

# **I-Care: A Web-Based Personal Health Management System**

**H.L.M Thilakarathna  
2025**



# **I-Care: A Web-Based Personal Health Management System**

**A thesis submitted for the Degree of Master  
of Information Technology**

**H.L.M Thilakarathna  
University of Colombo School of Computing  
2025**



# Declaration

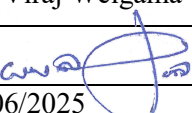
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# Preface

This thesis serves as a formal record of the work undertaken for the development of the ICare Personal Health Management System. It provides a comprehensive account of the challenges faced, the methodologies applied, and the outcomes achieved during the project. The purpose of this report is not only to document the steps taken in developing ICare but also to offer valuable insights to future researchers, developers, and healthcare professionals interested in personal health management systems and similar applications.

The creation of this system was driven by the need to enhance communication and data accessibility among healthcare stakeholders, including doctors, patients, guardians, pharmacists, lab technicians, and administrators. This thesis highlights the design, implementation, and evaluation phases of the project, reflecting the effort to create an efficient and secure solution for managing medical records, prescriptions, lab reports, health metrics, and vaccinations. It is intended to serve as a reference for future work in improving digital healthcare management.

Throughout this thesis, I have relied on continuous guidance and feedback from my supervisor, whose expertise has been invaluable in refining the project. Additionally, the support from my academic staff, colleagues, and family has played a crucial role in bringing this project to completion. Their encouragement and constructive input have helped shape the direction and quality of this work.

The structure of this thesis follows a standard project-based dissertation format, covering the following chapters:

- Introduction: Outlines the project scope, objectives, and significance.
- Background/Related Work: Reviews similar healthcare systems, existing literature, and best practices in digital health.
- Design: Details the architectural decisions, system components, and planning strategies.
- Implementation: Describes the development process, including key technologies, system functionalities, and database management.
- Evaluation and Testing: Provides insights from system validation, testing results, and user feedback.
- Conclusion: Summarizes key findings, project limitations, and future enhancements.

This thesis represents my understanding and proficiency in software engineering practices, particularly in web-based health management systems development. It also demonstrates my ability to apply academic writing standards, system design principles, and technical methodologies in a coherent and structured manner. Throughout the project, I have incorporated best practices in software architecture, user experience, data security, and system evaluation to ensure that ICare effectively meets the needs of its users and stakeholders.

This preface sets the stage for a deeper exploration of the ICare Personal Health Management System, and I hope it serves as both an informative and useful guide for readers interested in understanding the challenges, solutions, and results of this project.

# Abstract

Managing personal healthcare efficiently is a significant challenge due to the lack of a centralized system that connects patients, medical professionals, and healthcare stakeholders. Currently, patients must maintain medical records manually and communicate with multiple healthcare providers separately, leading to delays, inefficiencies, and difficulties in accessing medical history, prescriptions, and lab reports. This project aims to develop ICare: A Personal Health Management System, a web-based platform that streamlines the interaction between doctors, patients, guardians, pharmacists, lab technicians, and administrators, providing a structured and secure system for managing personal health data.

The ICare system facilitates healthcare management by offering features such as electronic prescription management, lab test result uploads, vaccination records, health metric tracking, and secure medical communication. The system ensures that patients can access and manage their medical information efficiently, while healthcare professionals can update and track patient records seamlessly. The role-based access control feature ensures that only authorized users can access relevant patient data, enhancing privacy and security.

This project follows a three-tier architecture with an MVC design pattern to maintain modularity and scalability. The system is developed using ASP.NET Core MVC for backend development, SQL Server for database management, and Angular for the frontend interface. The authentication process is secured using hashed passwords, ensuring data protection. The system also integrates jsPDF for report generation, allowing users to generate and download medical summaries, prescriptions, and test reports.

The development approach follows an iterative model, ensuring continuous improvements based on stakeholder feedback. Manual and automated testing was conducted to evaluate the system's functionality, performance, and user experience. The usability testing results indicate that users find the system intuitive, particularly in medical record accessibility, prescription handling, and lab test result management. However, some users suggested enhancements, such as additional notification features, improved search functionality, and expanded report customization options. These insights will be considered for future system enhancements to improve healthcare data management further.

By providing a centralized and secure digital health platform, the ICare system aims to improve patient-doctor communication, reduce medical record fragmentation, and enhance overall healthcare efficiency. This project lays the foundation for future advancements in personalized healthcare solutions, ensuring accessibility, accuracy, and reliability in managing medical records.

# Acknowledgments

I would like to express my sincere gratitude to my supervisor, [Supervisor's Name], for their invaluable guidance, support, and encouragement throughout the development of the ICare Personal Health Management System. Their insights and expertise have played a crucial role in shaping the direction of this project, ensuring that it meets both academic and practical standards.

I extend my heartfelt appreciation to the academic staff at the [Your University Name], whose continuous support and constructive feedback have been instrumental in refining my work. Their dedication to fostering a strong learning environment has greatly contributed to my growth as a researcher and developer.

I am also deeply thankful to my family and friends for their unwavering support and motivation during this journey. Their encouragement and belief in my abilities have been a constant source of strength.

Special thanks to the doctors, patients, pharmacists, lab technicians, and guardians who participated in the requirement gathering process and user evaluations. Their valuable insights and feedback have significantly contributed to the enhancement of this system, ensuring that it effectively meets the needs of all stakeholders.

Finally, I extend my gratitude to all the users who participated in testing and provided feedback, helping to improve the functionality and usability of the ICare system. Without the support of these individuals and groups, this project would not have been possible.

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# List of Acronyms

MVC - Model View Controller

ERD - Entity Relationship Diagram

UML - Unified Modelling Language

OOP - Object Oriented Programming

# Chapter 1: Introduction to the Project

This chapter presents an overview of I-Care, a web-based Personal Health Management System that enhances communication and data accessibility among healthcare stakeholders. It explains the motivation behind the project by identifying the limitations of existing healthcare management solutions. Additionally, the chapter introduces the proposed system, outlines its scope, and discusses the expected benefits and challenges. Furthermore, a feasibility study is included to evaluate the practicality of implementing the system.

## 1.1 Overview

Healthcare is a critical aspect of human life, and maintaining accurate medical records is essential for effective patient care. However, existing healthcare systems often lack an integrated platform for managing medical records, prescriptions, lab reports, vaccinations, and drug issuance in a centralized and secure manner. Most current systems provide isolated functionalities for different stakeholders (e.g., doctors, pharmacists, and lab technicians) without seamless communication between them.

Additionally, many healthcare applications fail to offer role-based access control, which ensures that only authorized users can access specific patient information. Guardians, for instance, may not always have permission to view a patient's medical details unless explicitly granted. Similarly, patients often struggle to track their prescribed medications, lab test reports, and vaccination history due to fragmented healthcare documentation.

To address these challenges, I-Care has been developed as a comprehensive web-based Personal Health Management System that enables multiple user roles—Doctors, Patients, Pharmacists, Guardians, Lab Technicians, and Admins—to interact within a single platform. The system enhances data management, improves patient-doctor communication, and provides analytical insights through real-time reports.

Furthermore, the proposed system includes an advanced role-based access control mechanism, ensuring data security and compliance with privacy regulations. With this system, users can efficiently manage healthcare-related information, reducing manual paperwork and streamlining healthcare processes.

## 1.2 Motivation

The increasing reliance on digital health solutions highlights the need for an integrated healthcare management system. Current medical record-keeping processes are often fragmented, leading to inefficiencies in accessing and managing patient data. Patients face difficulties in keeping track of their medical prescriptions, issued drugs, lab reports, and vaccination details, while doctors and pharmacists struggle with manual record management.

Moreover, guardians who assist in patient care often lack access to vital medical details unless provided manually. This creates a gap in healthcare decision-making, particularly for dependent patients such as children, elderly individuals, and those with chronic illnesses.

Given these challenges, I-Care has been designed to provide a unified, web-based solution that allows:

- Doctors to manage prescriptions, lab reports, vaccinations, and medical advice.
- Patients to access their medical history, issued drugs, and vaccination details.
- Pharmacists to track issued medicines and prescribed drugs.
- Guardians to view dependent patient records with explicit permissions.
- Lab Technicians to handle lab test reports efficiently.
- Admins to oversee user management and system analytics.

By digitizing and centralizing healthcare management, this system aims to improve efficiency, security, and accessibility for all stakeholders.

## 1.3 Aim and Objectives

### Aim:

The primary aim of the I-Care system is to develop a secure, web-based platform that facilitates efficient medical record management and enhances healthcare accessibility for patients, doctors, pharmacists, guardians, lab technicians, and admins.

### Objectives:

To achieve this aim, the system is designed with the following key objectives:

- Role-Based Access Control: Ensure that each user type (Doctor, Patient, Pharmacist, Guardian, Lab Technician, Admin) can access only the data relevant to their role.
- Prescription Management: Allow doctors to create, update, and track patient prescriptions.
- Lab Report Handling: Enable lab technicians to upload, manage, and share test results securely.
- Drug Issuance Tracking: Let pharmacists view prescriptions and track issued medications.
- Guardian Access Control: Provide authorized guardians access to dependent patients' health records.
- Health Metrics & Vaccination Tracking: Allow doctors and patients to record and monitor health-related data.

- Reporting & Analytics: Generate role-specific reports, such as:
  - Doctors: Prescription summary, appointment consultations, medical advice history.
  - Patients: Health metrics summary, prescription history, lab test reports, vaccination records.
  - Pharmacists: Most prescribed medicines, medication issued per patient.
  - Guardians: Dependent's prescription history, lab test reports, medication orders.
  - Lab Technicians: Patient test history, lab tests conducted.
  - Admins: Active user counts by role.

By implementing these features, the system provides an organized, efficient, and user-friendly platform for managing personal healthcare information.

## **1.4 Scope of the System**

The I-Care system is designed to be a web-based application, ensuring accessibility across various devices with internet connectivity. The following aspects define the scope of the system:

- User Management: Secure login and registration for different user types (Doctors, Patients, Pharmacists, Guardians, Lab Technicians, Admins).
- Electronic Health Records (EHR): Centralized storage of medical prescriptions, lab reports, health metrics, and vaccination records.
- Guardian-Patient Relationship: Patients can assign guardians with controlled access to their medical data.
- Role-Specific Features: Each user type has distinct functionalities tailored to their healthcare responsibilities.
- Reporting & Analytics: Users can generate reports based on time filters, patient IDs, and doctor IDs for detailed insights.
- Security & Compliance: The system implements role-based access to ensure patient privacy and medical data protection.

### **Limitations of the System:**

- Web-Based Only: The system is not developed as a mobile application, limiting accessibility for users preferring mobile-first solutions.
- Guardian Access Restriction: Patients must explicitly grant access to guardians for viewing their medical data.
- Data Entry Dependency: The accuracy of health metrics, prescriptions, and reports depends on correct data input by users.
- No Offline Mode: Requires an active internet connection for functionality.

## 1.5 Feasibility Study

A feasibility study evaluates the practicality of implementing I-Care by analyzing its technical, economic, and operational aspects.

- **Technical Feasibility:**  
The system is built using a .NET Core Web API backend and an Angular frontend, leveraging user authentication for secure access. The technology stack ensures scalability and data security.
- **Economic Feasibility:**  
The development and maintenance costs are minimized by using open-source technologies and cloud-based hosting, making the system cost-effective.
- **Operational Feasibility:**  
The system is designed to be user-friendly, with an intuitive interface for healthcare professionals, patients, and guardians. The role-based access model ensures smooth workflow integration within healthcare settings.

## 1.6 Structure of the Dissertation

The dissertation is structured as follows:

- **Chapter 1: Introduction to the Project** – Provides an overview of the project, its motivation, objectives, scope, and feasibility.
- **Chapter 2: Problem and Requirement Review**– Discusses existing healthcare systems, role-based access control, and related studies.
- **Chapter 3: Design** – Outlines the system architecture, development approach, and implementation techniques.
- **Chapter 4: Development and Implementation**– Covers the development process, system components, and key features.
- **Chapter 5: Testing and Evaluation** – Describes the testing procedures, evaluation criteria, and performance analysis.
- **Chapter 6: Conclusion**– Summarizes findings, system limitations, and potential future improvements.
- **References & Appendices** – Includes cited research and supplementary materials.



# Chapter 2: Problem and Requirement Review

## 2.1 Introduction

This chapter presents a comprehensive analysis of the problem domain, focusing on the existing healthcare management systems and their limitations. It highlights the gaps in current web and mobile-based medical record management solutions and justifies the need for the I-Care system. Additionally, the chapter includes a functional requirement analysis and a comparative review of similar healthcare applications to showcase the advantages of the proposed system.

## 2.2 Background of the Problem

### 2.2.1 Data Collection

To identify the challenges in the existing healthcare systems and define the requirements for the proposed **I-Care** system, data was collected using multiple research methodologies:

- Interviews with Healthcare Professionals: Discussions were conducted with doctors, pharmacists, lab technicians, and hospital administrators to understand the current challenges in managing medical records, prescriptions, and lab reports.
- Online Surveys: Feedback was gathered from people in the society to understand their difficulties in accessing medical records, prescriptions, and vaccination details.
- Guardian Observations: Data was collected on how guardians assist in patient care and their need for access to dependent patient records.

The insights gained from these data collection methods served as the foundation for designing I-Care, ensuring that it effectively addresses the challenges faced by different healthcare stakeholders.

### 2.2.2 User Research and Online Survey Analysis

To ensure that the I-Care system effectively addresses the needs of users, an online survey was conducted to gather insights on the limitations of existing healthcare applications and the challenges faced by users. The objective of this survey was to identify gaps in current personal healthcare management systems and to validate the necessity of I-Care's core functionalities. This survey aimed to answer the following key questions:

- What are the most common challenges faced by users when managing their personal health records digitally?
- How frequently do users interact with existing healthcare applications?
- What features are most desired by patients, doctors, and other stakeholders?
- What concerns do users have regarding data security and accessibility in healthcare apps?

The survey was conducted online and targeted individuals who actively engage with digital healthcare services, including patients, doctors, guardians, lab technicians, and pharmacists. The questionnaire was designed to cover the following key aspects:

Demographics & Background – Understanding the respondent's role in healthcare (patient, doctor, pharmacist, etc.).

Experience with Current Healthcare Apps – Identifying frequently used apps and common pain points.

Challenges in Personal Health Management – Gathering information on difficulties in accessing medical history, prescriptions, lab reports, and health metrics.

Feature Preferences for a New Healthcare App – Assessing the demand for functionalities like secure medical record storage, prescription tracking, vaccination reminders, health analytics, and role-based access.

Concerns Regarding Healthcare Apps – Evaluating users' views on privacy, security, and usability issues.

The survey was shared through email invitations, social media platforms, and healthcare professional networks.

Respondents were given 10-15 minutes to complete the survey, and their participation was voluntary and anonymous.

User Research Questionnaire for Personal Health App I-Care

Welcome to our user research survey! I am in the process of developing a personal health app called "I Care," and I am eager to gather your invaluable feedback to ensure it aligns perfectly with your needs and expectations. Your insights will play a crucial role in shaping the features and functionalities of the app. The survey will take approximately 10 to 15 minutes to complete, and your participation is greatly appreciated.

Question

Multiple choice

Option 1

Figure 2. 1:Online Survey Form

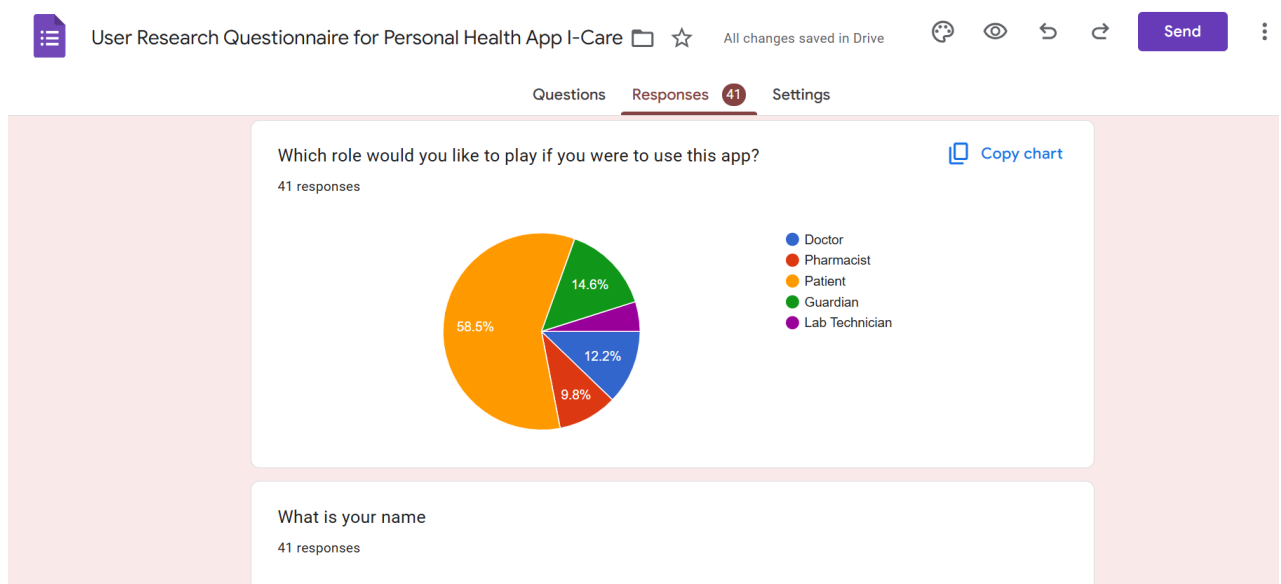


Figure 2. 2:Online Survey Results

## Key findings from the survey

The analysis of the survey responses highlighted the following major challenges with existing health management systems and applications:

### 1. Difficulty in Accessing Medical Records

Doctors (70%) reported difficulty in retrieving complete patient histories across different systems.

Patients (65%) mentioned issues with fragmented medical records, requiring them to manually track prescriptions, lab results, and vaccinations.

Guardians (50%) stated they found it hard to manage medical records for dependents.

## 2. Lack of Integration Between Systems

Across all user roles, one of the top concerns was the lack of a centralized system where prescriptions, lab reports, and medical advice could be accessed seamlessly.

Pharmacists (60%) and lab technicians (55%) indicated that manual processes cause inefficiencies in verifying prescriptions and processing lab test results.

## 3. Security Concerns in Existing Systems

Doctors (80%), pharmacists (75%), and patients (60%) expressed concerns about data privacy and security.

Many users preferred secure login mechanisms, encryption, and restricted access to sensitive medical information.

## 4. High Demand for Role-Specific Features

Doctors emphasized the need for features like electronic prescriptions, drug interaction warnings, lab test management, and patient health tracking.

Patients wanted features such as appointment scheduling, medical test notifications, symptom checkers, and integration with wearable health devices.

Guardians found medication reminders, dependent health tracking, and access to test results highly beneficial.

Lab technicians requested structured templates for test results, integration with hospital databases, and real-time validation tools.

Pharmacists needed automated inventory tracking, patient medication history, and easy prescription verification.

## 5. Preference for Mobile Notifications and Digital Updates

Patients (68%) and guardians (72%) preferred mobile notifications (push notifications, SMS, or emails) for medication reminders, appointment alerts, and lab result availability.

Doctors and pharmacists (85%) favored in-app messaging for communication rather than phone calls or emails.

## The Importance of Real-Time Data and Reporting

Doctors (75%) and lab technicians (65%) found real-time updates on patient vitals, test results, and medication interactions highly valuable.

Pharmacists (60%) wanted features that allowed them to track issued drugs and inventory levels in real time.

Guardians (55%) needed features that provided automated health reports for their dependents.

### Communication Gaps in Current Healthcare Solutions

Doctors (65%) and patients (60%) expressed frustration with the lack of direct and structured communication between healthcare providers and patients.

Many respondents suggested an in-app communication system that allows secure messaging between doctors, pharmacists, and patients.

## 2.3 Functional Requirements

The **I-Care** system introduces several key functionalities to enhance healthcare management.

### 2.3.1 Secure Role-Based Access Control (RBAC)

- Ensures that Doctors, Patients, Pharmacists, Guardians, Lab Technicians, and Admins can only access data relevant to their roles.
- Patients can control what information their guardians can view.

