built under Digital India [12, 13]. The layers of JAM–Jandhan Bank Accounts, Aadhaar, and Mobile linked with one another plugged the leakages of government subsidies leveraging digital tools [14]. The creation of our indigenous payment protocol, Unified Payments Interface (UPI) added to the success story of our digital public infrastructure [14].

Open networks and protocols, as used in other Digital India initiatives, would enable interoperable connections nationwide, decentralizing and securing information exchange among all stakeholders. Enabling open access among various health-care providers and patients can significantly expand demand–supply ecosystems. India's technology revolution, the change in people's attitudes towards healthcare due to the pandemic and appropriate government interventions are testimony to the pace at which digitization is going to thrive in the near future.

5 Innovation in Digital Health amidst the pandemic

The Covid-19 pandemic had created numerous challenges for healthcare services worldwide, leading to one of the largest societal crises in the last century. Until the pandemic, the use of telehealth solutions, e-pharmacies, etc. was minimal. Most patients and providers preferred traditional means of in-person/offline engagement for healthcare care delivery,

but lockdown and physical restrictions led to an increased demand for digital health solutions, underscoring the need for better incorporation of cutting-edge digital technologies into healthcare services in areas such as telemedicine, surveillance and remote clinical management [15].

Among some notable public digital solutions built amidst the Covid-19 pandemic include the Covid Vaccine Intelligence Network (CoWIN) and Aarogya Setu [16]. CoWIN enabled the registration of around a billion people with vaccines and the administration of more than 1.78 billion doses of the Covid-19 vaccine, which could be tracked remotely [17]. With many countries interested in using the open source technology of the application in their vaccination drives, the CoWIN digital certificate became a secure and trustworthy proof of universal vaccination [18].

The Ministry of Electronics and Information Technology developed Aarogya Setu, another digital application that guided our nation's efforts to manage Covid, in collaboration with the private sector. Real-time information on active cases and containment zones was sent to front-line workers and regular people, helping them assess the risk in their communities, making information exchange easier in emergency situations [16].

Around 85% of clinicians used teleconsultation during the lockdown, and 65% of doctors said they would continue to use telemedicine in the post-Covid era, according to a Boston Consulting Group survey [19]. This transition from in-person medical visits to telehealth solutions denotes not just an increase in patient uptake but also an expansion of the market's supply of digital solutions.

Therefore, as evidenced by rising engagement as well as public and private investment in digital healthcare, India is emerging as one of the leaders with enormous growth potential in this domain.

6 The making of ABDM

Digitisation in the Indian health landscape began with the government's intent and vision of providing quality healthcare using accessible and affordable technology through the National Health Policy in 2017 [20]. In 2018, NITI Aayog released the National Health Stack that envisaged the creation of common public goods for healthcare [9]. Based on these recommendations, the National Digital Health Blueprint was launched in 2019 laying out the architectural framework for an integrated national digital health ecosystem [21]. The vision of the policies, combined with a determination to effectively address our current health challenges, sowed the seeds for the Hon'ble Prime Minister's Ayushman Bharat Digital Mission (ABDM), which was launched in September 2021 [22].

Technology is persistently employed in the ABDM to streamline procedures and improve the availability, affordability, accessibility, inclusiveness, and safety of healthcare. This mission has combined best practices from around the world and redesigned systems to align with the Indian healthcare context. ABDM's architecture is based on common protocols that serve health needs, includes privacy by design, and employs a federated architecture. The federated nature allows for the flow of current and future health information through the system, such as between providers and patients, wearables and EHR/EMRs, consumers and physicians, labs, institutions, and payers and not get centrally stored. This allows for multiple entities to securely manage health data about users, allowing it to sit at the source and be accessible on demand [22].

The ABDM safeguards the autonomy and privacy of personal health information being shared by patients to health professionals through the Health Information Exchange and Consent Manager (HIE–CM). It refers to digital system which facilitates exchange of health information and management of consent. Through these means, the ABDM envisions an open, interoperable, secure and standards-based digital system.

7 Building blocks of ABDM

India is on its way to revolutionizing healthcare in the country by constructing a digital health system that will serve all citizens. There is an unmistakable need to accelerate digitization in order to bridge the existing gap between different stakeholders in the healthcare ecosystem via digital highways in order to capitalize on the ongoing digital wave and achieve improved health outcomes, supporting Universal Health Coverage (UHC).

In this quest, ABDM has rolled out key building blocks and verified registries to unite, enable, and catalyze all stakeholders in the digital healthcare ecosystem.

