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Mockup Design of Personal Health Diary App for Patients with Chronic Kidney Disease

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Abstract. Health self-management is important in the care of patients with chronic kidney disease. It is possible to improve the efficiency of patient self- management through the use of mobile technology and related software. This study is divided into three stages: 1. analysis of need: through observation, interview and content analysis of the chronic kidney disease health management manual; 2. design of system prototype: establish interface and system function; 3. prototype evaluation: evaluate whether the prototype designed by this study meets user needs. The system prototype includes: daily record, laboratory examination results, trend graphs, information search, sharing, communications and settings. Prototyping is done with Pencil Project for interface design and linking. The prototype is then exported in PDF format for mock-up simulation. Evaluation results: overall score was 4.01±0.60 leaning towards "agree", the highest score was ease of use (4.25±0.6), followed by easy to learn (4.15±0.68), acceptance (4.01±0.61), reliability (3.87±0.6) and functionality (3.83±0.49). The results show positive attitude towards the system.

Keywords. Mockup design, personal health diary, chronic kidney disease

Introduction

There are approximately 70,000 long-term dialysis patients in Taiwan, with an annual increment of 6%. More than 3 billion NTD is spent by the National Health Insurance on dialysis coverage yearly. Chronic disease is the main cause of kidney dysfunction, in particular diabetes mellitus and hypertension. Duration and poor control of chronic illness lead to increased probability of kidney disease. To further decrease the incident of dialysis, an intergraded chronic kidney disease care network providing vigorous management of early stage chronic kidney disease patient (Stages 1, 2, 3a) can prevent, decrease or delay deterioration of renal function, improve patient care and quality of life, thus decreasing cost burden on the National Health Insurance. The Bureau of National Health Insurance provides a pre-end stage renal disease care plan for patients with chronic kidney disease stages 3b, 4 and 5, which has been proven by the Taiwan Society of Nephrology to reduce the deterioration of renal function. The generalized use of smart phones with their mobility and ease of use can be combined with a self-

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management application for chronic kidney disease. The purpose of this initiative is to understand the needs of CKD patients and the current status, analyze the uniqueness of CKD patients with integration of current practices, habits, and existing health applications. Utilize prototype simulation to create a mobile personal health diary for CKD patients. Increase communication channels between the patient and case management healthcare teams. Establish the value of system prototype in the development process. Establish a detailed prototype as reference for future development of the actual system.

1. Literature Review

In 2002, the American National Kidney Foundation Kidney Disease Outcome Quality Initiative (NKF-K/DOQI) defines chronic kidney disease as kidney damage for more than 3 months with or without decreased glomerular filtration rate (GFR) manifest by either pathological abnormalities or markers of kidney damage, including abnormalities in the composition of the blood or urine, or abnormalities in imaging tests. Or GFR less than 60ml/min/1.73m^2 for more than 3 months with or without kidney damage [1]. The most commonly used formula for calculation of GFR is the "4-variable Modification of Diet in Renal Disease (MDRD)" using serum creatinine, age, ethnicity and gender

.eGFR (mL/min/1.73 m^2)= 186*Scr -1.154*Age -0.203*0.742(if female)＊1.212 (if black)

Patient care can be divided into early (stages 1, 2, 3a) and late (stages 3b, 4, 5) chronic kidney disease. Based on the different stages of disease (Table 1), different educational information is provided to the patients. Through listening, education, evaluation and reflection, the first step is to help the patient overcome psychological challenges with the disease, so they can effectively learn treatment knowledge and skills, to delay and control disease progression and improve quality of life [2]. The World Health Organization (WHO) considers mobile health (mHealth) as a component to electronic health (eHealth). It is defined as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices"[3]. Mobile communications industry is developing rapidly; in the medical field different needs have led to the research and development of new hardware and software programs. Commonly seen mobile devices in the current market include tablet personal computer, notebook computer, personal digital assistant (PDA), traditional mobile phones and smart phones. Among these, the smart phone is more popular because it is easily accessible on the move, light weight, easy to carry, with good computing abilities, and is able to process information in different environments[4].Contemporary design techniques often use prototyping tools that build mock-up designs of items such as application screens, database layouts, and system architectures[5]. When designing on mobile devices, one important goal is consistency in interface design, such as using uniform colors, interface layout, images, font type and size, button sizes. This allows users to clearly understand the interface operation and functions. Inconsistencies in elements such as buttons or colors will decrease user execution speed by 5-10%, while changes in terminology decrease execution speed by 20-25% [6]. Therefore, if designers use a consistent design principle, it will help users interact with the interface with easy and efficiency, achieving better usability and functionality of the program.

