รูปแบบโมบายแอพพลิเคชั่นสำหรับผู้ป่วยสูงอายุโรคความดันโลหิตสูง เพื่อจัดการเกี่ยวกับการดูแลตนเอง
Descriptive Model of a Self-care Mobile Application for Elderly Patients with Hypertension

นิพนธ์ต้นฉบับ

Original Article

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บทคัดย่อ

วัตถุประสงค์: เพื่ออธิบายรูปแบบโมบายแอพพลิเคชั่นที่เหมาะสมสำหรับผู้ป่วยสูงอายุโรคความดันโลหิตสูงในการดูแลตนเองตามปัญหาด้านความรู้และพฤติกรรม จากมุมมองของผู้ป่วย บุคลากรทางการแพทย์ และผู้พัฒนาโมบายแอพพลิเคชั่น **วิธีการศึกษา:** การวิจัยเชิงคุณภาพใช้การสัมภาษณ์เชิงลึกแบบเห็นหน้ากันกับผู้ให้ข้อมูล 3 กลุ่มซึ่งเก็บข้อมูลในช่วง 1 เมษายน – 31 ธันวาคม 2563 **ผลการศึกษา:** ผู้ให้ข้อมูลทั้งสิ้น 25 คน เป็นผู้ป่วยสูงอายุโรคความดันโลหิตสูง 14 คน บุคลากรทางการแพทย์ 7 คนและผู้พัฒนาโมบายแอพพลิเคชั่น 4 คน จากปัญหาด้านความรู้และพฤติกรรมที่พบ สามารถจัดตามมองค์ประกอบหลักดังนี้ 1) ด้านโครงสร้างหลักของเมนู ได้แก่ ความรู้เรื่องโรค การแปลผลค่าความดัน ความรู้เรื่องยา และการจัดการเกี่ยวกับยาที่ผู้ป่วยได้รับ การเตือนกินยา การเตือนวันนัด ช่องทางติดต่อโรงพยาบาล ข้อมูลผู้ป่วย พิกัดสถานพยาบาล ปุ่มกดเรียกรถพยาบาล และการวัดความเค็มของอาหาร 2) ด้านการออกแบบสื่อสาร สีที่สบายตา ตัวหนังสือขนาดใหญ่ ข้อความสั้นกระชับ มีเสียงหรือวีดิโอ และ 3) ด้านแรงจูงใจในการใช้งาน เน้นถึงประโยชน์ที่ผู้ป่วยจะได้รับ มีคำแนะนำของแพทย์ และไม่มีค่าใช้จ่าย **สรุป:** พบองค์ประกอบของรูปแบบโมบายแอพพลิเคชั่นที่จะช่วยให้การออกแบบเฉพาะเพื่อแก้ปัญหาที่ตรงกับความต้องการเกี่ยวกับความรู้และพฤติกรรมการดูแลตนเองของผู้ป่วย ตามเป้าหมายการดูแลผู้ป่วยตามแนวทางการรักษาโรคความดันโลหิตสูงในปัจจุบัน

คำสำคัญ: การดูแลตนเอง, ผู้สูงอายุ, โรคความดันโลหิตสูง, โมบายแอพส์, ความต้องการของผู้ป่วย, การผสานมุมมอง, การออกแบบเฉพาะ

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Abstract

Objective: To create a descriptive model for a mobile phone application that addresses the knowledge problems and behavioral needs of elderly patients in self-care with hypertension with emerging viewpoints of patients, medical personnel and mobile application developers. **Methods:** This qualitative study used semi-structured, face-to-face, in-depth interviews with three groups of key informants. Data collection was conducted between 1 April and 31 December 2020. **Results:** A total of 25 key informants were 14 elderly patients, 7 medical personnel, and 4 mobile application developers. Three core components emerged from the informants. First, Main Menu Structures included knowledge about hypertension, blood pressure interpretation, medication management and daily reminder, doctor's appointment reminder, hospital contact channels, patient information, hospital location, emergency call button, and measurement of sodium in food. Second, Design of Mobile Application included eye comfort colors, large text size, short and concise messages including voice or video. Third, Motivation to Use Mobile Application included benefits for the use, doctors' suggestions, and free-of-charge use. **Conclusion:** Important components for designing application that addresses hypertensive patients' knowledge and behavior on self-care based on the present hypertension management guideline were found.