The Ayushman Bharat Health Account (ABHA) number is the primary building block that contributes to the country's digital health infrastructure transformation. It is a 14-digit randomly generated unique identification number that is voluntarily generated to standardize an individual's identification process between healthcare providers and facilities [22].

ABHA has proved to be instrumental in making paradigm changes in the digital health sector as it is based on the foundations of ease of operating, inclusivity, and free consent. An individual can easily create an ABHA for themselves through self-registration or with assistance from participating healthcare facilities. Furthermore, each ABHA number can be linked to multiple ABHA addresses, making it easy for an individual to retrieve his ABHA details. As ABHA works on voluntary consent-based linking and sharing of

personal health records (PHR), it puts full control of data in the hands of patients. A person can access their health records from admission to treatment and discharge online. This helps to create longitudinal digital health records of an individual, giving doctors a better understanding of the disease history and previous treatments [23].

ABHA Application This application enables users to manage their Personal Health Records, which are an electronic record of a person's health-related information that conforms to nationally recognized interoperability standards. It can be managed, shared, and controlled by the individual. The most notable feature of the PHR is that the information contained within it is under the individual's control [22]. Viewing a longitudinal record, which includes all health data, lab reports, treatment details, and discharge summaries from one or more health facilities, is possible with this application. A citizen can use the ABHA application to share their records with the healthcare providers as and when required.

Health Professional Registry (HPR) It is a systematic and comprehensive database of all healthcare professionals involved in the delivery of healthcare services in both modern and traditional medical systems. This includes all types of doctors, nurses, paramedics, and other healthcare providers. The HPR is currently registering physicians in Modern medicine, Dentistry, Ayurveda, Unani, Siddha, Sowa-rigpa, and Homoeopathy. Other healthcare professionals will soon be able to register as an allied HPR.

Signing up for the HPR connects healthcare professionals to a plethora of interoperable, digitally enabled services for the distribution of healthcare activities and service delivery. In accordance with global healthcare standards, the HPR is intended to evolve into a citizen-centric and practitioner-centric platform. Provision of a unique healthcare professional ID will facilitate communication with all stakeholders in the healthcare ecosystem and augment online presence and discoverability of verified professionals who can facilitate telemedicine in India [24].

Health Facility Registry (HFR) This is a comprehensive repository of health facilities across the country in various medical systems. Hospitals, clinics, diagnostic laboratories, imaging centers, pharmacies, blood banks, and other health-care facilities, both public and private, are examples of health-care facilities.

All health facilities in India, both modern and traditional, are eligible to register with the HFR. It basically ensures that no unauthorized person has access to the health facility's details, acting as a source of truth. The anticipated benefits of HFR include verified health facilities establishing an online presence by sharing information about available specialties, services offered, contact information, and geolocation, allowing individuals easier access and fostering citizen trust. Mutual access to health facility information by various entities facilitates license registration and renewal, as well

as ease of empanelment with insurance agencies. As these facilities would go paperless and encourage creation of electronic medical records, it would lead to seamless retrieval and ease their administrative processes [24].

Drug Registry ABDM is establishing a registry that will serve as a centralized repository for all drugs which are available and approved to be sold in the Indian market. The drug registry will focus on creating a comprehensive repository of drugs in India, which will act as a primary source of information for all other databases and lists, allowing for the exchange of standardized data across all medical systems, from Allopathy to Ayurveda.

As a result, the drug registry will be an updated, single registry of all standardized medicines. Every ecosystem stakeholder is expected to use information from this centralized pool, helping maintain authenticated drug supply. This in turn will alleviate errors while drug identification and administration, thereby improving patients' healthcare-seeking experiences. By ensuring machine readability of prescribed drugs, the drug registry is intended to help smooth inventory flow throughout the drug supply chain over time, improving quality and eventually enabling patient-centric digitization [26].

Unified Health Interface (UHI) In a dispersed healthcare context, service seeking is challenging due to siloed infrastructure. UHI is creating an ecosystem to enable smooth communication among stakeholders on various platforms and the exchange of health data with patients' consent to address this issue. Similar to how UPI functions in payments, UHI is intended to be an open network that enables the interoperability of digital health services. Patients can find, book, conduct, and pay for services provided by a variety of collaborating providers via any application of their choice through UHI enabled applications. This is in direct contrast to the way digital health services are now delivered, where patients and clinicians must interact through a single platform or application [25].