Table 1. Stages of Chronic Kidney Disease

Stage	**Glomerular filtration rate GFR (ml/min/1.73m^2)**
Stage 1	>=90, normal GFR , with kidney damage, presenting with proteinuria,
Stage 2	89-60 mild kidney dysfunction with kidney damage, presenting with
Stage 3(3a, 3b)	3a: 59-45 moderate kidney dysfunction 3b: 44-30 moderate kidney dysfunction
Stage 4	29-15 Severe kidney dysfunction
Stage 5	<15 Kidney failure (end stage renal disease)

2. Methods

Research framework: Taking into consideration the communication between the end users and medical personnel the requirement analysis was done based on the information recorded within the chronic kidney disease patient manual, simultaneously recording requirements and on- site observation to establish preliminary development direction and necessary features. The second phase is prototyping: a preliminary hand-drawn prototype was done for planning and mapping, through the process, discussions were held with the case manager to determine required information record and order. After confirmation, graphic design software was used to draw the prototype mock-up design. Phase 3 is interface prototype evaluation: User assessment of the prototype was done through a questionnaire, with description of the prototype content and designed functions. The research framework is seen in Figure 1.

Requirement analysis
- Review existing related health diary app
- Required records for chronic kidney disease
- On-site observation of patient and case manager interaction

Prototyping
- Design planning and hand-drawn interface
- Prototyping with graphics design software
- Editing/Iteration through user discussion

Prototype evaluation
- Use simulation of completed prototype for user evaluation

Second paragraph.

Interface prototype design and development tool (Figure 2): The software used for prototyping is Pencil Project developed by the Evolus Company. It is a free, open source, cross-platform software with built-in Android stencils and shapes, it can export to PDF with page linking.

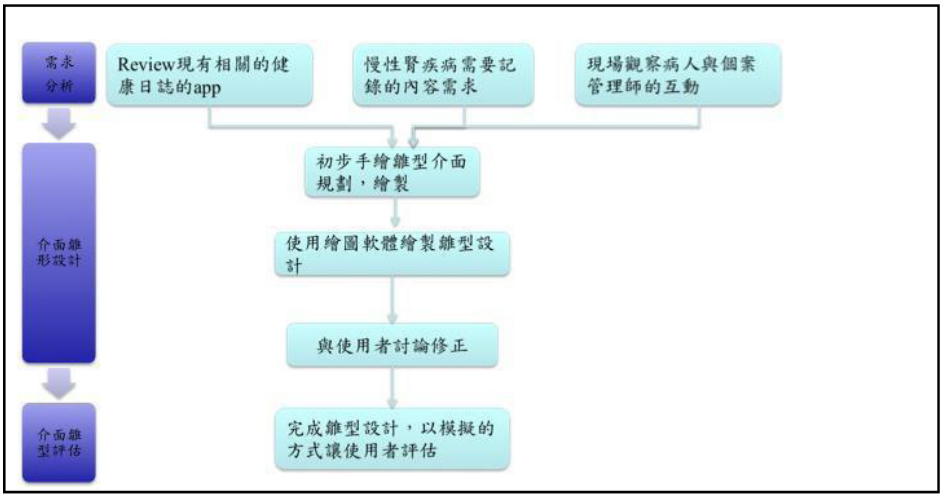

Figure 1. Research workflow/framework chart

Figure 2. Development tool: Pencil Project developed by Evolus Company. (Image source: http://pencil.evolus.vn/)

This study employs a cross-sectional structured questionnaire to obtain user assessment of the system interface prototype function and design. The questionnaire design is based on the Measuring usability with the USE questionnaire developed by Arnold M. Lund (2001), Technology Acceptance model for mobile service (TAMM) structure theory proposed by Kaasinen (2008) and the questionnaire in Ming-Chuan Kuo's iBaby newborn health record system. The questionnaire is divided into three parts, part one is basic information and device usage, the second part evaluates the

system's functional structure and the interface's functionality, ease of use, learnability, reliability and acceptance. The last part contains questions on the future implementation of the actual system.

