Adapting Telemonitoring Technology Use for Older Adults

A Pilot Study

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ABSTRACT

Telehealth technologies are increasing health care access for patients in the home and in community, rural, and underserved areas. Older adults may be challenged to use new technologies due to aging-related changes, lack of experience, and different attitudes toward their use. The current pilot study evaluated potential issues in one-on-one training/instructions and use of a telemonitoring application. Older adults may benefit from specific adaptations and training to use new health care technologies, and behavioral coding is an effective way to evaluate the user interface for new technologies. Feedback from the current study will be used to adapt the application and training to support dementia caregivers. **[Res Gerontol Nurs. 20XX; x(xx):xx-xx.]**

New developments in health care and advances in technology are creating telemedicine opportunities for enhanced care that can be delivered to patients in home and community settings, increasing access to care for individuals of all ages. Telemedicine and e-health services are promising care delivery modes and interventional modalities designed to meet the needs of a variety of patient populations. Technology can extend the reach of expert practitioners to patients and families in community, home, rural, and isolated populations. Although there are barriers to address (Bossen, Kim, Williams, Steinhoff, & Strieker, 2015; Wu, Damnee, Kerherve, Ware, & Rigaud, 2015), virtual care in the community, delivered via technology-based approaches, is able to overcome the limitations of face-to-face delivery (i.e., time constraints, geographic limitations, and transportation issues) (Lewis, Hobday, & Hepburn, 2010; White & Dorman, 2001). With the advent of the Affordable Care Act, industry projections include an increase of 500% in the use of telehealth technology in the United States by 2017 (Roashan, 2014).

Telehealth technologies initially developed for use in younger populations are now available for adaptation to help older adults. One such project is adapting a telemonitoring system originally designed to assist parents and teachers of children with autism spectrum disorder to the growing population of individuals with Alzheimer's disease

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and other dementias. Behavior Imaging Solutions© developed Behavior Capture™ (i.e., a secure application to collect and upload video recordings) and Behavior Connect™ (i.e., a secure, cloud-based website where practitioners can access and review submitted videos to provide feedback). This telemonitoring application works by capturing video recordings of challenging situations and behaviors that the caregiver and patient are involved in and caregivers' strategies to manage them, with a buffer that captures footage prior to the trigger for recording. Videos of behavior situations are then uploaded for clinical expert review, and feedback and training in behavior management are provided to caregiver participants. Because the authors planned to use this technology to assist caregivers of older adults with dementia, a large proportion of the target caregivers would be adults and older adults (i.e., spouses and adult children) who may face barriers to adopting this technology.

BACKGROUND

Telehealth is one of a number of available technologies to assist older adults, including those with Alzheimer's disease and other dementias, to remain living in the community (Bossen et al., 2015; Godwin, Mills, Anderson, & Kunik, 2013). New technology is meeting the needs of individuals with early-stage dementia through memory aids, cognitive stimulation, wayfinding, and information resources on the Internet. Family members who care for individuals with dementia living in the community are also supported by new technology. The Internet provides a valuable resource, as the number of individuals with dementia is projected to increase to 16 million by 2050, whereas the number of available caregivers will decline (Alzheimer's Association, 2014). Support for family caregivers, who experience a number of negative physical and psychological effects from the stress and burden of caregiving, has now been identified as a growing public health crisis (Talley & Crews, 2007). Technology currently supports family caregivers of individuals with dementia through information and support resources (available online); monitoring of movement, vital signs, and ambient and environmental conditions; tracking systems; and telemedicine and e-health services (Bossen et al., 2015; Godwin et al., 2013).