### 2.3.2 Electronic Prescription Management

- Doctors can create, update, and manage prescriptions.
- Prescriptions include recommendations for lab tests.
- Patients and pharmacists can view and download prescriptions.

### 2.3.3 Lab Report Handling

- Lab Technicians can upload, update, and delete lab test reports.
- Doctors, Patients, and Guardians (if allowed) can access lab reports.

### 2.3.4 Medication Issuance Tracking

- Pharmacists can track issued medications.
- Patients can view their issued drug history.

### 2.3.5 Health Metrics & Vaccination Tracking

- Doctors can add and update health metrics and vaccination details for patients.
- Patients and Guardians (if authorized) can view these records.

### 2.3.6 Guardian Role Management

- Patients can assign or update guardians with restricted access.
- Guardians can view prescriptions, lab reports, and issued drugs for their dependent patient.

### 2.3.7 Reporting & Analytics Dashboard

- Users can generate real-time reports based on their role.
- Reports include:
  - Doctors: Prescription summary, appointment consultations, given medical advice.
  - Patients: Health metrics summary, prescription history, vaccination reports.
  - Pharmacists: Most prescribed medicines, medication issued reports.
  - Guardians: Dependent's prescription history, medication order reports.
  - Lab Technicians: Patient test history, tests conducted by technician.
  - Admins: Active user statistics by user type.

## **2.4 Review of Similar Systems**

To assess the need for I-Care, a comparison was made with existing healthcare and medical record management applications. The analysis revealed several limitations in currently available systems.

### **2.4.1 MyChart (Epic Systems)**

MyChart is a patient-focused electronic health record (EHR) system that allows patients to view their medical history and communicate with doctors.

Limitations of MyChart:

- No Role-Based Guardian Access: Guardians cannot be assigned controlled access to patient records.
- Limited Prescription & Medication Tracking: It does not provide detailed tracking of issued medications.
- No Pharmacist or Lab Technician Integration: Pharmacists cannot verify issued drugs, and lab technicians cannot directly upload reports.
- Basic Reporting Features: Limited analytics for doctors and patients.

### **2.4.2 Medscape**

Medscape is a medical information platform used by healthcare professionals for drug interactions, disease research, and medical news.

Limitations of Medscape:

- Not a Personal Health Management System: It does not allow patients to track their prescriptions or medical history.
- No Role-Based User Access: Does not cater to multiple healthcare stakeholders.
- Lacks Lab Report Management & Medication Tracking.

### **2.4.3 Microsoft HealthVault (Discontinued)**

Microsoft HealthVault was an online personal health record system that allowed users to store and share health data.

Limitations of HealthVault:

- No Guardian Access Feature: Did not support role-based patient-dependent management.
- No Integrated Prescription & Lab Report Management: Users had to manually input data.
- Limited Support for Doctors & Pharmacists: No prescription tracking or pharmacist verification system.

## 2.5 Comparison of Features in Existing Systems and the Proposed System

The table below summarizes how I-Care improves upon existing solutions by integrating role-based access control, prescription tracking, lab report management, and real-time reporting.

| Features                              | MyChart | Medscape | HealthVault | I-Care (Proposed System) |
|---------------------------------------|---------|----------|-------------|--------------------------|
| Role-Based Access Control (RBAC)      | ✗       | ✗        | ✗           | ✓                        |
| Guardian Role with Restricted Access  | ✗       | ✗        | ✗           | ✓                        |
| Electronic Prescription Management    | ✓       | ✗        | ✗           | ✓                        |
| Lab Report Upload & Management        | ✗       | ✗        | ✗           | ✓                        |
| Pharmacist Drug Issuance Tracking     | ✗       | ✗        | ✗           | ✓                        |
| Health Metrics & Vaccination Tracking | ✓       | ✗        | ✗           | ✓                        |
| Advanced Reporting & Analytics        | ✗       | ✗        | ✗           | ✓                        |
| Patient Medical History Access        | ✓       | ✗        | ✓           | ✓                        |

Figure 2. 3: Comparison of Features

## 2.6 Conclusion

The comparative analysis of existing healthcare management systems demonstrates the gaps in current solutions and the need for a comprehensive, role-based web platform like I-Care. Unlike other platforms, I-Care provides secure, centralized healthcare management while ensuring data accessibility for patients, doctors, pharmacists, guardians, lab technicians, and admins.

# Chapter 3 – Design

This chapter provides an overview of the design process and strategies used to develop the proposed system's design. The transition of the requirements into a technical solution is outlined, covering the high-level architecture, user interaction flow, and various components of the system to ensure that it meets the needs of medical professionals, including doctors, pharmacists, patients, guardians, lab technicians, and administrators. This chapter discusses the related design strategies, system architecture, and visual representation through ER and UML diagrams.

## 3.1 Related Design Strategies

Various design strategies are available for software development, such as Structured, Functional, and Object-Oriented Design (OOD). This project focuses on an Object-Oriented Design (OOD)

strategy to adapt the requirements into a design, ensuring that the system is centered around objects that follow real-world entities. These include Doctors, Patients, Guardians, Pharmacists, Lab Technicians, and Administrators, each with unique roles and responsibilities. These objects interact with one another to perform various tasks, making the system more intuitive, modular, and easier to maintain.

By using OOD, each entity is treated as a separate class, encapsulating attributes (data) and behaviors (functions). This approach makes it easier to map the system's requirements into a structured model that reflects real-world healthcare management.

### **3.1.1 Key Classes and Objects**

- Doctor Class
  - Represents medical professionals who create prescriptions, update health metrics, and provide medical advice.
  - Attributes: Medical License Number, Specialization, Hospital Affiliation.
  - Behaviors: Creating prescriptions, adding health metrics, and managing patient records.
- Patient Class
  - Represents individuals receiving medical care.
  - Attributes: Personal details, Blood Group, Allergies, Medical History.
  - Behaviors: Viewing prescriptions, accessing lab reports, and checking vaccination records.
- Guardian Class
  - Represents individuals managing patient health on behalf of dependents.
  - Attributes: Relationship to Patient, Assigned Patients.
  - Behaviors: Viewing assigned patient records and medical history.
- Pharmacist Class
  - Represents pharmacy professionals managing drug issuance.
  - Attributes: Pharmacy License Number, Pharmacy Name.
  - Behaviors: Viewing prescriptions and issuing drugs.
- Lab Technician Class



- Represents professionals conducting lab tests and uploading reports.
  - Attributes: Lab License Number, Laboratory Name.
  - Behaviors: Conducting lab tests, uploading reports, and managing test records.
- Administrator Class
    - Oversees user management, system monitoring, and security.
    - Behaviors: Managing user roles, handling system reports, and ensuring compliance.

### **3.1.2 Encapsulation**

Encapsulation ensures that each class handles its data and methods independently. For example, the Patient class manages profile data without exposing it to other classes. Similarly, the Doctor class manages prescriptions, ensuring secure and controlled access.

### **3.1.3 Inheritance**

Inheritance helps in reducing redundancy by sharing common properties among related classes. In this system, both Doctors and Patients inherit from a generic User class, which provides common properties like UserID, Name, Contact Information, and Login Details.

### **3.1.4 Polymorphism**

Polymorphism allows different objects to be treated uniformly. In this system, all user roles (Doctors, Patients, Guardians, etc.) interact with the system through a uniform interface, ensuring consistency in accessing system functionalities.

## **3.2 System Architecture**

The proposed system follows an MVC (Model-View-Controller) architecture, a design pattern used to organize code in a modular and scalable way. This architecture maintains a separation of concerns, ensuring each layer is responsible for a specific system function.

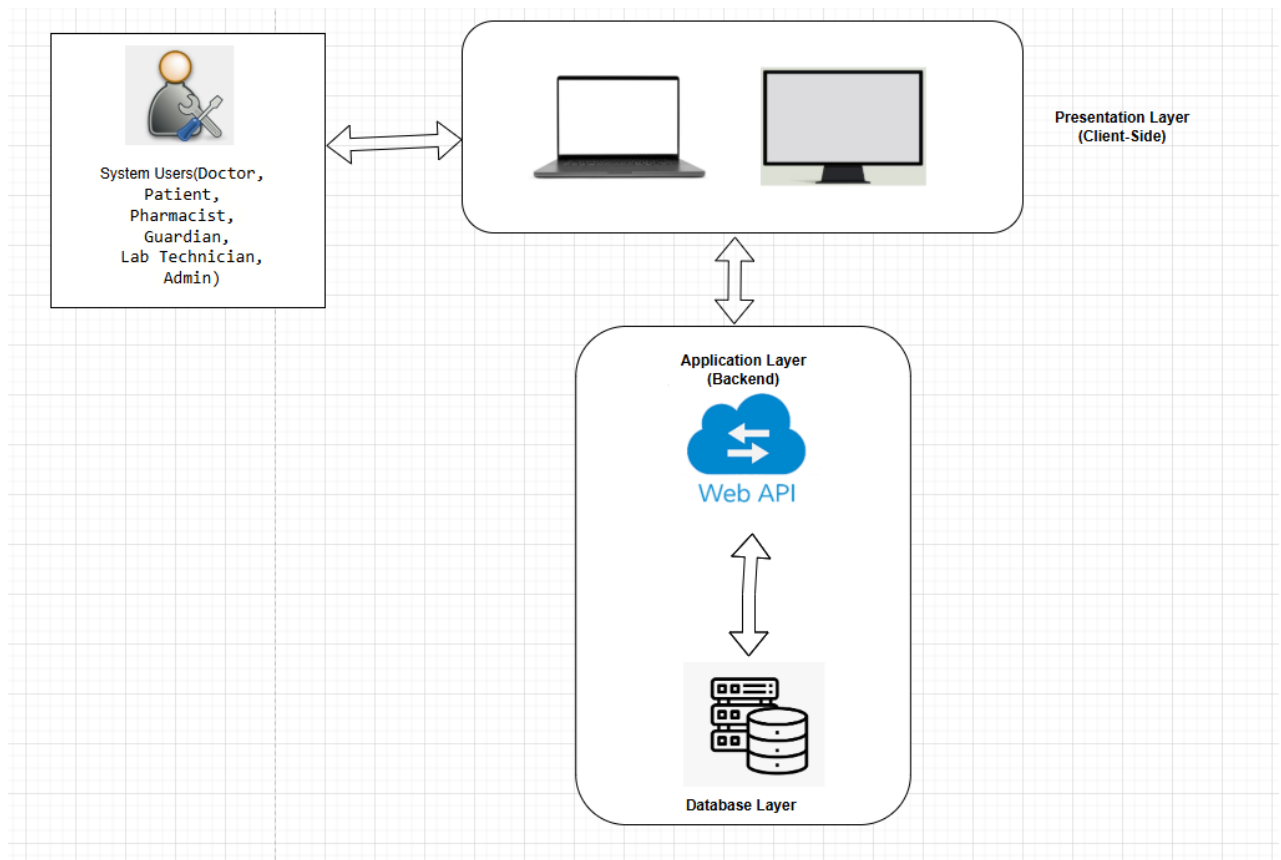


Figure 3. 1:High Level System Architecture

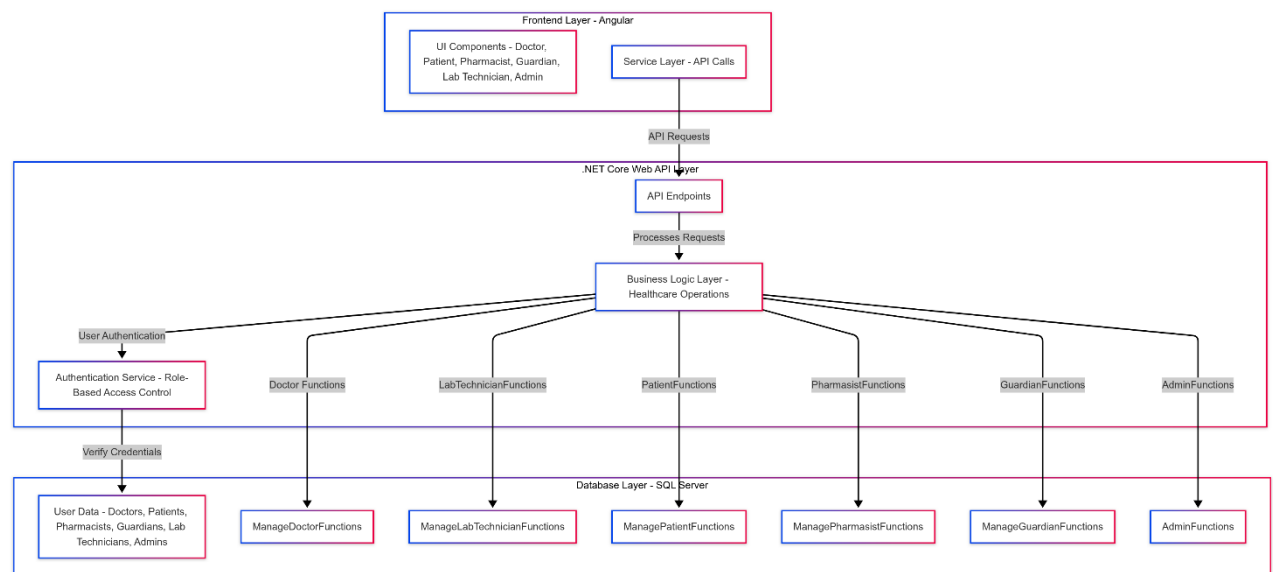


Figure 3. 2:Descriptive System Architecture

### **3.2.1 Model - Data Management**

- Manages core entities such as Doctors, Patients, Guardians, Pharmacists, Lab Technicians, Prescriptions, Lab Tests, and Health Metrics.
- Ensures data consistency, validation, and business logic execution.
- Stores structured data in an SQL Server database.

### **3.2.2 View - User Interface**

The View is responsible for presenting data to different users.

- Doctor View: Prescription management, patient records, health metrics.
- Patient View: Viewing prescriptions, lab reports, vaccination records.
- Guardian View: Managing assigned patients.
- Pharmacist View: Issuing drugs based on prescriptions.
- Lab Technician View: Uploading and managing lab reports.
- Admin View: Managing user roles, security settings, and system reports.

### **3.2.3 Controller - Business Logic and Interaction**

- Doctors Controller: Manages prescription creation, health metrics updates, and patient interactions.
- Patients Controller: Handles user authentication, prescription requests, and report access.
- Pharmacists Controller: Manages drug issuance and prescription validation.
- Lab Technicians Controller: Handles lab test processing and report uploads.
- Admin Controller: Oversees system settings, user management, and security policies.

### 3.3 Entity Relationship Diagram

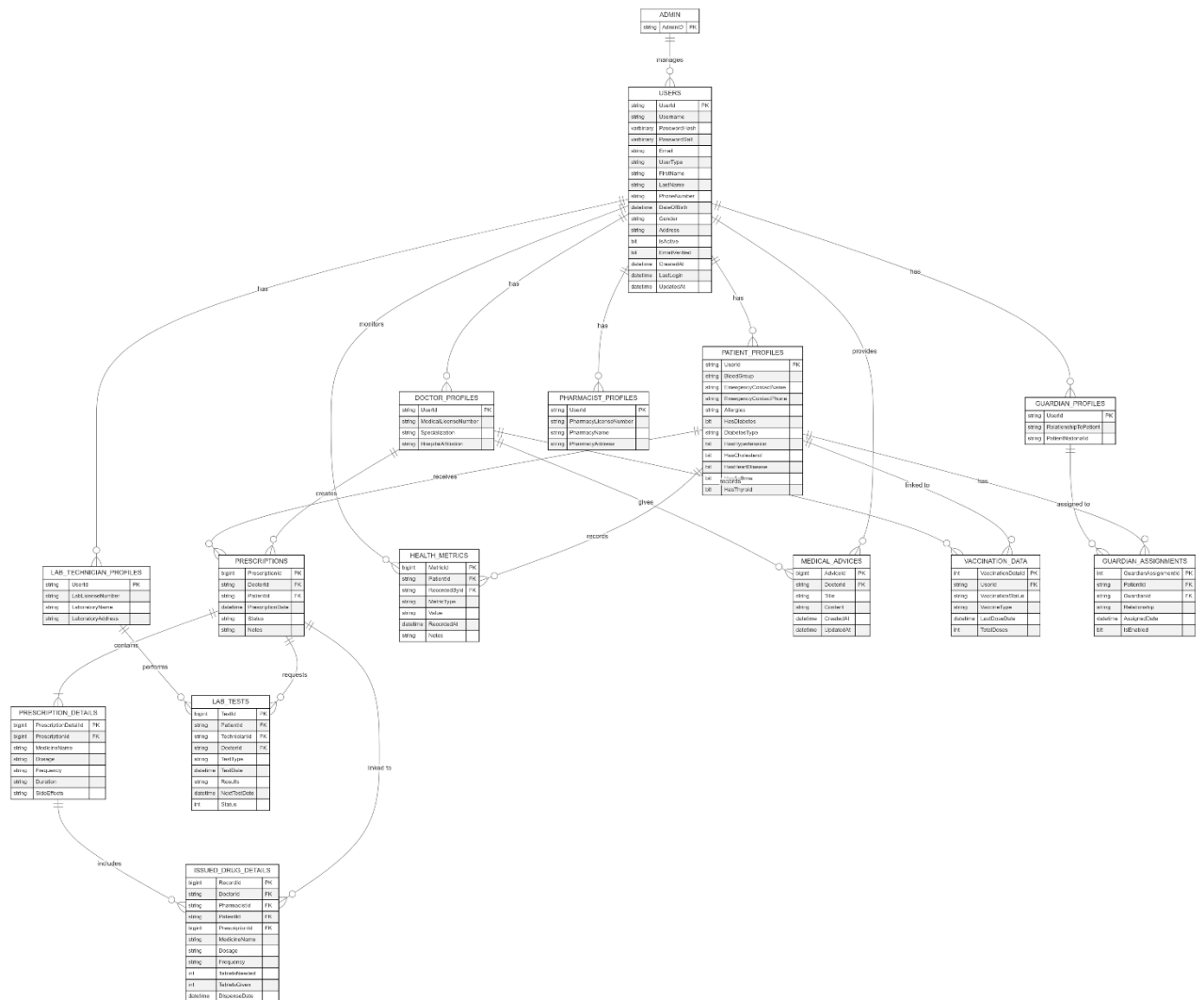


Figure 3.3: I Care ER Diagram

The ER Diagram illustrates the relationships among Doctors, Patients, Guardians, Pharmacists, Lab Technicians, Prescriptions, Health Metrics, and Lab Tests, mapping data dependencies in the system.