Keywords: self-care, mobile applications,elderly, hypertension, patient's needs, merging viewpoints, custom-designed

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Introduction

Hypertension increases the risk four times for cardiovascular diseases and twice for myocardial infarction.[1] In fact, hypertension among the elderly is a chronic disease which needs medications and can cause drug use problems. From a literature review of related research, the main problems of self-care behavior in elderly patients with hypertension are not taking drugs as prescribed and labeled, increasing or decreasing the dose by themselves, combining doses from two or three times a day into just once a day, and taking drugs irregularly.[2] Many patients forget to take their medications regularly and adjust the dose by themselves.[3] Missing doctors' appointments is also a common problem.[4] One study reported that 69.0% of patients did not know how to check expiration dates of medicines and how to store them in suitable conditions.[5] All of these problems can cause treatment failure and increase the use of medical resources.[6]

During this digital era, self-care using custom-designed mobile applications has become another platform to help elderly patients manage their health. Delivery of health care through mobile health devices has the potential to facilitate

and optimize patients' self-management.[7] Currently, 10% of the elderly access the Internet and 59% of them access by using smartphones.[8] A suitable mobile phone application for elderly patients with hypertension in self-care would be composed of a menu design for communication that uses colors, pictures, messages, and sounds to motivate them to self-manage their drug use. The appropriate features of mobile applications for drug adherence should contain similar components with prescription information, drug side effects, medication reminders, underlying diseases, history of drug allergies, emergency contacts, reminder of doctors' appointments and suitable expense that does not prevent users from accessing the application. The features for the mobile application that align with patients' needs are the clarity of sounds and visualizations. Moreover, a mobile application with favorable features increases patients' drug adherence and give benefits to patient treatment.[9] Mobile applications designed for elderly patients with hypertension in self-care do not currently exist in Thailand. Based on the need as mentioned previously, studies should focus more the application design to allow for more convenient and attractive use with the link of patient information to healthcare providers.

Therefore, this research aimed to describe a mobile application model based on the analysis of elderly patients with hypertension regarding their self-care problems together with the perspectives of patients, medical personnel and developers of mobile applications. Specifically, the study aimed to (1) analyze problems of knowledge, behavior and needs of elderly patients with hypertension to develop an appropriate mobile application model for self-care for elderly patients with hypertension, (2) analyze the perspectives of elderly patients with hypertension, medical personnel and developers of mobile applications regarding the features of a mobile application that addresses the problems and needs of self-care for elderly patients with hypertension, and (3) describe an appropriate model of a mobile application by integrating the perspectives of elderly patients with hypertension, medical personnel and mobile application developers that addresses the problems and needs of self-care for elderly patients with hypertension.

Methods

This was a qualitative study using semi-structured, face-to-face in-depth interviews. Purposive sampling was applied to select the participants.

Population and sample

The study population was three groups of individuals, namely patients receiving care the outpatient clinic of Phu Wiang Hospital, Khon Kaen, medical personnel working at the clinic, and applications programmer. To be eligible to be key informants, they all had to have Thai nationality and be willing to provide consent to participate in the study.

For patients, they had to be diagnosed with hypertension with a continuously regular out-patient care for at least one year, perform self-care for their hypertension, routinely use mobile phones, and be able to communicate with the researcher. For medical personnel, they had to be physicians or nurses working in Khon Kaen province, have experience providing healthcare to hypertensive patients for at least one year, and use mobile applications for work or in daily life. For developers of mobile applications, they had to have experience in developing at least one mobile application.

The prospective informants were approached in-person. The number of informants was not determined but until the interview data were saturated. The consented informants were in-person interviewed. With rising restrictions due to the COVID-19 pandemic, the researcher was not able to recruit as many elderly patients with hypertension at the outpatient clinic as originally planned. The researcher interviewed participants by strictly following the pandemic safety protocol of wearing medical face masks with physical distancing. There were 25 key informants in this qualitative study, including 14 elderly patients with hypertension, 7 medical personnel, and 4 developers of mobile health applications.

Research instruments

The research tools consisted of in-depth interviews conducted by the researcher, semi-structured questions for the interview, and audio-recorded interview. The questions were examined for content validity by three experts which were faculty members in social and administrative pharmacy. Critiques from the experts were, for example, in in-depth interviews, interviewees' thoughts and emotions should be revealed to obtain the truth. Could you show me how you are going to ask the questions that could bring the truth out? Some questions are not open-ended questions. In qualitative research, in-depth interviews must always use open-ended questions. There is no right or wrong answer. The interviewers must welcome all answers with no judgement so that the interviewees do not feel inhibited to express their genuine and

elaborated thoughts. Certain questions have no clear purposes. They need a thorough revision. For some elderly interviewees, they cannot visualize mobile phone applications. It would be better, in the interview, if you show them with picture of mobile phone with applications on. The transcribed interview content from the programmers seems interesting. However, the writing based on your summary made it uninteresting and needs revision. The questions after revision as guided by the critiques and recommendations by the experts are shown in Table 1.

Table 1 Questions for semi-structured interview after revision.