Technology is growing in use by middle-age and older adults. More than 50% of adults 65 and older use computers and other electronic devices daily to access the Internet for medical information and social support (Fox & Brenner, 2012). Surveys of family caregivers revealed that 80% to 95% request mobile systems and that interactive features assist in caregiving; 66% of technology-using family caregivers in the United States use a mobile wireless device and 69% of those find them helpful for caregiving. Mobile technology features, such as mobile text messaging, personal medical recording, and visual communication with health care providers, meet specific user needs (Fox & Brenner, 2012; National Alliance for Caregiving, 2011). Despite these estimates, as well as growing recognition of the potential benefits to older adults from Internet technologies that support personal fulfillment, health preservation, social connectedness, functional capability and activity, and caregiver support (Baker, 2013), concern remains regarding the abilities and attitudes of older adults in adopting new technology (Lee, 2013; D'Ambrosio & Mehler, 2014).

Barriers limiting technology use by older adults caring for individuals with dementia include (a) ethical considerations, (b) user perspectives and attitudes toward technology, (c) access to and reimbursement for technology, and (d) privacy. Privacy is a major concern because audio- and videorecordings can capture intimate and/or sensitive situations and present a risk of unauthorized release of sensitive, personally identifiable data. Although technology is intended to support independent living, unnecessary and too frequent use of technologies can diminish independence of choice and actions. Instead of being helpful, advanced technology beyond a user's capacity can become frustrating and dehumanizing (van Hoof, Kort, Rutten, & Duijnstee, 2011; Zwijsen, Niemeijer, & Hertogh, 2011).

There is also concern that technology use may replace human contact and lead to isolation. Health care providers need to acknowledge these cohort concerns with technology and assure human and technology contact. Families living in rural areas or with low incomes may have limited Internet access. Although the number of older adults with high-speed Internet connections has increased to 39% from 19% in 2008, there is still need to achieve universal access (Baker & Seegert, 2013). Insurance coverage for new technology to support dementia care is also lagging. Consumers must be able to afford these services, as many emerging technologies are not covered by personal health insurance, Medicare, or Medicaid (Lee, 2013).

A critical factor in the acceptance of technology is ease of use (Kramer, 2013). This is especially pertinent for dementia caregivers who experience daily stress and burden from their role, are experiencing cognitive and physical changes of aging, and may have limited experience and different attitudes toward technology. Normal aging changes, including reduced processing speed, less manual dexterity, and low visual acuity, may add to the challenge of learning and using new technologies. The current pilot study was developed to evaluate the ability of older adults to use the new telemonitoring technology to be used in the authors' larger research study and to evaluate training materials and instructions. Although longitudinal designs and comparison to younger adults would be helpful in understanding potential aging and cohort effects, the focus of the current study was limited to evaluating one specific user technology interface for older adults.

PILOT STUDY

The pilot study was completed in June 2014 and evaluated how difficult it would be for older adults (i.e., dementia caregivers) to use a telemonitoring application (app) originally designed for parents of children with autism spectrum disorder. Seven volunteers (age range = 70 to 86 years) from the local senior center were recruited and gave consent, as approved by a university institutional review board. Five volunteers were male. All participants had a college degree and some familiarity with computers; worked in teaching, medicine, and as college faculty prior to retirement; and used e-mail daily and cell phones. Cognitive status was not evaluated, but participants were able to read and understand the consent forms.

Participants were trained in a 1-hour session in a private room in the senior center or in their home to use the Behavior Capture app. Participants could choose which device to use: an iPod Touch® (i.e., the size of a cell phone) or iPad Mini® (i.e., a small tablet). During the session, a research assistant trained the older adult to use the telemonitoring application to complete a video capture and upload sequence. The research team used an illustrated instruction manual developed to provide step-by-step instructions. Upload settings were preset and additional device settings (i.e., large font, assistive touch, and app icon on a separate screen) were used to simplify the process.

On the return visit, the older adult was asked to demonstrate actual use of the device to capture, upload, and delete videos with access to the instruction manual. At the end of each visit, participants completed the System Usability Scale (Bangor, Kortum, & Miller, 2009) to evaluate their perceived ease of use of the technology. Participants received a $20 gift card at the end of each session.