## 3.4 UML Diagrams

### 3.4.1 Use Case Narratives

| Author                    | Limantha                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Purpose                   | Allows doctors to create prescriptions for patients, specifying medicines, dosages, and additional notes.                                                                                                                                                                                                                                                                                               |
| Requirements Traceability | 1. The system must allow doctors to create prescriptions.<br>2. The prescription must be linked to the correct patient record.                                                                                                                                                                                                                                                                          |
| Priority                  | High                                                                                                                                                                                                                                                                                                                                                                                                    |
| Preconditions             | 1. The doctor must be logged into the system.<br>2. The patient record must exist in the system.                                                                                                                                                                                                                                                                                                        |
| Postcondition             | 1. The prescription is successfully saved and linked to the patient.<br>2. The patient and pharmacist can view the prescription.                                                                                                                                                                                                                                                                        |
| Actors                    | Doctor, Patient, Pharmacist                                                                                                                                                                                                                                                                                                                                                                             |
| Extends                   | -                                                                                                                                                                                                                                                                                                                                                                                                       |
| Flow of Events            | Basic Flow:<br>1. The doctor logs into the system.<br>2. The doctor navigates to the "Create Prescription" page.<br>3. The doctor selects a patient.<br>4. The doctor adds prescribed medicines, dosages, and notes.<br>5. The doctor submits the prescription.<br>6. The system saves the prescription and updates the patient record.<br>7. The patient and pharmacist can now view the prescription. |
| Exceptions                | 1. If mandatory fields are missing, the system prompts the doctor to enter the required details.<br>2. If the doctor tries to prescribe an unavailable medicine, the system provides an alert.                                                                                                                                                                                                          |
| Includes                  | Patient Record Lookup                                                                                                                                                                                                                                                                                                                                                                                   |
| Notes/Issues              | The system should allow automatic dosage recommendations based on the patient's medical history.                                                                                                                                                                                                                                                                                                        |

*Table 3. 1: Use Case Narrative for Create Prescription*

|                           |                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Author                    | Limantha                                                                                                                                                                                                                                                                                                                                                 |
| Purpose                   | Allows patients, doctors, and guardians (if permitted) to view lab reports uploaded by lab technicians.                                                                                                                                                                                                                                                  |
| Requirements Traceability | 1. The system must allow lab technicians to upload lab reports.<br>2. The patient and doctor must be able to view the assigned reports.                                                                                                                                                                                                                  |
| Priority                  | High                                                                                                                                                                                                                                                                                                                                                     |
| Preconditions             | 1. The user (doctor, patient, or guardian) must be logged in.<br>2. The lab report must have been uploaded by the lab technician.                                                                                                                                                                                                                        |
| Postcondition             | 1. The user successfully views the lab report.<br>2. The system logs the access timestamp for auditing.                                                                                                                                                                                                                                                  |
| Actors                    | Patient, Doctor, Guardian, Lab Technician                                                                                                                                                                                                                                                                                                                |
| Extends                   | -                                                                                                                                                                                                                                                                                                                                                        |
| Flow of Events            | Basic Flow:<br>1. The user logs into the system.<br>2. The user navigates to the "Lab Reports" section.<br>3. The system fetches and displays the available reports.<br>4. The user selects a specific report.<br>5. The system displays the report details, including test results and uploaded files.<br>6. The user can download the report as a PDF. |
| Exceptions                | 1. If no reports are available, the system notifies the user.<br>2. If the user does not have permission to access a specific report, an access restriction message is shown.                                                                                                                                                                            |
| Includes                  | Report Download Feature                                                                                                                                                                                                                                                                                                                                  |
| Notes/Issues              | Consider implementing email notifications when a new report is uploaded.                                                                                                                                                                                                                                                                                 |

*Table 3. 2: Use Case Narrative for View Lab Reports*

|                           |                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Author                    | Limantha                                                                                                                                                                                                                                                                                                                                                |
| Purpose                   | Allows pharmacists to dispense medications based on prescriptions.                                                                                                                                                                                                                                                                                      |
| Requirements Traceability | 1. The system must allow pharmacists to view prescriptions.<br>2. The system must record issued medications for tracking purposes.                                                                                                                                                                                                                      |
| Priority                  | High                                                                                                                                                                                                                                                                                                                                                    |
| Preconditions             | 1. The pharmacist must be logged into the system.<br>2. The patient must have a valid prescription.                                                                                                                                                                                                                                                     |
| Postcondition             | 1. The prescribed medicine is marked as dispensed.<br>2. The system logs the pharmacist's actions for auditing.                                                                                                                                                                                                                                         |
| Actors                    | Pharmacist, Patient                                                                                                                                                                                                                                                                                                                                     |
| Extends                   | -                                                                                                                                                                                                                                                                                                                                                       |
| Flow of Events            | Basic Flow:<br>1. The pharmacist logs into the system.<br>2. The pharmacist navigates to the "Prescriptions" section.<br>3. The pharmacist selects a prescription.<br>4. The pharmacist dispenses the medication.<br>5. The system updates the prescription status as "Issued."<br>6. The patient can now see that their medication has been dispensed. |
| Exceptions                | 1. If the prescribed medicine is unavailable, the system alerts the pharmacist.<br>2. If the prescription is expired, the system prevents dispensing.                                                                                                                                                                                                   |
| Includes                  | Prescription Validation                                                                                                                                                                                                                                                                                                                                 |
| Notes/Issues              | Consider adding a notification system for patients to know when their medication is ready for pickup.                                                                                                                                                                                                                                                   |

*Table 3. 3: Use Case Narrative for Dispense Medicine*

|                           |                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Author                    | Limantha                                                                                                                                                                                                                                                                                                                                               |
| Purpose                   | Allows administrators to add, update, and remove users from the system.                                                                                                                                                                                                                                                                                |
| Requirements Traceability | 1. The system must allow administrators to manage user accounts.<br>2. The system must maintain user activity logs.                                                                                                                                                                                                                                    |
| Priority                  | High                                                                                                                                                                                                                                                                                                                                                   |
| Preconditions             | 1. The admin must be logged in.<br>2. The user being added/updated must have the required details.                                                                                                                                                                                                                                                     |
| Postcondition             | 1. The user account is successfully added, updated, or removed.<br>2. The system logs all user management actions.                                                                                                                                                                                                                                     |
| Actors                    | Admin                                                                                                                                                                                                                                                                                                                                                  |
| Extends                   | -                                                                                                                                                                                                                                                                                                                                                      |
| Flow of Events            | Basic Flow:<br>1. The admin logs into the system.<br>2. The admin navigates to the "User Management" section.<br>3. The admin selects "Add User," "Edit User," or "Remove User."<br>4. The admin fills in or updates the required details.<br>5. The system processes the request and updates the database.<br>6. A confirmation message is displayed. |
| Exceptions                | 1. If the required fields are missing, the system prompts the admin to enter the correct details.<br>2. If the admin attempts to delete a user with active dependencies, the system prevents deletion.                                                                                                                                                 |
| Includes                  | User Role Assignment                                                                                                                                                                                                                                                                                                                                   |
| Notes/Issues              | Ensure that audit logs track all changes made by the admin.                                                                                                                                                                                                                                                                                            |

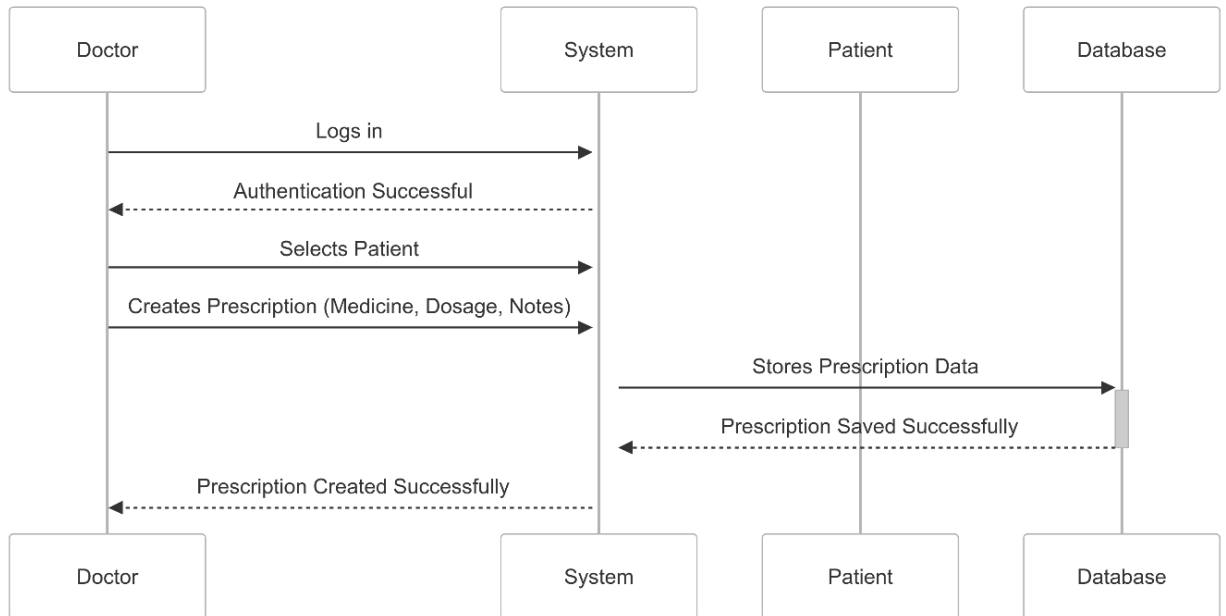
*Table 3. 4: Use Case Narrative for Admin Function*

The Use Case Narratives outlines interactions between Doctors, Patients, Guardians, Pharmacists, Lab Technicians, and Administrators, detailing primary system functionalities.



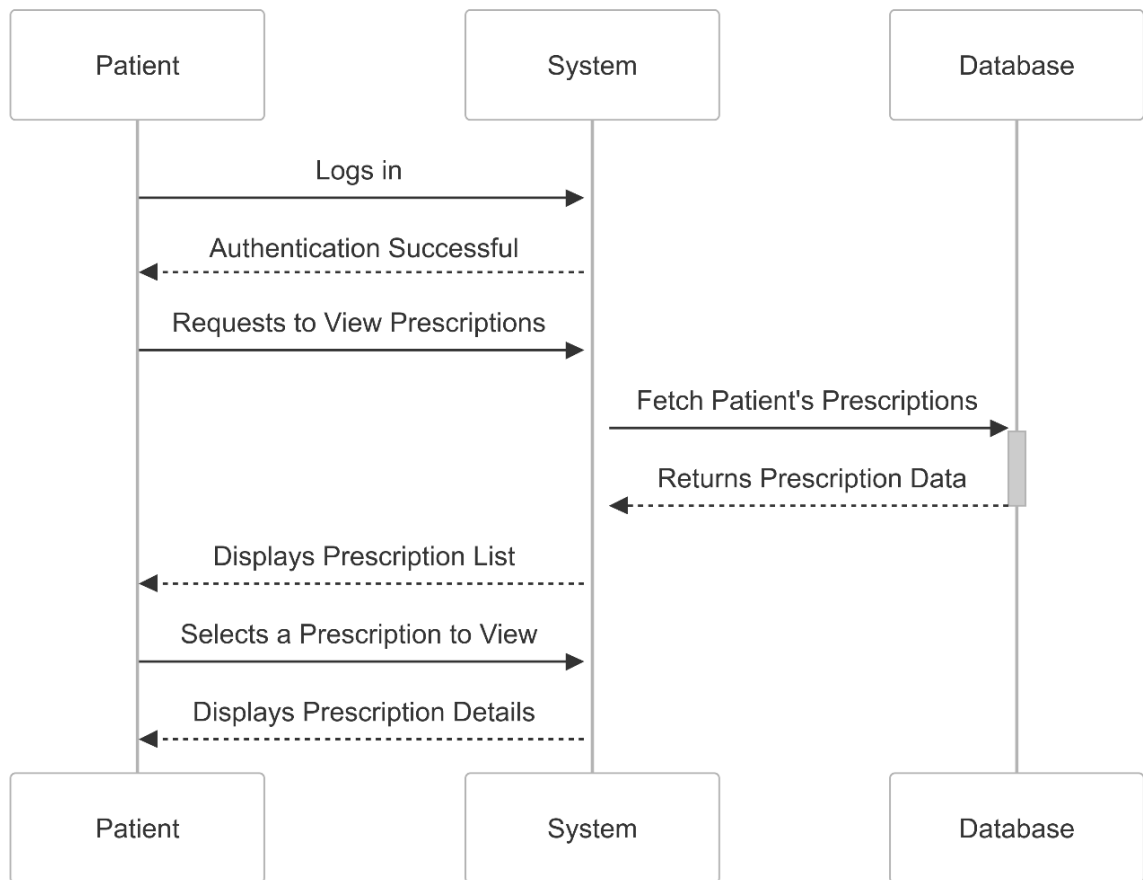
### 3.4.2 Sequence Diagrams

- **Doctor Creates Prescription**



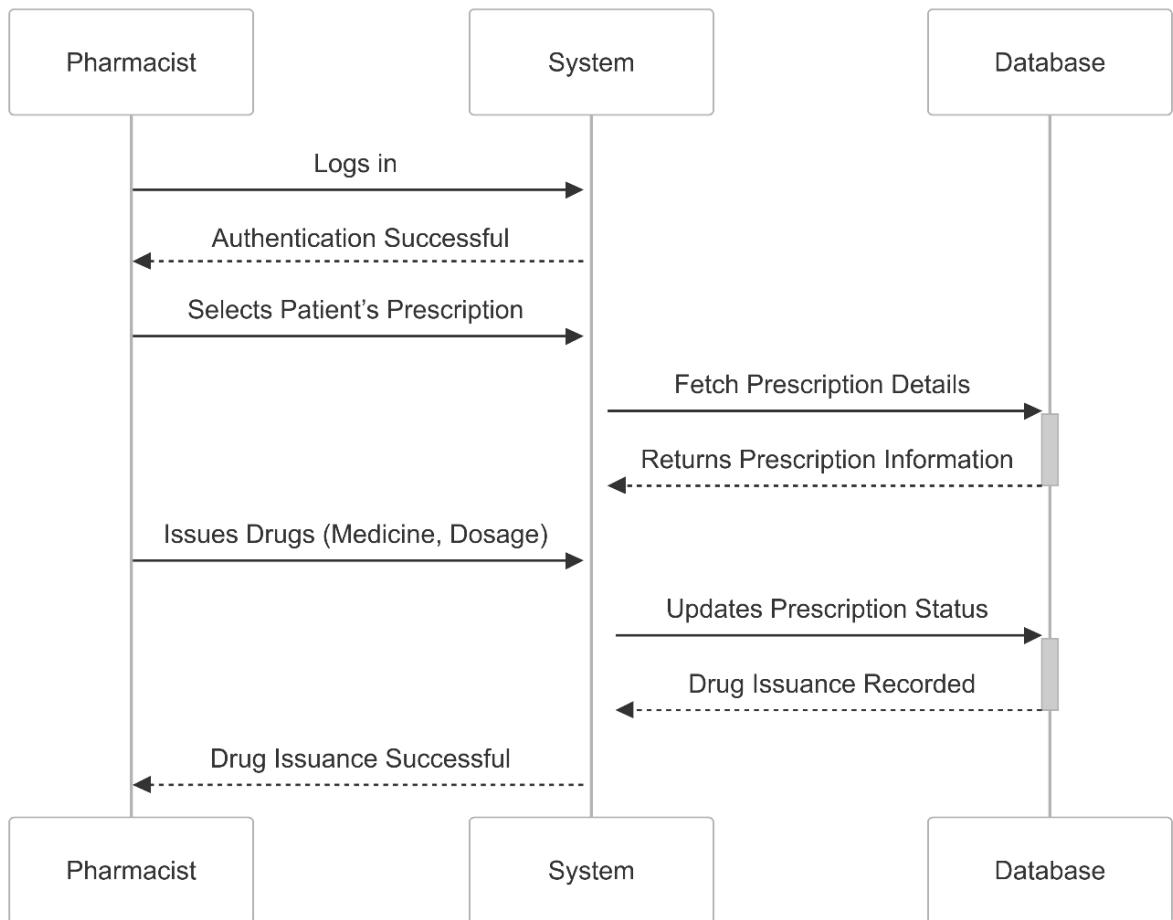
*Figure 3. 4:Sequence Diagram for Doctor Create Prescription*

- **Patient Views Prescription**



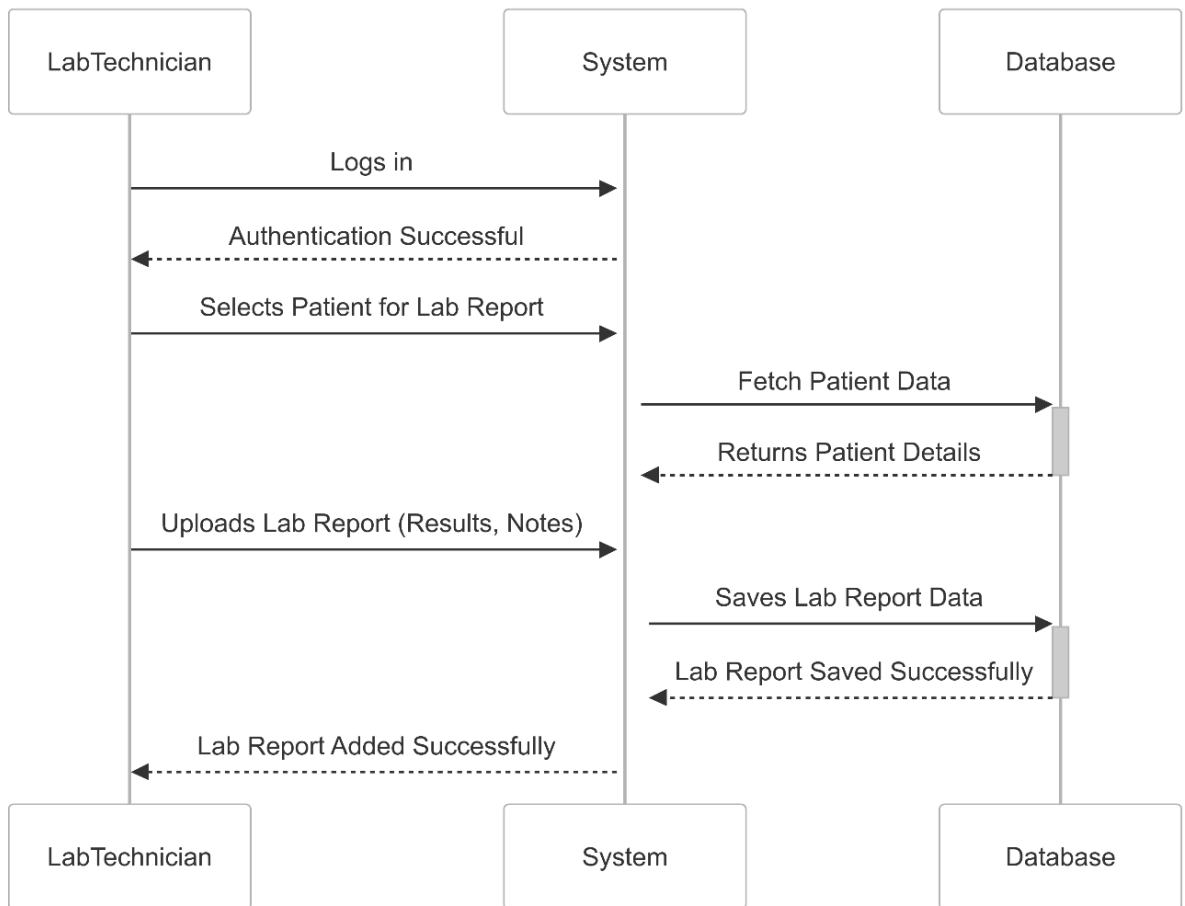
*Figure 3. 5:Sequence Diagram for Patient Views Prescription*

- **Pharmacist Issues Drugs**



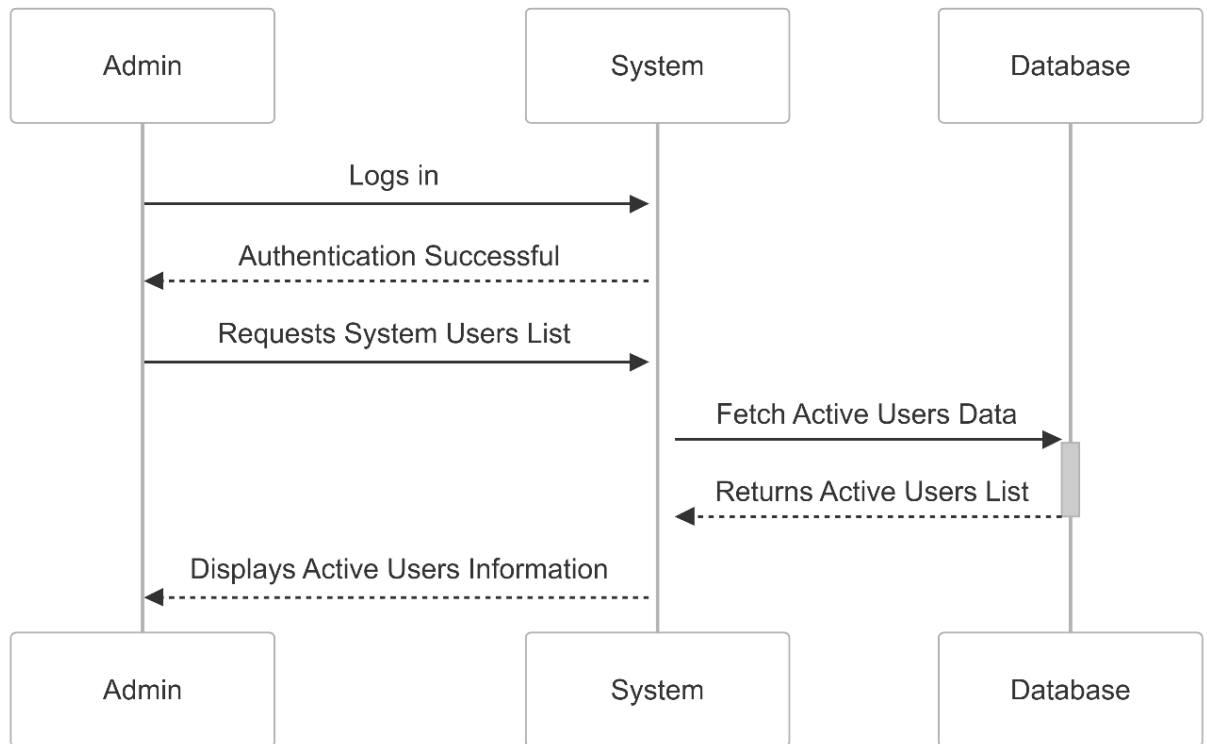
*Figure 3. 6:Sequence Diagram for Pharmacist Issues Drugs*

