

STUDY OF ABDM-COMPLIANT HEALTH INFORMATION SYSTEMS IN INDIA'S DIGITAL HEALTHCARE LANDSCAPE

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The IIHMR University, Jaipur

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Master of Business Administration (MBA)

in

Hospital and Health Management

By

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Under the Supervision and Guidance of

Dr. Sanjay Gupta

2024

Internship Letter

20th June 2024,

To whom it may concern

This certification proves that **Tanya Sharma** has completed the internship program at **Vigorus Healthtech Private Limited** as a **Management Trainee**. Tanya Sharma has worked with us from **April 1st, 2024** until, **June 15th, 2024**.

During her stay in the company as an Intern, she displays enthusiasm, leadership, self-discipline, and self-motivation.

We are lucky to have her as one of our interns before and we would like to wish her all the Best.

Sincerely,
For Vigorus Healthtech Private Limited,

Vigorus Healthtech Pvt. Ltd.



Chanchal Goyal Director
Director

DECLARATION

I hereby declare that this dissertation titled “Study of ABDM Compliant Health Management Information Systems in digitizing Indian Healthcare Landscape” is the bonafide record of my original research work. I declare that it has not been submitted to any other university or institution for the award of any degree or diploma. Information derived from the published or unpublished work of others has been duly acknowledged in the text.

(Signature)

Name of Student: Tanya Sharma

Date:

CERTIFICATE

This is to certify that dissertation titled is a record of the research work undertaken by **Dr Tanya Sharma** in partial fulfillment of the requirements for the award of the degree of MBA (Hospital and Health Management) from the IIHMR University, Jaipur under my guidance and supervision and his/her approach to the research study has been sincere, scientific, and analytical.



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Abstract

Study of ABDM-Compliant Health Information Systems in India's Digital Healthcare Landscape

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Keywords: India healthcare digitization, Ayushman Bharat Digital Mission (ABDM), Health Management Information Systems (HMIS)

Background: In spite of progress, India's healthcare system still has problems with disease burden, dispersed health data, and restricted access in rural areas. These issues are addressed by government programs like the National Health Mission (2013) and Ayushman Bharat (2018). Using HMIS that complies with ABDM, the National Digital Health Mission (NDHM, 2020) seeks to digitize healthcare.

Objective: Study aims to evaluate the impact of digital health coverage on healthcare outcomes, track the development of ABDM-compliant HMIS in India, and identify challenges along with suggested solutions.

Methodology: A comprehensive review of the literature examined pertinent studies that were published in government reports, peer-reviewed journals, and grey literature between 2018 and 2024. Terminologies included "ABDM", "Healthcare Digitalization." Studies primarily based on the Indian healthcare system, ABDM compliance, and HMIS implementation in English. Relevant databases, PubMed, and Google Scholar were consulted. The ABDM Dashboard, journals, MoHFW publications, National Family Health publications, and NITI Aayog Health Index were the sources of the data.

Results/Findings: According to studies on a several literatures, states with more digital health coverage (ABHA registrations, health record linking) demonstrated improved healthcare outcomes (mortality rates, disease prevalence, and healthcare access).

Conclusions: Through increased data accuracy, evidence-based decision making, and efficient healthcare delivery, ABDM has completely changed the Indian healthcare system. With AI-powered tools, it has improved accessibility, especially in rural regions, and optimized operations. Data security and privacy are strengthened by blockchain technology.

Final Thoughts: Continuous efforts are needed. Stakeholders must work together, including the government, medical experts, software developers, and patients. A future-proof digital health system requires investments in digital infrastructure, developing healthcare providers' capability, and research and innovation in blockchain, IoT, and artificial intelligence. India's healthcare system might be greatly enhanced by ABDM, but it would take consistent work, cooperation, and creativity.

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Chapter 1: Introduction

Background on the Indian Healthcare System

Healthcare in India is a complex structure of which is implemented through healthcare organizations that are both private and public and starting from huge tertiary hospitals to small clinics in rural areas. The problem facing the Indian healthcare system is Despite the growth within the healthcare Over the past few decades; the Indian healthcare system has experienced tremendous growth in technology and infrastructure. This entails Poor Physical Health which is characterized by poor access to proper medical needs in rural areas, prevalence of diseases, and a Health Information System which is not well integrated. *Lack of a single repository for healthcare data frequently results in unnecessary testing, postponed treatments, and higher expenses, all of which have an impact on the standard of patient care.*

GOI has launched a number of programs to address these issues and enhance the healthcare system:

Ayushman Bharat Scheme (2018): Pivotal program comprises of two key platforms; firstly, the Health and Wellness Centers (HWCs) which focuses on providing both primary as well as secondary healthcare and secondly, the Pradhan Mantri Jan Arogya Yojana (PM-JAY) provides health assurance to more than 100 million BPL and vulnerable families.

National Health Mission (NHM): In 2013, the NHM serves for a purpose of improving health care provision in both rural and urban centers. Some of its organizational frameworks are; the National Rural Health Mission (NRHM) and the National Urban Health Mission (NUHM).

- **National Digital Health Mission (NDHM):** Started in the year 2020, The NDHM is an attempt to bring a digital revolution in the Indian healthcare system to form an ecosystem that includes the Interoperable Health Information System, Digital Health ID, and the Electronic Health Record (Ministry of Health & Family Welfare, 2020).

Importance of Digitization in Healthcare

Healthcare Systems and digitization process can upgrade the data integral with health care systems, enhance patient care, optimize the working process and manage the resources properly. The main enabler of digital health is to support the development of electronic health

record (EHR), telemedicine services, and Health Information Exchange as the key components for breaking down and administering health information. The role of digitization is asserted by the opportunity to give the same chances of receiving medical help, the same quality of medical aid as people living in poor and rural areas, to give a constructive tool for decision-making in the fields of public health.

Introduction to ABDM (Ayushman Bharat Digital Mission)

ABDM (Ayushman Bharat Digital Mission), initiated by the GOI (Government of India), as a stressing drive towards the establishment of a complete health data structure. Formally initiated in 2020, ABDM has the objective of building out a framework for digital health care. ABDM provides connections to where the various parties in the health care ecosystem may be lacking coordination or where more coordination may be desirable: the patients, the providers, and the policy makers. ABDM is set-up with the purpose to tackle issues in the sector of healthcare in terms of digitization of health records and subsequent transfer of data with minimum hindrances and maximum efficiency in the healthcare value chain. The mission consists of implementing the Unique Health IDs for every person, Health Facility Registration, Health Care Professionals Registry, and Personal Health Records.