The return visit was videorecorded. Videorecordings were behaviorally coded using the Noldus Observer® program to determine the biggest challenges. Behavioral coding can be readily adapted to identify specific behaviors and temporal relationships between behaviors in live and videorecorded observations. Several coding protocols used in the authors' prior research were adapted (Williams, 2011; Williams, Herman, Gajewski, & Wilson, 2009).

TABLE 1

Definitions of Error Terms

Error Term	Definition
Ask question	Participant had to ask a question to complete the step.
Refer to manual	Participant was unable to proceed with a step without looking at the illustrated instruction manual.
Pause	Participant stopped during the demonstration for at least 15 seconds.
Ineffective tap	Participant failed to trigger an icon to initiate actions (e.g., opening the app). May have been a too-brief or prolonged touch.
Express frustration	Participant vocally expressed that he/she was challenged.
Cueing by the research assistant	Participant requested direction from the research assistant.
Mistake	Participant pressed a wrong icon or navigated to an incorrect screen.

Based on initial review of two videos, the process involved in using the application was divided into 10 steps:

1. Turn on device.
2. Get to the app screen.
3. Open the app.
4. Position/reposition the device to record.
5. Change front–back camera setting.
6. Record.
7. View recording.
8. Upload.
9. Delete.
10. Return to start screen.

Based on the initial coding of two videos, the following behavioral events that indicated challenges (i.e., errors) in performance were identified: *Ask question*, *Refer to manual*, *Pause*, *Ineffective tap*, *Express frustration*, *Cueing by the research assistant*, and *Mistake*. Definitions of the error terms are provided in **Table 1**. Two videos were coded (by two individual coders [K.W., A.G.]), compared, and discussed until coding agreement reached 90%.

RESULTS

TABLE 2

Mean System Usability Scale Results[a]

Item	First Visit	Return Visit
1. I think that I would like to use this system frequently.	4.29	4.29
2. I found the system unnecessarily complex.	1.57	1.71
3. I thought the system was easy to use.	4.43	4.71
4. I thought that I would need the support of a technical individual to be able to use this system.	1.43	1.71
5. I found the various functions in this system well-integrated.	4.71	4.71
6. I thought there was too much inconsistency in this system.	1.43	1.14
7. I would imagine that most people would learn to use this system quickly.	3.29	3.71
8. I found the system cumbersome to use.	1.29	1.14
9. I felt confident using the system.	3.43	4.43
10. I needed to learn a lot of things before I could get going with this system.	2.0	1.29

[a] Based on a Likert scale of 1 to 5, where 1 = *strongly disagree* and 5 = *strongly agree*.

Participants completed the initial and return visits as part of the study. All participants elected to use the larger iPad Mini, reportedly due to its greater ease in visualizing and manipulating the device.

Survey Results

Mean scores for the usability survey rating ease of use are provided in **Table 2**. In general, participants found the system easy to use and expressed confidence in their ability to learn the system. Most scores were at the top or bottom of the possible range, with the exception of item 7 (i.e., "I would imagine that most people would learn to use this system very quickly"); mean scores were mid-range.

Return Demonstration

The total return demonstration procedure took an average of 50 minutes. Participants reviewed the instruction manual for directions. **Table 3** shows the average and range of times to complete each of the 10 procedural steps and the total number of errors that occurred for each of the seven participants (a husband/wife pair who worked together was considered one participant). Participants varied in the number of challenges to completing the task, but all had at least six and an average of 19 coded challenges to complete a recording/upload/delete process. The most frequent errors occurred when turning on the device (mean = 3.67) and uploading (mean = 3.17). The most common type of error was pausing during uploading or requiring a cue to delete the video. There was variability in the number and type of mistakes by participants for each step. The number of specific mistakes by each step is documented for the total population in **Table 4**. The uploading step, followed by the delete step, had the most errors.

