Post Discharge Treatment and Readmission Predictor
IIE-CIS 2016 Software Documentation

SSIE mobile application development team
Amirhosein Gholami – PhD Student, Systems Science
Qi Jia – PhD Student, Electrical Engineering
Lu He – PhD Student, Industrial Engineering
Runpei Xu – MS Student, Industrial Engineering

State University of New York at Binghamton (SUNY)

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Executive Summary for the IIE-CIS 2016 Software Documentation

To reduce readmission penalty for hospitals and help patients to rehab effectively, an Android based mobile application, “Post Discharge Treatment and Readmission Predictor”, is developed and introduced in detail in this documentation. Three user types are considered in this developed Mobile App, which are patients, healthcare providers, and insurance agents. More than only predicting readmission risks for patients, a communication platform is built between healthcare providers and patients. Healthcare providers can request information from patients and offer remote medical instructions based on patients’ most recent vital signs and their readmission prediction results. Such that, both healthcare providers and patients can act timely to reduce readmission risks. For insurance agents, readmission reports including patients’ historical readmission risks are available, and they can send requests to remind healthcare providers of high risk patients. An information net on post discharge and readmission is formed in this developed Mobile app based on the data connection and communications between the three user types, which mobilizes post discharge rehabilitation treatments and reduces readmission risks more efficiently and timely.
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1. Introduction

This document covers information about the structure and prototype of the Android based mobile application, “Post Discharge Treatment and Readmission Predictor”, designed, developed, and implemented by Binghamton University SSIE mobile application development team for IIE-CIS Mobile Application Competition 2016.

1.1. Purpose

Hospital readmission can be broadly defined as patients who are hospitalized unexpectedly within 30 days after discharge. According to previous studies on this problem, the readmission rate in the U.S. is around 20% among the discharged patients, and it costs around 17 billion dollars annually [1]. Besides, Centers for Medicare and Medicaid Services (CMS) has treated readmission as a source of reimbursement penalty because it is highly related to mortality, morbidity, and financial costs [2, 3]. Since 2012, CMS took actions on reducing readmission on three diseases with highest readmission rates, which are acute myocardial infarction (AMI), heart failure (HF), and pneumonia [1]. In fact, readmission could be decreased by identifying high-risk patients using certain prediction techniques, and then actions can be taken in time during medical treatments or after discharging.

For this purpose, the “Post Discharge Treatment and Readmission Prediction” mobile application is designed to help healthcare providers to track and guide their discharged patients to reduce the risk of any possible re-hospitalization.

1.2. Scope

This application extends the scope of datamining techniques to the field of healthcare, specifically home treatment. Based on this concept, the readmission risky rate in this application is evaluated based on the proposed prediction algorithm. K-nearest neighbors (KNN), Logistic regression, and Naïve Bayes algorithms are playing big roles in the prediction algorithm. The proposed algorithm is a data-based assembled prediction model, which increases the prediction accuracy by 20% in average comparing to the traditional used logistic regression prediction models in health care.
Fast communication feature is the other scope of this mobile app. There are three groups of users considered for this app. Each group of users can send different types of messages to other groups under certain rules.

1.3. Software Context

The app is developed for Android based smartphones and tablets which are equipped with Android 4.0.4 (Ice Cream Sandwich) or higher. It means this app can be run on more than 90% of the available Android devices.

This app represents the first prototype of the more advanced app, which has been proposed by current team. Future work on this app will be adding more features, covering more diseases, and improving the UI.

1.4. Target Users

The proposed mobile application aimed three different end users:

- Post-discharged patients
- Health care providers
- Health insurance companies

2. System Overview

Today, smartphones and tablets can be found everywhere. These small computers have a good potential to be used as a home treatment assistant for their users. Access to the Internet is also available in many places through cell towers, Wi-Fi hotspots, cables, etc. This application tries to use those capabilities to help patients who are discharged recently to prevent being re-hospitalized by simple functions. Special messaging service is one of the features of this app. *PdtRp* (Post Discharge Treatment and Readmission Predictor) uses some simple rules to make a two-way communication between healthcare provider and their patients. It also gives chance to the insurance agents to check their patients’ status and warn the healthcare provider to take care of high-risk patients.
Predicting each patient’s readmission probability is the other feature of implemented mobile application. Comparing current status of each patient with other historical records using different datamining techniques gives a good prediction model for re-hospitalization possibility. A secured server analyzes data and returns a prediction result using secured connections over internet.

2.1. System Architecture

The mobile app is using secured connection to send and receive data into/from our dedicated secured server. A web service designed on the server receives request from mobile app and send back the proper information. There is no direct connection between mobile app and database to increase the security.

![General view of the architecture](image)

*Figure 1: General view of the architecture*

The mobile application by itself is designed for Android platform. It can be used on smartphones and tablets, which are equipped with Android 4.0.4 or higher. The vast variety
of the Android users pursued development team to focus on this platform. The app designed based on the multi-layer architecture. Following figure shows the brief view of each layer and their contents.

Among all of listed classes and modules, *User class* and *Message class* have their children classes. Figures 3 and 4 show more information about their hierarchy.