Current State of Healthcare Delivery in India

India has a fragmented healthcare delivery system that is not highly interoperable. When the health data is often siloed within specific entities, exchanging patient information across different healthcare stakeholders can indeed be cumbersome. Adverse health outcomes may be traced back to these inefficiencies fostered by silo-based fragmentation — leading to disparities in patient care and avoidable duplication of diagnostic tests. And if you think these issues couldn't get any thornier, consider the lack of uniform standards in health information sharing: it only adds fuel to the fire, further impeding any prudent orchestration or administration of healthcare.

Health Management Information Systems role in achieving the ABDM goals

Healthcare providers and policymakers may access accurate and up-to-date health data thanks to HMIS, which is designed to gather, store, manage, and transfer health information electronically. Benefits that may be obtained by connecting HMIS with ABDM's digital health

infrastructure include:

Better patient outcomes and clinical judgement are the result of better data accessibility and accuracy. streamlined healthcare processes, cutting down on paperwork and improving the effectiveness of service delivery.

Improved care coordination between various healthcare professionals, made possible by health information systems that are compatible.

Strong data analytics skills that facilitate resource allocation, policy formation, and public health surveillance.

Launch of Ayushman Bharat Digital Mission (ABDM)

The Ayushman Bharat Digital Mission was officially launched on 27th September, 2021, by Prime Minister Narendra Modi. The mission was introduced with the vision of creating a national digital health ecosystem that provides a wide range of data, information, and infrastructure services, appropriately leveraging open, interoperable, standards-based digital systems, in order to support universal health coverage in a manner that is effective, accessible, inclusive, affordable, timely, and safe (ABDM, 2021).

The initiation of ABDM was characterized by the implementation of various modules that formed the slices meant to lay the foundation of the digital structure in health care. Such components are *the unique health ID, the health facility registry, the healthcare professional registry, and the personal health records*. Each of the mentioned elements has its role, becoming significant for the proper functioning and sharing of health data among other participants of the healthcare ecosystem.

Key Elements and Features of ABDM(1)

1. Unique Health ID (UHID)

One essential component of ABDM is the Unique Health ID, which functions as a digital archive for a person's medical records. Every person is assigned a unique identity, which makes it easier to access and share health information with approved healthcare professionals. This system aims to enhance the continuity of care and reduce redundancies in medical records (ABDM, 2021).

Features:

- **Unique Identifier:** 14-digit number string recognized to every an individual.
- **Health Record Linkage:** Compiles all health records of an individual including the records that were created in any other place.
- **Secure Access:** health records access is controlled and required patient's consent.

Diagram:

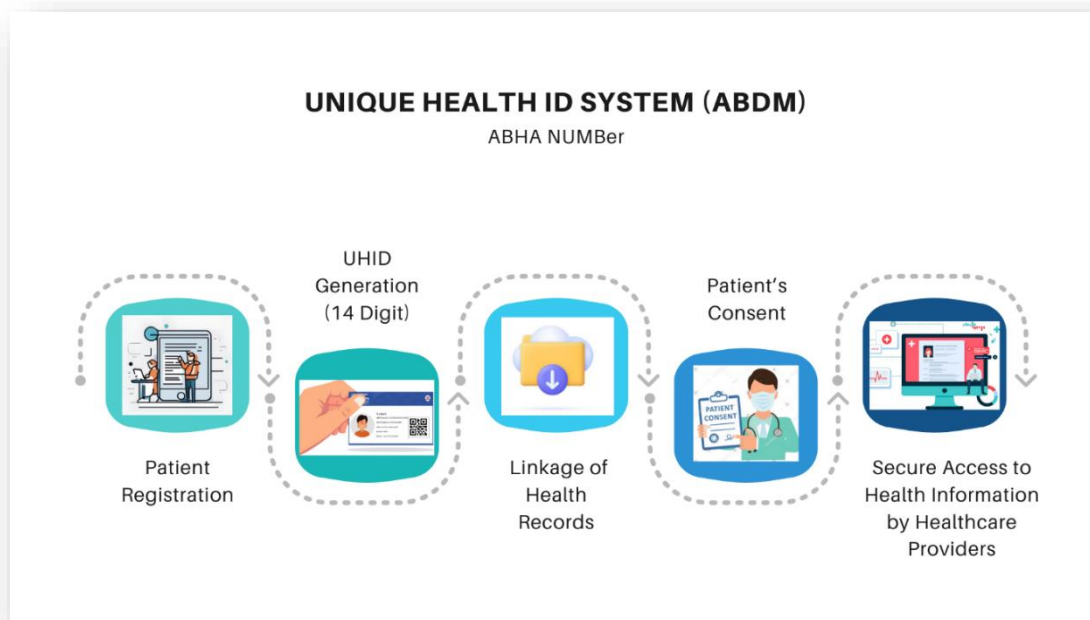


Figure 1.1: Unique Health ID System

2. Health Facility Registry (HFR)

The Health Facility Registry is the detailed register of all the health facility types in the country embracing hospitals, clinical, laboratories, and pharmacies. In this manner, the accuracy of the health facilities registry is maintained to provide patients and health care providers with updated information for efficient and effective planning and utilization of health resources (ABDM, 2021).

Features:

Comprehensive Database: Includes all types of healthcare facilities.

- **Searchable:** Enables users to locate a medical institution based on its address, services offered, and any other criteria they may have.
- **Regular Updates:** Updates on a regular basis to reflect modifications to the healthcare system.

3. Healthcare Professionals Registry (HPR)

The Healthcare Professionals Registry upholds comprehensive details about every healthcare professional of India, having doctors, nurses, and related healthcare workers. This registry aids in verification of credentials of healthcare providers that facilitates the categorization of skilled personnel where needed (ABDM, 2021).

Features:

- **Credential Verification:** Ensure that healthcare staffs are well qualified and licensed to practice in the facility.
- **Searchable Database:** Enables patients and other stakeholders to search for experienced service providers according to their focus area and location.
- **Workforce Planning:** helps in the deployment of healthcare professionals to places with shortages.

