International Journal on Science and Technology (IJSAT)
E-ISSN: 2229-7677 ● Website: www.ijsat.org ● Email: editor@ijsat.org

Assay formats and target recognition strategies in lateral flow assays for the detection of mycotoxins

Mangala S. Hiremath , H. R. Chandana, Sneha B. Koradakeri

A B S T R A C T

With the fast-developing digital healthcare system, secure storage and retrieval of medical prescriptions are becoming increasingly necessary in today's times. Patients tend to lose or misplace their paper-based prescription, which results in delays in treatment, multiple consultations, and wasted medical spending. The design and implementation of a web-based prescription recovery system would safely store medical prescriptions with links to the patients using their Aadhaar number, different from the common approaches since this system is totally independent of any UIDAI authentication API's and uses only simulated OYP verification in scenarios where access becomes an issue-even in resource-poor setups. The system enables doctors to upload encrypted prescriptions to a cloud database, patients to retrieve lost prescriptions using Aadhaar-linked OTP verification, and pharmacists to verify prescriptions through a role-based portal with patient consent. Security is enforced through end-to-end encryption, role-based access control(RBAC), and audit logging. The proposed platform aims to enhance convenience, minimize prescription fraud, improve medication traceability, and offer seamless access to medical records in both urban and rural healthcare setups. This literature-backed solution addresses a critical gap in current digital health infrastructure and has the potential to improve treatment continuity across India.

Keywords: Aadhaar-based authentication, Digital health records, Prescription recovery, Cloud storage, Role-based access control , Data encryption, Healthcare data privacy, Web-based health system, Prescription verification, Patient data management

1. Introduction

The Indian healthcare system is currently navigating a transformative digital revolution, supported by a variety of government-initiated and private sector interventions. Despite these significant technological advancements, a persistent and recurring challenge faced by patients across the nation is the frequent loss or misplacement of physical medical prescriptions. A misplaced prescription does more than create a minor inconvenience; it fundamentally disrupts the continuity of treatment and renders the patient more reliant on redundant hospital or doctor visits. These traditional paper-based methods are inherently prone to damage, forgery, and misinterpretation, which can lead to critical medical errors and administrative bottlenecks.

To address this critical gap in the current digital health infrastructure, we recommend the implementation of a secure, **Aadhaar-linked prescription recovery mechanism**. This system is designed to guarantee the long-term storage and authenticated retrieval of vital medical information. By utilizing the patient's Aadhaar number as a primary unique identifier, the platform establishes a centralized digital repository that bridges the gap between fragmented physical records.

While real-time UIDAI-based biometric or OTP (One-Time Password) authentication may not be practical during the initial stages of development, emulating these functionalities through alternative safe methods—such as simulated OTP verification and explicit user permission—can provide comparable levels of usability and security. The necessity for such a robust system has become increasingly evident as we transition into a post-pandemic world. In this modern era, contactless, remote, and authenticated access to health records has evolved from a mere convenience into a fundamental requirement for patient safety.

The proposed solution operates as a comprehensive web-based platform with several core objectives:

- **Enhanced Security and Integrity**: The system prevents prescription forgery by implementing a digital signature mechanism using SHA-256 cryptographic hashing to ensure that files remain untampered.
- **Rigorous Access Control**: Sensitive patient data is protected through a multi-layered security approach, including Role-Based Access Control (RBAC) and two-factor authentication (2FA) via OTPs delivered to registered mobile numbers or emails.
- **Workflow Efficiency**: The system streamlines the entire prescription lifecycle, enabling doctors to upload encrypted files or capture images directly via a camera, while allowing pharmacists to verify authenticity before dispensing medication.
- **Patient Empowerment**: By centralizing records, the system provides patients with a permanent and easily accessible digital record of their complete medication history from any connected device.

Ultimately, this literature-backed solution aims to minimize prescription fraud, improve medication traceability, and offer seamless access to medical records in both urban and rural healthcare setups across India

2. Prescription Storage and Retrieval Architecture

Aadhaar-linked prescription recovery is a web application developed to store, retrieve, and authenticate medical prescriptions securely in a centralized cloud database. The system has three main user roles: doctors, patients, and pharmacists.

Each role accesses the system via a custom interface with access permissions determined by Role-Based Access Control(RBAC)

Physicians log into the system and upload prescriptions, which are encrypted and kept in a safe cloud database. Each prescription is also tagged with the Aadhaar number of the patient to

facilitate retrieval in the future. Patients can access previous prescriptions by authenticating their Aadhaar number using a simulated OTP process, which allows access to data without real-time UIDAI authentication. Pharmacists, with the permission of the patient, can authenticate the validity of prescriptions prior to dispensing drugs.