In UHI, every service transaction comprises five parties:

1. A patient who uses UHI to get digital health services is a user.
2. Any application that a user selects to access health services is known as an end user application (EUA). Mobile applications, interactive voice response systems, virtual assistants who speak both English and the local language, and other types of technology can all be used as EUAs.
3. Health service providers (HSPs) include individual physicians, clinics, medical facilities, testing facilities, pharmacies, and organisations that combine health services.
4. Using Health Service Provider Applications (HSPA) that support UHI, they offer digital health services. Any provider-facing application that enables health care pro-

viders to respond to EUA requests and provide digital health services is known as a “health service provider application” (HSPA). HSPAs can be independent service providers or service/business aggregators.

5. The UHI Gateway routes initial service provider discovery requests and responses in UHI transactions between HSPAs and EUAs [26].

UHI will provide numerous benefits to healthcare providers and citizens. It will facilitate the access of citizens to health services, regardless of their location or socio-economic status. There will be improved coordination between healthcare providers, aiding to streamline the healthcare system, making it more efficient and reducing the administrative burden on healthcare providers. The use of UHI will facilitate in availing accurate and comprehensive data on healthcare in India, which can be used to inform policy and improve healthcare outcomes [26, 27].

The ABDM is evolving through innovation and introducing new components. One in the making is the Health Claim Exchange (HCX). The number of health insurance claims in India is set to grow exponentially over the next few years due to AB-PMJAY, a public health insurance scheme that covers 50 crore people, as well as growing retail or group health insurance coverage. Currently, much of the claim processing interactions between the payer, provider, and beneficiary is manual with cumbersome processes involved. It is time-consuming, expensive, and has operational overheads. The absence of requisite standards makes it fragmented, with each insurance company or their technology provider creating their own standards, preventing interoperability. The current model is not scalable enough to support low-value, low-duration claims, which requires large automation to be in place for processing. This tedious process gives a poor patient experience and can lead to delay in treatment.

To overcome the challenges of the health insurance industry and to improve the patient experience in delivering services on time, Health Claim Exchange (HCX) platform formulated under the ABDM, provides an interoperable, machine-readable, auditable, verifiable, explainable, and open standard-based communication protocol between payer, provider, and beneficiary to enable automation of the claims processing workflow for health insurance. It provides an open standard for enabling automation of interaction between the parties, enables a high volume of claims processing, facilitates faster and verifiable payment against claims.

Heal by India (HBI) is an initiative that aims to position India as a global resource for health care service providers. It aims to create an online database of all types of healthcare professionals, including doctors, nurses, and pharmacists, as well as the country in which they wish to work. The HBI platform will serve as a “one-stop” portal

for those seeking credible information from qualified and reputable Indian medical professionals. Once the portal is operational, recruiters from around the world will be able to search for qualified professionals based on their specialty or medical system, language, and location [28]. This will allow our healthmedical workforce to travel around the world and contribute to a global health.

Under the ABDM, NHA is also developing a digital platform for National Organ and Tissue Transplant Organisation (NOTTO) that aims to build verified digital registries for organ donors (live and deceased), recipients, automating the organ donation process and making it faster and more transparent for those in need.

8 ABDM : Implementation and Adoption efforts

Large scale adoption of the mission needs synergistic efforts from all stakeholders in the digital ecosystem. The primary participants who need to be engaged include-

- Citizen/Patient who are the beneficiaries of healthcare services and active users of digital health initiatives.
- Healthcare Services Providers.
 - Direct Providers are Public Sector (Government healthcare programs and States) and the private sector (Players in the private sector - hospitals, professionals, associations).
 - Indirect providers are the health technology startups, social enterprises, non-profits, academic and research institutions, innovators, and all the entities in the digital health entrepreneurial ecosystem.
- Health care payers, such as health plan providers and insurance companies, who set service rates, collect payments, process claims, and pay provider claims.
- Policy Makers are responsible for establishing frameworks, policy, guidelines, and governance models within which healthcare is provided to the citizens.

All of these stakeholders should find value in the offerings of the ABDM and be brought under the overarching ecosystem of ABDM for effective and efficient adoption of the scheme across all sectors.

Since the responsibility for the delivery of healthcare rests with the states and union territories, they are the front-runners in implementing the different components of the scheme. Through driving IEC campaigns to create ABHA, registrations on HPR, HFR and disseminating massive awareness about the ABDM among people, states are taking ownership of the mission.

9 Scan and share

National Health Authority has developed multiple use cases under ABDM. One of them which has scaled up across 450+ government health facilities across country is Scan and Share.