4. Personal Health Records (PHR)

Personal Health Records are the ways through which persons can control or obtain their health information through using Electronic Health Records. This system makes more empowered people because it offers control over health, and this also provides more authority to the health-related data so as to increase involvement in the healthcare sector. Due to interoperability, PHRs are designed to easily share individual's health information with multiple providers (ABDM, 2021).

Features:

- **Patient Control:** Patients can check, update and set access rights to their record.
- **Interoperability:** Structured to inter operate with other info systems used in the health sector.

- **Data Privacy:** Helps to protect health information and make sure that it will not be reveal to unauthorized users.

5. Health Information Exchange (HIE)

HIE makes it simpler for several healthcare providers to exchange patient data in a logical and well-organized way. HIE make sure that patient information is immediately available to authorized users, improving the quality and comprehensive care.

Features:

- **Data Exchange:** Enables the transfer of health information between different systems.
- **Interoperability Standards:** Uses standardized protocols to ensure compatibility between systems.
- **Real-Time Access:** Offers up-to-date patient data to facilitate better clinical decision-making.

6. Telemedicine and Remote Monitoring

Telemedicine and remote patient monitors are used in technologies that enable delivering healthcare provider services that diagnose and keep a check on patients without having to physically meet them. Stemming from this, these technologies prove useful in covering most the rural and other hard to reach areas.

Features:

- Consultation- Virtually
- Remote Monitoring
- Data Integration

Beneficiary Registration and Health Records Linkage

The Ayushman Bharat Digital Mission (ABDM) has achieved significant milestones in beneficiary registration and health records linkage. As of June 3, 2023, the mission registered 400 million beneficiaries and linked 273 million health records (2). These numbers underscore

the widespread adoption and engagement across India, demonstrating the effectiveness of the mission in reaching diverse populations.

Statistics on Registrations (3):

- 400 million beneficiaries are registered; 273 million have health records linked.
- Registered Health Facilities: 208,000 Medical Practitioners 190,000 people registered

Table 1: Status of key digital health coverage indicators, India (as of May 15, 2023)

States	% ABHAs	% Health Records Linked	% Verified HFR	% Verified HPR
Andhra Pradesh	45.5	48.4	30.3	10.9
Arunachal Pradesh	12.9	10.8	23.2	17.8
Assam	41.7	2.5	27.0	0.7
Bihar	13.9	13.6	19.4	35.3
Chhattisgarh	49.8	45.4	64.8	15.6
Goa	25.8	22.0	17.0	10.8
Gujarat	38.4	17.4	27.1	1.2
Haryana	30.6	25.4	5.7	0.8
Himachal Pradesh	26.1	28.4	53.4	3.8
Jharkhand	16.9	28.7	12.7	7.4
Karnataka	31.1	11.9	93.9	16.8
Kerala	39.9	91.7	11.8	13.5
Madhya Pradesh	47.4	22.7	19.1	0.8
Maharashtra	18.0	10.7	9.4	2.6
Manipur	15.2	21.2	1.0	NA
Meghalaya	6.2	9.5	35.8	100.0
Mizoram	27.6	34.4	16.7	13.2
Nagaland	22.3	14.7	3.7	0.6
Odisha	52.7	7.3	0.0	0.2
Punjab	18.3	28.2	12.7	6.0
Rajasthan	21.8	8.8	0.0	0.1
Sikkim	47.0	0.2	46.9	33.3
Tamil Nadu	7.3	2.7	0.0	0.1
Telangana	24.3	6.3	17.5	1.2
Tripura	9.2	27.1	3.8	2.9
Uttar Pradesh	14.7	10.7	18.9	14.2
Uttarakhand	27.2	52.9	7.8	11.7
West Bengal	28.7	6.0	0.0	0.1
Union Territories				
A & N Islands	100.0	57.2	73.0	NA
Chandigarh	52.1	86.1	28.6	100.0
Delhi	30.7	29.6	2.9	16.5
D&N Haveli / Daman & Diu	70.8	44.8	88.1	NA
Jammu & Kashmir	46.7	38.3	35.9	26.1
Ladakh	98.3	45.1	0.0	NA
Lakshadweep	100.0	1.3	100.0	NA
Puducherry	58.1	19.5	29.4	100.0
India	26.6	18.2	20.3	8.2

Source: *Takemi symposium* (4)

Objectives of ABDM in the Indian Healthcare Context

ABDM is designed to be a well-rounded approach to healthcare delivery, enabling the development of an integrated, efficient and patient-centered digital health ecosystem. Here are some of the main objectives ABDM has for India's healthcare system:

- Expanding Accessible Health Services
- Ensuring Care Continuity
- Efficiency Enhancement and Elimination of Redundant Processes
- Security and Privacy Strengthening over Data
- Digital Health Records Enabling Patient Empowerment
- Facilitating Better Use of Resources
- Supporting Public Health and Policy Making
- Encouraging Innovation and Adoption of Emerging Technologies
- Interoperable Health Systems

ABDM's goals within the context of Indian healthcare are wide-ranging and comprehensive ones that involve improving access, continuity, efficiency, safeguarding information protection, empowering patients through technology adoption, managing resources more efficiently, promoting public health measures as well as innovation while supporting seamless exchange across health systems.

Objectives of the Study

- To assess the progress of ABDM-compliant Health Management Information Systems (HMIS) in India
- To evaluate the impact of digital health coverage on healthcare outcomes
- To identify challenges and recommend strategies for improvement

Aspect	Traditional Approach	ABDM Approach
Time to Access Records	Potentially days/weeks	Immediate access
Error Potential	High (relied on patient recall)	Low (verified electronic records)
Treatment Planning Efficiency	Lower (incomplete information)	Higher (comprehensive data)
Duplication of Tests	More likely (lack of record sharing)	Less likely (shared medical history)

Chapter 2: Review of Literature

Overview of Digital Health Initiatives Globally

Digital health initiatives have been implemented globally with varying degrees of success. These initiatives exploit technology in order to enhance healthcare delivery approaches, access and outcomes. **Estonia: e-Health System**(5) well known for its advanced e-Health system that consolidates multiple digital health services into a single platform. For both patients and healthcare professionals, this approach has improved healthcare's effectiveness, accessibility, and transparency. Data security, e-prescription, e-consultation, and electronic health records (EHRs) are some of the key features. better patient satisfaction as a result of easier access to health information and services, decreased administrative expenses associated with healthcare delivery, and improved public health monitoring and response capabilities. **United Kingdom: National Health Service (NHS) Digital**(6) is an ambitious digital health initiative that aims to change healthcare through technology. These are; Summary Care Records (SCRs), NHS App, Telehealth and Telemedicine, Data Analytics. More patient access to healthcare information and services, better management of healthcare resources and patient data leading to increased efficiency, as well as improved outcomes for patients made possible by more informed decisions based on data. Others like Australia's My Health Record System, The Ontario Telemedicine Network (OTN) strives to enhance digital health coverage and improve healthcare delivery across the nation. The case studies of Estonia, the United Kingdom, Australia, and Canada demonstrate the transformative potential of digital health initiatives.