3. Result

Based on the chronic kidney disease health management handbook and analysis the most frequently asked questions by patients, laboratory results, chronic kidney disease staging, with emphasis on the ongoing healthcare issues and dietary considerations for each stage. In addition maintenance of stable blood sugar values, blood pressure control and weight management are necessary and need to be included in the interface design development. This is divided into 6 central themes in the first main page: daily records (blood sugar, blood pressure, body weight), laboratory results (including chronic kidney disease stage) including trend graphs, information search (diet and care considerations for each stage), sharing and communication, settings. In the system structure the relatively more important daily records is placed first, followed by the others as shown in Figure 3.

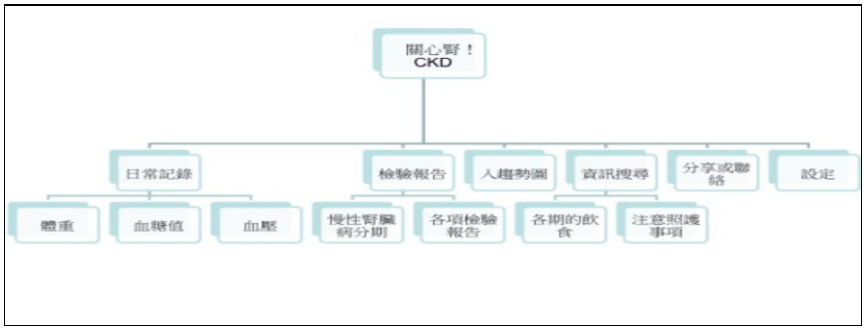

Figure 3. System architecture

According to the results of the organization, analysis and division, the researcher drew a first interface sketch. This version does not take into account actual operation practices, but only places all the functions into the interface. Then based on the system architecture, ease of development, user operation preferences and characteristics of related applications, the sketch is edited and the interface rough draft is drawn by hand as shown in Figure 4.

With this rough draft the system interface prototype is created. After correcting some support functions it becomes the final prototype as seen in Figure 5.

The basic demographics of this study's survey showed 30% in the 60-69 age group, followed by 50-59 group with 25%. The male-female percentage is 60% : 40%, marital status showed the majority as married (65%), educational level mostly high school and college. In chronic kidney disease stage most were distributed in stage 3a (25%), stage 3b (40%), and stage 4 (20%)(Table 2). Of the participants 80% had one mobile phone. The type of phone used in order of frequency is touchpad smart phone, push-button smart phone, and simple push-button phone. The most often used features are dialing or taking phone calls 100%, followed by receiving text messages, with

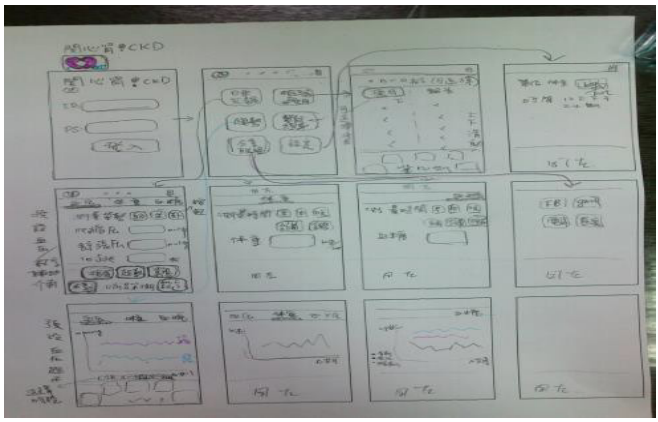

Figure 4. Second edition of system interface rough draft

Figure 5. Final draft of interface prototype

camera function being third. The interface prototype is assessed for functionality, ease of use, learnability, reliability and acceptance.