Table 1

User Role	Actions/Permissions	Authentication Method	Access Scope
Doctor	Upload prescriptions, view patient history	Username + Password	Create, Read (own patients)
Patient	Retrieve prescriptions, view history	Aadhaar number + OTP	Read (self only)
Pharmacist	Verify prescription, check validity	Username + Password + OTP	Read (with patient consent)
Admin	Manage users, view logs, control access	Admin login credentials	Full system access

Doctors or physicians log into the system and load prescriptions, which are encrypted and kept in a cloud database that is secure. The prescription is associated with the Aadhaar number of the patient in order to facilitate future retrieval. Patients are also to retrieve their older prescriptions by authenticating their Aadhaar number through a simulated OTP process so that data can be accessed without real-time UIADI verification. Pharmacists can authenticate priscriptions prior to dispensing medicine, with patient authorization.

3. Summary of some research papers

1. Smart Healthcare System for Biomedical and Health Care Applications using Aadhaar and Blockchain
   Published: Date not specified
   Summary: The paper presents a smart healthcare system that integrates Aadhaar authentication with blockchain technology to ensure secure and efficient biomedical data management. It aims to enhance data integrity and patient privacy in healthcare services.

2. Smart Way for Prescribing Medication
   Snehal Shinde
   Published: Date not specified
   Summary: The paper proposes a digital system for prescribing medications that enhances accuracy, reduces errors, and integrates patient history for informed decision-making. It emphasizes the importance of digitizing prescriptions to streamline the medication dispensing process.

3. A Secure Intelligent Decision Support System for Prescribing Medication
   Published: Date not specified
   Summary: The study introduces a decision support system that leverages intelligent algorithms to assist healthcare providers in prescribing medications securely and effectively. It focuses on enhancing decision-making processes in clinical settings.

4. Aadhaar Card: Challenges and Impact on Digital Transformation
   Summary: The paper examines the challenges and impacts of integrating Aadhaar into various digital systems, highlighting security concerns and the need for robust privacy measures in digital transformation initiatives

5. Scalable and Accurate Deep Learning for Electronic Health Records
   Published: January 24, 2018
   Summary: The study demonstrates the use of deep learning models on electronic health records to predict medical events with high accuracy, showcasing scalability and potential for personalized medicine. It emphasizes the benefits of using raw EHR data for predictive modeling.

6. Aadhaar Card-Based Android Application for Patient Monitoring System
   Published: April 11, 2018
   This study introduces a prototype Android application that integrates Aadhaar authentication to monitor patient health parameters such as body temperature, heartbeat, and blood pressure. The system aims to reduce the workload on healthcare professionals by providing real-time alerts when vital signs deviate from normal ranges. It also allows authorized personnel to access a patient's health history, facilitating timely and informed medical decisions.

7. Standard Electronic Health Record (EHR) Framework for Indian Healthcare System
   Published: 2020
   Summary: The paper proposes a standardized EHR framework tailored for the Indian healthcare system, aiming to improve data consistency, interoperability, and patient care quality. It suggests using Aadhaar for unique patient identification and emphasizes cloud-based solutions for data storage and access.

8. A Survey on Security and Privacy Issues in Modern Healthcare Systems: Attacks and Defenses
   Published: May 15, 2020
   Summary: This survey explores various security and privacy challenges in modern healthcare systems, detailing common attacks and proposing defense mechanisms to safeguard patient data. It underscores the importance of robust security measures in healthcare technologies.

9. "Biometric Infrastructures and the Indian Public Distribution System" by Published : September 2020
   This paper explores the implementation of biometric infrastructure—primarily Aadhaar-based biometric authentication—in India's Public Distribution System (PDS). It evaluates how integrating Aadhaar helps in reducing identity fraud, improving the accuracy of beneficiary identification, and enhancing transparency in the distribution of food and other subsidies.