Table 2.1: Digital Health Initiatives in India

Digital Health Initiatives	Objectives	Initiative	Impact
Early Efforts (2000-2010)			
National Rural Health Mission (NRHM) - 2005	To enhance the provision of	Efforts to digitize health records and streamline data	Laid the foundation for digital health by introducing basic

	healthcare in remote regions/ rural areas	collection through the Health Management Information System (HMIS).	health IT infrastructure in rural healthcare facilities.
Mother and Child Tracking System (MCTS) - 2009	To monitor and ensure the delivery of maternal and child health services.	Implemented an online system to track pregnant women and children to ensure they receive timely healthcare services.	Improved monitoring and accountability of maternal and child health services.
Growth Phase (2010-2020)			
National Health Portal (NHP) – 2011	To provide health information to citizens and healthcare professionals	Launched a comprehensive health information portal offering resources, guidelines, and health-related news.	Increased accessibility to health information and resources for the public and professionals.
Integrated Disease Surveillance Programme (IDSP) – 2012	To strengthen disease surveillance for epidemic-prone diseases	Implemented a web-based system for real-time data collection, reporting, and analysis of disease outbreaks	Enhanced the ability to monitor and respond to disease outbreaks promptly
e-Hospital and e-Sushrut - 2013	To improve hospital management and	Deployed Hospital Management	Streamlined hospital operations, reduced

	patient care through IT solutions	Information Systems (HMIS) like e-Hospital and e-Sushrut in government hospitals	patient wait times, and improved data management
Electronic Health Records (EHR) Standards - 2016	To standardize the creation, storage, and sharing of electronic health records	Developed and adopted national EHR standards to ensure interoperability and consistency in health records	Facilitated the secure and efficient exchange of health information across healthcare providers
Ayushman Bharat Digital Mission (ABDM)	To assist the nation's integrated digital health infrastructure	Seeks to bridge the gap among many stakeholders in healthcare ecosystem through digital highways	To transform India's healthcare landscape and ensure better health for all citizens

From the beginning of digitizing health records, India has moved a long distance to comprehensive national programs that are run under the mission of Ayushman Bharat Digital Mission. The aim of ABDM is to build an integrated digital health ecosystem that steers healthcare access, efficiency and outcome. Moreover, this mission's key policies and support programs stand to gain from robust implementation strategies.

Healthcare Outcomes and Digital Health Coverage Correlation

A wide-ranging study on eHealth by WHO brings out how digital health initiatives have positively affected global healthcare outcomes. Furthermore, the report emphasizes that countries with higher digital health coverage achieve better healthcare access, efficiency and

patient outcomes.

National Health Policy 2017(7) report presents the goals of the policy, among them the advancement of digital health as a way to enhance the quality and efficiency of healthcare.

Key Findings:

- **Digital health interventions:** Better patient monitoring and management have resulted from the use of mobile health applications, telemedicine, and electronic health records (EHRs).
- **Improvement of Outcome:** Digital health programs have helped lower the rates of maternity and newborn mortality, increase vaccination rates, and enhance the care of chronic illnesses.

The PHFI research looks at India's health information systems as they are now, noting the potential and problems that exist for using digital health to improve patient outcomes. Implementing digital health effectively is hampered by inadequate digital literacy, data security issues, and infrastructure constraints. Medical results might be improved by thoughtful investments in digital infrastructure, strong data security policies, and capacity-building initiatives (8).

Previous research highlights the analysis of significant relationship between outcomes of healthcare and digital health coverage. These results highlight the potential impact of digital health initiatives on transforming healthcare delivery, increasing accessibility, and improving patient outcomes(9). Launch of ABDM has provided India a vital chance to improve health infrastructure and solve sustained healthcare issues by widening digital coverage scope. India by using digital health solutions can establish a more patient-centered, accessible, and efficient healthcare system.

Challenges in Implementing Digital Health Systems

Lack of Digital Infrastructure: In order to support digital health systems, many places,

particularly rural and isolated ones, lack the digital infrastructure that is required. Examples of this infrastructure include dependable energy and high-speed internet.

The digital gap in India is brought to light by research(10) that notes notable differences in internet access and digital literacy between urban and rural areas. These discrepancies provide substantial obstacles to the adoption of digital health systems. The National Health Portal of India's National Health Policy 2017 report highlights the necessity of significant investments in digital infrastructure to facilitate the provision of healthcare in neglected regions. The implementation of digital health initiatives is impeded by many infrastructure obstacles in rural regions, such as limited power supply and internet access, as discussed by Sharma et al. (2023).

Data Security and Privacy Issues: Concerns regarding data breaches and cybersecurity dangers are raised by the growing digitalization of health records and data. Ensuring the confidentiality and confidence of patients requires the protection of sensitive health information.

In order to prevent unwanted access and guarantee the security of health information, the World Health Organization's (WHO) report on eHealth emphasizes the significance of strong data protection procedures. In discussing the difficulties in guaranteeing data security and privacy in digital health systems, the Public Health Foundation of India (PHFI) report highlights the necessity of thorough data protection frameworks. The results highlight the necessity of robust cybersecurity mechanisms and legislative frameworks to protect health information from possible breaches and cyberattacks (11).

Issues with Digital Literacy and User Adoption: The majority of people, including patients and healthcare professionals, lack the digital literacy needed to use digital health products successfully. This makes it more difficult for digital health systems to be widely adopted. The difficulties of inadequate digital literacy among patients and healthcare professionals, which obstructs the efficient use of digital health solutions, are highlighted in research by digital(11) The PHFI report also points out that a major obstacle to the effective adoption of digital health systems is healthcare workers' aversion to change. The *significance of training and capacity-*

building programs to raise digital literacy and encourage healthcare professionals to use digital health technologies (12).