Through scanning the hospital's unique QR Code with their phone camera/scanner/ABHA App/Aarogya Setu App/ or any other ABDM enabled App, patients can share their profile details with the hospital. Post this, a token number (queue number) is generated and shared by the hospitals as notification to the patient's chosen app. Simultaneously, this token number is displayed on screens placed on the OPD registration counters for patient's convenience. Based on their token number, the patient can directly collect their outpatient slip (OP Slip) for doctor consultation, as their details were shared with the hospital at the registration desk.

This service allows both old and new patients to scan a QR code and share their demographic information with the hospital, such as name, father's name, age, gender, address, mobile number, and so on. This shortens the time spent at the OPD registration counter from on an average of 50 min to 4–5 min and provides accurate data in the hospital record.

Scan and Share is a use case that aims to ease the lives of citizens when accessing healthcare services in facilities, solving for persistent problems of long queues on registration, tests, and payment counters at the hospitals [29].

10 Repurposing CoWIN and Aarogya Setu

The government intends to repurpose its two applications under its flagship scheme, ABDM, to support the overarching digitization drive to transform the way public health is delivered in the country. Aarogya Setu, which began as a contact tracking app for Covid, is now being repurposed as India's health and wellness application. CoWIN has been widely used in the implementation of the Covid-19 vaccination and will now be used as a health management information system for small doctor's clinics and nursing homes. The goal is to make access to digital health solutions easy and convenient for citizens and health professionals [29].

The NHA has envisioned the expansion of the digital health ecosystem that is being built under ABDM with successful integrations of both government and private digital health applications. This collaborative approach towards digitising healthcare delivery can help India achieve its goal of providing healthcare for all and help in ensuring that the benefits of ABDM reach the last mile.

11 Way forward

The future of healthcare in India is digital and India is at a significant stage of implementation of the ABDM mission. In the coming years, digitization would improve India's healthcare system through -

1. *Creating reliable healthcare* By building ABHA, HFR, HPR, HCX and other building blocks, ABDM introduces transparency and reliability into the system. Additionally, it will integrate numerous digital identity services that help healthcare organisations verify patients' identities while availing health services, thus preventing possible fraud or misuse of identity.
2. *Ensuring affordability via integration of telehealth solutions* ABHA Number helps link electronic health records facilitating access to patient's medical history, helping doctors to make better diagnosis, reducing overall cost of treatment. Teleconsultations are making healthcare more affordable by increasing accessibility to a larger number of doctors, allowing doctors to consult patients throughout the country, solving demand and supply concerns.
3. *Driving inclusive healthcare innovation* UHI will introduce interoperability, and allow healthcare innovations across demographics. Similarly, to the role played by UPI, UHI will act as a market enabler and will provide multiple health services without the need to subscribe to multiple platforms.

ABDM is aspiring to drive substantial change in the healthcare ecosystem of the country. With over 35 crore ABHA accounts and nearly 25 crore health records linked, 1.6 lakh HPR and nearly 2 lakh HFR created, it is clear that ABDM is being widely adopted by healthcare professionals and citizens [30].

Despite the mission's rapid progress, more health technology players, large public and private hospitals, and laboratories must join forces with it. There is also a need to focus on mass publicity, consistent advocacy, and social acceptability of the mission through incentivization of key stakeholders, operationalizing pragmatic use cases that make seeking quality healthcare services convenient for the general public, thereby reducing out-of-pocket expenses.

Monitoring, evaluation and impact assessment is a vital part of any government program and all initiatives under the ABDM should be continually tracked for progress and undertake mid-course correction based on evidence and results.

The ABDM intends to lay the foundation for the country's integrated digital health infrastructure. It employs digital highways and open networks to bridge the existing gap

between the various stakeholders in the healthcare ecosystem. The multiplicity of factors, such as the overall India's technology revolution, the appropriate government policies and interventions in healthcare, the emergence of health-tech start-ups, the pandemic-induced impetus in digital healthcare, and the awareness among citizens of health and wellness; all create a lucrative opportunity in healthcare. This makes 'now' the right time to accelerate digitisation in healthcare and spearhead health equity.

Digital health is likely to be the central pillar to influence care models, deliver value-based services throughout the healthcare continuum in India, and have a cascading impact on all stakeholders within the ecosystem. Citizens, healthcare providers, innovators, government, and civil society organisations all need to reposition themselves in this digitally driven ecosystem and support the Ayushman Bharat Digital Mission in empowering citizens with the information and tools so that they take control of their own health.

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Declarations

Conflict of interest All authors declare that they have no conflicts of interest.

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