A Usability Inspection of Medication Management in Three Personal Health Applications

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Abstract. We present the findings of a cognitive walkthrough inspection on three Personal Health Applications (PHAs). Two of the PHAs, Google Health and Microsoft HealthVault, are general purpose PHAs that are freely available to the general public. The last PHA, Colorado Care Tablet, is a prototype PHA that was designed specifically for older adults to manage their medication information. Older adults need a way to manage medications and share this information with their caregivers and healthcare providers to avoid complications during transitions of care. PHAs provide people with the ability to collect and share health information. However, given the problems older adults have with navigating applications and web pages, we needed to inspect currently available PHAs and identify problems older adults may have when using them for medication management before conducting user studies. Based on our findings, we encourage the design community to place more of an emphasis on interface consistency and tightly coupling information with links.

Keywords: Usability Inspection Methods, Cognitive Walkthrough, Personal Health Applications, Personal Health Records.

1 Introduction

In 2006, we set out to develop a Personal Health Application (PHA) that could provide older adults an easy way to manage their medications during transitions of care. Transitions of care are broadly defined as seeing a new healthcare provider to being discharged after a long hospital stay. Older adults during transitions of care are particularly at risk for medication errors [2]. PHAs can empower patients and improve the information flow between patients, caregivers, and health professionals, however we believe that the current design of PHAs is inadequate for older adults. The design of our PHA, the Colorado Care Tablet (CO Care Tablet), was informed by a successful paper-based Personal Health Record (PHR) transitions intervention that improved the quality and safety of transitional care [2]. During the development of the CO Care Tablet, Microsoft and Google developed general purpose, web-based interoperable PHRs that provided third party developers a way to connect with their respective PHR

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repositories. We did not want to reinvent the wheel by developing yet another PHA, however we wondered if Microsoft HealthVault and Google Health could meet the medication management needs of older adults given the issues older adults have with manual dexterity [3] and computer tasks [8].

The aim of this paper is to identify usability issues older adults may have using the CO Care Tablet, Google Health, and Microsoft HealthVault and share design recommendations with the usability community. To this end, our team conducted cognitive walkthroughs on each PHA with seven common medication management tasks using an older adult persona informed by our own research and the Association for the Advancement of Retired Persons (AARP) (Section 2). We found that: the most common tasks took less than five steps to complete; layouts with three columns had more usability issues; and usability issues were caused by inconsistent linking of data with the cause or action (Section 3).

2 The Study

We completed usability inspections on three PHAs: Microsoft Health Vault, Google Health, and Colorado Care Tablet. Here we discuss the rationale for PHA, inspection method, and task selection.

2.1 The PHAs

In October 2007, Microsoft launched HealthVault (http://healthvault.com) to provide users a centralized place to track health information, prepare for health professional visits, manage health-related devices (e.g., participating blood pressure monitors), and utilize third party health services to share information and receive personalized feedback (e.g., physical activity recommendations). Google Health (http://www.google.com/health) offered a PHA in May 2008 to provide Google users the ability to create online health profiles, import medical records from participating hospitals and pharmacies, find authoritative information about health issues, search for health providers, and connect to third party health services. The major differences between these systems is that Microsoft HealthVault emphasizes the ability to connect health devices to the PHA for better data tracking and personal feedback, whereas Google Health emphasizes the ability to connect to third party services (e.g., hospitals, pharmacies) and find authoritative information about issues and providers.

The CO Care Tablet is a prototype system developed as part of the Robert Wood Johnson Project HealthDesign initiative. We spent six months conducting a needs assessment with older adults and caregivers to inform the interface design. The next nineteen months were dedicated to iteratively implementing and evaluating low and high fidelity prototypes with older adults. We found older adults were more comfortable with wizard-based interfaces that lead them step-by-step with description instructions through tasks. The current prototype provides users the ability to: create medication lists; share medication lists with healthcare providers; find authoritative

Table 1. Task Complexity for common medication management tasks. The log in task was not inspected.