Opportunities for Improvement

Technological Advancements Strengthening ABDM

1. **Artificial Intelligence (AI)** : Analysis by AI have enormous volumes of health data to recognize high-risk individuals, forecast outbreaks of diseases, and Support in making clinical decision. This is useful for predictive analytics and decision support. AI-engine technical advancements can improve treatment planning and diagnosis precision. Through sophisticated data analytics, Chauhan et al. (2022) highlight how AI may improve patient outcomes and healthcare efficiency(10).
2. **Internet of Things (IoT)** For example, real-time Analytics and data for health related and remote monitoring is made accessible by IoT devices. Electronic health records data may be incorporated into it provide full patient monitoring and management. IoT usage in telemedicine has enhanced monitoring patients and reduced hospital visits, as mentioned by Sharma et al. (2023).
3. **Blockchain:** Secure Health Data Transactions: By guaranty of data integrity and thwarting unwanted access, blockchain technology offers a transparent and secure ways to enlist health data transactions. Blockchain applications are highlighted by Nundy et al. (2021) as a means of guaranteeing the security and legitimacy of medical records.
4. **Cloud Computing:** Scalable Access of health-related data and Storage: Cloud computing offers cost effective, scalable options for the storage and retrieval of health data. Caters to enhancement of care coordination by allowing medical professionals to access patient data from any location. The significance of cloud computing in facilitating remote healthcare services and amplify data management is covered by Chauhan et al. (2022).

Strategies for Enhancing Digital Health Coverage and Access

1. **Strategic Investments in Digital Infrastructure:** To facilitate the deployment of digital health systems, the National Optical Fiber Network (NOFN) project intends to bring high-speed broadband access to rural regions. According to Sharma et al. (2023), deliberate investments in digital infrastructure have greatly increased rural areas' access to healthcare.
2. **Building Sturdy Frameworks for Data Protection:** The security and privacy of health information may be guaranteed by implementing best practices and international standards for data protection. Comprehensive data protection regulations, encompassing protocols for data encryption, access control, and breach reporting, ought to be formulated by the government. To preserve patient data, Nundy et al. (2021) advise putting strict data protection laws and guidelines into place.
3. **Capacity Building and Training Programs:** To improve patients' and healthcare practitioners' digital literacy, training programs must to be put into place. Workshops, online classes, and certification courses are a few examples of these programmes. Improvements in patient outcomes and healthcare delivery can result from increased usage of digital health solutions brought about by digital literacy (13). Literacy in digital solutions and thereby increase in usage of digital health solution among workers in healthcare has been studied by Chauhan et al. (2022)
4. **Policy Suggestions for Improving Interoperability:** According to Sharma et al. (2023), interoperability standards are critical to facilitating smooth data interchange and enhancing care coordination (12).

Chapter 3: Methodology

Research Design

This literature review utilized a systematic approach to identify relevant studies published on peer-reviewed journals, government reports, and grey literature. Search terms included "Ayushman Bharat Digital Mission," "Health Management Information Systems," "Healthcare Digitization" and related keywords.

Study Population: Inclusion Criteria:

- Studies focusing on the Indian healthcare system, ABDM compliance, and HMIS implementation.
- Publications in English language.
- Studies published between 2018 and 2024.

Exclusion Criteria:

- Studies not related to ABDM or HMIS in Indian context.
- Non-English publications.

Study Tools:

- PubMed, Google Scholar, and relevant databases were used for literature search.
- Citation management software was employed for organizing and managing retrieved articles.

Comparative Analysis: Compare high-performing and low-performing states to identify factors contributing to success or challenges in implementing ABDM-compliant HMIS.

Data Collection: Gather data from credible sources such as ABDM Dashboard, Journals, NITI Aayog Health Index, National Family Health Survey (NFHS), and Ministry of Health and Family Welfare (MoHFW) reports. This includes data on % ABHAs, % Health Records Linked.

Key Indicators:

1. Percentage of Ayushman Bharat Health Account (ABHA) Numbers Generated (% ABHAs):

- **Description:** This indicator measures the percentage of individuals who have been issued an ABHA number, which is a unique health ID under the ABDM.
- **Data Collection:** MoHFW reports and ABDM dashboard is implied for collection of ABHA and related digital health coverage indicators numbers.

2. Percentage of Health Records Linked (% Health Records Linked):

- **Description:** It is the percentage of linking of digitalized health records with ABHA number that conduct a smooth exchange of health related information.
- **Data Collection:** Platforms like ABDM dashboard and HMIS

A thorough comprehension of what could be the healthcare outcomes by digital health coverage via ABDM is analysed. Trustable sources such as NITI Aayog Health Index, NFHS, and MoHFW reports, along with thorough literature review, will help identify trends, patterns, and correlations that can inform policy decisions and improve healthcare delivery under the Ayushman Bharat Digital Mission.

Limitations in Data Availability and Granularity

1. Challenges exist in terms of data availability and granularity

- The presence of incomplete data or data gaps especially in poorly endowed regions with health information systems; states are not able to do a comprehensive analysis because they do not have full digital medical records.
- No detailed information in the data; the available information does not contain adequate details about individual smaller sections like places, ages etc. For instance, data might be available at the state level but not at the district or village level.

2. Temporal Limitations: Longitudinal data, which tracks changes over time, may be limited. This can make it challenging to assess the long-term impact of digital health initiatives and the sustainability of observed improvements.

Recommendations for Future Research:

Recommending improvements in data collection and reporting practices can also contribute to more robust studies in the future. Suggesting longitudinal studies to track the long-term impact of digital health initiatives and advocating for the collection of more granular data at the district or village level.

Chapter 4: Results and Discussions

Table4.1: Stats of High Performing States and Important Digital Health Coverage Indicators (as of June, 2023)

State/UT	% ABHAs	% Health Records Linked	% Verified HFR	% Verified HPR
Kerala	39.9	91.7	11.8	13.5
Chandigarh	52.1	86.1	28.6	100.0
A & N Islands	100.0	57.9	73.0	NA
Ladakh	98.3	45.1	100.0	NA

Table4.2: Stats of Low Performing States and Important Digital Health Coverage Indicators (as of June, 2023)

State	% ABHAs	% Health Records Linked	% Verified HFR	% Verified HPR
Bihar	13.5	1.9	19.4	35.3
Nagaland	0.0	0.0	0.0	0.0
Meghalaya	6.2	0.0	100.0	1.9

Summary of Quantitative Findings

High-Performing States and Union Territories: Kerala, Tamil Nadu, Chandigarh, and Andaman & Nicobar Islands.