- **Lab Technician Uploads Lab Reports**



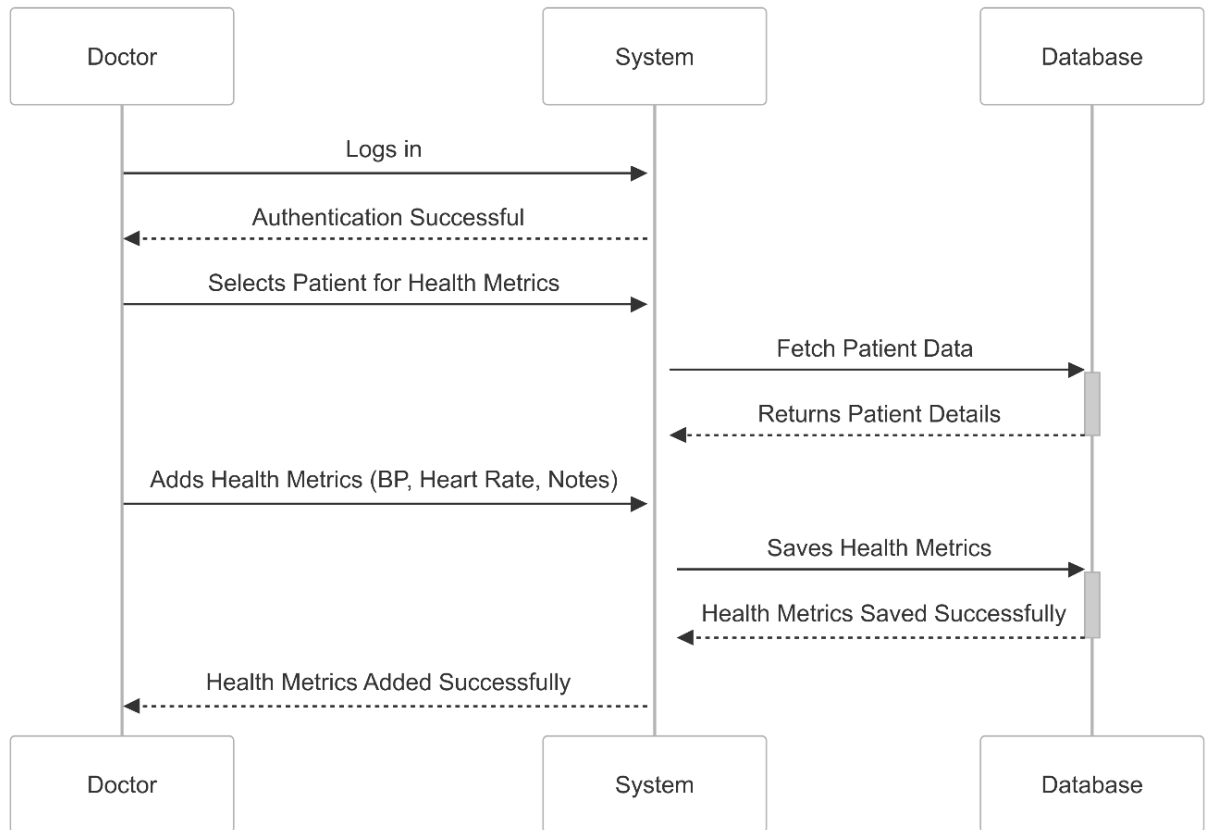
*Figure 3. 7:Lab Report Upload*

- **Admin Manages Users**



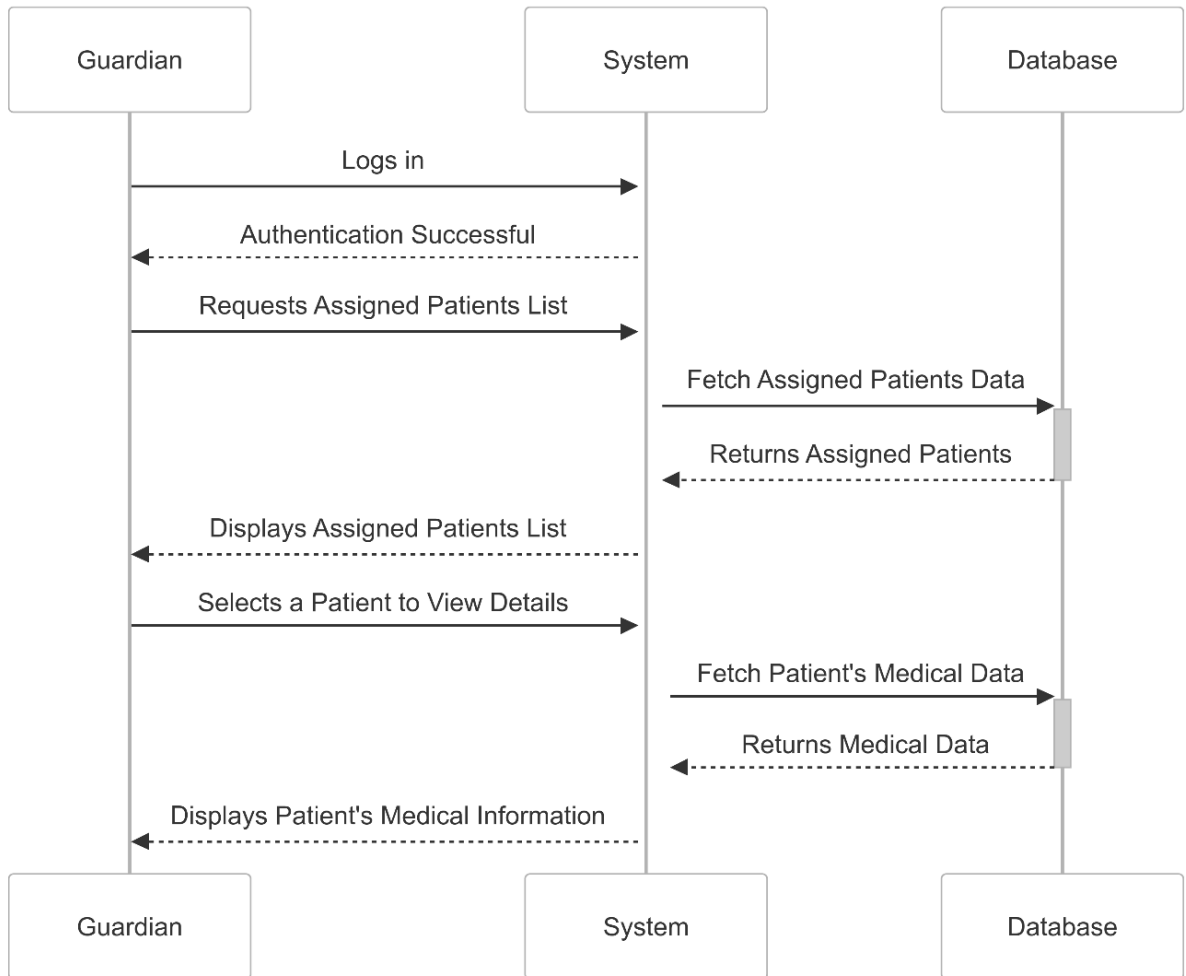
*Figure 3. 8:Sequence Diagram for Admin Manage Users*

- **Doctor Record Health Metrics of Patients**



*Figure 3. 9: Sequence Diagram for Doctor Record Health Metrics*

- **Guardian Manages Assigned Patients**



*Figure 3. 10:Sequence Diagram for Guarding Manage Patients*

### 3.4.3 Class Diagram

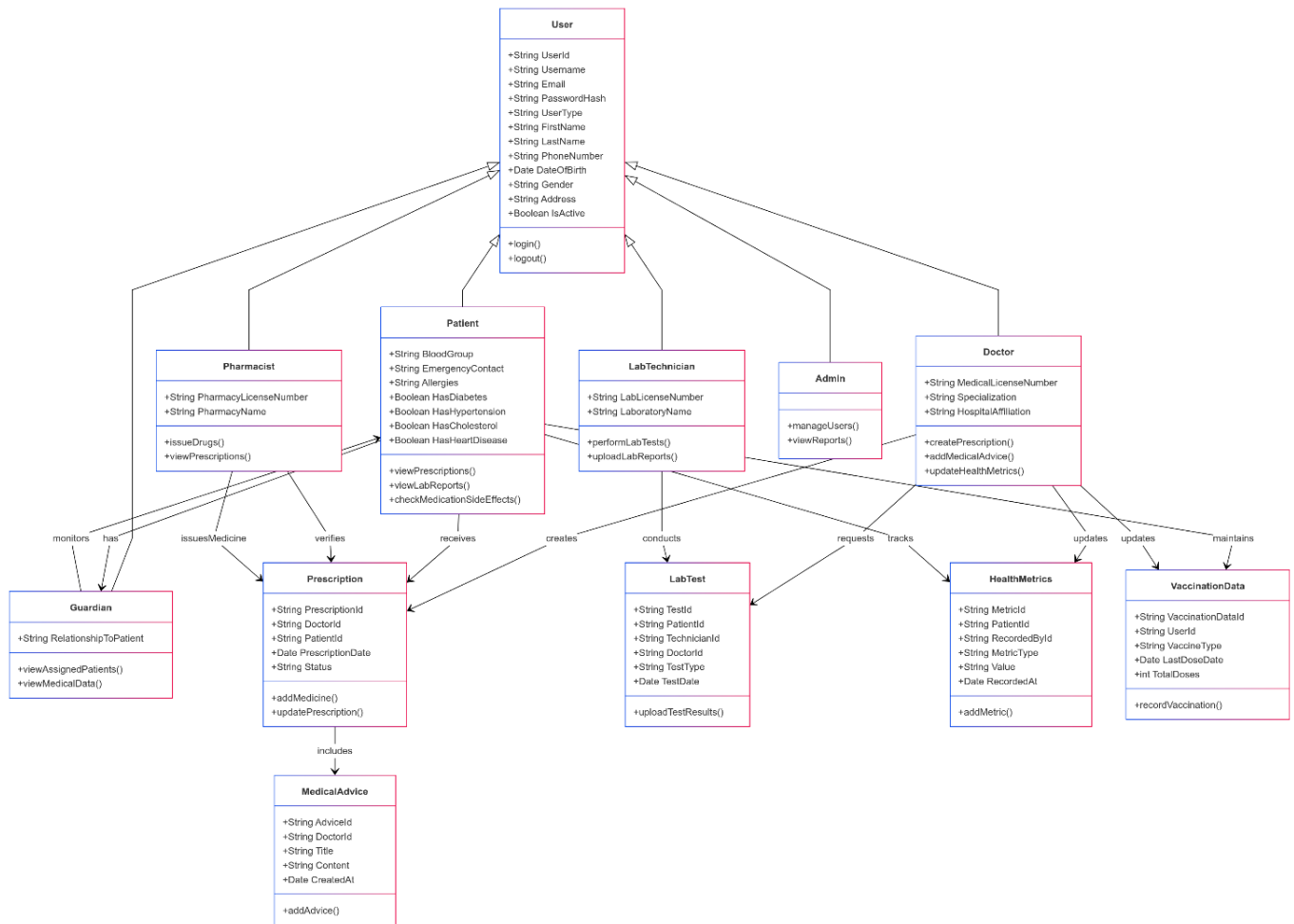


Figure 3. 11: Class Diagram for ICare

The Class Diagram defines system structure, listing key attributes and methods, aligning entities such as Doctors, Patients, Guardians, Pharmacists, Lab Technicians and Administrators.



### 3.4.4 Flow Charts

These Flow Charts represents workflows such as prescription creation, drug issuance, and view prescription, outlining system logic.

- **Prescription Creation**

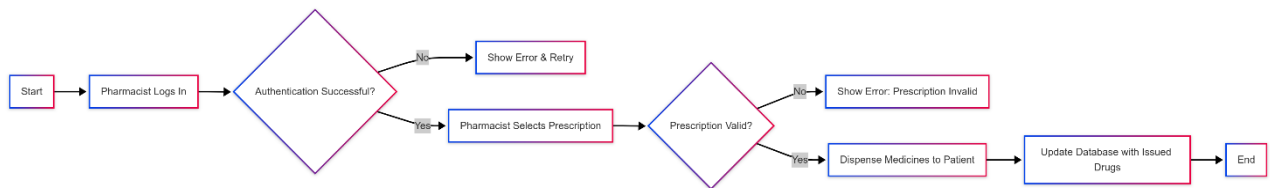


Figure 3. 12:Flow Chart for Create Prescription

- **Drug Issuance**

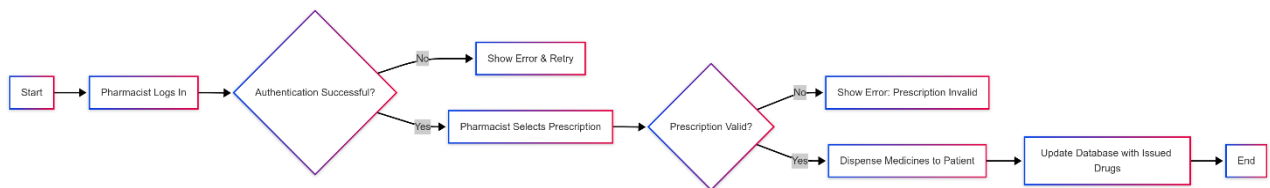


Figure 3. 13:Flow Chart for Drug Issuance

- **View Prescription**

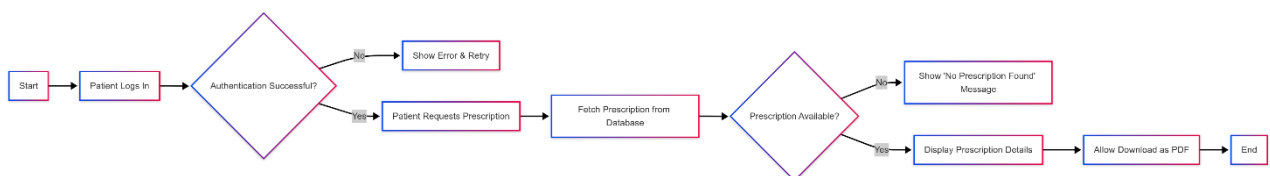


Figure 3. 14:Flow Chart for View Prescription

## 4. Development and Implementation

This chapter outlines the implementation of the Personal Health Management System (I-Care), focusing on the interaction between the web interface, RESTful web services, and SQL Server database. It describes the system modules, connectivity, and key implementation details using the MVC repository pattern and 3-tier architecture.

### 4.1 Related Technology

The system is structured using a three-tier architecture, with a clear separation of concerns:

1. Presentation Layer (Frontend)
  - Developed using Angular 18 for a responsive and dynamic UI.
  - Implements role-based views for different users (Doctors, Patients, Pharmacists, Guardians, Lab Technicians, and Admins).
  - Uses jsPDF to generate reports.
2. Business Logic Layer (Backend API)
  - Built using .NET Core Web API and follows MVC repository pattern.
  - Implements password hashing for authentication instead of JWT.
  - Uses dependency injection to manage services.
3. Data Layer (Database)
  - SQL Server used to store structured data.
  - Ensures data integrity and security with proper indexing and constraints.

### Technology Stack

| Component      | Technology Used           |
|----------------|---------------------------|
| Frontend       | Angular 18                |
| Backend        | .NET Core Web API         |
| Database       | SQL Server                |
| Authentication | Password Hashing (BCrypt) |
| Hosting        | Local Server              |
| Reports        | jsPDF                     |

*Figure 4. 1: Technology Stack*

## 4.2 System Architecture

The high-level system architecture consists of:

- Users (Doctors, Patients, Pharmacists, Guardians, Lab Technicians, Admins) interacting via the web application.
- Frontend (Angular 18) sending HTTP requests to the RESTful API.
- Backend (.NET Core Web API) processing user requests and managing business logic.
- SQL Server database storing and retrieving information.
- Reports generated dynamically using jsPDF.

### Development Approach: Agile Model

The system follows an Agile software development approach, ensuring flexibility and iterative enhancements.

- Sprint-based Development: Features are developed and tested in iterations.
- Backlog Management: Features are prioritized and adjusted based on feedback.
- Code Reviews & Testing: Regular testing is performed before deployment.

## 4.3 Functionalities and Implementation Details

Each role in the system has specific functionalities:

### Doctor Functionalities

1. Create, Update, and View Prescriptions – Add medicines and lab test recommendations.
2. Download Lab Reports (PDF) using jsPDF.
3. Manage Medical Advice – Add and View.
4. Manage Health Metrics & Vaccination Details.
5. Generate Reports using jsPDF:
  - Prescription Summary Report.
  - Appointment Consultations.
  - Given Medical Advices.

### Patient Functionalities

1. Download Lab Reports (PDF).
2. View Prescriptions & Medical Advice.
3. Check Prescribed Medicine Side Effects.
4. Manage Health Metrics & Vaccination Details.
5. View Issued Drugs Details.
6. Manage Guardian Assignments.
7. Generate Reports using jsPDF:

- Health Metrics Summary.
- Prescription History.
- Lab Test Reports.
- Vaccination Reports.

#### Pharmacist Functionalities

1. View Prescriptions & Lab Reports.
2. Issue Drugs to Patients.
3. Generate Reports using jsPDF:
  - Most Prescribed Medicines Report.
  - Issued Drugs Report .

#### Guardian Functionalities

1. Download Lab Reports (PDF) for Assigned Patients.
2. View Prescriptions, Lab Reports, and Medical Advice.
3. Check Assigned Patient's Medicine Side Effects.
4. View Assigned Patient's Health Metrics & Vaccination Details.
5. Generate Reports using jsPDF:
  - Dependent's Prescription Report.
  - Lab Test History Report.
  - Medication Order Report.

#### Laboratory Technician Functionalities

1. View Prescriptions & Identify Required Lab Tests.
2. Add, Update, and Delete Lab Reports.
3. Upload Lab Reports in PDF Format.
4. Generate Reports using jsPDF:
  - Patient Test History Report.
  - Lab Tests Conducted by Technician.

#### Admin Functionalities

1. Manage Users (Add, Update, Delete).
2. Generate Reports using jsPDF:
  - Active Users Count by Role.

## 4.4 Implementation Environment

### 4.4.1 Hardware Environment

| Component | Specification        |
|-----------|----------------------|
| OS        | Microsoft Windows 10 |
| Processor | Intel Core i7        |
| RAM       | 16GB                 |
| Storage   | 512GB SSD            |

*Figure 4. 2:Hardware Environment*

### 4.4.2 Software Environment

| Component      | Tools Used                            |
|----------------|---------------------------------------|
| Backend        | .NET Core Web API, Visual Studio 2022 |
| Frontend       | Angular 18                            |
| Database       | SQL Server                            |
| Authentication | Password Hashing (BCrypt)             |
| Reporting      | jsPDF                                 |

*Figure 4. 3:Software Environment*

## 4.5 Major Code Segments

### Backend Implementation

- Developed using .NET Core Web API (MVC Repository Pattern).
- Controllers manage API endpoints for different user roles.
- Uses Password Hashing instead of JWT for authentication.