Questions by key informants
Elderly patients with hypertension
Knowledge about self-care for hypertension
1. How did you know that you have hypertension?
2. What are signs and symptoms of hypertension and how have you been with these ones?
3. What can cause hypertension and what were the causes which lead you to hypertension?
4. Can you define normal and abnormal blood pressure?
5. If patients with hypertension are not treated, how will the severity be?
Behaviors of self-care for hypertension
6. What is your management of self-medication?
7. Do you go to see the doctor at every appointment?
8. What kind of food do you eat? What kind of food should you avoid taking?
9. How do you exercise? How should elderly patients with hypertension exercise?
10. What is your smoking and drinking behavior?
Problems of self-care for hypertension
11. If you would like to consult with healthcare professionals in hospitals, how will you contact them?
12. What are the problems or barriers of self-care for your treatment of hypertension?
13. How do you cope with self-care for the treatment of hypertension?
A mobile application for self-care in elderly patients with hypertension
14. In your opinion, what is a mobile application?
15. What mobile applications are you currently using?
16. How can a mobile application help you in self-care?
17. What reasons will you use a mobile application for helping you in self-care?
18. What menus do you think a mobile medication should have?
19. How should font, text size and message length in a mobile application be?
20. How should pictures in a mobile application be?
21. What colors should be applied in a mobile application and how?
Medical personnel
Behavior and problems of self-care in elderly patients with hypertension
1. What do you think about how elderly patients with hypertension cope with self-care?
2. What are barriers for self-care in elderly patients?
3. What problem solutions do you think can help self-care of medications in elderly patients with hypertension?
A mobile application for self-care in elderly patients with hypertension
4. In your opinion, what is a mobile application?
5. What mobile applications are you currently using?
6. How can a mobile application help elderly patients with hypertension for their self-care?
7. What reasons can make elderly patients with hypertension use the mobile application for their self-care?
8. What menus do you think the mobile application should have?
9. How should font, text size and message length be in the mobile application?
10. How should pictures be in the mobile application?
11. What colors would you recommend putting in the mobile application?
Developers of mobile applications
Behavior and problems of self-care in elderly patients with hypertension
1. What do you think about how elderly patients with hypertension cope with self-care?
2. What are barriers for self-care in elderly patients?
3. What problem solutions do you think can help self-care in elderly patients with hypertension?
A mobile application for self-care in elderly patients with hypertension
4. In your opinion, what is a mobile application?
5. What mobile applications are you currently using?
6. What are your experiences in the development of mobile applications?
7. How can a mobile application help elderly patients with hypertension in their self-care?
8. What reasons can make elderly patients with hypertension use the mobile application for their self-care?
9. What menus do you think the mobile application should have?
10. How should font, text size and message length be in the mobile application?
11. How should pictures be in the mobile application?
12. What colors would you recommend putting in the mobile application?

Participation protection

This study was approved by the Ethics Committee in Human Research, Khon Kaen University (HE611301). All prospective participants were informed about the objective, process, and voluntary, anonymity and confidentiality nature of the study. Written informed consent was obtained from all participants with the willingness to participation.

Data collection procedure

The data were collected from April 1 to December 31, 2020. Prior to the study, the researcher submitted an official letter for permission to the relevant agencies for data collection among all three groups of key informants. After gaining the institutional approval, in-depth interviews were conducted using the semi-structured questionnaires as a guideline until data saturation. Patient informants and medical personnel informants were interviewed at the study hospitals while programmers were interviewed at their office.

Data validation

Regarding the validity and reliability, the researcher established a good relationship with the key informants and created a comfortable interview atmosphere. The interview date, time and place were selected based on the key informants' preferred choices depending on their availability and comfort, such as homes, workplaces, conference rooms or restaurants. Toward the end of each interview, the researcher would check on the key discoveries by verifying them with the interviewee.

Data analysis

The collected data were verbatim transcribed and analyzed by an inductive approach through line-by-line analysis. The analytical process involved coding, categorizing, data indexing, making a provisional conclusion, and presenting data as the research findings.

Results

The researcher conducted in-depth interviews with 25 key informants in three groups. Firstly, 14 elderly patients with hypertension with an average age of 65.9 years. Most of them were men (64.3%), had education level under secondary school (64.3%) and worked in agriculture (35.7%). The second group comprised seven medical personnel who were doctors,

pharmacists, and nurses with an average age of 35.4 years and with 3 - 29 years of experience in giving care to patients with hypertension. The third group included four developers of healthcare mobile applications with an average age of 44.8 years and had 3 - 10 years of experiences in developing healthcare applications. There was one key informant who was a medical professional and a developer of mobile applications.