10. "Aspects of E-Prescription: Creation and Security"
    Published : March 30, 2022
    This paper explores the transition from traditional handwritten prescriptions to electronic prescriptions (e-prescriptions), emphasizing the importance of data quality, centralized data storage, and security in modern healthcare systems. It highlights the challenges associated with paper-based prescriptions, such as loss, deformation, and lack of centralized records, which can lead to medical errors and inefficiencies. The authors advocate for the adoption of e-prescription systems that leverage technologies like big data and machine learning to enhance healthcare delivery. By digitizing prescriptions, healthcare providers can improve data accuracy, facilitate better communication between hospitals, and enable predictive analytics for disease detection and personalized treatment plans. The paper also underscores the need for robust security measures to protect sensitive patient information in electronic systems.

11. Review Paper on Implementation of Management of Patient Data Records using Web Application
    Published: April 14, 2022
    Summary: This review discusses the development of web applications for managing patient data records, focusing on improving accessibility, security, and efficiency in healthcare data management. It highlights the benefits of centralized digital records in enhancing patient care.

12. Machine Learning for Administrative Health Records: A Systematic Review of Techniques and Applications
    Published: August 27, 2023
    Summary: This systematic review analyzes machine learning techniques applied to administrative health records, highlighting their effectiveness in predicting health outcomes and optimizing healthcare operations. It identifies challenges and proposes future research directions for enhancing the utility of such data.

13. Artificial Intelligence in the Field of Pharmacy Practice: A Literature Review
    Patil, T.M. Pramod Kumar
    Published: October 21, 2023
    Summary: The literature review examines the application of artificial intelligence in pharmacy practice, discussing its potential to improve
    drug discovery, patient counseling, and medication management. It highlights AI's role in enhancing clinical decision-making and patient care

14. Evolution of Electronic Health Records in India: Leveraging Aadhaar Integration for Seamless Healthcare
    Published: June 20, 2024
    Summary: The study explores the evolution of electronic health records (EHR) in India, emphasizing the role of Aadhaar integration in creating a seamless and interoperable healthcare system. It discusses the potential of technologies like blockchain and AI in enhancing EHR systems.

15. Methodology for proposed solution

The solution we are proposing for the issues discovered in the literature review is a centralized website accessible via any mobile device. The platform serves as a secure digital bridge between patients, doctors, and pharmacists, ensuring that medical records remain accessible regardless of physical document status. By providing a permanent digital repository, the system eliminates the risks of document loss and the resulting disruptions in treatment continuity. Additionally, the interface is designed to be responsive and lightweight, allowing for seamless operation even in resource-constrained environments or areas with limited connectivity.

4.1. System Functionality and User Roles

The platform operates as a multi-user web application with distinct, secure dashboards tailored to specific needs:

- **Patient Access**: The website assists users in maintaining a permanent record of their previous prescriptions and allows them to view their complete history in a consolidated view.
- **Doctor Assistance**: Authorized physicians can create and upload new digital prescriptions by either selecting files from a device or using a live camera to capture a photo of a physical document.
- **Pharmacist Verification**: Pharmacists are provided with a dedicated portal to check the validity of prescriptions prior to dispensing medicine, provided they have patient authorization.

4.2. Core Workflow and Authentication

The system uses a structured workflow to ensure that sensitive data is managed with high levels of security and usability:

- **Aadhaar-Linked Login**: Users access the platform using their registered mobile number and Aadhaar number, which acts as the primary identifier for linking patient records.
- **Identity Verification**: The system utilizes a simulated OTP (One-Time Password) process to

authenticate users, ensuring secure access without requiring real-time government API dependencies.

- **Data Preservation**: All prescriptions are uploaded to a secure cloud database where they are tagged with the patient's Aadhaar number for reliable long-term retrieval.

4.3. Integrity and Security Mechanism

To prevent the risks of forgery associated with physical documents, the methodology incorporates a verifiable chain of custody:

- **Digital Signatures**: The system automatically generates a unique SHA-256 cryptographic hash for every uploaded prescription file to ensure its integrity.
- **Tamper Detection**: Users and pharmacists can verify a prescription by re-computing its current hash; if the file has been altered, the system will signal a mismatch, flagging it as tampered.
- **Role-Based Access Control (RBAC)**: Permissions are strictly defined so that users only have the scope required for their role, such as patients only having "Read (self only)" access.