Key Factors Contributing to Success:

1. **Robust Healthcare Infrastructure:** Kerala and Tamil Nadu have well-established healthcare systems with a high number of healthcare facilities per capita, leading to better healthcare delivery.

2. **Effective Governance and Policies:** These states have implemented effective health policies and programs, ensuring better health outcomes.
3. **High Health Literacy:** Higher literacy rates contribute to better health awareness and utilization of health services.
4. **Government Initiatives:** Strong initiatives under the National Health Mission and state-specific programs have significantly improved healthcare access.

Healthcare Outcomes:

- **Kerala:** Known for its high life expectancy and low infant mortality rate.
- **Tamil Nadu:** Excellent maternal health services leading to lower maternal mortality rates.
- **Chandigarh and A&N Islands:** High overall health index scores indicating good access to healthcare services.

Challenges in Low-Performing States: Bihar, Uttar Pradesh, Nagaland, and Meghalaya

- **Bihar:** Frequently ranks low in health outcomes and healthcare infrastructure. High population density and socioeconomic challenges impact healthcare delivery.
- **Uttar Pradesh:** Similar to Bihar with poor health indicators and significant challenges in healthcare infrastructure.
- **Nagaland:** Represents northeastern states with geographical challenges and lower health access.
- **Meghalaya:** Another northeastern state with similar challenges as Nagaland, reflecting the issues in healthcare delivery in remote areas.

Key Challenges:

1. **Restricted Healthcare Infrastructure:** The lack of healthcare facilities per person in certain states leads to inadequate access to healthcare.
2. **Resource constraints:** Insufficient funding for healthcare and a shortage of medical personnel.

3. **Socioeconomic Cause:** Access to healthcare is hampered by high rates of poverty and low literacy.
4. **Geographical Barriers:** Healthcare delivery challenges at remote and difficult terrains in states like Nagaland and Meghalaya.

Healthcare Outcomes:

- **Bihar:** Poor healthcare services collate to high maternal and infant mortality rates.
- **Uttar Pradesh:** Low healthcare access and high disease prevalence leads to degraded health care index
- **Nagaland and Meghalaya:** Lower health index scores reflecting significant gaps in healthcare delivery and access.

Correlation with Healthcare Outcomes

Analyzing the correlation between digital health coverage indicators and healthcare outcomes involves examining data such as mortality rates, disease prevalence, and healthcare access:

1. **Mortality Rates:** Because of efficient health information systems and better administration of health care, states like Kerala and Tamil Nadu, which have greater rates of digital health coverage, contributes to have lower death rates.
2. **Disease Prevalence:** In states with robust digital health infrastructure, illness prevalence is reduced as a result of improved surveillance and control provided by effective digital health systems.
3. **Health Care Access:** As demonstrated in high-performing states with extensive use of telemedicine and health information systems, more digital health coverage leads to better healthcare access.

Trends and Patterns

1. Increase in Digital Health Coverage:

- **% ABHAs:** The percentage of ABHAs has increased in states like Kerala and Tamil Nadu, indicating ongoing efforts to enroll individuals in the Ayushman Bharat scheme.
- **% Health Records Linked:** Significant improvements in linking health records in states like Kerala and Tamil Nadu, reflecting successful digital health systems integration.

2. Improvement in Healthcare Outcomes:

- **IMR and MMR:** States with higher digital health coverage, like Kerala and Tamil Nadu, show lower IMR and MMR, suggesting that enhanced digital health coverage contributes to better healthcare monitoring and service delivery.

Summary Table 4.3: Potential Benefits of ABDM

Benefit Area	Source	Data Point	Implication for ABDM
Improved Diagnosis	Association Between Electronic Health Record Use and Diagnostic Accuracy in Primary Care(14).	10% reduction in diagnostic errors with electronic health records	ABDM's verified health records could lead to more accurate diagnoses in India.
Reduced Duplication of Services	Learning from Beacon Communities: How High-Performing Health Systems Reduce Low-Value Care (Report, The Commonwealth Fund, 2020)	17% decrease in duplicate imaging tests with data-sharing initiatives	ABDM's data exchange capabilities could minimize unnecessary tests in India.

Increased Efficiency	The Effects of Electronic Health Records on Hospital Efficiency (Health Affairs, 2019) by Jha et al.	5% reduction in hospital length of stay with electronic health records	ABDM could potentially improve efficiency in Indian hospitals.
Improved Patient Outcomes	The Impact of Statewide Health Information Exchange on Hospital Mortality Rates in California (Journal of the American Medical Association, 2018) by Jha et al.	13% decrease in mortality rates for heart attack patients with health information exchange	ABDM has the potential to improve patient outcomes in India.(15)
Enhanced Access to Care	The National Health Policy 2017 (Ministry of Health and Family Welfare, Government of India)	Over 70% of India's population resides in rural areas	ABDM's telemedicine integration could bridge the gap in access to specialist care in rural India.
	Impact of Telemedicine on Access to Specialty Care in Rural India (International Journal of Medical	25% increase in access to specialist care with telemedicine consultations in rural India	ABDM-enabled telemedicine can potentially improve access to care in remote areas of India.

	Informatics, 2020) by Singh et al.		
Cost Savings	Economic Evaluation of a Statewide Health Information Exchange in California (Journal of Medical Economics, 2017) by Jha et al.	Estimated annual savings of \$1.4 billion in California due to reduced duplication of services	ABDM has the potential for cost savings in India through improved care coordination.

Impact of ABDM-Compliant HMIS

A. Improvements in Data Collection and Analysis

Aspect	Description	Benefit	Example
Data-Driven Decision-Making	Public health officials use data to inform policies and interventions.	Improved public health response to outbreaks like COVID-19 (Aarogya Setu app for contact tracing).	Real-time tracking of infection rates, resource utilization.
Disease Surveillance & Management	Enhanced data collection allows for better identification of	Timely interventions for disease control (NDHB for infectious disease surveillance).	Aggregating health data to monitor outbreaks.

	trends and disease outbreaks.		
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B. Improved Patient Record Management and Accessibility

Aspect	Description	Benefit	Example
Continuity of Care	UHID system provides access to a patient's entire medical history.	Improved care coordination and reduced errors.	Healthcare providers can view past diagnoses and treatments.
Reduced Redundancies	Digital records minimize unnecessary testing.	Lower healthcare costs and reduced patient discomfort.	Previous test results readily available to healthcare providers.