Task	Google Health	Microsoft HealthVault	CO Care Tablet
Log In	3	4	2
Add a Medication	7	5	7
Delete Medication	4	6	4
View Medication List	2	3	1
Find information on a Medication	4	5	4
Share Medication List	N/A	4	4
Medication Interactions	9	N/A	N/A
Two different Doses of Same Medication	24	10	14

information about medications; schedule medication reminders; send questions about their health to providers; and identify health conditions that require immediate medical attention (e.g., a fever over a specified degree). Since the goal of the CO Care Tablet was to minimize adverse medication related incidents through medication management, we spent significant amount of time decreasing the input intense nature of medication list management. We provided users with multiple input mechanisms, such as: (1) selecting medications from pharmacy dispense records; (2) scanning barcodes on medications; (3) typing in prescription numbers on medications; and (4) typing in the medication name and verifying the medication by looking at a picture of it. For this study, we chose the most input intensive method, typing in a medication name and verifying the medication by looking at a medication image, that most closely mirrored the input method used by the other two PHAs.

Although Microsoft HealthVault and Google Health are general purpose PHAs and not specific to medication management, we chose them because they are freely available to the target population and could be utilized now for medication management, whereas the CO Care Tablet is still in prototype phases and needs further development in the areas of authentication and interoperability before it is released for general use.

2.2 Inspection Method

We used the Cognitive Walkthrough (CW) usability inspection method because it thoroughly evaluates tasks based on the theory of exploratory learning [10]. CW is not without its critics, however, who have argued that CW is time consuming [7], tedious [7, 11], and inconsistent at finding usability issues [5, 7]. We continued to use CW because it is a task-driven methodology and we wanted to inspect seven specific tasks shown in Table 1. In addition, CW has been used to inspect many health systems [9].

The first two authors are similarly trained in CW and used the four metrics proposed by Wharton [13] to guide the inspection: (1) match to intent; (2) visibility; (3) labeling; and (4) indication of progress. We developed a persona based on our own needs assessment and personas developed by the AARP [1]. We assumed the older adult could use the computer and input devices (e.g., a mouse), although we understand this is a limiting factor for some older adults [6]. The older adult did not use the Internet much, but was willing to use computers to manage their medication

information. We chose the tasks in Table 1 based on our needs assessment that identified the tasks older adults most wanted to do when managing their medications. The two evaluators separately conducted CWs on each PHA in one sitting and then compared results. Inconsistencies in categorization or usability issues were discussed until a consensus was met. The evaluators found discussing the thought process and reminding each other of the persona was especially helpful when discussing inconsistencies in inspections.

3 Findings

Here we present abstracted findings from the cognitive walkthrough on three PHAs. The key findings are:

- Tasks older adults want to utilize most often in managing medication lists had the least amount of steps to complete them.
- Layouts with three-columns had more usability issues than a two-column layout for PHA information.
- Visibility of medication lists and linking tasks to medications were common medication list management usability issues.
- Warning and confirmation screens were inconsistent for all of the PHAs.

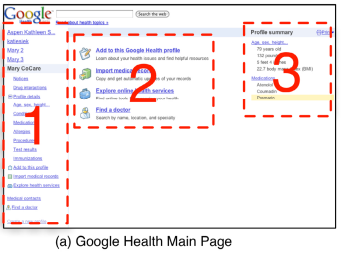
3.1 Task Complexity

We show a basic measure of task complexity for each PHA in Table 1 by counting how many actions (e.g., clicks) a user would have to do to complete the eight selected medication management tasks. The happiest path for each of these tasks was developed by referencing the PHA help guides. Previous studies [9] have used actions and screen transitions as a metric for task complexity, however calculating screen transitions was difficult for these web-based PHAs because each uses overlays and pop-ups to convey information to the user that would not otherwise be defined as a screen transition. Each PHA inspected had at least one task that was not supported. Google Health did not have the functionality to share medication lists, although there was an option to save and print the lists, we were specifically looking for an electronic method to share medication lists. Users had to use a third party application on Microsoft HealthVault to check medication interactions, thus it was not part of the HealthVault PHA we were evaluating. The CO Care Tablet did not support checking for medication interactions.