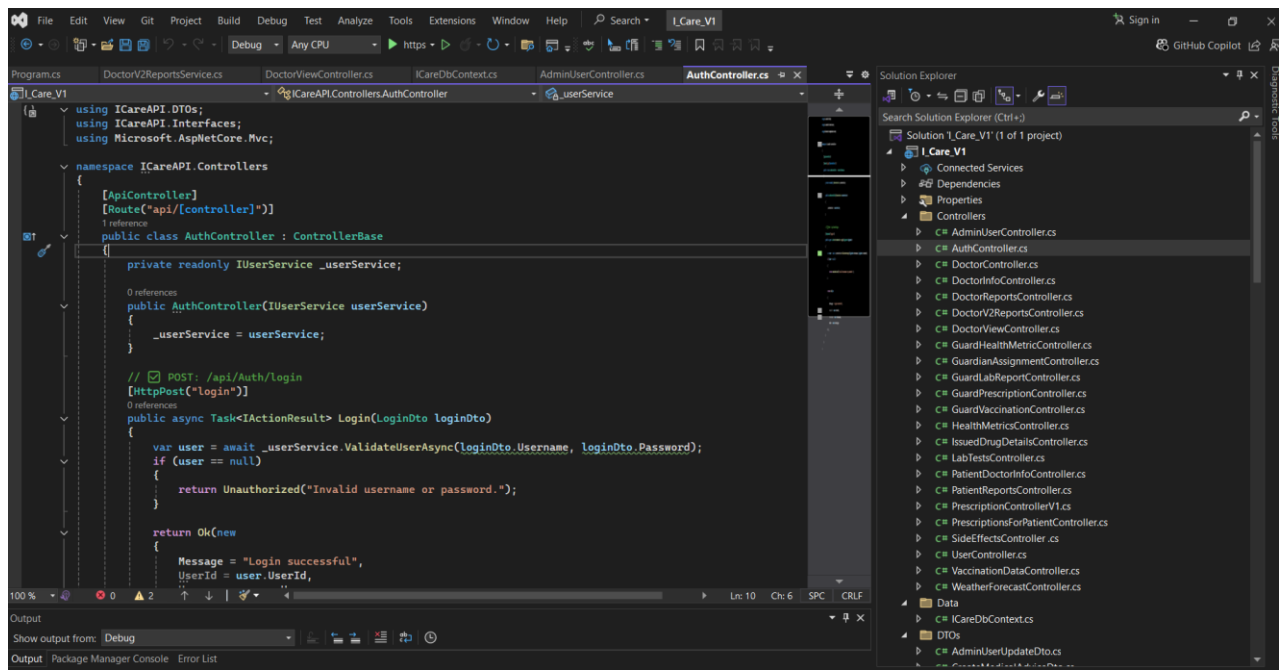


Figure 4. 4:Back End Controllers Overview

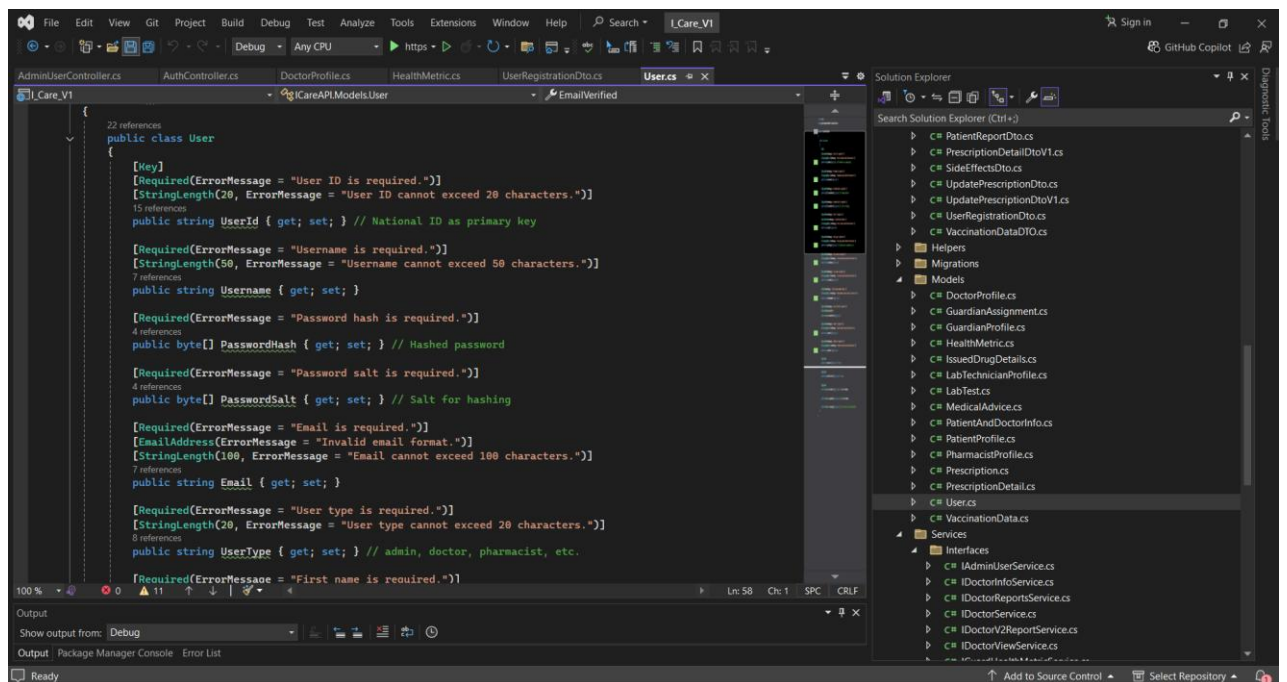


Figure 4. 5:Back End Models Overview

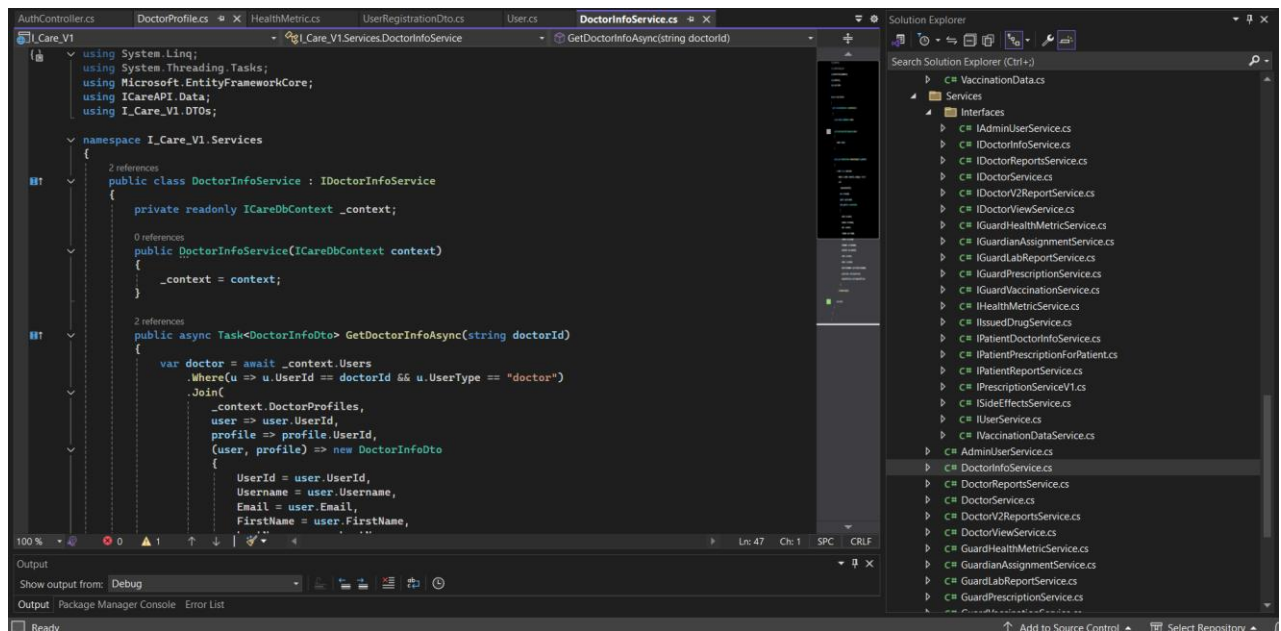


Figure 4. 6:Back End Services Overview

## Frontend Implementation

- Developed using Angular 18.
- Uses Angular Material for UI components.
- State Management via RxJS & Services.

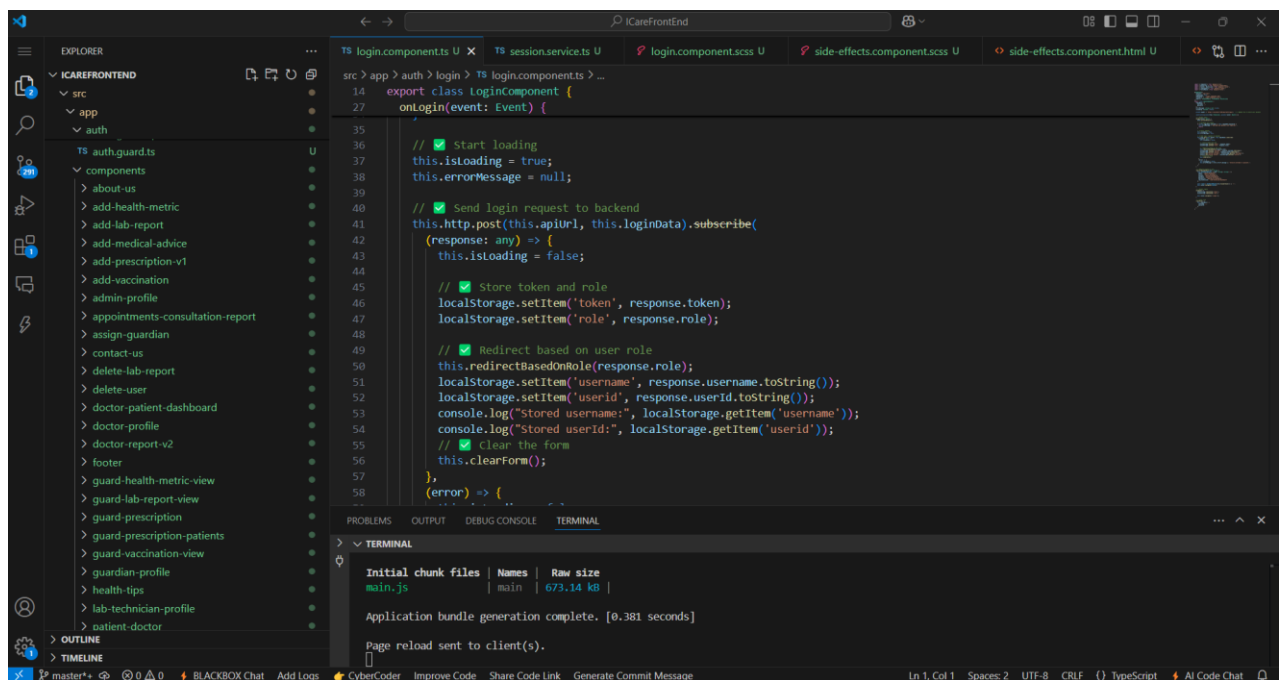


Figure 4. 7:Front End Components Overview

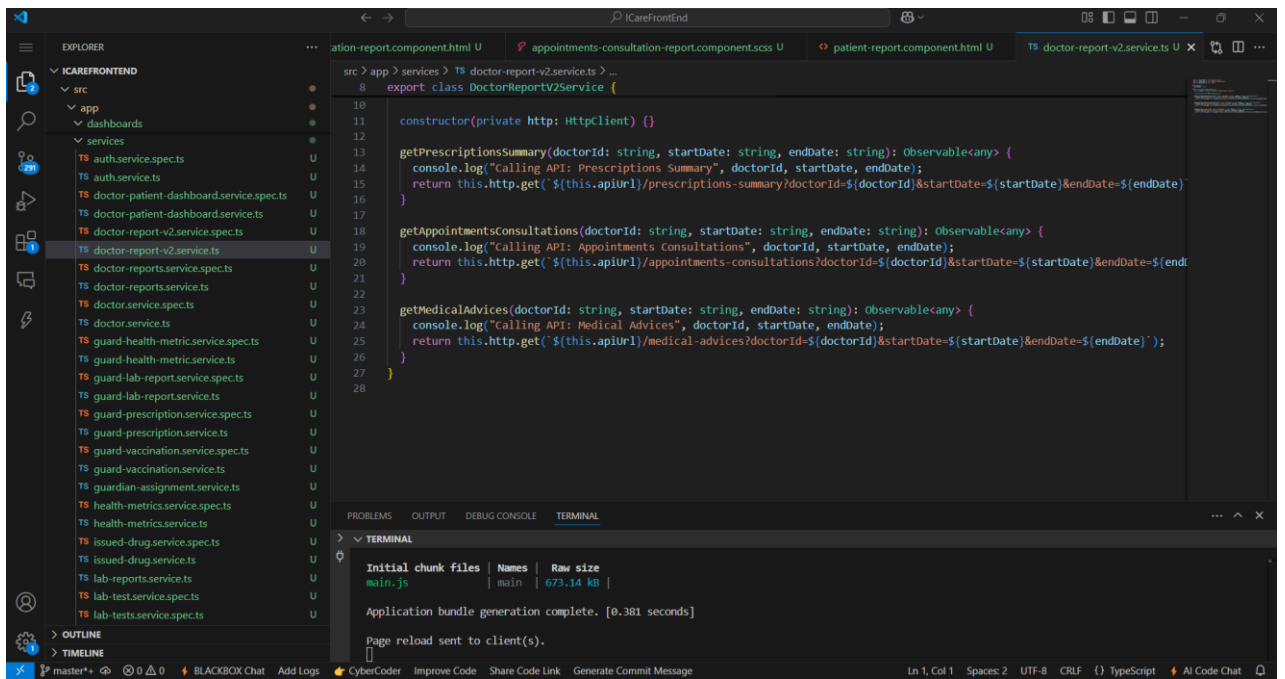


Figure 4. 8:Front End Services Overview

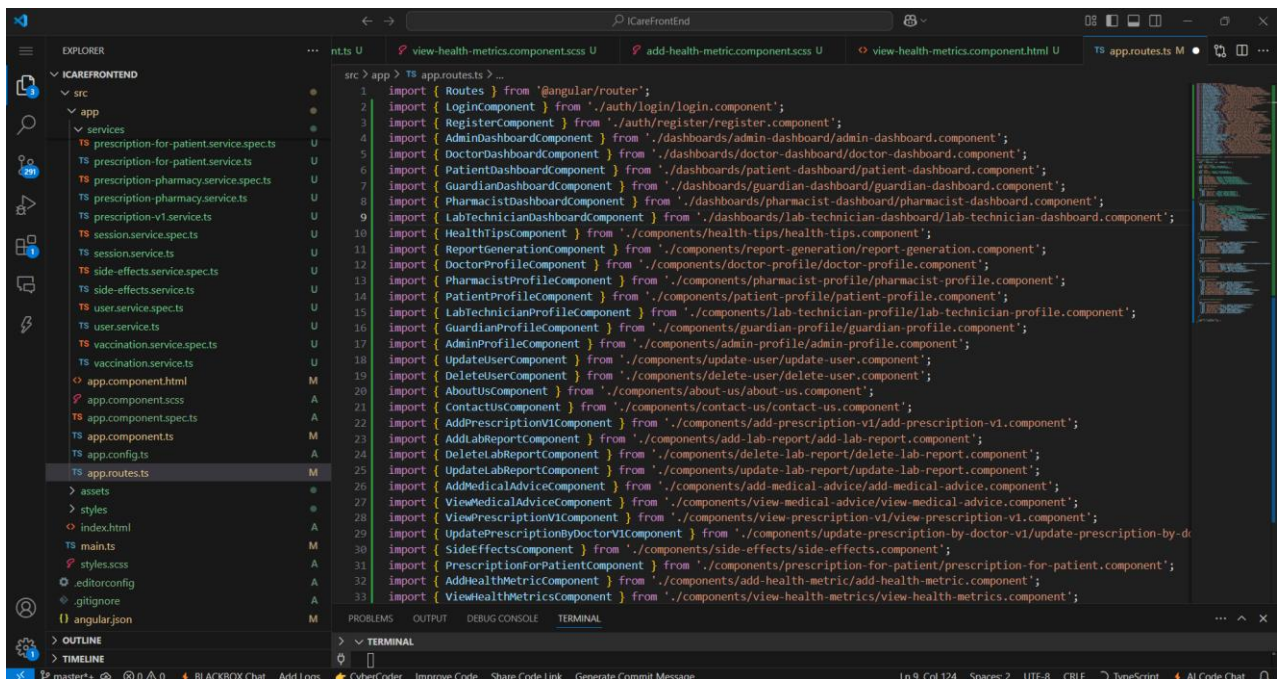


Figure 4. 9:Front End App Routes Overview



## **4.6 Deployment Strategy**

- Locally Hosted System.
- SQL Server installed on-premises.
- Manual deployment of frontend and backend.

## **4.7 Security Measures**

- Role-Based Access Control (RBAC).
- Password Hashing with Salt for User Authentication.
- Data Encryption for Sensitive Information.
- Audit Logs for User Activities.

# **Chapter 5 – Testing and Evaluation**

This chapter presents the testing and evaluation process of the I-Care Personal Health Management System to ensure its functionality, reliability, and performance. The validation and verification process began during the design phase and continued through system implementation, concluding with automated and manual testing and user acceptance testing.

## **5.1 Related Testing Types**

Different types of testing were conducted at various stages of development to verify the accuracy, integrity, and efficiency of the system. These included unit testing, integration testing, system testing, user acceptance testing, and automated testing using the Page Object Model (POM) with TestNG.

### **5.1.1 Unit Testing**

Unit testing was conducted on individual components of the system to ensure their correct functionality. Each module and functions were tested independently before integrating them with other components.

### **5.1.2 Integration Testing**

Integration testing was performed to validate the interaction between different components of the system. It ensured that data flow between modules (e.g., doctor-patient interactions, lab test updates, and pharmacy prescriptions) worked correctly.

### **5.1.3 System Testing**

System testing was conducted at the final stage of development to ensure that all features of the system worked as expected. It also helped evaluate the system's non-functional requirements such as performance, security, and usability.

## 5.1.4 User Acceptance Testing

User acceptance testing (UAT) involved real users interacting with the system under real-life scenarios. The goal was to evaluate usability, functionality, and user satisfaction. A survey was conducted to gather user feedback on key features such as patient records, lab reports, and prescription management.

## 5.1.5 Automated Testing (Selenium with TestNG)

To ensure regression-free releases, automated tests were written using Selenium WebDriver and TestNG following the Page Object Model (POM). These tests covered essential functionalities, including:

- Doctor functionalities (creating prescriptions, adding health metrics)
- Lab Technician functionalities (add lab reports)
- Pharmacist functionalities (issuing prescribed drugs)
- Admin functionalities (managing users) etc....

The automation scripts were executed on multiple browsers and reported through TestNG reports.

