Mobile Application (DMemo) for Gathering Data from Diabetic Patients and Caregivers

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Abstract:

Background: Currently the device which everyone takes everywhere with him is a smartphone. Data collection via mobile applications can conveniently help patients gather their health information. In addition, the users can view the information from the database in graph or chart for easy interpretation.

Objective: The aim of this study is to help diabetic patients record their data easily, to see the trends of each data set and to improve theircompliance, by developing a mobile application for self-gathering of their glucose data.

Methods: A total of fifteen subjects, five physicians and ten diabetic patients, tested this application and used this application for both collecting data and other functions. After a week of using this application, the users completed a satisfaction questionnaire so that their suggestions could be used to improve this application performance.

Results: After a week of testing this application, the overall efficiency of this application was good (more than 3.41/5.00). The patients found recording their data on this application was easy. In addition, showing the trend of each patient data had benefit for both patients and physicians. However, some functions were too complicated to use without assistance from staff.

Conclusions: This mobile application was useful for patients and physicians to gather data and see the trends of each data. Future enhancement could include adding some beneficial features such as notification, adding others relevant data, or connection to the health care system. Importantly, this application should be able to be run on every operating system and be displayed in other languages. Therefore, using technology is helpful for long-term data gathering and analysis.

Keywords: Diabetes self-management, compliance of diabetic patients, glucose monitoring, mobile applications

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Introduction

Diabetes mellitus is one of the non-communicable diseases (NCDs) which is increasing in incidence worldwide. Over 60% of global diabetic patients live in Asia, with the prevalence across these countries ranging from 3% to 47.3%. The prevalence of diabetes in Thailand, one of the Asian countries, has become very high[1]. The overall prevalence of diabetes in Thai adults, aged ≥ 20 years, was 9.9% (95% CI: 9.4%, 10.4%)[2]. The American Diabetes Association has confirmed that effective self-management, leading to improved clinical outcomes, health status, and quality of life, are key goals of diabetes self-management education and supports that these parameters should be measured and monitored as part of routine care[3]. Therefore, physicians should provide education and self-monitoring to persons with diabetes.

Self-monitoring requires that diabetic patients should record data on blood glucose in their notebooks. But sometimes the patients may forget to take notes or bring their notebooks when they attend hospital. Moreover, patients must maintain good compliance with medication therapy and lifestyle modifications. According to the International Diabetes Federation, consistently high blood glucose levels can lead to disease-related complications affecting the heart and blood vessels, eyes, kidneys, nerves, and teeth. In addition, people with diabetes also have a higher risk of developing infections[4]. Therefore, diabetic patients who show good compliance, usually have a greatly improved prognosis.

At present, the increase of smartphone use leads to increased and more convenient access to relevant information. *"Hootsuite"*, the most ubiquitous social media management platform, and *"We Are Social"*, the global conversation agency from the United Kingdom, reported that there were 55.56 million mobile users (80%) in Thailand[5]. Using a smartphone to record data in an application can make data collection easier compared with taking notes in a notebook; moreover, collecting data using a smartphone reduces paper use. Applications that help data collection, such as blood glucose levels, blood pressure, body weight, meal times, medication times and exercise participation, can help the patients and their physicians know the trends of each data. Furthermore, this application assists physicians to adjust medications, tailored to each patient.

Objective

The research study aimed to develop a mobile application and test this application system, for gathering data of diabetic patients, which help them to record their data easily, see the trends of each data set and improve their compliance.

Methods

2.1 User Involvement

The study protocol was ethically approved by the Ethics in Human Research Committee of Mae Fah Luang University (REH-62012) in 2018. A total of fifteen subjects, five physicians and ten diabetic patients, tested this application. The subjects were recruited using the following inclusion and exclusion criteria. In addition, all study participants agreed to follow the study protocol and provided written consent. After the subjects had used this

application for a week, they completed a satisfaction questionnaire, as detailed in Appendix B for the patients and Appendix D for the physicians.

Patient Inclusion Criteria

1. Type 2 Diabetic patient between the ages of 30 and 70 years.
2. Patient undergoing treatment at Mae Fah Luang University Medical Center Hospital and Mae Fah Luang University Hospital from January 1, to March 31, 2019.
3. Patient who was able to use an Android smartphone and access the internet.
4. Patient who was able to read and understand Thai language proficiently.