Problems associated with self-care knowledge of the elderly patients with hypertension

Regarding the problems associated with knowledge of the elderly patients with hypertension, there were several issues addressed by this cohort. The elderly patients with hypertension were unaware and unsure about the causes of hypertension and how to interpret the criteria of abnormal and dangerous blood pressure levels. Certain concerns from men and women participants (abbreviated as PM and PWM, respectively) are as follows.

"I really don't know about the causes of hypertension …" (PWM_06)

"Umm… Is it related to my age? I am not sure …" (PM_11)

For the medications, most elderly patients did not know about the side effects from antihypertensive medications and how to manage those side effects and medication storage, and check expiration dates, expired medications, and medication deterioration. In fact, many elderly patients perceived that taking antihypertensive medications in the long-term may cause harm to their kidney. Elderly patients with hypertension were likely to forget to take medications properly, and some even adjusted the dose of medications by themselves by dose reduction or temporarily stopping their medications following other people's recommendations. Their certain concerns were as follows.

"I am not sure...but somebody told me to ask the doctor and see what caused me to cough. Because of the medication or my body was just weak…I have no idea…" (PM_05)

"Well, I just know that it is low when it is about 130, right? But how high could it be for a dangerous level?" (PWM_06)

"The drugs that the doctor prescribed…I don't know how to see the expiration date, though. It does not say… Unlike the OTC drug, I can spot the expiration date" (PM_02)

In addition, non-attendance at scheduled doctor's appointments was another common problem. Participants provided many reasons such as having some remaining medications, forgetting appointments, being caught up with some urgent situation, or having no abnormal symptoms. In fact, many elderly patients revealed that if they wanted to contact the health personnel, they had to visit the hospital. They had no experience communicating with the hospital via other channels such as phone calls, with many saying they did not want to disturb the hospital staff.

Perspectives toward the mobile applications among the three groups of key informants

Based on these problems, we explored how a mobile application to help elderly patients in their self-care needs should look from the perspectives of three different groups of key informants, namely, the patients, the medical personnel, and the developers of mobile applications. Their views can be described as follows.

The elderly patients with hypertension

The elderly key informants suggested the mobile application should contain the following menu features.

Medication Reminder: Most elderly patients wanted a medication reminder to remind them to take their medications at the proper time by sending an alarm. Informants suggested the sound of human voice or having drug pictures appear with the notification.

"It would be good because we will know the exact time to take medications and we will just take the drugs!" (PWM_10)

Patient Profile: Several informants preferred a menu with patient information shown in the mobile application as it is important to keep all the information and history related to the individual patient. For instance, the information should include his or her name and surname, age, address, telephone number, photo, history of drug allergies, pictures of drugs they are allergic to, and types of skin rashes. Nevertheless, other patients disagreed with such a menu because they could remember the detailed information and it already existed in the hospital database.

"Personal information such as name and surname, address, telephone number, drug allergies and symptoms of the allergies" (PM_12)

Current Medications: Many elderly informants wanted a menu to show all the current medications that the patients

were taking including drug information, pictures of the drug packaging and identification, dosage form, dose administration and regimen.

"When tapping the menu, the drug packages will pop up. So, we can know which medication to take. For example, 2 drug packages are shown and that means taking each tablet after breakfast." (PM_01)

Knowledge about Hypertension and Other Comorbidities: The elderly key informants wanted information about hypertension and other comorbidities to appear on the mobile application because they would like to know the signs and symptoms to prevent some other related illness like diabetes mellitus and kidney diseases.

"For hypertension and diabetes mellitus, I want to know how to treat myself and stay away from diabetes." (PM_02)

Knowledge about Antihypertensive Drugs: Many key informants wanted information about antihypertensive drugs in the mobile application for them to refer to and be able to explain to other people. Furthermore, they wanted a menu of drug side effects and instructions if any side effects occurred. They believe this menu would be important for patients so they could be careful when taking medications and aware of any behavioral precautions. However, some key informants did not need this menu because the information already existed on drug packages.

Hospital Contact Channels: Most key informants wanted a menu of hospital contact channels to communicate with the hospital. Most of them wanted to contact via a phone call due to convenience and ease of communication. Some key informants wanted a video call or an application to be a hospital contact channel. Nevertheless, most informants agreed that the hospital contact channels should be available for 24 hours a day because illnesses can occur anytime.

"I want it to have contact channels. When no one is in the house, I can contact them by myself." (PM_05)

For a reminder of doctors' appointments, the key informants suggested reminding before the appointment date about 2 - 3 days for patients' planning and preparation. The appointment reminder can be in various forms such as a notification sound, voice, or message. However, some key informants did not want the appointment reminder because they can remember and have a look at the appointment card or their marked calendar.

Appointment Reminder: Some key informants wanted an appointment reminder menu which could help when they lose their appointment card or forget the appointment date.

