

AN EVALUATION OF A VIRTUAL PILLBOX DESIGNED FOR THE ELDERLY

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Abstract

The advent of technology has changed how healthcare is being perceived. While physicians and other healthcare professionals continue to remain primary care providers, the patient-centred care approach focuses on empowering patients with the autonomy to make informed choices. Drawing upon theories founded in the disciplines of healthcare, social sciences and learning, we constructed the Patient-Alert-Care-Education (PACE) framework with the intention to implement it through CuePBox; a virtual pillbox prototype. The virtual pillbox was designed and specifically developed to address medication adherence issues through exploration via a patient-centred focus of the constructs of “alert”, “care” and “education”.

Keywords

Virtual pillbox, elderly, chronic illness, mHealth

Introduction

The increased use of technology has undoubtedly changed how healthcare is being perceived and provided. While physicians and healthcare professionals maintain their role as primary care provisoners, the patient-centred care approach seeks to empower patients with the autonomy to make informed choices based on available information suitable to their needs, preferences, and lifestyles e.g., [1], [2].

As a case example, the development and design rationale of the CuePBox was centred on the elderly suffering from chronic conditions; individuals whom needed to be reminded, encouraged and educated about medication adherence regularly.

The CuePBox comprises of 4 main features:-

- **My Pillbox** – Stores all medication records, medication details and information about relevant medication regimens
- **Progress Report** – Tracks and records user’s health statistics such as heart rate, weight and adherence to medication regimen
- **Calendar** – Stores user’s doctoral appointments and easily tracks medication adherence on a daily basis

- **My Contacts** – Address book for users to communicate with caregivers and family members through video or text messaging

Before further development of the CuePBox, a pilot study using a paper-based mockup design of the system was run. The purpose of the current paper is to present initial findings from the pilot user-testing of the CuePBox with elderly participants.

Method

In order to obtain user feedback about the design, in-depth interviews with elderly participants suffering from chronic conditions were conducted to better understand individual daily medication regimentation and the challenges faced in adherence. The study obtained IRB approval from the host institution’s IRB Board (Ref: IRB-2014-04-046).

Participants

Participants for this study were recruited from a government funded elder-care focused community centre in a Singaporean neighbourhood. These participants were from the lower to mid income group with varying levels of regimental medication adherence. We recruited 3 female and 3 male participants aged between 61 to 78 years old through collaborative aid with the centre. As not all participants were able to converse in English, the interviews were conducted in the language that participants were most

comfortable with (i.e. Mandarin and Malay; of which the interviewers were fluent in).

Table 1 is a summary of the participants interviewed for this study. The number of medication dosages taken per day ranged from 3 to 20 pills. Dosages were to be taken between once to three times a day. Pseudonyms are used for all participants of this study to ensure relevant confidentiality issues.

Table 1. Participant demographics

Name	Age	No. Pills Taken daily	Caregiver
Tan	77	3	Self
Siti	75	12	Daughter
Kee	67	20	Wife
Seng	76	11	Self
Chen	78	8	Self
Ali	61	5	Wife

Procedures

The interview was conducted at a community centre located close to the participants' home. Each participant was interviewed for approximately 30 minutes in English, Mandarin or Malay. All interviews were recorded using a video camera with consent from participants. The interview began by asking questions pertaining to the participants' lifestyle, familial support network and medication regimen. This provided us with an understanding of the typical routine that participants go through over the course of their day. This remains an important part of the design feedback consideration when developing the mobile app.

For this study, we used a paper-based prototype of the CuePBox. The paper-based prototype was printed to scale and in colour so users can have realistic visual representation of the developed product. Our decision to employ a paper-based prototype allowed us to test quickly the system's design and granted us the flexibility to make changes to the design flow process based on user feedback.

In the second part of the interview, participants were presented with several screens of the CuePBox. The researcher explained the purpose of the interface and participants were asked to speak freely about their general impression of the design (e.g., colour, look and feel, icons).

The next step of the interview process involved participants completing a series of simple tasks such as simulating their medication-consumption when a reminder alarm comes on, contacting caregivers through video calls and navigating through the menu options.

Findings

Medication regimen

This initial study gathered important insight into the challenges that elderly patients suffering from chronic conditions faced when taking their medication. As described in the previous section, the amount of medicine consumed by the participants varies determinant to their medical condition. This is especially true for individuals suffering from multiple chronic conditions.