4.4. Block Diagram of the Proposed Solution

The following block diagram outlines the sequence of operations for the proposed system, ensuring every user action is authenticated and recorded within a secure environment:

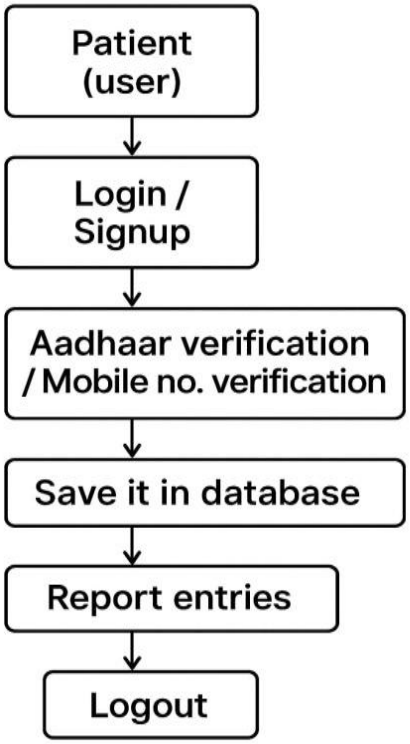


Figure 1: Methodology Block Diagram

16. System Design and Implementation

The architecture of the **Aadhaar-linked prescription recovery system** is designed to be a scalable, web-based application that ensures high accessibility and security. To provide a reliable experience across both urban and rural healthcare setups, the system follows a multi-tier architectural blueprint.

5.1. System Architecture

The platform is built using the **Model-View-Controller (MVC)** pattern within the Flask framework.

- **Client Tier (Presentation Layer)**: This is the user's web browser, which handles interactions, displays dashboards, and captures prescription images via the camera.
- **Server Tier (Application Layer)**: A Python-based Flask application that contains the business logic, request routing, and session management.
- **Data Tier (Persistence Layer)**: A MySQL database server that persistently stores user profiles, prescriptions, and cryptographic digital signatures.

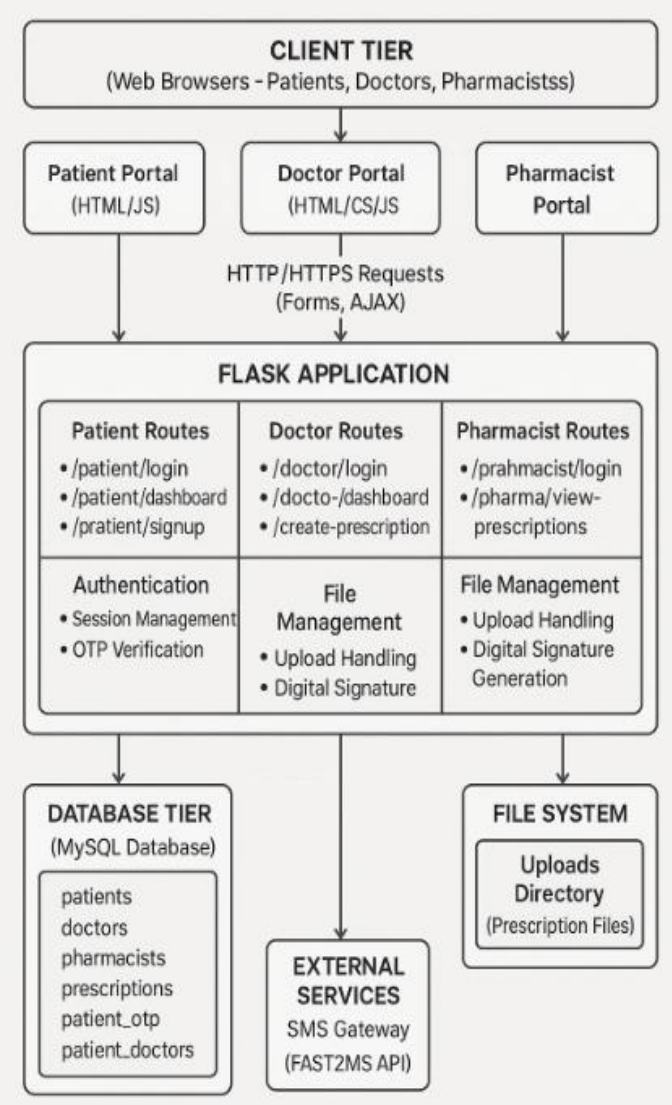


Figure 2: Multi-Tier System Architecture

5.2. Technical Specifications

The system is designed to be lightweight, allowing it to operate efficiently even on standard hardware.

- **Hardware**: Requires a minimum of 4 GB RAM and a 1.5 GHz dual-core processor for development.
- **Software**: Built using Python 3.8+, Flask web framework, and a MySQL database.
- **Security Tools**: Utilizes the SHA-256 algorithm for generating digital signatures to ensure file integrity.