"It would be good because sometimes we have to look up and recall where we put the appointment card." (PWM_06)

Interpreting the Blood Pressure Level: Most key informants wanted a menu of how to interpret the blood pressure level concerning their current blood pressure and condition.

"It is good if we can know our blood pressure at that particular time." (PM_11)

Hospital Locations: Some key informants wanted a menu of hospital contacts as patients or people can find the nearest hospital in case of emergency.

"We can use this menu in an emergency situation, it will be great." (PWM_10)

Hospital Emergency Call Button: Some key informants wanted a hospital emergency call button for when they do not have their care providers around.

"It is necessary in case of emergency because sometimes I am alone in the house and my children are not around." (PWM_07)

Nevertheless, some key informants did not want this feature since there are emergency services such as ambulance from telephone number 1669.

Designing of features on the mobile application

Message Features: Most key informants wanted voice messages to draw their attention and to help patients who cannot read to be able to receive messages via delivered voices.

"So, illiterate people in our country can listen to voice messages." (PM_05)

In addition, most key informants wanted a large text size for the elderly to see it clearly. Also, most key informants wanted short and concise messages in the mobile application.

Colors: Most key informants wanted light and cool colors of background for eye comfort and better vision. However, they did not specify any particular colors.

"Clear colors would be comfortable for the eyes." (PM_11)

Pictures: Most key informants wanted real pictures contained in the mobile application such as pictures of drug packages and characteristics for clear understanding.

"It should be real pictures. If choosing a medication pack, it must be the real pictures of medication packs and tablets." (PM_08)

Motivation for patients to use the mobile application

Most key informants were motivated to use the mobile application from their perception of its advantages, for example, knowledge, convenience, and promptness.

"Knowledge gained which are about our health or green fruits and vegetables that we should consume, for example, healthy fruit shakes containing basil and pineapple. It's good to know about that." (PWM_03)

One key informant believed that mobile applications introduced by healthcare professionals must have advantages. In the meantime, supplying the application free of charge was one of the factors that key informants were motivated to use the mobile application.

Advantages of using the mobile application

Results showed most elderly patients with hypertension gained advantages from a mobile application in communication by phone or Line™ application.

"I am using the Line™ application. I have Line™ application in case there is coordination with any agencies related to the Sub-district Administrative Organization" (PM_11)

Furthermore, some elderly patients with hypertension had taken advantage of the mobile application for searching knowledge both in health and general knowledge, for example, antihypertensive herbs, healthy fruit shakes, food for patients with hypertension, exercise, planting, and animal husbandry. Some key informants had experience using mobile applications for entertainment such as watching movies and listening to music. However, some lacked skills in using mobile applications. They used a mobile phone for verbal communication only.

Perspectives of medical personnel

The medical personnel suggested some key components that should be included in the main menu of the mobile application as follows.

Medications reminder: Key informants had the opinion that this would help remind the patients about taking medications and preventing them from forgetting or not taking medications on time. Most of them agreed that the design of medication reminders should be a text voice that could be turned off after reminding. Concerns from pharmacists, nurses, and doctors (HPP, HPN, and HPD) are as follows.

"This application will be helpful. The first reason is to remind about taking anti-hypertensive medication on time and it is similar to an alarm clock. There will be a reminder with text voice saying when it's time to take medications." (HPP_03)

Patient Information: If there are any problems in treatment or the process of treatment, medical personnel can directly contact patients or relatives from this menu. The details of the menu included name-surname, address, phone number of patients, history of medication/food allergy, underlying diseases, and phone number of relatives and sub-district hospitals' health promotion.

"The menus in the program include personal information, name-surname, address, phone number of patients, and sub-district health promoting hospitals which helps contact patients when the medications were not enough. History of medication allergy, history of food allergy, and underlying diseases should be included in the personal information page." (HPD_04)

Knowledge about Antihypertensive Medications: Most key informants had the opinion that this menu is important because some patients did not know the purpose of taking antihypertensive medications, the indication of medication used, and management of side effects from medications.

"Knowledge that patients should know is the reasons for taking antihypertensive medications, the consequences of not taking medications, the indication of medication used, the precaution of side effects, and management of adverse medication reactions." (HPP_03)

Knowledge about Hypertension: Most key informants wanted to add on information about the causes of diseases, the signs and symptoms, interpretation of blood pressure levels, and concomitant diseases of hypertension.

"As mentioned, patients should be provided with the knowledge of diseases, for example, what is the disease, what is a criterion for diagnosis of hypertension, what is the optimum blood pressure level, and what is the harmful blood pressure level which needs to consult with doctors before the appointment date." (HPD_04)

Appointment Reminder: Key informant suggested reminding the patients before the appointment date about 1 to 3 days and reminding them again on the appointment date, therefore patients and relatives would have enough time for the appointment preparation at the hospital.