A key finding was that participants who did not live alone were heavily reliant on family members to facilitate their medication consumption. Family members would often aid those under their care by sorting and organizing the medication weekly. This was commonly done employing a physical pillbox with multiple compartments that separated the different times and days of the week. Participants would be required to take all the pills within each compartment during the specific time of the day.

Design principles

The principles utilized in designing the CuePBox was based on the PACE framework that approaches healthcare through the constructs of Alert (reminders), Care (communication with caregivers), and Education. The CuePBox was developed with a special focus to be elderly-friendly (See Figure 1). Design and embellishment around the periphery of the screen was kept to a minimal as older adults have been observed to have problems extracting information presented around the periphery of a locale [3].



Figure 1. Virtual Pillbox Interface Design

Navigation

Navigation was kept linear so that users are able to easily navigate through the different submenus. Each submenu has a quick navigation menu located at the top corner to enable users to quick return to the main menu. Navigation to commonly accessed functionalities is not more than 3 sub-menus.

The navigation screen was tested with the elderly participants by assigning a task to them. However, less

than half the participants were able to complete the assigned task. Participants were simply not able to comprehend the navigation task assigned. One participant (Seng) described himself as too old to learn “new technology” as an explanation for his inability to complete the task.

It should be noted that participants who were able to complete the task were those who had used smartphones. Therefore, rather than a design and interface issue, we believe that the participants’ unfamiliarity with mobile technology was the primary cause for them being unable to complete the navigation task.

Colour Scheme and Font Size

The CuePBox incorporates soft pastel colours that were purposefully selected to be easy on the eyes. Colour sensitivity issues and difficulty of colour differentiation has been observed within elderly populations [4]. Colour schemes were kept consistent with minimal animation elements to prevent confusion during use among the elderly users. Font sizes were kept large with more salient information appearing larger on screen (See Figure 1 and Figure 2).

Utilizing a coloured print-out, text legibility and comprehension was assessed. All participants were able to read the text presented to them. They found the colours pleasing to the eyes and did not have difficulty differentiating between the different colours of the prototype mock-up.

Icons

Icons were designed to be large with both visual elements and text as research implies that symbol comprehension in older adults might be lower when compared to individuals from other age groups [5]. The CuePBox’s icons were designed to incorporate both image and text, enhancing visual acuity and comprehension while describing the functionality of each icon.

After interviewers had explained the various functions, all the participants were able to recall the purpose of each icon on the paper mock-up. We believe that this indicates that the CuePBox’s clean and minimalist interface icons were comprehensible them.

Alert - Medication reminder

The CuePBox’s primary function is its purpose as a reminder system. During the medication dosage timing window within a day, a pop-up box appears that remind users to consume their medication (See Figure 2). The window is designed to be large so that it is easily visible to elderly users. In order to facilitate the recognition of differing medication, an image of each tablet that is to be consumed will be displayed sequentially. Users may then compare the virtual

representation of the pill to the medication that they are to take.



Figure 2. Medication reminder alert screen

We tested several different screen designs and found that employing visual aids may help with the elderly in recognizing their medication. However, displaying the front and back of the tablet (as per pharmaceutical practice) is observed to confuse the users. Some of the participants assumed that two tablets need to be taken instead of one when the front and back image of the medication was displayed on screen. Therefore future iterations will only include one image to avoid any confusion.

Care – Communication

The CuePBox is designed to be deployed as an app on tablets. Voice-over-IP (VoIP) software will be integrated into the CuePBox so that users can communicate with their caregivers or family members through the “My Contacts” function. It is also possible to integrate the system so that nurses or other care professionals can be contacted in the event that the user is in need of assistance. Other functionalities include sending text messages (SMS) or instant messages (IMs) via the system.

Elderly participants who had close ties to family members appeared to be keen on the idea to be able to communicate with their loved ones, with one participant even having experience in using video conferencing software. However, the participants appeared to be less keen on the use of text messaging citing difficulties in reading and intricate typing.

Conclusion

The CuePBox shows promise as a boon companion to facilitate medication adherence among the elderly with chronic conditions. The mobility of a virtual solution integrated into a tablet provides healthcare providers and caregivers more cost-effective and time-saving alternatives to monitor the people under their care. When introduced to the prototype system, most participants were able to complete the assigned tasks

and expressed willingness to learn and use such a system.

The graphical interface was intuitive enough that most patients who could not speak or read in English were able to perform the task assigned to them, although several of the instruction screens require modification for the next development of the CuePBox.

Acknowledgement

This research is supported by the National Research Foundation, Prime Minister's Office, Singapore under its International Research Centres in Singapore Funding Initiative and administered by the Interactive Digital Media Programme Office

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