Suggested Modifications/Implications

In collaboration with the research team, which included a human factors engineer, the authors reviewed the results and developed modifications for the training protocols, reference manual, and application developer. It was determined that the iPad Mini should be used due to the larger screen and button size, which were easier for participants to see and manipulate. Suggestions were made for identifying recorded videos by date and time, reducing the need for users to change between screens during various steps in the process and the number of steps for deleting videos, and improving the labeling to be larger and more distinct.

Edits and additions (i.e., font size, labeling steps, and including a problem-solving page) needed to be made to the instruction manual for clarity. For example, to simplify the process, the instructions were modified to leave the device on (and periodically plugged in for charging) and set to record, eliminating the first three steps (if the app is closed, these first steps need to be completed).

Following the pilot, the step-by-step instruction manual was modified to include larger text with clearly labeled screen shots with directions for performing steps, with breakdowns of each step. An example of a page from the manual is provided in the **Figure**.

DISCUSSION

Survey results did not correspond to actual performances coded in the videorecordings (i.e., the duration of the return demonstration and number of errors encountered). The older adults in the sample may have been overly confident or more tech-savvy than most other older adults. This may be due in part to the sampling for the study. All participants volunteered for the study; thus, many who were less confident or had negative attitudes toward technology may have opted not to participate.

Responses to the usability survey indicated that participants thought in-person support would be important if they were to use this technology routinely, emphasizing the need for human support in using advancing technologies.

Modifications were identified to improve the user interface for older adults related to sensory and cognitive changes that occur in normal aging as well as cohort characteristics (e.g., experience with and attitudes toward technology). The instruction manual was simplified and the training plan modified to accommodate older adult users. Additional application modifications will enhance usability for older adults.

Modifications of the device settings and app to simplify the user interface may have helped participants succeed in learning the technology (regardless of their background). Volunteers were open to participation without the tie to having a real use for the technology (i.e., in improving the care of a family member). Family members and caregivers may be more open to learning this simplified technology given long-term implications.

The current study was limited by the size and characteristics of the sample. A convenience sample of highly educated older adults who were technology adopters was used. Thus, the results are not generalizable to all older adults. Although longitudinal designs could have provided the opportunity to examine age-related changes over time, and comparison to a younger sample would provide evidence of cohort effects, the fo-

TABLE 3

Time (Seconds) to Complete and Errors for Each Step of Return Demonstration ($N = 7$)[a]

				No. of Errors						
Step	**Mean Time**	**Min Time**	**Max Time**	**Participant 1**	**Participant 2**	**Participant 3**	**Participant 4**	**Participant 5**	**Participant 6**	**Mean Errors**
Turn on device	51.74	20.89	132.16	3	0	8	3	6	2	3.67
Get to app screen	47.17	2.94	103.57	0	4	5	3	1	0	2.17
Open app	28.34	2.37	97.76	0	4	0	11	1	0	2.67
Position/reposition[b]	41.21	4	98.63	0	0	—	1	1	3	1.00
Front—back camera[b]	16.33	8.61	24.06	—	—	—	1	—	0	0.50
Record	49.11	15.45	124.42	0	0	1	4	2	3	1.67
View recording[b]	44.89	12.98	110.98	0	1	—	7	—	0	2.00
Upload	101.09	17.45	392.05	1	0	5	1	0	12	3.17
Delete	57.06	27.76	118.75	2	7	3	1	1	1	2.50
Return to start screen[b]	54.24	8.04	141.71	0	0	—	2	—	3	1.25
Total[b]	—	—	—	6	16	22	34	12	23	19

[a] A husband/wife pair who worked together was considered one participant.
[b] Values missing because steps were not completed. Mean, Min, and Max times and Mean Errors values include only participants who completed the step.

TABLE 4

Number of Errors Made During Steps of the Procedure[a]

Error	Record	View	Upload	Delete	Return to Start Screen
Refer to manual	2	3	3	2	1
Ask question	3	1	3	0	1
Cueing	1	1	4	5	1
Mistake	0	0	0	4	0
Frustration	3	3	4	1	2
Ineffective tap	1	0	0	0	0
Pause	0	0	5	2	0
Total	10	8	19	15	5

[a] Totals for all participants.