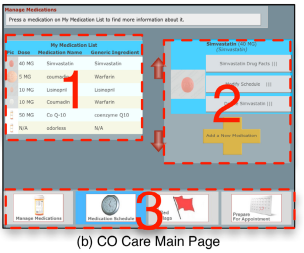
Each PHA or browser had an option to save log in information, thus although log in steps are counted here for completeness, we assumed that the person who set up the PHA would save the log in so the older adult could easily access the information. Although this brings in many questions about information security and privacy, the difficulties with creating PHA accounts and logging in are beyond the scope of this paper and will not be discussed in the inspection findings.

Tasks that older adults wanted to use the most often [4], such as viewing lists, sharing lists, and getting more information about medications all took less than five actions for each PHA to complete. Unfortunately, as we will report later, these tasks had some usability issues (Section 3.3-3.5). Adding and deleting medications required more actions depending on how much automation each PHA used - discussed more

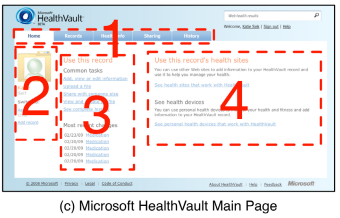
in Section 3.3. Adding two different doses for the same medication had the most steps for each PHA because it required adding a medication twice, editing the dose in most cases, and verifying the doses.



(a) Google Health Main Page



(b) CO Care Main Page



(c) Microsoft HealthVault Main Page

Fig. 1. Overview of PHA main page layouts with boxes around navigation areas

3.2 Information Layout

The two most common issues, visibility and match to intent, we identified when inspecting the PHAs were largely problematic because of the information layout and navigation areas. Labeling was the third most common issue and was usually linked to match to intent issues. The CO Care Tablet had the most indication of progress issues because, as discussed in Section 2.1, the designers used a wizard-based layout that required more navigation indicators than the other two PHAs.

Google Health and Microsoft HealthVault both used a three-column layout shown in Figure. 1 and had the most usability issues identified in the inspections (63 and 51 respectively). Google Health duplicated succinctly worded navigation links in columns 1 and 3 (Fig. 1a). Users had to look in column 3 to verify when actions were completed (e.g., adding a medication). We reasoned that older adults would have problems identifying the navigation areas, understanding the duplicated navigation links, and verifying the subtle changes based on their actions (e.g., when medications were added, they appeared with yellow highlighting in column 3) because of the succinct wording and abundance of information on one page.

Microsoft HealthVault had four navigation areas and a three-column format in the main area of the site. Navigation areas 1 and 3 duplicated information (Fig. 1c), however navigation area 1 had succinct links and navigation area 3 had more descriptive links. From our research [12], we found that older adults want more instructions and descriptive links, thus this layout would meet the needs of older adults and experienced users who want quick access to information. A possible area of confusion for older adult users would be the labeling of some of the navigation links. For example, adding a medication is categorized under the *Add, view, or edit information* link or the

Health info tab which should not be confused with the *View and update profile* link that brings the user to a general account updating page. In other areas of the application, navigation 3 becomes the main area and navigation are 4 is eliminated. All medication list changes are verified in the main area, navigation area 3, thus older adults would have an easier time verifying the updates.

The CO Care Tablet has a total of three navigation areas and 44 identified usability issues. A possible issue is that navigation area 1 only customizes the data shown in navigation area 2 (Fig. 1b). For example, when a medication is selected in the medication list in navigation area 1, the links about drug facts, schedule, and deletion are updated to name the appropriate medication in navigation area 2. Medication scheduling is the only duplicated link in navigation areas 2 and 3, thus this can decrease confusion on what each link does. However, since navigation area 2 is dependent on navigation area 1, if an older adult does not read the directions on the top of the page, he will not understand how to do many of the common medication management tasks. In other areas of the application, only navigation area 3 is shown, thus the simplified navigation scheme would be easier for older adults if they remember what is categorized under the four links.

3.3 Medication List Management

Medication list management includes viewing, deleting, and adding medications. All of the medication lists had problems with visibility. When the lists were long and went off the viewable portion of the page, it is debatable among our team if the older adult would have enough knowledge to scroll to view the rest of the list. Each PHA had a different way to order medications – Google Health ordered medications alphabetically; Microsoft HealthVault ordered medications in the order they were added with the newest on top of the list; and CO Care Tablet ordered medications in the order they were added, but with the newest on the bottom of the list. The CO Care Tablet created custom scrolling arrows to prominently display scrolling, shown in Fig. 1b, however it is unclear what part of the interface these arrows belong to.

