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Needing smart home technologies: the perspectives of older adults in continuing care retirement communities

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ABSTRACT

Background At present, the vast majority of older adults reside in the community. Though many older adults live in their own homes, increasing numbers are choosing continuing care retirement communities (CCRCs), which range from independent apartments to assisted living and skilled-nursing facilities. With predictions of a large increase in the segment of the population aged 65 and older, a subsequent increase in demand on CCRCs can be anticipated. With these expectations, researchers have begun exploring the use of smart home information-based technologies in these care facilities to enhance resident quality of life and safety, but little evaluation research exists on older adults' acceptance and use of these technologies.

Objective This study investigated the factors that influence the willingness of older adults living in independent and assisted living CCRCs to adopt smart home technology.

Subjects and setting Participants (n = 14) were recruited from community-dwelling older adults, aged 65 or older, living in one of two mid-western US CCRC facilities (independent living and assisted living type facilities).

Methods This study used a qualitative, descriptive approach, guided by principles of grounded theory research. Data saturation (or when no new themes or issues emerged from group sessions) occurred after four focus groups (n = 11 unique respondents) and was confirmed through additional individual interviews (n = 3).

Results The findings from this study indicate that although privacy can be a barrier for older adults' adoption of smart home technology their own perception of their need for the technology can override their privacy concerns.

Conclusions Factors influencing self-perception of need for smart home technology, including the influence of primary care providers, are presented. Further exploration of the factors influencing older adults' perceptions of smart home technology need and the development of appropriate interventions is necessary.

Keywords: frail elderly, smart home technology, telemedicine

Introduction

At present, the vast majority of older adults reside in the community, with fewer than 5% of elders living in skilled-nursing facilities.[1] Though many older adults live in their own homes, increasing numbers are choosing to live in continuing care retirement communities (CCRCs). The residential options offered by CCRCs range from independent apartments to assisted living and skilled-nursing facilities, and the amenities include meals, housekeeping, transportation, and on-site ambulatory care. With predictions of a large increase in the segment of the population aged 65 and older,[2] a subsequent increase in demand on CCRCs can be anticipated. As a result, these CCRCs are increasingly adopting smart home information technologies for the well-being of their residents. Smart home technologies are information-based technologies that passively collect and share resident information with the resident and family members in addition to primary care providers. The purpose of some smart home technologies is to help individuals with tasks they would otherwise be unable to do or to help individuals perform tasks more easily or safely.[3,4] In addition, smart sensor technologies are proposed to identify warning signs for early intervention. Types of smart home technology under development include: emergency help, falls detection, physiological and mobility monitoring, cognitive reminder systems, and medication management.[5,6] Little evaluation research exists on user willingness to adopt and effectiveness of smart home technology in CCRCs.[5]

The purpose of this study was to explore the willingness of older adults living in CCRCs to adopt smart home technologies. A description of the specific smart home technologies included in this study is in Box 1. This study focused on community-dwelling older adults, who were living within an independent living facility or assisted living type facility. A descriptive, qualitative approach guided by grounded theory principles was undertaken using focus groups and individual interviews.

Background

Williams argued that the meaning of a place is a key to understanding the importance of that place.[7] The term home can be understood as a specific location where

Box 1 Smart home devices

What is a smart home technology or device?	Smart home technologies are information-based technologies that *passively* collect and share resident information with the resident and family members in addition to primary care providers. These devices collect multiple types of data, including: physiological, location or movement data. Algorithms transform the raw data into activity patterns which can be used for early detection and intervention by healthcare providers or residents and their families. Examples of smart home technologies that were used in this study are listed below.
Bed sensor	This device slips under the mattress pad and detects resident heart rate, respiration and restlessness.
Motion sensor	This device detects motion within the home or apartment. By itself, the device provides data regarding the resident's location over time. For example, a motion sensor in the bathroom doorway can track the number of nocturnal bathroom visits. This data can then be compared against the resident's personal norm to look for pattern changes. The motion sensor can also be used in combination with other sensors to develop richer activity patterns.
Kitchen safety sensor	This device combines a motion sensor for the area surrounding the stove top with a heat sensor for the burners. This device is designed to alert the resident and facility staff if a stove burner is turned on and left unattended for a set amount of time.
Falls detection sensor	There are several different approaches being explored for passive monitoring for resident falls. The system under development that was presented to residents during this study used resident silhouette video images to passively detect if a resident had fallen and was unable to get up from the floor. The system would then alert facility staff, primary care providers and family members according to the resident's protocol. Unlike the emergency communication systems that are used widely in the USA, such as *Lifeline*, the resident would not have to activate the system in order to report a fall or summon help.

privacy and identity are protected; as a familiar place of comfort; and as the centre of everyday experiences.[8, 9] All three of these dimensions of home are connected to familiar routines, physical arrangements, and the social structure of the home and are often idealised by residents.[8] The addition of health services to the home environment can influence change in the experiences and meaning of home.[7,9] When home is a CCRC, the concepts of self-identity and privacy are inextricably linked with home.