*Figure 2: Overview of the designed layers*

*Figure 3: User class hierarchy*
2.2. Design Considerations

The mobile application is considered as a tool for post discharge treatment. Based on this consideration, different user types have been considered for this application.

- Healthcare provider
- Discharged Patient
- Insurance Agent

Each user in this system has a specific permission to access the application features. Constraints and limitations of each user type is summarized as follows:

1. Healthcare provider:
   a. Allowed to
      i. Request vital information from patients
      ii. Contact patients directly
      iii. Answer the insurance agent’s message (One way connection)
      iv. Review all under track patients’ readmission prediction history
      v. Update patient’s readmission prediction model
   b. Prohibited from
      i. Send a request message to the insurance agent
      ii. Access to the patient’s information who is not under his track
2. Patient:
   a. Allowed to
      i. Send an emergency request to the healthcare provider
      ii. Contact his/her healthcare provider directly
      iii. Send vital information to the healthcare provider (even without request)
      iv. View his/her own readmission report
   b. Prohibited from
      i. Contacting insurance agent
      ii. Viewing other patients’ information
      iii. Updating his/her readmission prediction model

3. Insurance agent:
   a. Allowed to
      i. Send a request to the patients’ healthcare provider
      ii. View patients’ readmission history report
   b. Prohibited from
      i. Contact patients directly
      ii. Update patients’ readmission prediction model
      iii. View patients’ vital information
3. Application Overview

This section covers detailed information about the workflow and mobile application’s prototype.

3.1. Prototype

3.1.1. Main menu:

Using this menu, a user is able to access to different features available in this mobile app.

Using this menu, a user can access to the

- Login page (Login)
- Dashboard (Home)
- List of received messages and reply to them (Messages)
- List of patients/healthcare provider and send a request (Patients)
- Readmission report and update tool (Readmission report).

3.1.2. Login

Permission to use the application is given to the registered users using Login menu. Each user have his/her unique username and password. Access to different activities is possible based on different access rules assigned to each user after logging in using this menu. The result of getting permission is as follow:

- Your access is guaranteed as DOCTOR
- Your access is guaranteed as PATIENT
- Your access is guaranteed as INSURANCE AGENT
• Your access is denied.

3.1.3. Home (Dashboard)

Each user has access to its quick view notifications in Home. This section introduces information about

• Number of under track patients
• Number of high risk patients
• Number of new messages
• Any emergency request from patients
• Newly replied message from other users
• Any vital information received from patients
• Any instructions received from healthcare provider
• …

3.1.4. Messages

Each user can access to his/her messages sent by others using Messages menu. A type of message is different based on different user types. There are two icons dedicated for each message.

• Heart
• Ambulance

A message that indicated by a highlighted heart means it contains vital information.

A message with highlighted ambulance means it is an emergency request.
Content of each message is accessible by clicking on the title of that message.

Each message has three parts

- **Body**
- **Vital information**
- **Reply section**

Body and Reply sections are similar for all users. The vital information is shown differently for different user types.

- **Healthcare providers** have read-only access to the received vital information
- **Patients** have access to input the information and send them to the healthcare provider. Patients see the requested vital information as highlighted icons, which are mandatory to fill, in the message. Patients also can send other vital information as an optional.
- **Insurance agent** does not see any vital information or icon in the message. Agent can only send the text message to the healthcare provider.

Different message types are shown here:
3.1.5. Patient

The Patient menu provides different contents based on different user types.

- Healthcare provider: is able to see the list of all under track patients and send them a request separately. Healthcare provider can easily select different vital icons and send the message to each patient.

- Patient: is able to see the healthcare provider in this menu and send a request, message, or emergency message to him/her. The emergency request can be easily made by only touching the ambulance icon on the healthcare provider’s title.

- Insurance agent: is able to see the list of all patients and their latest re-hospitalization prediction status. Agent is also able to send a message to each patient’s healthcare provider using this patient list.
3.1.6. Readmission report

A linear chart shows the history of predicted readmissions for each patient in this section. Access to this report is also different for different types of users.

- Healthcare provider: has the maximum access to this unit. The healthcare provider is able to view and calculate the readmission information by selecting each patient from the patient list accessible at this unit.

- Patient: can only see his/her own readmission history report in this section. Access to the other patients’ information and the new readmission calculation units are blocked for this type of users.
• Insurance agent: has access to the list of patients. The readmission prediction history is available for insurance agent by selecting the patient from patient list. The access to the new readmission calculation unit is also blocked for the insurance agent.

3.1.7. Vital icons guide

There are icons in messaging units that represent the vital information or health related activities. Following figure represents more information about those icons.

4. Future work

Although the proposed mobile application is fully functional and working on a real smartphones (not only on the emulators), mobile app development team is continue working on this app to improve the quality and user-friendliness of the future versions.

Possible future works for this mobile app can be summarized as follow:

• Improve the graphic of the User Interface
• Adopt the application to be used in more smart devices. Right now, devices with small screens may not show some icons. Scroll the patient list also would face to some difficulties on such devices.

• Improve the UI to be compatible with different orientations. Horizontal orientation is not supported at the time of writing this document.

• Improve the app to be more user-friendly on tablets.

• Connect the app to the wearable devices and smart watches to import the vital information automatically.

• Design the app for other smart phone platforms (specially for iOS devices)
5. References