Patient Exclusion criteria

1. Patient having a significant past medical history or other co-existing serious diseases (including coronary artery disease, stroke, or chronic obstructive pulmonary disease).
2. Patient having dementia or any other similar conditions (including drug abuse, alcohol abuse, or psychiatric disorder)

Physician Inclusion Criteria

Subjects were physicians at Mae Fah Luang University Medical Center Hospital and Mae Fah Luang University Hospital between the January 1, and March 31, 2019.

2.2 System Architecture

This application was created with the Ionic framework. Ionic framework is an HTML5 mobile application development framework, targeted at building cross-platform applications, which can be exported and run on every operating system. Figure 1 indicates that all data is stored on a secure database server. The users are patients who can add their data and physicians who can access the data via this application. The following overview figure summarizes the integration of the application and database server:

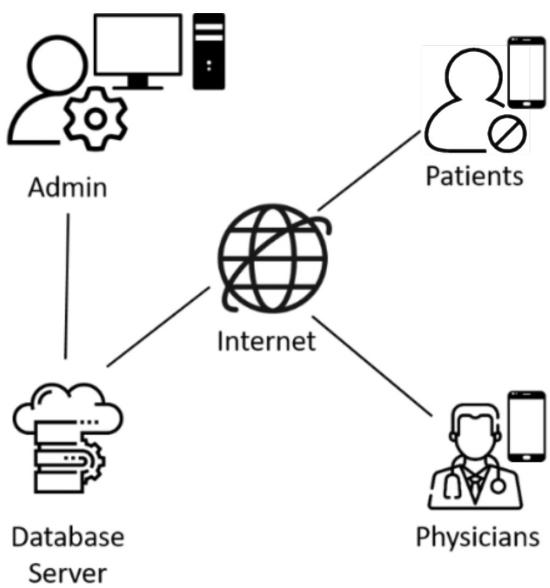

Figure 1 System Architecture of this application

2.3 User Case Diagram

This user case diagram indicates users and subsystems of this application. The features for the patients are log in, edit personal profile, see the trend of the data, add daily data, and edit daily data. In addition, the features of the physicians are search patients' name, see daily data, and see the trend of the data as shown in Figure 2.

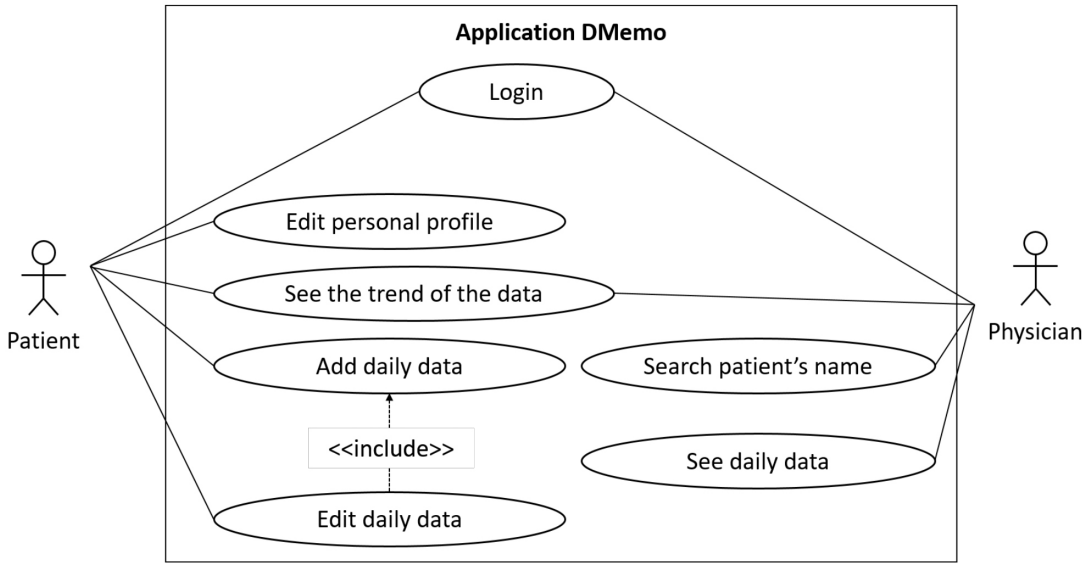

Figure 2 User Case Diagram of this application

2.4 Assessment

The questionnaire is divided into three parts, comprising information about patients or physicians by checklist, the satisfaction of this application based on Likert Scale[6], and recommendations for this application. In the satisfaction part, there are 8 questions, scored from 1 to 5 (1: strongly agree, 2: agree, 3: neutral, 4: disagree, and 5: strongly disagree). In addition, the summation points of each question were calculated and the mean of the satisfaction displayed as a graph using Microsoft Excel 2016.