Privacy can play a role in an individual's view of smart home technologies, which passively collect and share information, such as one's activity levels, sleeping patterns or treatment adherence, with the individual's primary care providers or family members. Bauer noted how home-based telemedicine applications can simultaneously enhance privacy through limiting the intrusion of healthcare providers into the home setting but increase the risk of privacy violations through inappropriate or unintentional information sharing via the technology.[10]

Examples of existing CCRC smart home technology projects include Oatfield Estates in Oregon[11] and TigerPlace in Missouri.[5] In these settings, smart home technologies are installed within the private apartments, rooms or 'homes' of the residents. Smart home technologies used in the CCRCs may include devices for: emergency communication, falls detection, gait and movement monitoring, cognitive reminder systems, and medication management. The arguments for bringing these smart home technologies into CCRC facilities are that they enhance residents' quality of life; help maintain them living at home; and reduce healthcare costs through prevention and early intervention.[12,13]

Existing evaluation literature on smart home technology often focuses on the potential benefits or usability of the technology and pays inadequate attention to the concerns of potential users or their willingness to adopt the technology. Several studies have suggested that not all older adults or families may uniformly benefit from smart home technology.[12,13] Understanding older adults' willingness to adopt new technologies is one necessary component for identifying which seniors might benefit from the technology. Without this understanding, researchers may not be able to effectively develop smart home technology interventions or target the most appropriate users.

This study explored seniors' willingness to adopt smart home technology within a CCRC living environment. The results of this study are applicable for the development of smart home technology interventions and can inform the practice of healthcare providers, technology developers, and policy makers.

Methods

Design

With approval from the Health Sciences Institutional Review Board, data were collected during focus group sessions and during individual interviews. Grounded theory analytic approaches are useful for understanding social processes and were chosen for this project, which investigates the process of individual willingness to adopt smart home technology. Data analysis resulted in a description of the factors influencing older adults' willingness to adopt smart home technology.

Because we were interested in the complex interaction between the living environment and smart home technology adoption within CCRC facilities, focus groups were selected. Individual interviews were added to increase the subject diversity of the sample and to confirm data saturation from the focus group data. Within focus groups, participant responses can be influenced by the contributions of other participants. As a result, participants may provide a greater diversity of responses and not repeat ideas that have already been expressed by another group member. We have therefore provided terms in this paper to indicate the relative frequency with which participants expressed an idea (few indicates two to three participants; several or some, up to half of participants; most, greater than two-thirds of participants).

Sample: size and sampling procedure

Data saturation, or when no new themes or issues emerged from group sessions, occurred after four focus groups (n = 11 unique respondents) and was confirmed through additional individual interviews (n = 3). Participants were recruited from community-dwelling older adults, aged 65 or older living in one of two mid-western US CCRC facilities (independent living or assisted living type facilities). Participants were recruited using flyers in their mailboxes and on bulletin boards within the residence.

Instrument

The instrument was a semi-structured series of questions to guide the facilitator during the focus group and individual interview sessions. Using a constant comparative process, the interim findings from each group generated modifications to the interview guide. For example, early in the group sessions, residents' self-perception of need emerged as an important factor in their willingness to adopt smart home technologies

and subsequent interview guides were expanded to explore this area further.

Each group and individual session began with a general discussion about privacy and participants' residential setting. This was followed by introduction of each technology (bed sensor, kitchen sensor, motion sensor, and fall detection sensor), a discussion of initial reactions, and whether or not they would be willing to adopt (use) this technology.

Data collection procedure

Following informed consent and a brief study introduction, the facilitator began each session using the interview guide. Focus groups and interviews were audiotaped and transcribed. Field notes were taken. Discussions lasted until the respondents had nothing new to add, usually 60 minutes. Following the discussion, the facilitator summarised the main points from the discussion as a member check to ensure that the meaning of what the participants intended was captured. Data collection occurred over a period of four months in 2006.