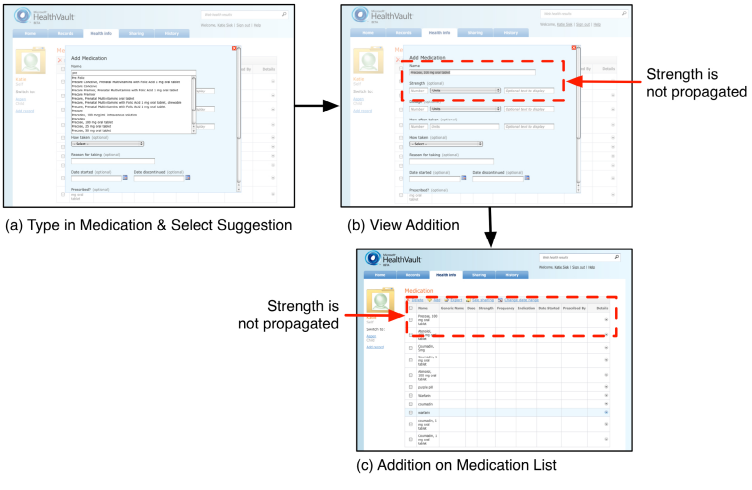


Fig. 2. Adding a medication in Microsoft HealthVault

Users must be able to view the medication they want to delete on the list in all three PHAs, thus this viewing medication list issue can pose a significant management issue. Google Health and CO Care Tablet have the delete link closely tied to the medication list. Indeed, Google Health has the delete link on the same table row as the medication listed. As discussed in Section 3.2, CO Care Tablet has the delete link connected to another navigation area, but the medication name and picture of the medication is shown near the delete link. Microsoft HealthVault had the most actions required to delete a medication because they had a list of check boxes near each medication where a user selects the medications to delete and then presses the delete button on top of the list. Although the HealthVault design provides users the ability to delete multiple medications at a time, we believe older adults would not have the knowledge necessary to connect check boxes to a delete function at the top of the page.

All three PHAs utilized different services to suggest medication spellings to decrease the complexity of medication additions. The information in these services is not always utilized completely by Microsoft HealthVault and Google Health. For example, Microsoft HealthVault provided users the ability to select the name and strength of the medication (Fig. 2a), but did not propagate the strength field with what was selected (Fig. 2b&c). This could lead to confusion of older users since they already selected the strength, but have to input it again. In addition, if a mistake is made in either selection or strength input, the older adult could become confused on what the strength is suppose to be. Google Health decreased the size of the suggested medications by only providing users with suggestions of medication spelling and *How to Take* (e.g., by mouth). This design decision increased the amount of input needed to complete a medication addition if strength and form were needed because users would have to edit each medication on the list.

In contrast, the CO Care Tablet PHA utilized a wizard configuration, shown in Fig. 3., where users selected the medication, strength, and look of the medication to add. All of the information selected was then represented in the appropriate area of the medication list. This method had more steps and problems with definite indications of progress, however it decreased the amount of user input with suggestions at each step.

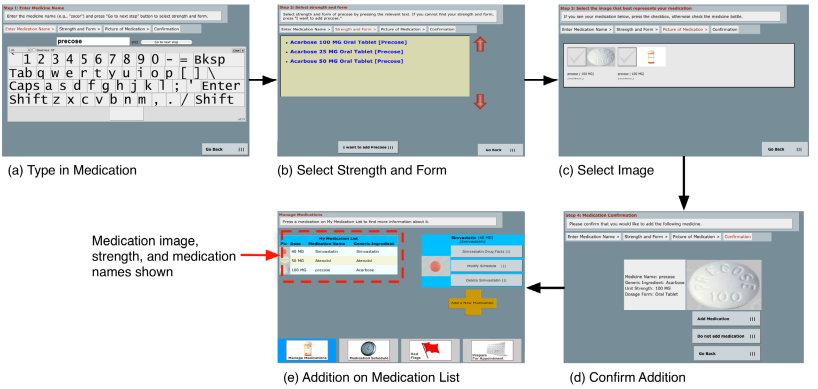


Fig. 3. Adding a medication in CO Care Tablet

3.4 Medication Information

A user could easily get information about a specific medication in the Google Health and CO Care Tablet PHAs. Similar to deleting a medication, both PHAs had medication information closely tied to the medication name. Only CO Care Tablet had an issue with labeling for getting information on a medication because of a change in terminology – <*Medication Name*> *Drug Facts* instead of <*Medication Name*> *Medication Facts.* Despite this labeling issue, our team thought that users would be able to receive medication information easily in either PHA.