Results

3.1 Implementation system

3.1.1 Patient user interface

The patient has to input their email and password for login as shown in Figure 3a. After that, this application showed the patients' home page, as shown in Figure 3b. There are four basic patient features which consist of Edit personal profile, Add daily data, See the trend of the data, and Edit daily data.

(a) (b)

Figure 3 Login page (a) and Patient home page (b)

Then the patient has to put the personal profile include name, date of birth, gender, age, height, weight, e-mail, and telephone number. The medicine name list and the drug names included medication administration route (tablet or injection), dosage, and directions. Then daily data which consists of blood glucose level, blood pressure, weight, waist circumference, medication time, meal time, and exercise participation. Blood glucose level, measured time duration of the measurement, blood pressure feature and weight, waist circumference is added. Then medication time, including the drug name and dosage time is added. Exercise intensity, exercise time, the length of exercise, and kind of sport is then added. The line graph of blood glucose, blood pressure is plotted with time. Furthermore, meal time and medication time are also displayed below this blood glucose level graph.

3.1.2 Physician user interface

Logging onto the physician account shows the list of patient's names which can be searched using the text box. The profile, the trends of each data, and the daily data of the patient chosen can be accessed. In addition, the instructions of each feature in this home page are the same as the patient feature.

3.2 Questionnaire Results

This application was tested by five physicians and ten patients. The demographics of the patients and the physicians are shown in Table 1 and 2. They used this application for collecting data and used the other features. After a week of using this application, the users completed satisfaction questionnaires so that their suggestions can be used to fine tune this application.

Table 1 shows the information about the patients who completed the patient questionnaire. A total of 10 patients treated at Mae Fah Luang University Medical Center Hospital and Mae Fah Luang University Hospital 80% where male 20% were female. The number of patients aged 40–49 years, 50–59 years, and 60–70 years were 20%, 20%, and 60% respectively. 80% of informants were patients, and 20% of informants were caregivers. The number of users who used this application less than two times/week, 2 to 4 times/week, and more than four times/week was 70 %, 20, and 10% respectively.

Table 2 shows information about the physicians who completed the physician questionnaire. A total of 5 physicians at Mae Fah Luang University Medical Center Hospital and Mae Fah Luang University Hospital were male 100%. The number of physicians whose age 20–29 years, 30–39 years, 40–49 years, and 60–65 years are 40%, 20%, and 20% and 20% respectively. The participating physicians included general practitioners (40%), anesthesiology (20%), surgery (20%), and internal medicine(20%). All of these physicians used this application less than two times/week.

Table 1 Information about the patients who completed the patient questionnaire

Variables	%
Gender	
Male	80
Female	20
Age	
40 - 49 years	20
50 - 59 years	20
60 - 70 years	60
Informant	
Patient	80
Caregiver	20
Frequency of using this application	
Less than 2 times/week	70
2 to 4 times/week	20
More than 4 times/week	10

Table 2 Information about the physicians who completed the physician questionnaire

Variables	%
Gender	
Male	100
Age	
20 - 29 years	40
30 - 39 years	20
40 - 49 years	20
60 - 65 years	20
Specialty	
General practitioner	40
Anesthesiology	20
Surgery	20
Internal medicine	20
Frequency of using this application	
Less than 2 times/week	100

The results of patient satisfaction and physician satisfaction are shown in Figure 4 and Figure 5 respectively.