Method of analysis

Data were analysed using a qualitative approach guided by grounded theory principles. Data codes and themes were inductively generated. Analysis of the data was performed by the principal investigator and validity of interpretations was checked by other members of the research team. Interpretations were validated with each new focus group session. Following each focus group transcript data were coded, using a constant comparative analysis, by line and sentence for descriptive (first-level) and theme (pattern) codes.[14] Following open and axial coding, conceptual maps were created.[14]

Findings

This study was initially designed to develop better understanding of the relationship between privacy, residential setting and participants' subsequent willingness to adopt smart home technology. However, throughout the sessions it became apparent that residents' self-perception of need was a critical factor in their willingness to adopt smart home technology. One respondent noted their most critical technology adoption question was 'Do I need it?'

After the first focus group, the facilitator further explored the issue of 'needing' the technology in each group and interview. Participants discussed who would be ideal candidates for the technology as well as describing when they personally might need the technology. Exploration of residents' self-perception of need yielded several factors. Initial responses from participants neither uniformly rejected nor accepted all of the various technologies presented.

The decision to adopt a smart home technology

Privacy concerns rarely dictated respondents' adoption choices. Rejection of smart home technology was solely guided by privacy concerns by only a few respondents. 'My privacy is too important to me.' Most participants, however, used a pragmatic approach to their technology needs and indicated that their perception of their need for the technology was the most important consideration in the decision to adopt a smart home technology. 'Because if I need it, I would get it in a minute, if I could get there before my daughter did.'

For participants who had privacy concerns about the smart home technology, the privacy concerns were not as important as their perception of their need for the technology. 'But as far as privacy is concerned, I think the usefulness of the piece of equipment is the thing that determines that amount of privacy.' Residents seemed willing to trade personal privacy preferences for the perceived benefits of the smart home technology. 'Why, you know if it's going to be helpful then I have no problem.' More detailed results regarding the meaning of privacy in CCRCs and the privacy concerns of residents about smart home technology are presented elsewhere.[15]

Factors that influence the perception of smart home technology need

The perception of need for the technology was from the respondents' point of view and assumed that residents will have the opportunity to make a decision about using the technology rather than having the decision made for them. During the sessions, participants described a number of factors that influenced their perceptions of their need for smart home technology. These factors were:

- self perception of health
- physical condition
- mental and emotional condition
- anticipatory living
- the influence of family and friends
- the influence of healthcare professionals
- the physical environment
- the technology type
- the perceived redundancy of the technology.

Respondents' perceptions of their own need for technology may not be consistent with the external opinions

of family, friends, facility staff or their healthcare providers. Participants consistently described themselves as 'healthy', 'very healthy' or 'blessed with good health all my life'.

Contrasting with this self-perception of health, though, were their statements regarding their health history and mobility difficulties. The respondents in this study listed a wide variety of health problems including serious cardiac and pulmonary conditions, degenerative processes such as osteoporosis and arthritis, and histories of joint replacements, long bone fractures and falls. Additionally, a few respondents relied on supplemental oxygen or mobility devices such as canes, walkers and mobilised chairs (scooters).

Respondents often said that older adults with cardiac or pulmonary conditions, cognitive disorders or mobility problems would be good candidates for these types of smart home technology. However, these same respondents did not feel that they were *personally* in need of the smart home technology. For example, one woman who had balance issues and a history of falls described her health condition and then stated that she did not need a fall detection technology at this time. She described her current health concerns with 'Since I don't have any balance anymore, I have a plate in this leg also, I crushed the femur. Eleven screws ... I'm unbalanced with all of this in here [pointing to leg], and it makes me wobbly sometimes'. Following this description, she noted that 'I'd have to be very dependent on my cane' before she would need the technology.

Very few respondents indicated that they currently needed the technology, but several anticipated that future changes in their physical, mental or emotional condition could influence their need for technology. 'Well, now, as far as something like this is concerned, I would not object to it if there was a purpose for it, as in the case of this gentleman [with recent cardiac surgery]. He needed it because he was ill.' Other respondents noted they were unlikely to adopt a technology now based only on an anticipated future need. 'I'm glad for the people who are fearful, and I think, in a way, it's a kind of fear of what's going to happen that makes you want [it] – and I can't live that way. I never have.'

Participants also said that family and friends can influence their perceptions of needing the technology. One respondent gave a reverse example of how he influenced his sister to adopt an emergency communication service. Several noted the importance of their children's concerns when determining if they needed a service or a technology. A respondent also mentioned being influenced by the recommendations of their primary care provider.