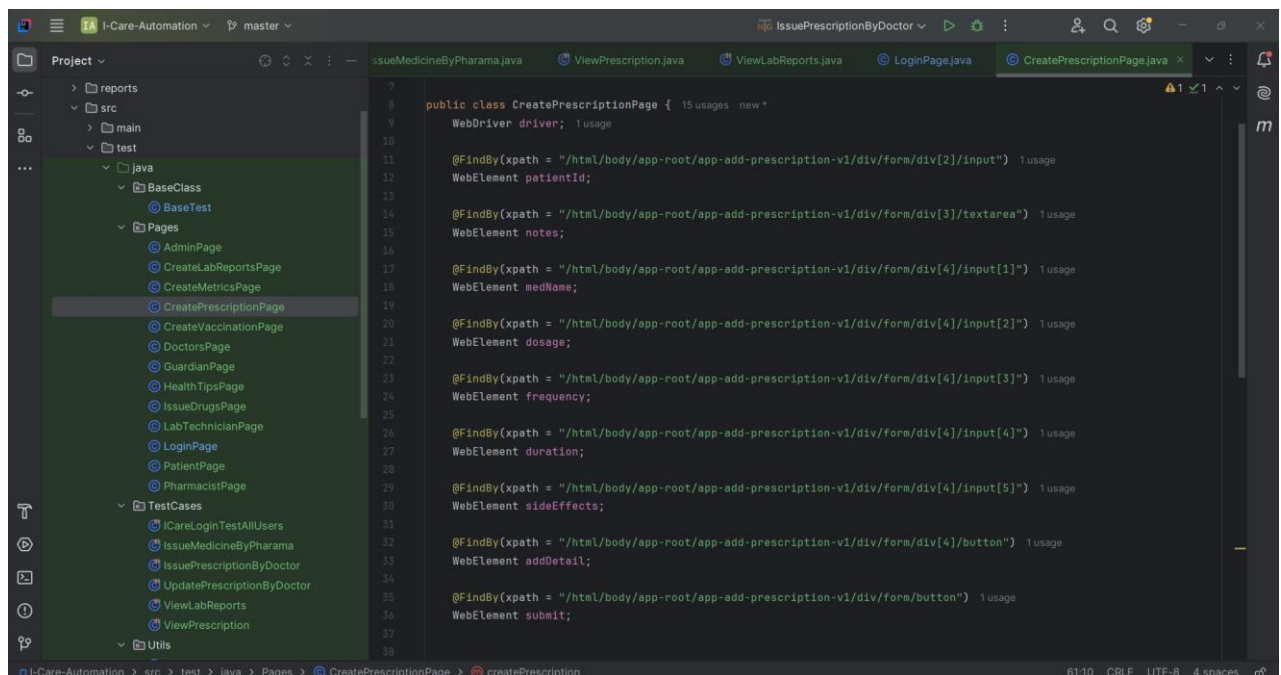


Figure 5. 1:Page Objects

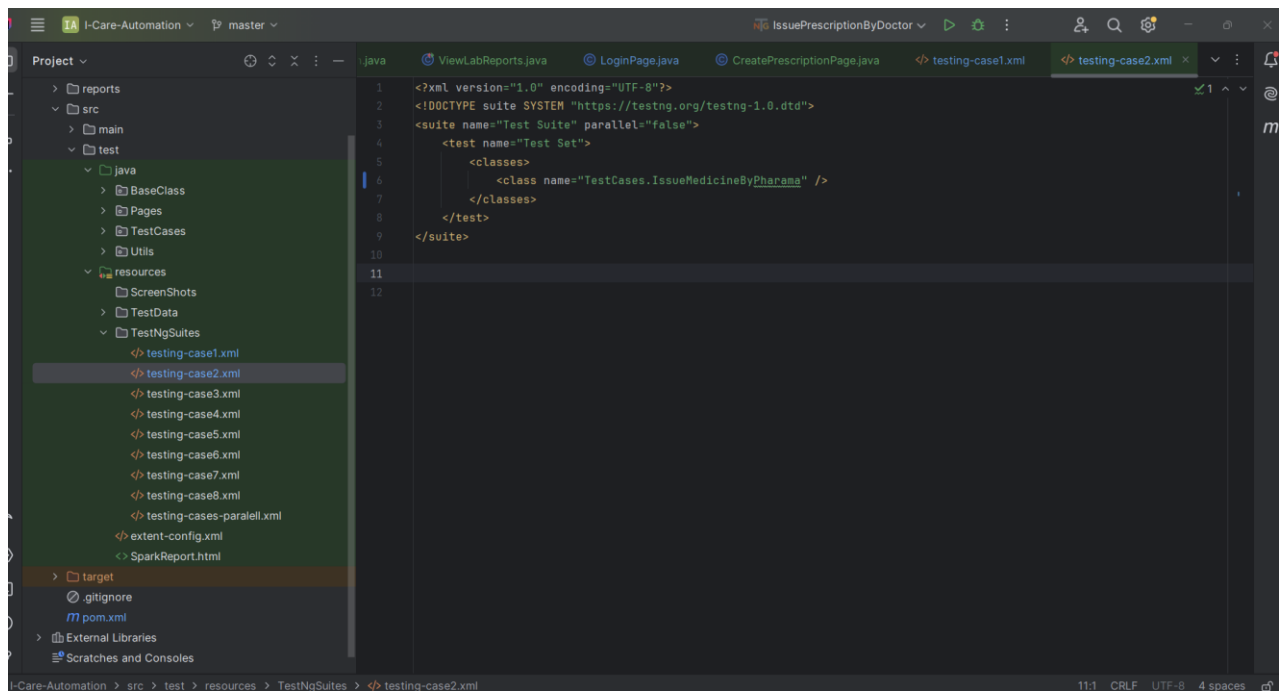


Figure 5. 2: Test Cases

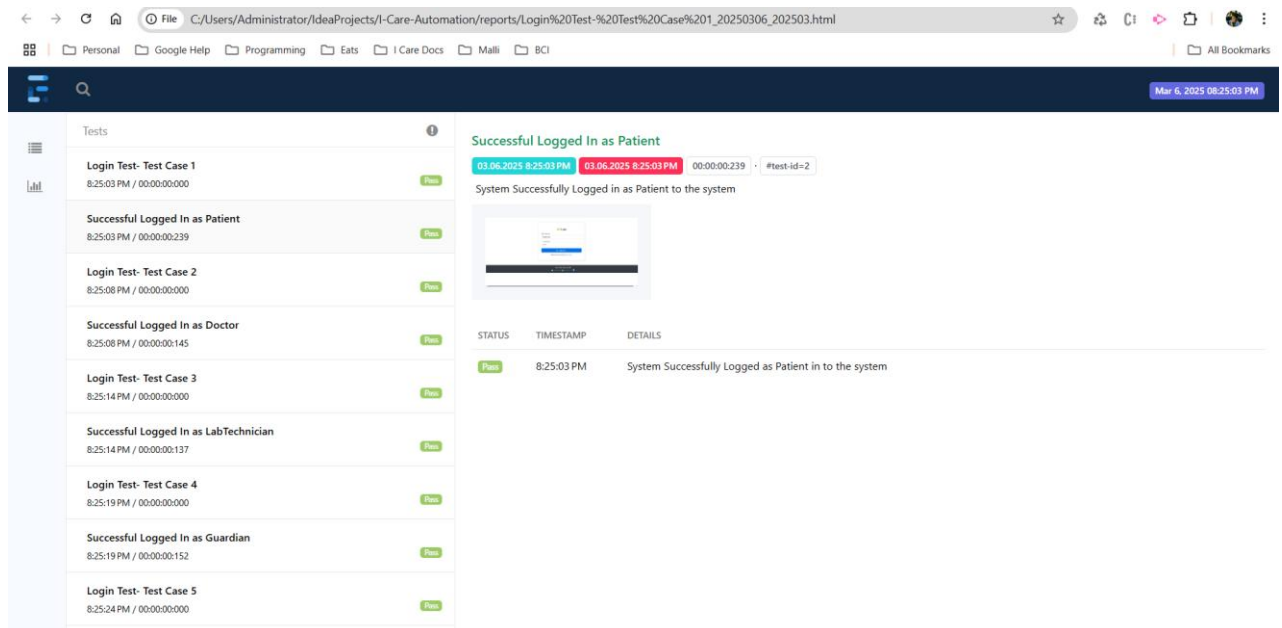


Figure 5. 3: Test Report

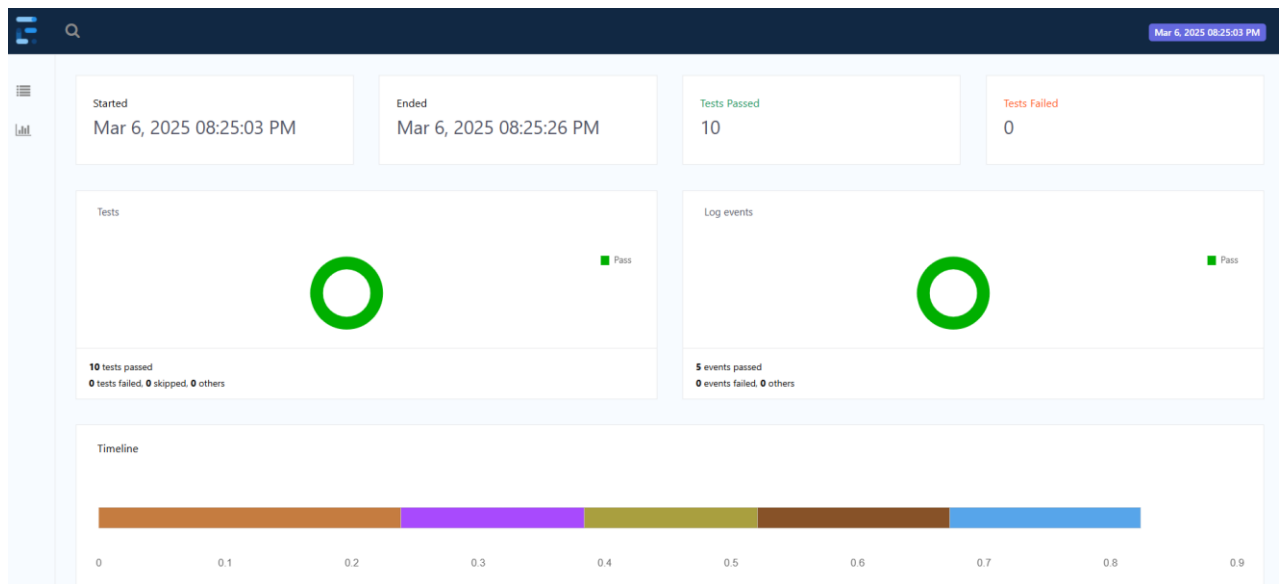


Figure 5. 4: Test Summery Report

## 5.2 Manual Testing – Test Cases and Results

| Test Case ID | Test Case                                        | Test Steps                                                                                | Test Data                                                     | Expected Results                                              | Actual Results                                                | Status Pass / Fail |
|--------------|--------------------------------------------------|-------------------------------------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|--------------------|
| D01          | Verify successful login for a patient            | Navigate to login page<br>Enter valid credentials<br>Click "Login"                        | patient Login<br>Username - 290991262V<br>Password - Pass123# | Redirected to patient dashboard                               | Redirected to patient dashboard                               | Pass               |
| D02          | Verify a patient can view dashboard              | Navigate to login page<br>Enter valid credentials<br>Click "Login<br>Check listed Buttons | patient Login<br>Username - 290991262V<br>Password - Pass123# | Redirected to patient dashboard and all the buttons are there | Redirected to patient dashboard and all the buttons are there | Pass               |
| D03          | Verify a patient can View a medical prescription | Navigate to login page<br>Enter valid credentials<br>Click "Login"                        | patient Login<br>Username - 290991262V                        | Prescription successfully Viewed                              | Prescription successfully Viewed                              | Pass               |

|     |                                                            |                                                                                                                              |                                                               |                                            |                                            |      |
|-----|------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|--------------------------------------------|--------------------------------------------|------|
|     |                                                            | View a medical prescription                                                                                                  | Password - Pass123#                                           |                                            |                                            |      |
| D04 | Verify a patient can View and existing medical Advice      | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Advice<br>View Advice                           | patient Login<br>Username - 290991262V<br>Password - Pass123# | Medical Advice successfully viewed         | Medical Advice successfully viewed         | Pass |
| D05 | Verify a patient can View and existing Health metrics      | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Health metrics<br>View Health metrics           | patient Login<br>Username - 290991262V<br>Password - Pass123# | Medical Health metrics successfully viewed | Medical Health metrics successfully viewed | Pass |
| D06 | Verify a patient can View and Side effects                 | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Side effects<br>View Side effects               | patient Login<br>Username - 290991262V<br>Password - Pass123# | Side effects viewed                        | Side effects viewed                        | Pass |
| D07 | Verify a patient can View and existing Vaccination Details | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Vaccination Details<br>View Vaccination Details | patient Login<br>Username - 290991262V<br>Password - Pass123# | Vaccination Details successfully viewed    | Vaccination Details successfully viewed    | Pass |
| D08 | Verify a patient can View patient Reports                  | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Reports<br>View Reports                         | patient Login<br>Username - 390991262V<br>Password - Pass123# | Reports can view                           | Reports can view                           | Pass |
| D09 | Verify a patient can                                       | Navigate to login page                                                                                                       | patient Login                                                 | Reports can Downloaded                     | Reports can Downloaded                     | Pass |

|     |                                           |                                                                                                               |                                                                                        |                                    |                                    |      |
|-----|-------------------------------------------|---------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------------------------------------|------------------------------------|------|
|     | Download patient Reports                  | Enter valid credentials<br>Click "Login"<br>Select Reports<br>Down Load Reports                               | Username - 390991262V<br>Password - Pass123#                                           |                                    |                                    |      |
| D10 | Verify a patient can add guardian         | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select patient<br>Add guardian<br>Save  | Doctor Login<br>Username - 390991262V<br>Password - Pass123#<br>Patient ID- 290991262V | Guardian successfully saved        | Guardian successfully saved        | Pass |
| D11 | Verify a patient can edit guardian        | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select patient<br>Edit guardian<br>Save | Doctor Login<br>Username - 390991262V<br>Password - Pass123#<br>Patient ID- 290991262V | Guardian successfully saved        | Guardian successfully saved        | Pass |
| D12 | Verify a patient can View Doctors Details | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select doctor and check details         | patient Login<br>Username - 290991262V<br>Password - Pass123#                          | Doctor Details successfully viewed | Doctor Details successfully viewed | Pass |

*Table 5. 1:Test Cases for Patient Functions*

| Test Case ID | Test Case                                          | Test Steps                                                                                                                | Test Data                                                                              | Expected Results                                             | Actual Results                                               | Status Pass / Fail |
|--------------|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|--------------------------------------------------------------|--------------------------------------------------------------|--------------------|
| D01          | Verify successful login for a doctor               | Navigate to login page<br>Enter valid credentials<br>Click "Login"                                                        | Doctor Login<br>Username - 390991262V<br>Password - Pass123#                           | Redirected to doctor dashboard                               | Redirected to doctor dashboard                               | Pass               |
| D02          | Verify a doctor can view dashBoard                 | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Check listed Buttons                                | Doctor Login<br>Username - 390991262V<br>Password - Pass123#                           | Redirected to doctor dashboard and all the buttons are there | Redirected to doctor dashboard and all the buttons are there | Pass               |
| D03          | Verify a doctor can add a medical prescription     | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select patient<br>Add prescription<br>Save          | Doctor Login<br>Username - 390991262V<br>Password - Pass123#<br>Patient ID- 290991262V | Prescription successfully saved                              | Prescription successfully saved                              | Pass               |
| D04          | Verify a doctor can edit and existing prescription | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select patient<br>Edit prescription<br>Save changes | Doctor Login<br>Username - 390991262V<br>Password - Pass123#<br>Patient ID- 290991262V | Updated prescription is saved                                | Updated prescription is saved                                | Pass               |
| D05          | Verify a doctor can add a medical Advice           | Navigate to login page<br>Enter valid credentials<br>Click                                                                | Doctor Login<br>Username - 390991262V<br>Password - Pass123#                           | Medical Advice successfully saved                            | Medical Advice successfully saved                            | Pass               |

|     |                                                                     |                                                                                                                                         |                                                                                                 |                                                     |                                                     |      |
|-----|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------|------|
|     |                                                                     | "Login"<br>Add advice<br>Save                                                                                                           | Patient ID-<br>290991262V                                                                       |                                                     |                                                     |      |
| D06 | Verify a<br>doctor can<br>View and<br>existing<br>medical<br>Advice | Navigate to<br>login page<br>Enter valid<br>credentials<br>Click<br>"Login"<br>Select<br>Advice<br>View<br>Advice                       | Doctor Login<br>Username -<br>390991262V<br>Password -<br>Pass123#<br>Patient ID-<br>290991262V | Medical<br>Advice<br>successfully<br>viewed         | Medical<br>Advice<br>successfully<br>viewed         | Pass |
| D07 | Verify a<br>doctor can<br>add a Health<br>metrics                   | Navigate to<br>login page<br>Enter valid<br>credentials<br>Click<br>"Login"<br>Add Health<br>metrics<br>Save                            | Doctor Login<br>Username -<br>390991262V<br>Password -<br>Pass123#<br>Patient ID-<br>290991262V | Medical<br>Health metrics<br>successfully<br>saved  | Medical<br>Health metrics<br>successfully<br>saved  | Pass |
| D08 | Verify a<br>doctor can<br>View and<br>existing<br>Health<br>metrics | Navigate to<br>login page<br>Enter valid<br>credentials<br>Click<br>"Login"<br>Select<br>Health<br>metrics<br>View<br>Health<br>metrics | Doctor Login<br>Username -<br>390991262V<br>Password -<br>Pass123#<br>Patient ID-<br>290991262V | Medical<br>Health metrics<br>successfully<br>viewed | Medical<br>Health metrics<br>successfully<br>viewed | Pass |
| D09 | Verify a<br>doctor can<br>add a<br>Vaccination<br>Details           | Navigate to<br>login page<br>Enter valid<br>credentials<br>Click<br>"Login"<br>Add<br>Vaccination<br>Details<br>Save                    | Doctor Login<br>Username -<br>390991262V<br>Password -<br>Pass123#<br>Patient ID-<br>290991262V | Vaccination<br>Details<br>successfully<br>saved     | Vaccination<br>Details<br>successfully<br>saved     | Pass |



|     |                                                           |                                                                                                                              |                                                                                        |                                         |                                         |      |
|-----|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------------|-----------------------------------------|------|
| D10 | Verify a doctor can View and existing Vaccination Details | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Vaccination Details<br>View Vaccination Details | Doctor Login<br>Username - 390991262V<br>Password - Pass123#<br>Patient ID- 290991262V | Vaccination Details successfully viewed | Vaccination Details successfully viewed | Pass |
| D11 | Verify a doctor can View Doctor Reports                   | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Reports<br>View Reports                         | Doctor Login<br>Username - 390991262V<br>Password - Pass123#                           | Reports can view                        | Reports can view                        | Pass |
| D12 | Verify a doctor can Download Doctor Reports               | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Reports<br>Down :Load Reports                   | Doctor Login<br>Username - 390991262V<br>Password - Pass123#                           | Reports can Downloaded                  | Reports can Downloaded                  | Pass |

*Table 5. 2:Test Cases for Doctor Functions*

| Test Case ID | Test Case                                                   | Test Steps                                                                                                 | Test Data                                                            | Expected Results                                                     | Actual Results                                                       | Status Pass / Fail |
|--------------|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------|--------------------|
| D01          | Verify successful login for a Lab Technician                | Navigate to login page<br>Enter valid credentials<br>Click "Login"                                         | Lab Technician Login<br>Username - 290991262V<br>Password - Pass123# | Redirected to Lab Technician dashboard                               | Redirected to Lab Technician dashboard                               | Pass               |
| D02          | Verify a Lab Technician can view dashBoard                  | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Check listed Buttons                 | Lab Technician Login<br>Username - 290991262V<br>Password - Pass123# | Redirected to Lab Technician dashboard and all the buttons are there | Redirected to Lab Technician dashboard and all the buttons are there | Pass               |
| D03          | Verify a Lab Technician can View a medical prescription     | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>View a medical prescription          | Lab Technician Login<br>Username - 290991262V<br>Password - Pass123# | Prescription successfully Viewed                                     | Prescription successfully Viewed                                     | Pass               |
| D04          | Verify a Lab Technician can Download Lab Technician Reports | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Reports<br>Down :Load Reports | Lab Technician Login<br>Username - 390991262V<br>Password - Pass123# | Reports can Downloaded                                               | Reports can Downloaded                                               | Pass               |
| D05          | Verify a Lab Technician can add lab Report                  | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Lab                           | Lab Technician Login<br>Username - 290991262V<br>Password - Pass123# | lab Report successfully saved                                        | lab Report successfully saved                                        | Pass               |

|     |                                               |                                                                                                                        |                                                                      |                                 |                                 |      |
|-----|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|---------------------------------|---------------------------------|------|
|     |                                               | Technician<br>Add lab<br>Report<br>Save                                                                                |                                                                      |                                 |                                 |      |
| D06 | Verify a Lab Technician can edit lab Report   | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Lab Technician<br>Edit lab report<br>Save | Lab Technician Login<br>Username - 290991262V<br>Password - Pass123# | lab Report successfully saved   | lab Report successfully saved   | Pass |
| D07 | Verify a Lab Technician can delete lab Report | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Lab Technician<br>delete lab report       | Lab Technician Login<br>Username - 290991262V<br>Password - Pass123# | lab Report successfully deleted | lab Report successfully deleted | Pass |