There was no obvious way to get medication information using the Microsoft HealthVault PHA. A work-around we used for this task was to search for the medication name in the search box. It is unclear if the search component of the PHA was a third party application because of all of the advertisements shown when a term was searched. This method to find medication information is not intuitive because the term *search* does not answer medication related questions (e.g., What are some side effects of this medication?) that prompt older adults to look for *more information* about a medication. In addition, the search function created a new window or tab depending on the browser configuration. Thus, the user would have to understand that they are no longer in the PHA window and navigate back once the appropriate information was found.

3.5 Sharing Medication Lists

Microsoft HealthVault was the only application that prominently displayed sharing functionality. A sharing link was always shown in the tab menu (Fig. 1c, navigation area 1) and was displayed at the top of the medication list (Fig. 2c). In addition, the application described different sharing levels (view, view and modify, and custodian). The team agreed that although older adults probably would not set-up sharing, it would be easy enough to find and understand how to use for highly motivated older adults or caregivers.

CO Care Tablet provided users with the ability to share medication lists with their healthcare providers, however it was difficult to identify how to do this since it was categorized in the *Prepare for Appointment* link. Once users clicked on the appropriate link, they were faced with every cognitive walkthrough issue listed – from labeling to indications of progress. This part of the application provides useful functionality to users, however it is doubtful an older adult would understand that creating a memo, answering questions about how they are feeling, and then verifying the medication list and symptoms before sending the information to their doctor would be intuitive for older adults.

3.6 Confirmations and Warnings

All three applications had inconsistent confirmation screens – utilizing a mix of pop-up windows, overlaid screens (e.g., Fig. 2a), and regular web pages. For example, all three applications utilized a pop-up window to verify if the user wanted to delete a medication. However, when a medication was added, CO Care Tablet and Google Health used a regular web page. CO Care Tablet dedicated the entire page to confirming the medication addition, whereas Google Health only added the medication to the

navigation area 3 in Fig. 1a. The Google Health method was incredibly confusing when adding two medications with different strengths because instead of listing the medication twice in navigation area 3, the interface only highlighted one instance of the medication name. Microsoft HealthVault utilized an overlaid screen when adding a medication and then showed a regular web page to verify the addition. The inconsistent confirmation screens and buttons could confuse older adults.

Google Health was the only application that had a built in medication interaction functionality. Similar to the confirmation interface, when a possible interaction (e.g., adding two blood thinner medications that could be dangerous) was on a user's medication list, a small red circle with a white exclamation point icon appeared near the *Drug Interactions* link (Fig. 1a, navigation area 1). Users could get more information about the drug interaction by clicking on the link, however no warnings were prominently shown on the medication list page or on the medication confirmation area. The subtle warning may not be visible to older adults. In addition, the information provided on the interaction warning page simply stated, "*Requires immediate attention*" – but did not give an indication of what kind of attention or action was required.

4 Summary

In this paper we have presented the results of a CW on three PHAs with an emphasis on medication management tasks. Although these results are from a usability inspection method and thorough user testing is necessary to identify more usability issues, they provide a basis for improvements to PHAs. Based on our findings, we encourage the design community to place more of an emphasis on interface consistency and tightly coupling information with links. For older adults to effectively user a consistent interface, we must provide them seamless interactions (e.g., no transitions between new windows or tabs) and uniform interface components (e.g., choose pop-ups, overlays, or web pages, but not a subset of these). In addition, we must consider how information is presented to older adults and ensure the actions (e.g., delete a medication, find information on a medication) is intuitively linked to the target item (e.g., the medication). If we can improve on these items, PHAs could be more usable for older adults and improve medication management during transitions of care.

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