"I think I will be reminded one day before the appointment date. If there was a reminder longer than that, it will be forgotten." (HPP_05)

Hospital Contact Channels: Most key informants suggested a 24-hour phone communication with hospital service should be one of the hospital contact channels.

"In case patients have side effects from medications and patients are still not sure about which medications caused side effects even though pictures and information provided, hospital contact channels should be presented in the application." (HPP_01)

Foods to avoid: Key informants recommended providing knowledge about foods to avoid for hypertensive patients because they found that some patients cannot control their diet.

"This is the most important because high blood pressure is a behavioral disease. All of them have a history of consuming salty food." (HPN_02)

Design of mobile application

Types of messages in the mobile application: Most key informants had the opinion that messages should be in the form of text voice or video. The messages need to be concise and easy to understand because some patients have problems with eyesight and may not be able to read those messages.

"It may be in the form of text voice. Patients may not be able to read because of eyesight problems." (HPN_07)

At the same time, we found that most key informants suggested the large text size in the mobile application for ease of reading.

Types of color in the mobile application: Most key informants suggested that colors in the application should be comfortable with eyes such as bright and reflective colors not recommended.

"The comfortable color for eyes or light color should be used such as light green, light blue or light yellow." (HPP_01)

Pictures: Most key informants suggested using real pictures such as medication packs, tablets, and other pictures and the information must be current data.

"Real pictures with the current information must be used in case pharmaceutical companies or medication packs have been changed." (HPD_04)

Motivation for patients to use the mobile application

Most health personnel key informants had then opinion about the main motivation of elderly patients with hypertension using the mobile application is the perceived benefits gained from this application.

"I think one of the benefits included the free of charge application. There are no charges for the advantage and the strengths of the mobile application can be presented. It should be helpful to the patient." (HPP_05)

In addition, key informants believed that the introduction of the mobile application by medical personnel was another reason why elderly patients with hypertension are motivated to use the application because advice from medical personnel is reliable in their point of view.

"Motivation for patients to use the mobile application is the doctor. Doctor can introduce the application to the patient. The patient will be interested. Besides, it is easy to use and interesting." (HPP_03)

In the meantime, key informants had the opinion that being free to use and easy to use are the reasons that elderly patients with hypertension will be motivated to use the mobile application.

Perspectives of mobile application developers

The developers of mobile application (abbreviated as DMA) in this study suggested some key components that should be included in the main menu of the mobile application as follows.

Medication reminder: Key informants suggested the medication reminder menu is another menu that helps remind elderly patients with hypertension to take the medications. Medication reminders should be in the form of text, voice or vibration and alarms should be able to be stopped.

"It could be the text voice or text reminder which is able to be set in both forms. Because I think if it is a text voice reminder, patients may not be comfortable in some situations, for example, when they did not tell people around them about their hypertension. Text

reminder would be appropriate in those situations as their privacy." (DMA_02)

Patient information: Key informants agreed with the patient information menu. This menu will assist in searching or coordinating with the patient problems by providing name-surname, address, phone number, patient identification number, relative's phone number, and hospital's phone number.

"In the patient information menu, it should include the patient's name, patient identification number, relative's phone number, doctor's phone number, hospital's phone number, emergency button, and GPS address." (DMA_04)

Knowledge about the antihypertensive medications: Key informants recommended this menu. It is not necessary to develop independently by developers, but it can also connect to other medication knowledge applications.

"This menu may not be developed by the team and make it link to the phone or the existing system, for example, other applications like YaToYou will appear when pressing this button, we don't have to develop this part by ourselves." (DMA_04)

Knowledge about hypertension: Key informants suggested that this menu should be in the application and connect the information in other existing programs.

"Maybe linked to existing applications." (DMA_04)

Interpretation of blood pressure level: Key informants recommended that this menu should be included in the mobile application. Patients can fill the information into the application so the system will interpret the result into text or signs. In case there was an abnormal result, the management and advice will appear. In the meantime, compliments will be provided to motivate the self-care of patients when the results are in the range of blood pressure goals.

"Blood pressure level is presented in number and criteria for interpretation about the severity of blood pressure levels in colors such as red, yellow, and green, or any signs such as a smiley sign. After presenting the results, they will be advised according to the results or complements if blood pressure levels were in the range of goals for self-care motivation. If the results were out of the goal range, there must be advice for hypertension management." (DMA_04)

Measuring salinity of food: One key informant recommended using this menu for measuring salinity of foods using pictures of food and presenting salinity to provide the information to elderly patients with hypertension.