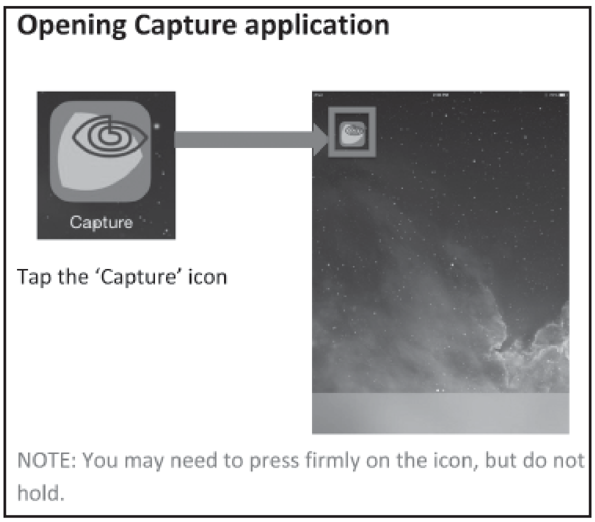

Figure. Sample instruction.

cus of the current pilot was limited to evaluating the user interface for the specific application and device. Expanded research, such as studies comparing strategies for training young and older adults (Hickman, Rogers, & Fisk, 2007), is important to inform the future preparation for the use of technology across age groups.

The more devices are used and demonstrate that technology can improve older adults' ability to live independently and not cause isolation or violation of privacy, the more acceptance and changes in attitudes toward technology use will improve. Additional functions for high-tech devices (e.g., medication reminders) could also be programmed in the app, which would make the technology even more useful; however, complexity would also increase.

CONCLUSION

Older adults may not admit or realize challenges in learning to use new technology; the survey responses were positive compared to the length of time and number of errors encountered in observation-based measurements. Despite the challenges encountered by participants, all were able (some with cueing) to complete the demonstration on the return visit. Some participants expressed frustration, but none abandoned the task. In addition, this completion success suggests that, with support, older adults have the motivation and ability to learn to use new technologies (despite that participants were daily technology users).

Behavioral coding identifies performance on technological steps and where challenges occur in adapting technology for use by older adults. The current results reinforced the importance of considering aging changes (normal and abnormal) that older adults may experience that challenge learning and using new technology (Czaja et al., 2006). Sensory changes, such as reduced vision and manual dexterity, may present challenges to seeing and pressing touch screen areas required by apps. Adequate time must be allowed for training and ongoing support may be needed (e.g., many participants required cueing during the return visit). Training materials must be explicit, clear for those with reduced vision, and broken into minute steps.

Teams including clinicians and researchers are important to adapt technology for use by older adults. For example, the developer may perform data collection in the development of an app. However, researchers using the app in research and clinical settings face additional challenges, such as adapting the user interface for older adults and working with those who have limited experience with technology. It is critical that developers and real-world users establish communication and feedback mechanisms to support good use of new technologies. In addition, having a human factors engineer as part of the research team is critical for facilitating these adaptations and should be considered as telehealth and other technologies advance.

Ongoing research is needed to evaluate how modifications may improve ease of learning and using new technologies to extend health care to older adults. It is also important to include older adults in the design of new products (Lee, 2013) as well as in adapting current products. Acceptance of technology may also involve attitudinal change about technology, such as being a support for aging in place instead of a negative concept (D'Ambrosio & Mehler, 2014; Smith, 2014). These changes may take time and, as cohorts mature, the evolving population of older adults may be enthusiastic about technology.

As health care transitions to include more virtual care, health care providers will need to be educated in how to most effectively intervene using technology and balance its use with human contact (Coughlin, 2014; Zwijsen et al., 2011). Ensuring professionals have the necessary skills to be effective telehealth providers will support ongoing acceptance and success with telehealth technology for older adults in home and community settings.

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