17. System Testing and Performance Evaluation

Rigorous testing was conducted to verify that the integrated platform meets the safety and usability requirements identified in the literature.

6.1. Functional and Security Validation

The system was tested against several key scenarios to ensure a "verifiable chain of custody".

- **Integrity Testing**: The system accurately identified "verified" status for unaltered prescriptions and flagged "tampered" status for files modified in storage.
- **Access Control**: Testing confirmed that pharmacists can only view prescriptions after validating an OTP provided by the patient.
- **Authentication**: Unauthorized attempts to access dashboards directly via URL were successfully blocked by the system's session management.

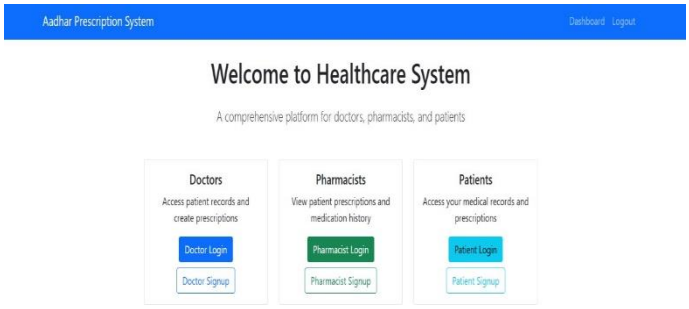
6.2. Performance Metrics

The system remains highly responsive, meeting the requirement for sub-3-second load times.

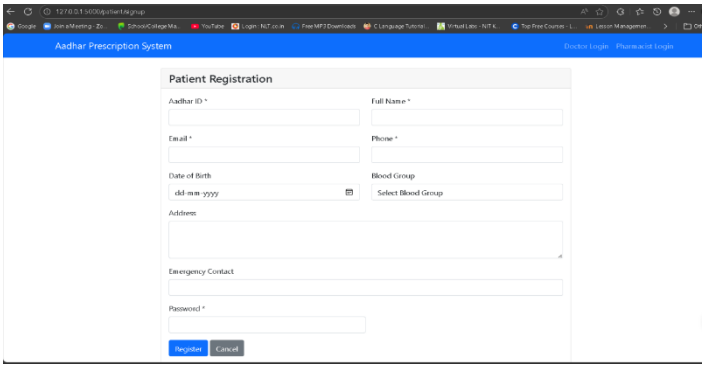
- **Dashboard Loading**: Standard views load in under 1 second.
- **Hashing Efficiency**: The SHA-256 operation is completed in under 1 second for files up to 10 MB, ensuring security does not delay treatment.

18. Results/Outcomes

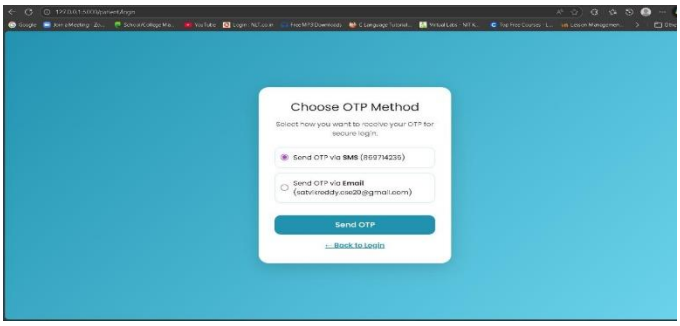
[1] Role-based landing interface of the Aadhaar Prescription System providing separate access portals for doctors, pharmacists, and patients.



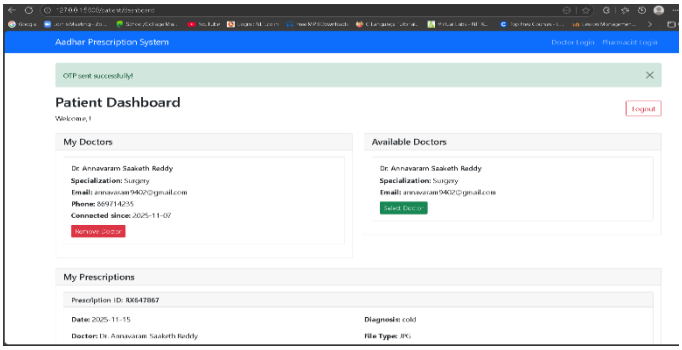
[2] Patient registration module capturing Aadhaar-linked demographic and contact information for secure account creation.