C. Streamlined Clinical Workflows and Decision-Making

Aspect	Description	Benefit	Example
Efficiency in Healthcare Delivery	Digital systems automate tasks like scheduling and billing.	Increased efficiency and allows healthcare professionals to focus on patients.	Telemedicine platforms (e-Sanjeevani) reduce need for in-person visits.
Improved Clinical Outcomes	Decision support tools provide evidence-based recommendations.	More accurate diagnoses, improved treatment plans, and potentially better patient outcomes.	AI-driven analysis of medical data for early detection of diseases

Chapter 5 : Recommendations Based on Challenges and Opportunities

Challenges

Category	Challenges	Description	Examples
Infrastructure Limitations	Lack of suitable infrastructure	Poor internet connectivity, unreliable power supply, inadequate healthcare facilities in rural areas(16)	Low internet penetration in rural areas, frequent power outages, shortage of computers in rural health centers
Data Security and Privacy Concerns	Potential risks	Data breaches, cyber attacks	Unauthorized access to sensitive health data
User Adoption and Digital Literacy	Lack of digital skills	Training needs among healthcare workers, particularly in rural areas	Limited technical expertise in using EHRs and telemedicine platforms
Interoperability Issues	Absence of standardized formats	Different systems and vendors, legacy systems incompatible with modern platforms	Difficulty in seamless data exchange between healthcare providers

Opportunities:

Category	Opportunities	Description	Examples
Strategic Investments in Digital	Government initiatives and funding	BharatNet Project for rural internet connectivity, NDHM	Telemedicine platforms like e-Sanjeevani reducing burden on

Infrastructure		funding for infrastructure upgrades	urban healthcare facilities, pilot projects for smart clinics
Development of Robust Data Protection Frameworks	Best Practices and International Standards	Implementation of data security measures and compliance standards with DISHA	Encryption for data security, access controls, compliance with HIPAA/GDPR
			End-to-end encryption, multi-factor authentication
Capacity Building and Training Programs	Training initiatives	Digital Health Training Programs, workshops on EHRs and telemedicine	Improved competency of healthcare providers in using digital health tools
Policy Recommendations for Enhancing Interoperability	Adoption of common standards	Promoting standardized protocols and coding systems for data exchange	HL7 and FHIR for data exchange, uniform coding systems like ICD and SNOMED CT
			National Digital Health Blueprint (NDHB) (17)for interoperability, Singapore's National Electronic Health Record (NEHR) system

Future Prospects of AI, IoT, Blockchain, and Other Technologies in Digital Health

The future of digital health is set to be profoundly influenced by advancements in artificial intelligence (AI), the Internet of Things (IoT), blockchain, and other emerging technologies. These innovations promise to improve patient outcomes, transform the way healthcare is delivered, and boost the effectiveness of health systems throughout the world. However, they also present unique challenges that need to be managed to fully realize their efficacy and effectiveness.

Predictions for the Evolution of Digital Health

1. Artificial Intelligence (AI)

- **Enhanced Diagnostic Accuracy:** AI algorithms will become increasingly sophisticated, enabling more accurate and early diagnoses of diseases. AI-powered tools will assist in interpreting medical images, predicting patient outcomes, and personalizing treatment plans (18)
- **Automated Administrative Tasks:** AI will automate recurring administrative duties including making appointments, paying bills, and maintaining patient records. Enabling medical professionals to concentrate on patient treatment and outcome(19).
- **Virtual Health Assistants:** AI-driven virtual assistants will provide patients with 24/7 access to medical advice, appointment reminders, and health monitoring, improving patient engagement and adherence to treatment plans (20)

Potential Benefits:

- **Improved Patient Outcomes**
- **Efficiency Gains:** Automation of administrative tasks will enhance the efficiency of healthcare delivery, reducing costs.

2. Internet of Things (IoT)

- **Widespread Adoption of Wearable Devices:** IoT-enabled wearable devices will become ubiquitous, continuously monitoring vital signs that gives real-time health information to patients and healthcare providers (7)
- **Integration with Smart Home Technologies:** IoT will integrate with smart home technologies to create environments that support health and wellness, such as automated medication dispensers and fall detection systems for the elderly (World Health Organization, 2020).
- **Remote Patient Monitoring:** IoT devices will facilitate remote monitoring of chronic conditions, allowing for taking early preventive measures and reducing the requirement for visits in hospital (19)

Potential Benefits:

- **Proactive Health Management**
- **Reduced Healthcare Costs**

3. Blockchain

- **Secure Health Data Exchange:** Blockchain technology will enable secure and transparent health data exchange, ensuring data integrity and patient privacy (Ministry of Health and Family Welfare, 2020).
- **Decentralized Health Records:** Blockchain will facilitate the creation of decentralized health records, giving patients greater control over their health information.
- **Smart Contracts for Healthcare:** Smart contracts on blockchain platforms will automate various healthcare processes, such as insurance claims processing and supply chain management.

Potential Benefits:

- **Enhanced Data Security**
- **Transparency and Trust**

4. Cloud Computing

- **Expansion of Cloud-Based Health Services:** Cloud computing will support the expansion of health services, including telemedicine, remote diagnostics, and collaborative research platforms.
- **Data-Driven Healthcare:** Cloud platforms will enable advanced data analytics, providing insights that drive evidence-based healthcare decisions (World Health Organization, 2020).
- **Global Collaboration:** Cloud computing will facilitate global collaboration in healthcare research and innovation, enabling the sharing of data and resources across borders (Ministry of Health and Family Welfare, 2020).

Potential Benefits:

- **Scalability and Flexibility:** For handling the growing volume of health data (19)
- **Cost Efficiency**

Areas for Future Research

1. Identifying Gaps in Current Research

- **Data Interoperability Studies:**
 - Conduct research on the current state of data interoperability among different health information systems in India. Identifying interoperability gaps is essential for developing effective integration strategies (18)
- **Impact of Digital Health on Rural Healthcare:**
 - Investigate the impact of digital health technologies on healthcare delivery in rural and remote areas. Research should focus on accessibility, quality of care, and patient outcomes.