The residents' physical environment also affected their perceptions of needing smart home technology. Several residents noted that their apartments were not appropriate for certain types of technology. The most commonly cited example was the lack of a stove which made the kitchen/stove top sensor irrelevant to them. The type of technology influenced the residents' perception of need. Few respondents saw a need for motion sensor technology even after being provided with sample case scenarios such as urinary tract infection detection. Additionally, some types of technology (image-based technologies) were perceived by the residents as more obtrusive than others, which negatively affected residents' willingness to adopt them. However, none of the smart home technologies presented was unanimously rejected by the participants.

Some respondents viewed specific technologies as redundant due to other systems they already had. Examples given included: the stove top indicator light for the kitchen sensor; the emergency communication service for the fall detection sensor; and medical devices such as a continuous positive airway pressure (CPAP) machine and pulse oximeter for the bed sensor.

Although the willingness to adopt smart home technology was primarily driven by the residents' perceived need for the technology, privacy did play a role in smart home technology adoption. Privacy was a potential barrier to adoption for some respondents. For a few individuals in our study, the privacy factors would supersede any perception of need. 'It's just kind of against my feelings of privacy. I think that that's my prerogative to make those choices.' For most individuals, however, the perceived need for a smart home technology would outweigh their privacy concerns in making an adoption decision. 'I think if I had a problem, I wouldn't hesitate to go electronically.' Respondents did not uniformly accept all of the smart home technology shown and most indicated a preference for being able to select only the technology or technologies they perceived they needed. The two technologies mentioned the most often for privacy concerns were the video-based fall detection sensor and the motion sensor.

Discussion

For most individuals, however, the perceived need for a smart home technology would outweigh their privacy concerns in making an adoption decision. Residents seemed willing to trade personal preferences for privacy for the perceived benefits of the smart home technology. Residents' self-perceptions of need, however, are not necessarily congruent with the opinions of their family members or healthcare providers. Healthcare providers will need to strike a delicate balance in supporting older adults' autonomy and independence

in decision making, while advocating for services or technologies which could be beneficial.

Because respondents indicated that the relationship between privacy and smart home technology is multidimensional and can be a barrier to adoption despite resident need, the design of smart home technology and subsequent interventions needs to consider both privacy and self-perception of need. For example for privacy concerns, smart home technology devices need to be made unobtrusive to the participant and undetectable to the casual observer in order to address concerns about privacy. Similarly, personalised algorithms for information sharing may alleviate residents' informational privacy concerns.

The findings from this study are consistent with components from several health behaviour and technology adoption models. The Health Belief Model suggests that adoption of preventive actions is a result of the interactions of an individual's perception of susceptibility, severity, benefits, and barriers in addition to cues to act.[16] Perceptions of personal health despite physical decline by older adults has been noted in the literature.[17] This model may prove to be a useful one to explain how perceived need (or susceptibility and severity of potential health conditions) in consideration of technology benefits (such as early detection) and barriers (such as loss of privacy) can influence the willingness of an older adult to adopt smart home technologies for their home.

Study limitations include the small sample size and that residents' adoption of the technologies, which may have differed from their attitudes, were not measured. In the future as the technologies become readily available for individual consumers, the relationship between self-perception of need, privacy, home environment and smart home technology should be re-examined.

An underlying assumption of this study was that the residents would be the decision makers regarding smart home technology implementation. If, however, the facilities, family members or primary care providers were to make this decision instead of the resident, additional research would be needed to explore the relationship of perceived need, privacy, living environment and smart home technology when the adoption choice is beyond resident control.

Conclusion

The findings from this study indicate that self-perception of need for the technology can override older adults' privacy concerns about smart home technology. Interestingly, there appeared to be an inconsistency between the identified ideal candidates for the technology and participants' own health conditions. Perhaps denial of a potential problem is a mechanism to avoid making a decision about the technology. Acceptance of the technology could be an acknowledgement of their frailty to themselves and others. If so, older adults who might benefit the most from smart home technology would be the persons least likely to adopt it. As participants indicated that their perceptions of need are influenced by their healthcare providers, primary care providers may play an important role in encouraging the appropriate adoption of smart home technologies for their community-dwelling older adult patients. This study has implications for both the design of smart home technology interventions and the evaluation of smart home technology.

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CONFLICTS OF INTEREST

None.

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