Overall score was highest in ease of use (4.25±0.60), followed by learnability (4.15±0.68), and in decreasing order acceptance (4.01±0.61), reliability (3.87±0.60) and functionality (3.83±0.49). Overall score is 4.01±0.60 with the majority of the participants selecting “agree” or “no opinion”. In functionality assessment, the participants felt that the system can help them manage their health records more completely and easily, with better grasp of their own condition. The participants found the system to be easy to use. Normally scores average above 4.0 for systems that are easy to use. So the is a positive review on ease of use of the system.

All participants found the system easy to learn with little difficulties. There were three questions on reliability and the scores approached but did not reach 4.0 in all of them with an average of 3.87±0.60. This means that the users still consider the possibility of issues or errors arising should there be system malfunctions. On the

statement "I think the model of using of mobile phones to provide health care services is worth promoting" the average score is 4.2±0.62. This shows that there is a need for the development of health care software on mobile devices.

Based on the above results of the evaluation questionnaire, we conclude that there is both a demand and a need for the use of mobile technology in health care. In actual practice the software needs to be easy to use, to learn and to access, with emphasis on stability and confidentiality.

Table 2. Basic demographics of study population

Item	Type	Number	(%)
Age			
	20-29	1	5
	30-39	3	15
	40-49	3	15
	50-59	5	25
	60-69	6	30
	more than 70	2	10
Gender			
	male	12	60
	female	8	40
Staging of chronic kidney disease			
	1	0	0
	2	2	10
	3a	5	25
	3b	8	40
	4	4	20
	5	1	5

4. Discussion

In the recording of a personal health log such as blood pressure, blood sugar or body weight, convenience and ease of use are very important. Usually hospitals will provide patients with paper logs or small booklets for daily record to be reviewed in the next out-patient visit in order for medical personnel to understand the patient's daily condition. This study attempts to develop a system which integrates the widespread use and portability of mobile devices, focused on the complicated records for chronic kidney disease, hoping to improve the communication between patients and the medical team without compromising the original logging, medical visits or case management process.

In the current health management care for chronic kidney disease, the patients included for case management spread over a wide range of ages. From the completed questionnaires it can be seen ranging from 20 years old of over 70 years old. This

must be taken consideration during system development so it can be used by all age groups. The score for reliability and usefulness is low because more participants selected "No opinion". This is probably due to the fact that participants have difficulty imagining actual system operation through simulation on paper prototype mock-ups. In addition, for this survey, more elderly participants selected the "no opinion" option.

When asked about the restrictions and preferred platform for the formal development of the system, for restrictions over half of the participants selected open or both, which shows a preference for unrestricted accessibility. On platform preference, 70% of the participants selected all of the above, showing that users did not lean towards a particular platform. The user is more concerned on whether the functions of the system meet their needs rather than on which platform it is based.

The purpose for developing this system is to assist chronic kidney disease patients in their own health management. But the applications of this system can extend to other fields and purposes. For example it can provide trend changes in results, allowing medical personal to better evaluate the patient at the moment or in advance. This system structure is not limited and can be applied as demonstration for similar health management App and modified as necessary. While the assessment results of this study have research value, due to the small sample size (20 participants), uneven distribution of age and chronic kidney disease stages, whether the results are representative enough remains to be discussed. In addition, this only assesses a prototype through mock-up simulation without actual operation. When the actual system is developed, extended evaluation with a larger group of participants is necessary in order for the final system to better meet user requirements.

5. Conclusion

It is possible to gather the majority of user basic requirements through observation and prototyping. This provides ideas for preliminary development and can be used for the creation of user-oriented systems in the future. There are differences in function between the initial design sketch and the interface prototype. Discussion and review with participants is necessary to avoid wasting time and resources on making corrections. Therefore prototyping is necessary in the development of new systems or personalization of systems when it is not possible to determine exact end-users needs and operating environments. Future research includes development of the system and performing usability assessment. Through it provide more effective and advance health self-management and improve quality of life.

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