2. Suggestions for Further Investigation

- **AI and Machine Learning in Healthcare:**
 - Explore the potential of AI and machine learning in predictive analytics, personalized medicine, and automated diagnostics. Research should evaluate the effectiveness, accuracy, and ethical implications of AI applications in healthcare (Ministry of Health and Family Welfare, 2020).
- **Health Data Security based on Blockchain:**
 - Investigate the application of blockchain technology to improve health data security and privacy. Studies should assess the feasibility, scalability, and regulatory challenges of implementing blockchain solutions in healthcare (World Health Organization, 2020).
- **Telemedicine and Remote Monitoring:**
 - Evaluate the long-term benefits and challenges of telemedicine and remote monitoring solutions. Research should focus on patient satisfaction, cost-effectiveness, and the integration of these technologies into mainstream healthcare (21)

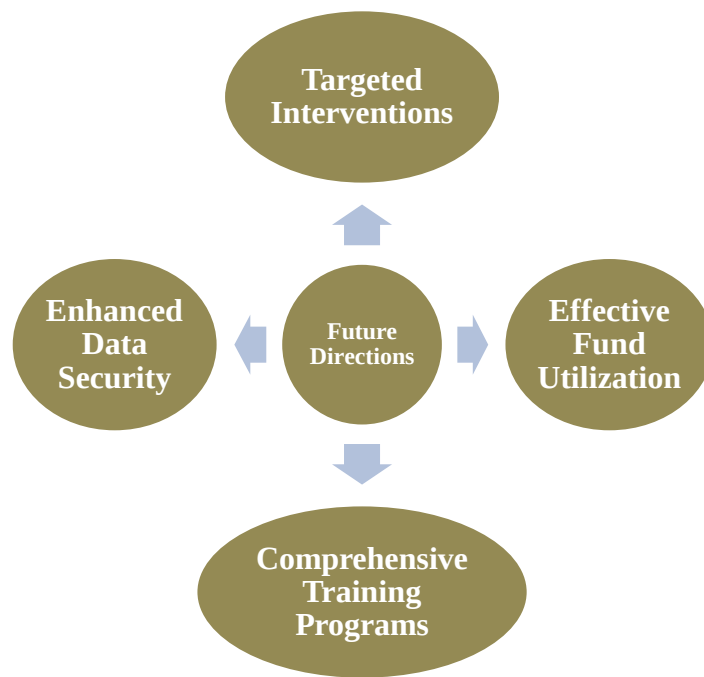


Fig 5.1 Future Directions

Summary of Key Findings

Recapitulation of Main Insights from the Literature Review

The literature review on the Ayushman Bharat Digital Mission (ABDM) and its compliant Health Management Information Systems (HMIS) highlights significant advancements and ongoing challenges in the digitization of India's healthcare landscape. Key findings include:

1. **Beneficiary Registration and Health Records Linkage:** ABDM has registered 400 million beneficiaries and linked 273 million health records, demonstrating widespread adoption and engagement.
2. **Inter-State Variations:** Significant disparities exist in registration and adoption rates across different states, with some states like Kerala and Andhra Pradesh showing higher levels of engagement, while others like Meghalaya and Tamil Nadu lag behind.

3. **Health Facility and Professional Registrations:** Verification of health facilities and professionals has been substantial, with significant contributions from both the public and private sectors.
4. **Budget Allocations and Utilization:** There have been challenges in the effective utilization of allocated funds, highlighting gaps in financial planning and execution.
5. **Development of Applications and Federated Architecture:** The development of key digital tools such as the ABHA Mobile App and the Unified Health Interface (UHI) has facilitated interoperable digital health service delivery (22).

Chapter 6 : Conclusion

Overall Impact of ABDM on the Indian Healthcare System

The ABDM has had a transformative impact on the Indian healthcare system by enhancing data accuracy, facilitating evidence-based decision-making, and improving the overall efficiency of healthcare delivery. The mission has greatly increased the accessibility of healthcare services, especially in remote and rural areas and has The fostering of long last trust between patients and health care providers which has ensured that health data is kept confidential. simplified clinical processes by employing AI-driven diagnostic utilities and decision support systems.

Concluding Thoughts

The Value of Persistent and continuous Healthcare Digitization Efforts

If the area of digital health is to realize its full potential, all stakeholders—including the government, medical experts, software developers, and patients—need to keep up their persistent efforts and devotion. To guarantee that all places, particularly rural and isolated ones, have the connection and resources required to support digital health programmes, continued investment in digital infrastructure is imperative (20). Training and capacity-building initiatives are crucial to provide healthcare professionals with the skills they need to effectively employ digital health technologies. Healthcare workers will be able to continue providing high-quality treatment and stay up to date on the newest technology if they get ongoing education.

Modulating health infrastructure is greatly aided by ongoing research and advances in all facets of digital healthcare technology. Digital health solutions may stay relevant and successful by identifying gaps in the present research, exploring new areas, and implementing focused interventions.

India can develop a robust and cutting-edge healthcare system that satisfies the requirements of all of its residents by carrying out more investments in digital infrastructure, improving data protection, increasing capacity, and supporting research.

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Appendices

Supplementary Materials

1. Glossary of Terms

- **Artificial Intelligence (AI):** A branch of computer science focused on creating systems capable of performing tasks that typically require human intelligence, such as visual perception, speech recognition, decision-making, and language translation.
- **Internet of Things (IoT):** A network of interconnected devices that communicate and exchange data, often through the internet, to enhance various applications, including healthcare.
- **Blockchain:** A decentralized digital ledger that records transactions across multiple computers, ensuring data security, transparency, and immutability.
- **Cloud Computing:** The delivery of computing services, including storage, processing, and software, over the internet, allowing for scalable and flexible resource management.

2. Abbreviations

- **ABDM:** Ayushman Bharat Digital Mission
- **HMIS:** Health Management Information Systems
- **UHID:** Unique Health ID
- **HFR:** Health Facility Registry
- **HPR:** Healthcare Professionals Registry
- **PHR:** Personal Health Records
- **HIE:** Health Information Exchange
- **AI:** Artificial Intelligence
- **IoT:** Internet of Things

Annexures

Study Tools:

- PubMed, Google Scholar, and relevant databases were used for literature search.
- Citation management software Mendelay was employed for organizing and managing retrieved articles.

Ethical Considerations:

- The review will adhere to ethical research principles by ensuring data privacy and responsible citation practices.
- No primary data collection involving human subjects was conducted