"If this mobile application has a taking photo feature to present the amount of salt in food, this may need research study which is possible." (DMA_02)

Hospital contact channels: Key informants suggested that including hospital contact channels in the mobile application was necessary for urgent cases. Those channels might be the advice channels for non-pharmacological intervention and management by specifying the emergency number for contact.

"Besides, there should include a phone number for emergency calls because patients with hypertension can have self-care when there is a hypertensive crisis or know the direct channels for calling to the hospital." (DMA_02)

Mobile Application Design

Types of messages in the mobile application: Most key informants suggested that messages used in the mobile application should be in the voice form with concise messages because elderly patients may have problems with eyesight.

"Yes. As I mentioned, some patients cannot read therefore they prefer text voice. However, this opinion is not from all of them." (DMA_03)

However, text reminders are still necessary. We found that most key informants would like to have a large text size in the mobile application so it can be seen clearly by the patient.

Type of color in the mobile application: The color used in the application was also an important component. However, the developers recommended lively bright colors and allowing the patient to customize according to their preference.

"Any colors …Let the patients adjust by themselves. The meaning is more important than color itself." (DMA_01)

Pictures: Picture features used in the mobile application need to be real pictures and should be easily understood.

"I am not sure, but it should have signs that represent the meaning. For example, a doctor's picture should contain a stethoscope and not just showing only a human's picture because patients cannot recognize and understand who the person is." (DMA_01)

Motivation for patients to use the mobile application

The key informant had the opinion that the motivation for elderly patients with hypertension to use the mobile

application was the perceived benefits from the application, recommendations from others, and the use with free of charge, which are helpful for patients' self-care.

"I think it must be the benefits of the application that need to think carefully… which advantages are suitable for patients. For sure, it must be free of charge." (DMA_02)

In addition, some key informants suggested that good mobile applications should always be actively updated. For example, newly published blogs or filling forms for blood pressure levels should be launched every day. This could create a relationship between users and the mobile application.

Analysis of the mobile application formats

For the appropriate format of the mobile application, results showed that elderly patients with hypertension had problems with their knowledge of hypertension and interpretation of blood pressure levels. Most elderly patients with hypertension would like to include information about hypertension and interpretation of blood pressure levels in the application menu. Meanwhile, medical personnel had the opinion that those menus are also important because they have advantages for the self-care of patients. Health application developers had the opinion that the information about hypertension menu could be connected with other existing applications or programs. The interpretation of blood pressure levels should be in the application. In case there are abnormal results, advice for self-management should appear in the application. If the results are in the normal range, there should be compliments for the patient's motivation.

In addition, there were problems associated with knowledge about side effects, management of side effects, and risks from antihypertensive medications. Some elderly patients with hypertension thought that long-term and continuous use of antihypertensive medications harmed their kidneys. Moreover, we found that there were problems associated with patient knowledge of medication quality control such as misunderstanding medication storage. Elderly patients with hypertension would like to have information about antihypertensive medications included. In the meantime, medical personnel key informants had the opinion that knowledge about antihypertensive medication side effects, management of side effects, and risks from the medications should be included in the application. Key informants who were application developers also had the opinion that information about antihypertensive medications should be included in the application, but it does not need to be developed solely by developers. It could be set to connect with other applications about medication knowledge.

In addition, the results showed that patients had problems associated with self-care medication, including forgetting to take medications, not taking medications on time, adjusting dose manually, and missing medication doses. Patient behaviors that helped them to not forget to take medications and to take medications on time were immediately taking medications after meals and keeping medications at various places. However, key informants who were elderly patients had the opinion that the medication reminder menu has benefits for patients. Meanwhile, medical personnel key informants also believed that the medication reminder menu helps remind patients, prevents them from forgetting to take medications, or prevents them from not taking medications on time. In the same way, opinions of the mobile application developers showed that this menu should be included in the mobile application.

We found that the elderly patients had problems associated with noncompliance to follow-up or missing the treatment, which were caused by many reasons. Elderly patient key informants wanted an appointment reminder menu in the mobile application because some key informants could not find hospital appointment documents or forgot the date. In the meantime, medical personnel and mobile application developers also saw the importance of the appointment reminder menu which reminds them about 1 to 3 days before the appointment date, so patients and relatives would be able to prepare themselves for the appointment at the hospital.

There were problems associated with communication with the hospital. Most elderly patients would visit the hospital to seek advice from the doctor and so the consultation might be delayed. Therefore, most key informants desired phone communication in hospital contact channels because of the convenience and ease of communication. The medical personnel and health application developers also believed that the hospital contact channels menu is important and it should be a 24-hour service.