Table 5. 3: Test Cases for Lab Technician Functions

| Test Case ID | Test Case                              | Test Steps                                                         | Test Data                                                            | Expected Results                               | Actual Results                     | Status Pass / Fail |
|--------------|----------------------------------------|--------------------------------------------------------------------|----------------------------------------------------------------------|------------------------------------------------|------------------------------------|--------------------|
| D01          | Verify successful login for Pharmacist | Navigate to login page<br>Enter valid credentials<br>Click "Login" | Lab Technician Login<br>Username - 590991262V<br>Password - Pass123# | Redirected to Pharmacist dashboard             | Redirected to Pharmacist dashboard | Pass               |
| D02          | Verify Pharmacist can view dashBoard   | Navigate to login page<br>Enter valid credentials                  | Lab Technician Login<br>Username -                                   | Redirected to Pharmacist dashboard and all the | Redirected to Pharmacist dashboard | Pass               |

|     |                                                                    |                                                                                                                    |                                                                                  |                                            |                                        |      |
|-----|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|--------------------------------------------|----------------------------------------|------|
|     |                                                                    | Click "Login<br>Check listed<br>Buttons                                                                            | 590991262V<br>Password -<br>Pass123#                                             | buttons are<br>there                       | and all the<br>buttons are<br>there    |      |
| D03 | Verify<br>Pharmacist<br>can View a<br>medical<br>prescription      | Navigate to login<br>page<br>Enter valid<br>credentials<br>Click "Login"<br>View a medical<br>prescription         | Lab<br>Technician<br>Login<br>Username -<br>590991262V<br>Password -<br>Pass123# | Prescription<br>successfully<br>Viewed     | Prescription<br>successfully<br>Viewed | Pass |
| D04 | Verify<br>Pharmacist<br>can<br>Download<br>medical<br>prescription | Navigate to login<br>page<br>Enter valid<br>credentials<br>Click "Login"<br>Select Reports<br>Down Load<br>Reports | Lab<br>Technician<br>Login<br>Username -<br>590991262V<br>Password -<br>Pass123# | Prescription<br>successfully<br>Downloaded | Prescription<br>successfully           | Pass |
| D05 | Verify a<br>pharmacist<br>can view<br>Pharmacist<br>Reports        | Navigate to login<br>page<br>Enter valid<br>credentials<br>Click "Login"<br>Select Reports<br>View Reports         | Lab<br>Technician<br>Login<br>Username -<br>390991262V<br>Password -<br>Pass123# | Reports can<br>Viewed                      | Reports can<br>Viewed                  | Pass |
| D06 | Verify a<br>Pharmacist<br>can view<br>Pharmacist<br>Reports        | Navigate to login<br>page<br>Enter valid<br>credentials<br>Click "Login"<br>Select Reports<br>View Reports         | Lab<br>Technician<br>Login<br>Username -<br>390991262V<br>Password -<br>Pass123# | Reports can<br>Viewed                      | Reports can<br>Viewed                  | Pass |
| D07 | Verify a<br>Pharmacist<br>can<br>download<br>Pharmacist<br>Reports | Navigate to login<br>page<br>Enter valid<br>credentials<br>Click "Login"<br>Select Reports<br>download Reports     | Lab<br>Technician<br>Login<br>Username -<br>390991262V<br>Password -<br>Pass123# | Reports can<br>download                    | Reports can<br>download                | Pass |

*Table 5. 4: Test Cases for Pharmacist Functions*

| Test Case ID | Test Case                              | Test Steps                                                                                 | Test Data                                                            | Expected Results                                            | Actual Results                                              | Status Pass / Fail |
|--------------|----------------------------------------|--------------------------------------------------------------------------------------------|----------------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|--------------------|
| D01          | Verify successful login for Pharmacist | Navigate to login page<br>Enter valid credentials<br>Click "Login"                         | Lab Technician Login<br>Username - 590991262V<br>Password - Pass123# | Redirected to admin dashboard                               | Redirected to admin dashboard                               | Pass               |
| D02          | Verify admin can view dashBoard        | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Check listed Buttons | Lab Technician Login<br>Username - 590991262V<br>Password - Pass123# | Redirected to admin dashboard and all the buttons are there | Redirected to admin dashboard and all the buttons are there | Pass               |
| D03          | Verify admin can add users             | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>add users            | Lab Technician Login<br>Username - 590991262V<br>Password - Pass123# | user successfully add                                       | user successfully add                                       | Pass               |
| D04          | Verify admin can update users          | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>update users         | Lab Technician Login<br>Username - 590991262V<br>Password - Pass123# | user successfully update                                    | user successfully update                                    | Pass               |
| D05          | Verify a admin can delete users        | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>delete users         | Lab Technician Login<br>Username - 390991262V<br>Password - Pass123# | user successfully delete                                    | user successfully delete                                    | Pass               |
| D06          | Verify a admin can view admin Reports  | Navigate to login page<br>Enter valid credentials<br>Click "Login"                         | Lab Technician Login<br>Username - 390991262V                        | Reports can Viewed                                          | Reports can Viewed                                          | Pass               |

|     |                                                       |                                                                                                               |                                                                                  |                           |                           |      |
|-----|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|---------------------------|---------------------------|------|
|     |                                                       | Select Reports<br>View Reports                                                                                | Password -<br>Pass123#                                                           |                           |                           |      |
| D07 | Verify a<br>admin can<br>download<br>admin<br>Reports | Navigate to login<br>page<br>Enter valid<br>credentials<br>Click "Login"<br>Select Reports<br>downloadReports | Lab<br>Technician<br>Login<br>Username -<br>390991262V<br>Password -<br>Pass123# | Reports can<br>downloaded | Reports can<br>downloaded | Pass |

Table 5. 5:Test Cases for Admin Functions

| Test<br>Case<br>ID | Test Case                                                             | Test Steps                                                                                                 | Test Data                                                               | Expected<br>Results                                                           | Actual<br>Results                                                             | Status<br>Pass /<br>Fail |
|--------------------|-----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------|--------------------------|
| D01                | Verify<br>successful<br>login for a<br>guardian                       | Navigate to<br>login page<br>Enter valid<br>credentials<br>Click "Login"                                   | guardian<br>Login<br>Username -<br>690991262V<br>Password -<br>Pass123# | Redirected to<br>guardian<br>dashboard                                        | Redirected to<br>guardian<br>dashboard                                        | Pass                     |
| D02                | Verify a<br>guardian can<br>view<br>dashboard                         | Navigate to<br>login page<br>Enter valid<br>credentials<br>Click "Login"<br>Check listed<br>Buttons        | guardian<br>Login<br>Username -<br>690991262V<br>Password -<br>Pass123# | Redirected to<br>guardian<br>dashboard<br>and all the<br>buttons are<br>there | Redirected to<br>guardian<br>dashboard<br>and all the<br>buttons are<br>there | Pass                     |
| D03                | Verify a<br>guardian can<br>View a<br>medical<br>prescription         | Navigate to<br>login page<br>Enter valid<br>credentials<br>Click "Login"<br>View a medical<br>prescription | guardian<br>Login<br>Username -<br>690991262V<br>Password -<br>Pass123# | Prescription<br>successfully<br>Viewed                                        | Prescription<br>successfully<br>Viewed                                        | Pass                     |
| D04                | Verify a<br>guardian can<br>View and<br>existing<br>medical<br>Advice | Navigate to<br>login page<br>Enter valid<br>credentials<br>Click "Login"<br>Select Advice<br>View Advice   | guardian<br>Login<br>Username -<br>690991262V<br>Password -<br>Pass123# | Medical<br>Advice<br>successfully<br>viewed                                   | Medical<br>Advice<br>successfully<br>viewed                                   | Pass                     |

|     |                                                             |                                                                                                                              |                                                                |                                            |                                            |      |
|-----|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|--------------------------------------------|--------------------------------------------|------|
| D05 | Verify a guardian can View and existing Health metrics      | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Health metrics<br>View Health metrics           | guardian Login<br>Username - 690991262V<br>Password - Pass123# | Medical Health metrics successfully viewed | Medical Health metrics successfully viewed | Pass |
| D06 | Verify a guardian can View and Side effects                 | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Side effects<br>View Side effects               | guardian Login<br>Username - 690991262V<br>Password - Pass123# | Side effects viewed                        | Side effects viewed                        | Pass |
| D07 | Verify a guardian can View and existing Vaccination Details | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Vaccination Details<br>View Vaccination Details | guardian Login<br>Username - 690991262V<br>Password - Pass123# | Vaccination Details successfully viewed    | Vaccination Details successfully viewed    | Pass |
| D08 | Verify a guardian can View guardian Reports                 | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Reports<br>View Reports                         | guardian Login<br>Username - 690991262V<br>Password - Pass123# | Reports can view                           | Reports can view                           | Pass |
| D09 | Verify a guardian can Download guardian Reports             | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select Reports<br>Down :Load Reports                   | guardian Login<br>Username - 690991262V<br>Password - Pass123# | Reports can Downloaded                     | Reports can Downloaded                     | Pass |

|     |                                            |                                                                                                                   |                                                                |                                                |                                                |      |
|-----|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|------------------------------------------------|------------------------------------------------|------|
| D10 | Verify a guardian can view assign patients | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select guardian<br>Search assigned patients | guardian Login<br>Username - 690991262V<br>Password - Pass123# | Guardian successfully Search assigned patients | Guardian successfully Search assigned patients | Pass |
| D11 | Verify a guardian can View Doctors Details | Navigate to login page<br>Enter valid credentials<br>Click "Login"<br>Select doctor and check details             | guardian Login<br>Username - 690991262V<br>Password - Pass123# | Doctor Details successfully viewed             | Doctor Details successfully viewed             | Pass |

*Table 5. 6:Test Cases For Guardian Functions*

A total of 56 test cases were created and executed manually to validate different roles and functionalities within the system.

### 5.3 Test Cases Summary

| User Role      | Number of Test Cases |
|----------------|----------------------|
| Doctor         | 12                   |
| Patient        | 12                   |
| Lab Technician | 7                    |
| Pharmacist     | 7                    |
| Admin          | 7                    |
| Guardian       | 11                   |
| Total          | 56                   |

*Table 5. 7:Test Cases Summary*



## 5.4 API Testing Approach

The I-Care system's backend services were validated through manual API testing using Swagger. The testing process involved executing API endpoints, verifying response status codes, validating data integrity, and ensuring the correct enforcement of business rules. Each API request was tested with different input parameters to assess its reliability, error handling, and security. The manual testing ensured that core functionalities such as authentication, role-based access control, prescription management, and vaccination record retrieval functioned correctly before front-end integration.

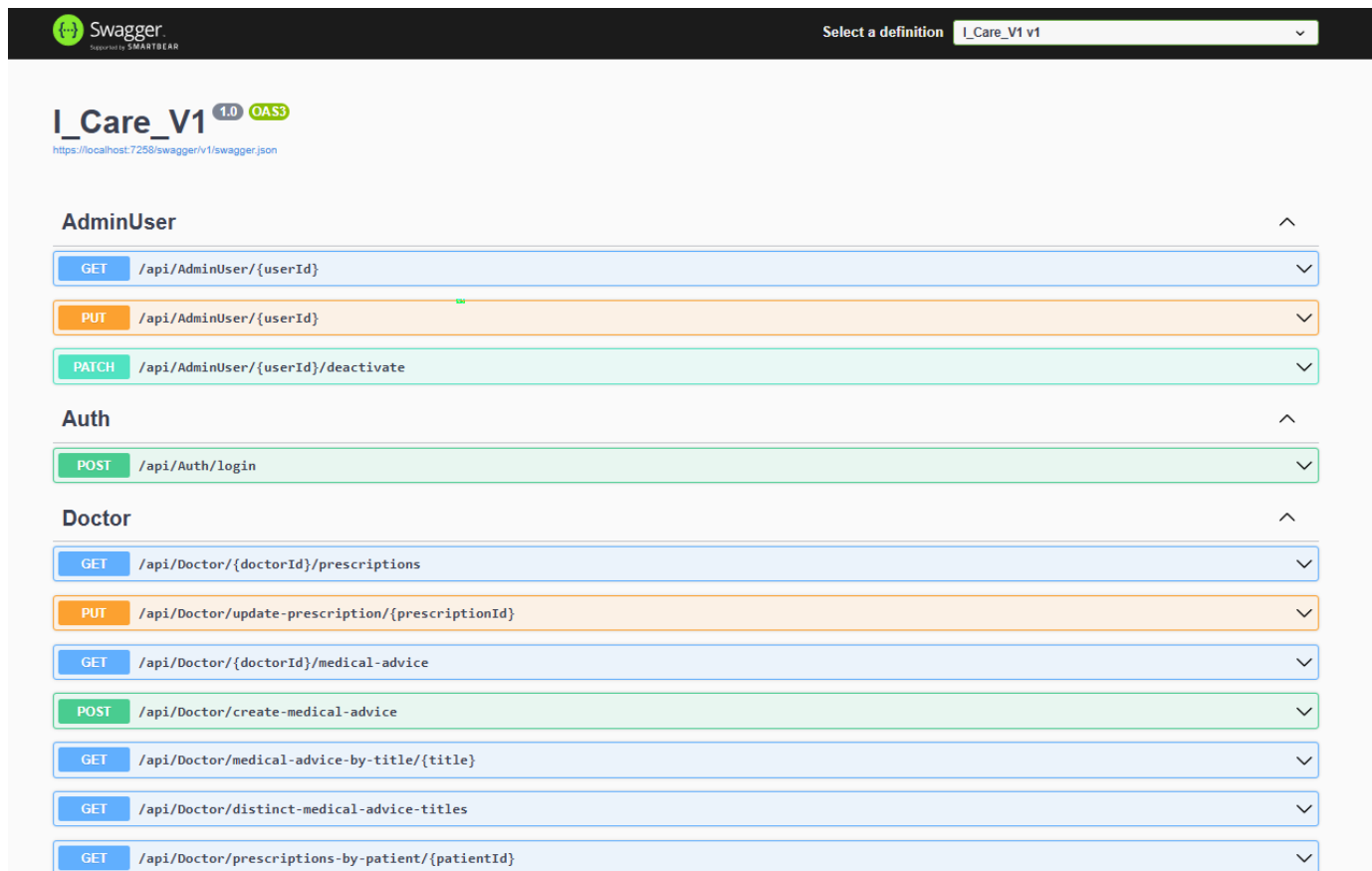


Figure 5. 5:API End Points for Login and Doctor Functions

|                           |                                                             |   |
|---------------------------|-------------------------------------------------------------|---|
| <b>GuardHealthMetric</b>  |                                                             | ^ |
| GET                       | /api/guardian-health-metrics/view                           | ▼ |
| GET                       | /api/guardian-health-metrics/assigned-patients/{guardianId} | ▼ |
| <b>GuardianAssignment</b> |                                                             | ^ |
| POST                      | /api/GuardianAssignment                                     | ▼ |
| PUT                       | /api/GuardianAssignment/{id}                                | ▼ |
| GET                       | /api/GuardianAssignment/patient/{patientId}                 | ▼ |
| <b>GuardLabReport</b>     |                                                             | ^ |
| GET                       | /api/guardian-lab-reports/assigned-patients/{guardianId}    | ▼ |
| GET                       | /api/guardian-lab-reports/view                              | ▼ |
| <b>GuardPrescription</b>  |                                                             | ^ |
| GET                       | /api/guard-prescriptions/assigned-patients/{guardianId}     | ▼ |
| GET                       | /api/guard-prescriptions/view/{guardianId}/{patientId}      | ▼ |
| <b>GuardVaccination</b>   |                                                             | ^ |
| GET                       | /api/guardian-vaccination/assigned-patients/{guardianId}    | ▼ |
| GET                       | /api/guardian-vaccination/view                              | ▼ |

Figure 5. 6:API End Points for Other User Functions

## 5.5 User Feedback and Beta Testing

To evaluate the usability and effectiveness of the system, a beta testing phase was conducted involving key target users, including doctors, patients, lab technicians, pharmacists, guardians, and administrators. During this phase, users interacted with the system in real-world scenarios and provided valuable feedback on various aspects of its performance.

The user survey focused on assessing multiple factors critical to user experience and system efficiency, including:

- Ease of Use – How intuitive and user-friendly the interface is for different user roles.
- Accuracy of Information – The reliability and correctness of data displayed and processed.
- Feature Effectiveness – How well the system’s functionalities align with user needs and expectations.
- Areas for Improvement – User suggestions for enhancing the system’s usability and adding new features.

The feedback collected from this beta testing phase is instrumental in refining the system, addressing any usability concerns, and ensuring that it meets the needs of all stakeholders effectively before its full-scale deployment.

- Doctors found the prescription and health metric modules useful.
- Patients appreciated easy access to medical history.
- Lab Technicians suggested adding a bulk upload feature for lab reports.
- Pharmacists requested an alert system for pending medication pickups.
- Admins found the role-based access control well implemented.
- Guardians requested better notification features for medical updates.

## 6. Conclusion

### 6.1. Overview of the Developed System

The I-Care system has been successfully developed to enhance communication and data accessibility among healthcare stakeholders, including doctors, patients, pharmacists, guardians, lab technicians, and administrators. The system provides a centralized platform for managing medical records, prescriptions, lab reports, health metrics, and vaccinations, ensuring secure, efficient, and role-based access to critical healthcare information.

The system was designed following the Model-View-Controller (MVC) architecture and was built using .NET Core Web API for the backend and Angular for the frontend. By implementing role-based access control, each user type has been assigned specific functionalities, ensuring privacy, security, and compliance with medical data management standards.

The I-Care system successfully enables:

- Doctors to create and manage prescriptions, track patient health metrics, and review lab reports.
- Patients to access their medical records, prescriptions, and vaccination history.
- Lab Technicians to manage lab tests and upload reports.
- Pharmacists to dispense medications based on prescriptions.
- Guardians to track the health records of their assigned patients.
- Administrators to manage users, roles, and overall system integrity.

Through manual and automated testing, the system was evaluated for functionality, security, and performance, ensuring it meets user expectations. User feedback confirmed that I-Care enhances efficiency in managing medical data, reduces paperwork, and streamlines interactions between healthcare providers and patients.

## 6.2. Lessons Learned

The development of I-Care provided significant learning opportunities in software engineering, healthcare IT systems, and secure medical data management. Throughout the project, the following key insights were gained:

- **Software Design & Development:** Implementing a secure and scalable architecture using .NET Core Web API and Angular allowed us to modularize features and ensure maintainability.
- **Role-Based Access Control (RBAC):** Implementing secure authentication and authorization was crucial for ensuring that sensitive medical data is accessed only by authorized users.
- **Data Security & Privacy:** Healthcare data is highly sensitive, so encryption, secure APIs, and proper access control mechanisms were integrated to comply with best security practices.
- **Integration of Automated Testing:** Automated testing using TestNG and the Page Object Model (POM) significantly improved test coverage and reduced the time required for regression testing.
- **Agile & Iterative Development:** Adopting an iterative approach allowed us to refine system requirements based on continuous user feedback and usability testing.
- **Challenges in Healthcare Systems:** Handling medical data formats, ensuring compliance with industry standards, and designing an intuitive UI for diverse user groups were some of the key challenges that were successfully addressed.

## 6.3. Future Improvements

While the I-Care system has successfully achieved its primary objectives, several enhancements can be introduced in future iterations to improve usability, efficiency, and overall functionality.