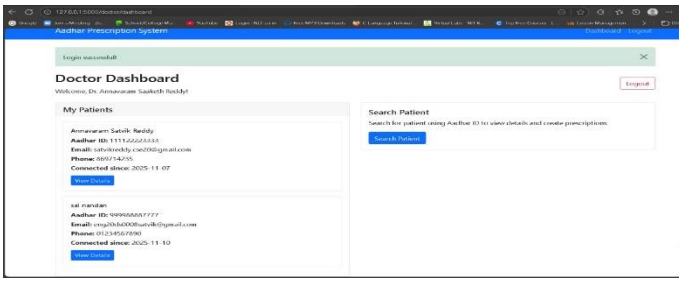
[3] OTP-based authentication interface allowing users to verify identity via registered mobile number or email.



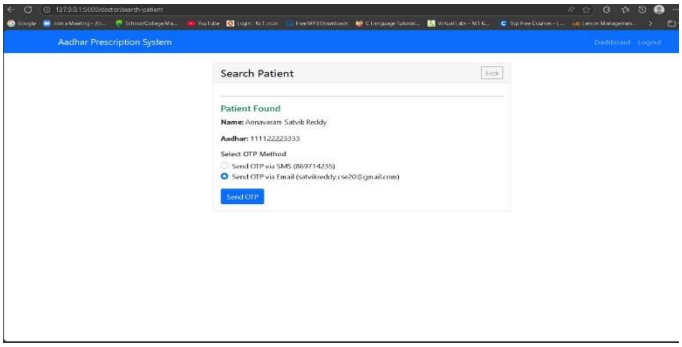
[4] Patient dashboard displaying connected doctors and retrieved digital prescriptions after successful authentication.



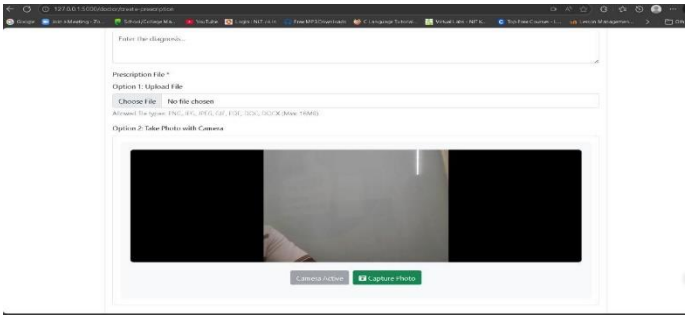
[5] Doctor dashboard enabling patient search, record access, and prescription management using Aadhaar ID.



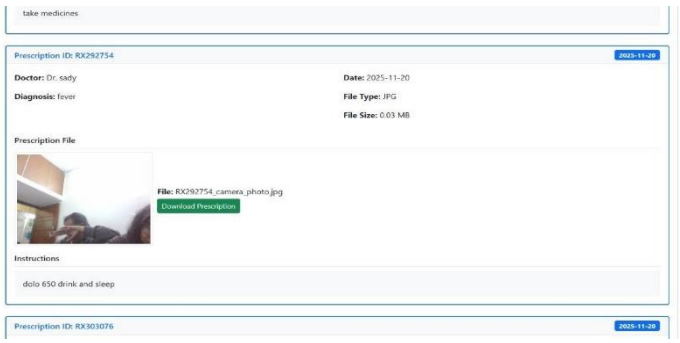
[6] OTP-based patient consent mechanism allowing doctors to access patient records only after verification.



[7] Prescription creation interface supporting both file upload and live camera capture of handwritten prescriptions.



[8] Secure prescription storage and retrieval view showing prescription metadata and downloadable prescription file.



19. Conclusion

From this review and implementation, it is evident that a scalable and Aadhaar-referenced system for prescription recovery is both feasible and necessary. The project successfully demonstrates a secure, web-based solution that addresses the critical shortcomings of traditional paper systems—specifically the risks of loss, forgery, and unauthorized access.

By integrating **SHA-256 digital signatures** and a **simulated OTP-based verification** process, the platform ensures that medical records remain both intact and accessible only with patient consent. While the current system is a functional prototype, it lays a strong foundation for future integration with national health infrastructure and the development of modules like telemedicine and AI-powered analytics. Ultimately, this solution serves to enhance treatment continuity and foster trust across the Indian healthcare ecosystem.

Acknowledgements

The authors confirm that this research was conducted as an independent study. This work did not receive any specific grant or financial assistance from funding agencies in the public, commercial, or not-for-profit sectors.

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