Other menus also gave an advantage on patients and mobile application development even though there were no problems or concerns about these menus, including patient information, current medications, hospital locations and

hospital emergency call button. In addition, key informants who were medical personnel and developers of mobile applications proposed measuring the salinity of food. For example, taking the photo of food with sodium measurement menu and dipping sensors in food for measuring salinity in food therefore elderly patients with hypertension will get informed. In the domain of mobile application design for communication, all three groups of key informants suggested the large text size, clearly visible, and concise messages which may include text voice or video. Pictures in the application should be real such as real medication packs and real tablets. The current updated information and data are needed. For the domain of motivation for patients to use the mobile application, most key informants had an opinion that the elderly patients use the mobile application because of gained benefits, introduction by doctors, and free to use. The mobile application design that emerged from this research is shown in Figures 1-9.

Discussions and Conclusion

This study illustrated the appropriate mobile application design for self-care of medications among elderly patients with hypertension by integrating the opinions of relevant informants. The results reflect that most elderly patients with hypertension may have noncompliance with doctor's prescriptions, including self-dose adjustment, not taking medications on time, and forgetting to take medications. There were some alarming problems with medication use behavior among the elderly patients in this cohort which was also revealed in a previous study such as increasing or decreasing the dose by themselves, combining multiple daily doses into a once-daily dose, and taking medication irregularly.[2] However, our study also found that elderly patients with hypertension had various solutions for forgetting to take medication prevention including immediately taking medications after meals and keeping medications at various places. Theoretically, keeping medications at various places might not be a good solution, as it is likely to make it difficult for patients to keep track of doses from multiple locations. Therefore, pharmacists or healthcare professionals should advise and provide knowledge on these issues accordingly. In addition, the research finding reflects that it may not be sufficient to provide patient education about side effects from taking hypertensive medications and management when side effects occur may be given through drug package insert or advice from healthcare professionals.

The elderly patients with hypertension also dealt with some issues regarding follow-ups. Our results are consistent with a previous study reporting general problems of noncompliance to follow-up caused by transportation expenses, inconvenient transportation, and no caregivers.[4] In fact, elderly patients with hypertension may have problems with knowledge about medication storage and viewing expiratory dates of the medications, which are consistent with the behavior of medication uses among elderly patients with chronic diseases.[5] That previous study found that 69% of patients had inappropriate behavior and lacked knowledge and understanding of the expiratory dates of medications and medication storage.[5] Meanwhile, most elderly patients with hypertension could not interpret the blood pressure value. If patients can understand and interpret whether their results are abnormal or not, it is hoped that they will realize the state of their disease leading to closer monitoring and accessing immediate treatment when blood pressure level is in the risky and harmful range. Moreover, we found that there was a lack of communication channels available to patients in case of emergency. Thus, a custom-designed mobile application may render as a self-care educational, reminder, and communication tool for the elderly patients to have access to the needed information at any time.

Our study reflects the viewpoints of elderly patients with hypertension for self-care regarding appropriate mobile application design and their perspectives. These viewpoints are in line with the previous study about desired characteristics and clinical effectiveness of the mobile application for medication use compliance in patients with metabolic syndrome older than 50 years.[9] That study confirmed that a desirable mobile application should contain main components similar to prescription, medication name, dose administration, side effects, medicine reminder system, information about underlying diseases, history of medication allergies, emergency contact channels, appointment reminder, and acceptable price for using the mobile application. Moreover, the design of the mobile application related to the patient needs must include measures for the clarity of hearing and vision. Using the mobile application with desired characteristics can increase the compliance of medication use and yield good treatment results for patients older than 50 years old.

Furthermore, another study on innovative mobile application for the elderly's healthcare found that the elderly wanted to take care of their health at home. They wanted a technology to help remind them of continuous care and wanted up-to-date and reliable information for healthcare.[10] They also found that knowledge and behavior of self-care in elderly patients with hypertension could make healthcare professionals perceive and understand elderly patients with hypertension more and it could lead to better patient care under current guidelines on the treatment of hypertension and better treatment outcomes.

In conclusion, from the study results, knowledge and behavior of self-care in elderly patients with hypertension could make healthcare professionals understand more about the self-care of elderly patients with hypertension. This can then lead to better patient care under current guidelines on the treatment of hypertension and better treatment outcomes. We found in-depth information of the participants from the perspectives of the mobile application users, medical personnel and developers of mobile applications in order to guide the development of a mobile application which suits the needs of elderly patients with hypertension in self-care of medication in the future. The explanation of the appropriate features for a mobile application in this study is at the beginning stage of development in the context of Phu Wiang Hospital, a 60-bed community hospital. The mobile application still needs the evaluation according to users' opinions. This research studied elderly patients with hypertension only and it does not cover populations with other underlying diseases or comorbidities or aged under 60 years. The study results are perspectives for a mobile application that would be appropriate for the self-care of medications in elderly patients with hypertension. There is still a need for the prototype mobile application to be applied in practice.

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