Planned Enhancements:

- **Integration of Telemedicine Features:** Enabling video consultations between doctors and patients would enhance remote healthcare services.
- **AI-Powered Health Analytics:** Implementing machine learning models to analyze patient health trends and provide predictive healthcare insights.
- **Mobile Application Development:** Developing a mobile version of I-Care would improve accessibility for patients and healthcare providers on the go.
- **E-Prescriptions & Direct Pharmacy Integration:** Automating prescription delivery to partnered pharmacies to reduce manual processing time.
- **Improved Notification System:** Enhancing email/SMS alerts for appointments, prescription refills, and lab results.
- **Multi-Language Support:** Adding support for multiple languages to improve accessibility for diverse user groups.

## **6.4. Summary**

The I-Care system successfully addresses the challenges of managing healthcare data by centralizing patient information and enabling seamless collaboration between stakeholders. The system's modular design, role-based access control, and integration of automation make it a scalable and reliable healthcare IT solution.

This project has been an insightful journey, providing valuable experience in healthcare software development, security best practices, and efficient medical data management. Future enhancements will continue to refine and expand the system's capabilities, ensuring that I-Care remains a robust and impactful solution for modern healthcare needs.

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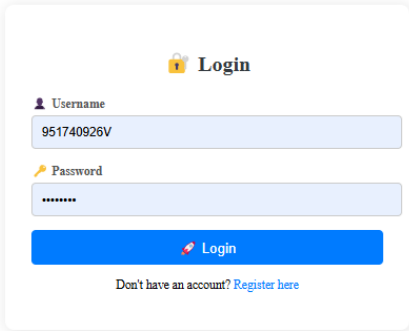
1. IBM Research (2023) *Enhancing AI-driven Predictive Analytics for Medical Diagnosis*. New York: IBM Press.
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# Appendix – User Manual

- System Name: I-Care – Personal Health Management System
- Version: I-Care 1.0
- Date: 2025.03.10
- Author: Limantha Malika

## 1. Getting Started

### UI For Login



The screenshot shows a login form titled "Login" with a key icon. It contains two input fields: "Username" with the value "951740926V" and "Password" with masked characters. Below the fields is a blue "Login" button. At the bottom, there is a link: "Don't have an account? [Register here](#)".

Below the login form is a dark footer bar containing the text "Current Time: 2:45 PM" and links for "About Us", "Contact Us", and a Facebook icon.

## 2. Role-Based Data Access

The **I-Care** system implements a **role-based access control (RBAC) mechanism** to ensure that different user types receive only the information relevant to their roles. The system dynamically filters and delivers data based on the authenticated user's role, ensuring privacy, security, and compliance with access policies.

- Doctors can access patient medical histories, prescriptions, and lab reports.
- Patients can view their own medical records, prescriptions, and upcoming appointments.
- Guardians can access only the vaccination details of assigned patients where `IsEnabled = 1` in the `GuardianAssignments` table.
- Pharmacists can retrieve prescription details but do not have access to patient medical histories.
- Lab Technicians can manage and upload lab test results but cannot view patient diagnoses.
- Admins have full access to manage users, permissions, and system settings.

### 3. Account Management

#### 3.1. Creating an Account

1. Go to the I-Care website.
2. Click on "Register".
3. Select the user role (Doctor, Patient, Guardian, Pharmacist, Lab Technician, or Administrator).
4. Fill in the required details.
5. Click "Register", and confirm the registration in the pop-up dialog.
6. Upon successful registration, a confirmation email will be sent.

Eg –Patient Registration

The screenshot shows a web form titled "Register" with a red icon. The form contains the following fields and sections:

- NIC:** A text input field with the placeholder "Enter your NIC".
- User Name:** A text input field with the placeholder "Enter your username". Below it, a blue button says "Use NIC as Username" and a green checkmark icon with the text "Recommended: Use your NIC as your username for easy login."
- Password:** A text input field with the placeholder "Enter your password".
- Email:** A text input field with the placeholder "Enter your email".
- First Name:** A text input field with the placeholder "Enter your first name".
- Last Name:** A text input field with the placeholder "Enter your last name".
- Phone Number:** A text input field with the placeholder "Enter your phone number".
- Date of Birth:** A date picker field showing "mm/dd/yyyy".
- Gender:** A dropdown menu with "Select Gender" as the placeholder.
- Address:** A text input field with the placeholder "Enter your address".
- User Type:** A dropdown menu with "Patient" as the selected option.
- Blood Group:** A text input field with the placeholder "Enter your blood group".
- Emergency Contact Name:** A text input field with the placeholder "Enter your emergency contact name".
- Emergency Contact Phone:** A text input field with the placeholder "Enter your emergency contact phone number".
- Allergies:** A text input field with the placeholder "Enter any allergies (if any)".
- Height (cm):** A text input field with the placeholder "Enter your height in cm".
- Weight (kg):** A text input field with the placeholder "Enter your weight in kg".
- Diabetes:** A checkbox.
- Diabetes Type:** A text input field with the placeholder "Enter your diabetes type".
- Hypertension:** A checkbox.
- Cholesterol:** A checkbox.
- Heart Disease:** A checkbox.
- Asthma:** A checkbox.
- Thyroid Condition:** A checkbox.

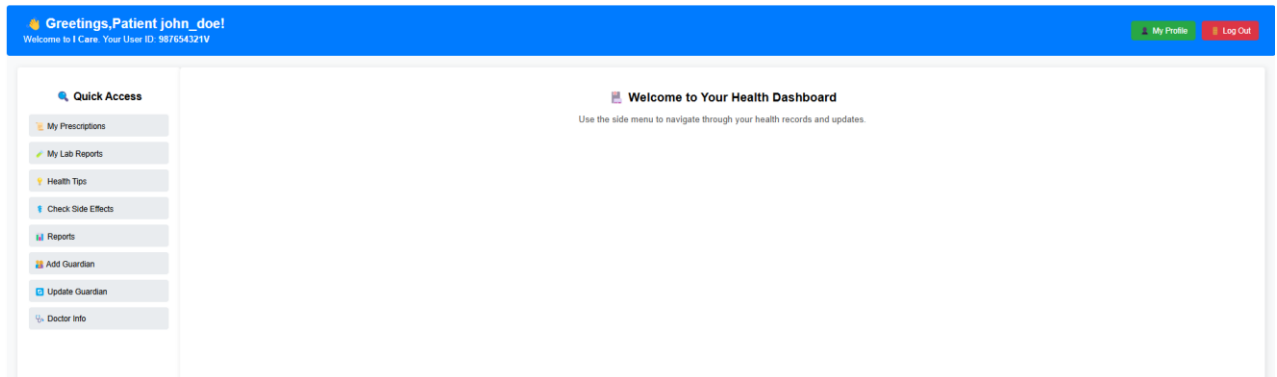
At the bottom of the form, there are three buttons: a blue "Register" button, a grey "Cancel" button, and a teal "Back to Login" button.



### 3.2. Logging In

1. Enter your NIC and password on the login page.
2. Click "Login".
3. If credentials are correct, you will be redirected to your dashboard.
4. If credentials are incorrect, an error message will appear.

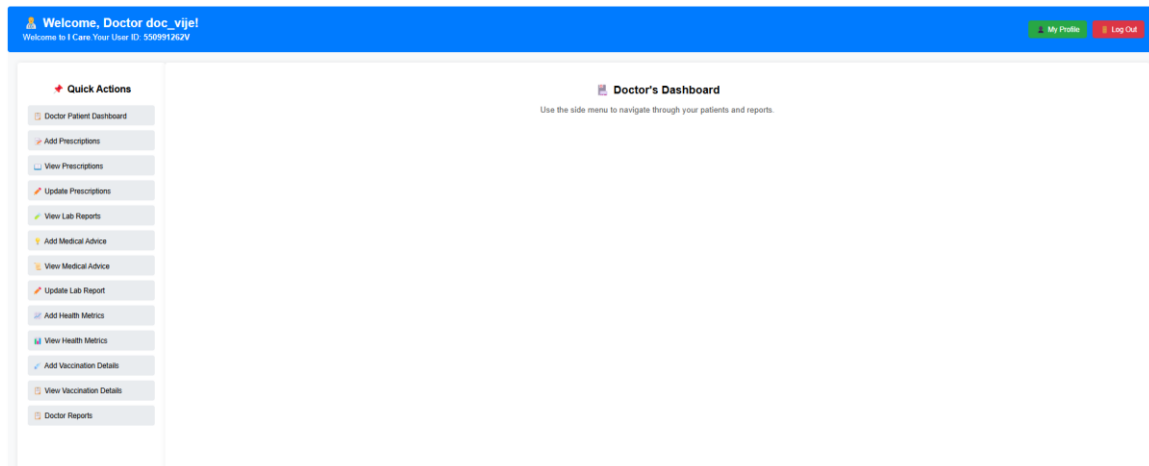
### Patient Dashboard



### 3. Doctor Functionalities

#### 3.1. Managing Prescriptions

- Create a Prescription – Enter the disease, prescribed medication, dosage, and duration.
- Add Lab Test Requests – Enter test details in the notes section while creating prescriptions.
- View & Update Prescriptions – Modify existing prescriptions if necessary.



Details

Prescription Details

ID: 30

Date: 2023-03-08 08:14

Notes: Do fbc

Medicine Details

| Medicine   | Dosage | Frequency | Duration | Side Effects |
|------------|--------|-----------|----------|--------------|
| metformine | 500mg  | 3         | 30       | dizay        |
| penadol    | 45mg   | 2         | 30       |              |

- View Medical Advice – Access previously given advice.
- Add Health Metrics – Update health-related data like blood pressure, sugar levels, etc.
- View Health Metrics – Review past health data of patients.

View Medical Advice

Select Title: 

cholesterol

Advice for: cholesterol

Exercise Be active most days Exercise helps lower blood sugar levels and reduce the risk of heart disease Activities like swimming, biking, walking, and playing with a frisbee can help

Current Time: 6:25 PM

About Us | Contact Us |

View Health Metrics

Patient ID (NIC): 

987654321V

Filter by Metric Type: 

Cholesterol

View Metrics

Health Metrics for 987654321V

Cholesterol: 190 mg/dL  
Recorded At: 2/15/25, 6:22 AM  
Slightly high cholesterol level, needs monitoring.

Current Time: 6:27 PM

About Us | Contact Us |

### 3.4. Managing Vaccination Details

- Add Vaccination Records – Record vaccination details for patients.
- View Vaccination Details – Access patient immunization records.

View Vaccination Records

Enter Patient ID: 987654321V Search

Vaccination Records

Vaccine: Pfizer  
Status: 2  
Last Dose Date: 2025-02-15T11:28:20.282  
Total Doses: 3

Vaccine: z  
Status: 2  
Last Dose Date: 2025-02-15T11:28:20.282  
Total Doses: 3

Vaccine: A  
Status: 2  
Last Dose Date: 2025-02-15T11:28:20.282  
Total Doses: 3

Vaccine: ddd  
Status: 1  
Last Dose Date: 2025-02-15T00:00:00  
Total Doses: 5

Vaccine: Pfizer  
Status: 0  
Last Dose Date: 2025-03-28T00:00:00  
Total Doses: 5

Current Time: 6:27 PM  
About Us | Contact Us |

### 3.5. Generating Reports

Doctors can generate:

- Prescription Summary – List of prescribed medications.
- Appointment Consultations – List of patient consultations within a selected period.
- Medical Advice Reports – Record of provided medical advice.  
(Filters available: Date range, Doctor ID)

### Doctor Reports

Doctor ID:

550991262V

Select Report Type:

Appointments & Consultations

▼

Start Date:

02/08/2025

📅

End Date:

03/10/2025

📅

Fetch Report

Report Data

**Description:** A detailed listing of all patient visits and consultations conducted by a doctor within a defined timeframe. This report provides visibility into patient interaction history and appointment volumes to monitor workload and patient care delivery.

| Patient Name    | Patient ID | Consultation Date |
|-----------------|------------|-------------------|
| John Doe        | 987654321V | 2025-02-15        |
| John Doe        | 987654321V | 2025-02-22        |
| Dulanga Mihiraj | 10V        | 2025-03-02        |
| John Doe        | 987654321V | 2025-03-05        |
| John Doe        | 987654321V | 2025-03-08        |
| John Doe        | 987654321V | 2025-03-08        |

Download as PDF

## 4. Patient Functionalities

### 4.1. Viewing Medical Records

- View & Download Lab Reports – Patients can download their lab results as PDFs.
- View Prescriptions – Access prescribed medications.
- View Medical Advice – Review medical guidance given by doctors.
- Check Side Effects – Analyze potential medication side effects.
- View Health Metrics – Access personal health data.
- View Vaccination Records – Check immunization history.
- View Issued Drugs – Track dispensed medication details.

65

### Check Side Effects

Patient ID:

987654321V

Search

#### Prescriptions for Patient ID: 987654321V

Prescription ID: 19 | Date: Jan 27, 2025

Prescription ID: 20 | Date: Jan 27, 2025

Prescription ID: 21 | Date: Jan 27, 2025

Prescription ID: 24 | Date: Feb 16, 2025

Prescription ID: 25 | Date: Feb 22, 2025

Prescription ID: 27 | Date: Mar 6, 2025

Prescription ID: 28 | Date: Mar 6, 2025

Prescription ID: 29 | Date: Mar 6, 2025

Prescription ID: 30 | Date: Mar 8, 2025

Prescription ID: 31 | Date: Mar 8, 2025

#### Side Effects

Prescription ID: 21  
Date: Jan 27, 2025  
Medicine Side Effects:

- metformine: can be dizzy
- zedos: No

## 4.2. Managing Guardians

- Add a Guardian – Assign a guardian to access medical records.
- Update Guardian Information – Modify existing guardian details.

Update Guardian

Patient ID (NIC)

987654321V

Search Guardian

Guardian details loaded successfully!

Guardian ID

111111111V

Relationship

Brother

Enable Guardian?

Enabled

Update Guardian

### 4.3. Checking Doctor Information

- View Preferred Doctors – Access details of doctors treating the patient.

**Doctor Information**

Enter Doctor ID:

550991262V

Search

**Doctor Details**

Username: doc\_vije  
Full Name: Limantha Malika  
Email: limanthakmalith@gmail.com  
Phone: 0719207988  
Date of Birth: 1989-04-08  
Gender: Male  
Address: 43 B , Mangala Road , kurana , Negombo  
Medical License: 444  
Specialization: diabetics  
Hospital Affiliation: nawaloka

Download as PDF

Current Time: 6:30 PM

[About Us](#) | [Contact Us](#) | [Facebook](#)

### 4.4. Generating Reports

Patients can generate:

- Health Metrics Summary – Overview of health trends.
- Prescription History – Complete record of prescribed medications.
- Lab Test Reports – History of test results.
- Vaccination Reports – Immunization details.  
(Filters available: Date range, Patient ID, Doctor ID)

Patient Reports

Patient ID:

987654321V

Select Report Type:

Prescription History

Doctor ID:

550991262V

Start Date:

02 / 08 / 2025

End Date:

03 / 10 / 2025

Fetch Report

Report Data

| Key        | Value            | Date       |
|------------|------------------|------------|
| 1          | 1, 1, 1          | 2025-02-16 |
| 2          | 2, 2, 2          | 2025-02-16 |
| matfo      | 3mg, 3, gggg     | 2025-03-06 |
| metformine | 500mg, 3, dizzy  | 2025-03-08 |
| penadol    | 45mg, 2,         | 2025-03-08 |
| njdfj      | vffd, 3, vfgdgdg | 2025-03-08 |

Download Report as PDF

## 5. Pharmacist Functionalities

### 5.1. Managing Medication Dispensing

- View & Dispense Prescriptions – Process prescriptions and provide medications.
- View Lab Reports – Access patient lab test results if needed.
- View Health Metrics & Vaccination Records – Access relevant health data.
- Manage Issued Drugs – Keep track of dispensed medications.



**Issue Drugs to Patient**

**Doctor ID:**

**Pharmacist ID:**

**Patient ID:**

**Prescription ID:**

**Medicine Name:**

**Dosage:**

**Frequency:**

**Tablets Needed:**

**Tablets Given:**

**Dispense Date:**

Issue Drug

🕒 Current Time: 6:32 PM

📄 About Us | 📧 Contact Us |

## 5.2. Checking Doctor Information

- View Preferred Doctors – Check details of prescribing doctors.

## 5.3. Generating Reports

Pharmacists can generate:

- Most Prescribed Medicines Report – Analytics on frequently prescribed drugs.
- Dispensed Medicine Report – List of medications dispensed.  
*(Filters available: Date range, Patient ID, Doctor ID, Pharmacist ID)*

## 6. Guardian Functionalities

### 6.1. Viewing Medical Records (If Allowed by Patient)

- Download Lab Reports
- View Prescriptions
- View Lab Reports
- View Medical Advice
- Check Side Effects of Prescribed Medicines
- View Health Metrics
- View Vaccination Records
- View Issued Drugs


**View Prescriptions**

**Select Patient:**

987654321V (ujj)


**Search**


**Prescription List**

ID

Prescription ID: 19

Date: 2025-01-27

Doctor:

890991262V

Status:

Active

Notes:

You have to check HBA1C , Lipd Profile

Medicines:

ID

Prescription ID: 20

Date: 2025-01-27

Doctor:

890991262V

Status:

Active

Notes:

you have to do SGPT

Medicines:

amoxiline - 500 mg - 2 times a day times/day

ID

Prescription ID: 21

Date: 2025-01-27

Doctor:

890991262V

Status:

Active

Notes:

do HBa1c and Lipd Profile

Medicines:

metformine - 500 mg - 3 times a day times/day

zedos - 5 mg - 2 times times/day

## 6.2. Generating Reports

Guardians can generate:

- Dependent's Prescription Report – List of prescribed medicines and their side effects.
- Lab Test History Report – Dependent's test results.
- Medication Order Report – History of medicines ordered on behalf of the dependent.  
(Filters available: Date range, Patient ID, Doctor ID)

## 7. Lab Technician Functionalities

### 7.1. Managing Lab Reports

- View Prescriptions – Identify prescribed tests from doctors' notes.
- Add Lab Reports – Upload and record test results.
- Update & Delete Lab Reports – Modify or remove reports if necessary.
- Download & Upload Reports in PDF – Ensure secure record management.

The screenshot displays a web form for adding a lab report. The form is organized into several sections, each with a label and a corresponding input field:

- Patient ID:** A text input field with the placeholder "Enter Patient ID".
- Technician ID:** A text input field with the placeholder "Enter Technician ID".
- Doctor ID:** A text input field with the placeholder "Enter Doctor ID".
- Test Type:** A text input field with the placeholder "Enter Test Type".
- Test Date:** A date picker input field showing "mm/dd/yyyy".
- Results:** A large text area for entering test results, with the placeholder "Enter Test Results".
- Next Test Date:** A date picker input field showing "mm/dd/yyyy".
- Status:** A dropdown menu with a downward arrow.

At the bottom of the form is a blue button labeled "Add Lab Report".

Below the form is a dark grey footer bar containing the following information:

- Current Time: 6:33 PM
- Links: [About Us](#), [Contact Us](#), and a Facebook icon.

## 7.2. Generating Reports

Lab technicians can generate:

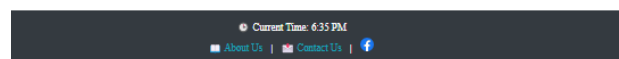
- Patient Test History Report – All test results for a specific patient.
- All Tests Performed Report – Summary of lab tests done by the technician.  
(Filters available: Date range, Patient ID, Doctor ID, Lab Technician ID)

## 8. Administrator Functionalities

### 8.1. User Management

- Add User – Register a new system user.
- Update User Information – Modify user details.
- Delete User – Remove inactive or unauthorized users.

The screenshot shows a web form titled "Update User". It includes a search bar with the text "990991202V" and a blue "Search User" button. Below this are several input fields: "Email:" with the value "limanthakmalith@gmail.com", "User Type:" with the value "doctor", "First Name:" with the value "Limantha", "Last Name:" with the value "Malika", "Phone Number:" with the value "0719207988", "Date of Birth:" with a date picker showing "mm/dd/yyyy", "Gender:" with the value "Male", "Address:" with the value "43 B, Mangala Road , kurana , Negombo", and "Is Active:" with a dropdown menu showing "Active". A blue "Update User" button is at the bottom of the form.



### 8.2. Generating Reports

Administrators can generate:

- Active Users by Role Report – Count of active users by role.  
(Filters available: Date range, User Type)