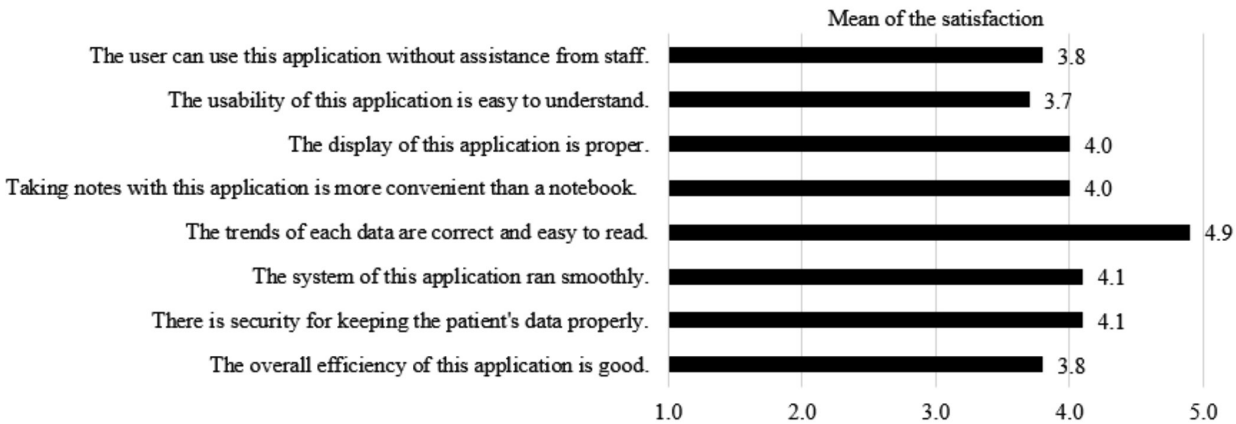

Figure 4 The result of the questionnaire about the patient satisfaction for this application (N = 10)

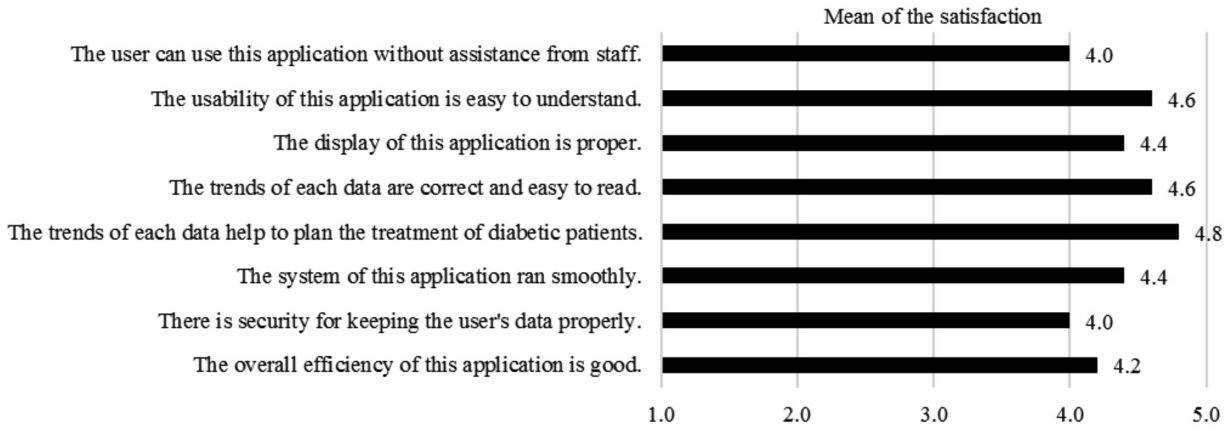

Figure 5 The result of the questionnaire about the physician satisfaction for this application (N = 5)

Discussion

All questions of the patient and physician satisfaction questionnaires received good score (more than 3.41/5.00). This application helped these diabetic patients to record and see the trend of their data with real-time data from the database server, in the same way as *Diamate*, a popular application for diabetic patients in Thailand[7]. In addition, the strength of this application is the display of the graph of blood glucose level, as well as the graph of blood pressure with meal times and medication times, to highlight possible causes of ineffective blood glucose control. Some applications merely list data or graphs of blood glucose levels and so correlation is difficult[8, 9]. The trends of each data set in this application help the physicians to monitor behavior and plan optimal treatment schedules for their patients. However, there are some limitations of this application. For example, some users cannot use this application properly by themselves because some features are too complicated. For instance, the user has to select the start date and end date before seeing the trends of each data set, by clicking on the date above each graph. Also, some functions might be forgotten, such as seeing the details by clicking on a plot or bar on the graph. In addition, this application is an Android-based mobile application so that it can be run on Android smartphones only, and not iphone or web based platforms.

Conclusion

In this project, this mobile application was developed and used smoothly. The results have shown that using information technology for gathering data is good for both patients and physicians. This application is also useful for other hospitals or diabetic clinics as it helps to collect data at the expert level. Further studies should add some additional beneficial features, such as notifications for recording data, adding other relevant data, which can help to prevent diabetic complications, connection of this application to health care systems so that data can be checked and confirmed by physicians or staff, show edited history, use one account for one physician, export the data in a file for opening on other operating systems.

In addition, this application should be run on every operating system such as Apple iOS and Microsoft's Windows Phone OS, because this application was developed with the Ionic framework which is a program for developing cross-platform applications. Furthermore, this application should be displayed in other languages such as English and French. Furthermore, hospitals, which have diabetic clinics or collection of diabetic patients, should publicize this application in both website and poster

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