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## Exploring an informed decision-making framework using in-home sensors: older adults' perceptions

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Cite this article: Chung J. Exploring an informed decision-making framework using in-home sensors: older adults' perceptions. *Inform Prim Care*. 2014; 21(2):73–77.

<http://dx.doi.org/10.14236/jhi.v21i2.53>

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Accepted February 2014

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### ABSTRACT

**Background** Sensor technologies are designed to assist independent living of older adults. However, it is often difficult for older adults to make an informed decision about adopting sensor technologies.

**Objective** To explore Bruce's framework of informed decision making (IDM) for in-home use of sensor technologies in community-dwelling elders.

**Method** The IDM framework guided development of a semi-structured interview. A theory-driven coding approach was used for analysis.

**Results** Participants supported most of the elements of the framework, but not all aspects of each element were addressed. Perceived usefulness of technologies was identified as an area for framework extension.

**Conclusion** This paper provides useful information for health care professionals to consider how to enhance IDM of older adults regarding the use of sensor technologies. The results also illuminate elements of the IDM framework that may be critical to facilitating independent living for older adults.

**Keywords:** Aged, aged 80 and over, decision making, monitoring ambulatory/instrumentation, technology

## INTRODUCTION

Home-based sensor technologies have the potential to assist older adults in managing chronic disease and preventing adverse health outcomes by allowing continuous measurement of physiological and behavioural data.<sup>1</sup> Despite potential benefits, it is often difficult for older adults to make an informed decision about sensor technologies, especially when there is a lack of information about benefits and limitations.<sup>2</sup> Age-related changes may also present challenges to older adults' ability to understand the information and to make reasonable choices related to the use of in-home sensors.<sup>3</sup> While efforts to design and implement sensor-based solutions for older adults continue to increase and are commercially available, the process by which older adults decide to adopt or reject such technologies remains largely unexamined. Understanding how older adults decide whether or not to use sensor technologies is important for the implementation of home-based technologies.

The conceptual framework undergirding this study was Bruce's framework of informed decision making (IDM).<sup>2</sup> Bruce put forward three elements necessary for IDM related to motion-sensor-based technologies in the context of aging—information, comprehension, and voluntariness.<sup>2</sup> The first element states that older adults should have adequate information about new technologies, including purpose, features, costs, privacy, and confidentiality issues related to the technology itself or data obtained from the technology. The second element involves ensuring the ability of older adults to comprehend the information provided. To fulfil the third element of the framework, older adults should be encouraged to make decisions voluntarily, gaining a sense of empowerment and independence. The IDM framework is suggested to support health care professionals by providing practical recommendations to engage older individuals and their families in making informed decisions.

There are limited published studies that examine older adults' perceptions of IDM related to the adoption of sensor technology. Bruce's IDM framework provides a potential structure for this examination.<sup>2</sup> Thus, our aim was to apply this IDM framework in the analysis of older adult interview responses to sensor technologies to confirm or refute it and identify possible opportunities to extend it in a sample of community dwelling elders.

## METHODS

### Study design and protocol development

This investigation was a part of a larger study to test the feasibility of sensor technology installed in homes of older adults.<sup>4</sup> Qualitative interviews were conducted at the end of the six-month study. Bruce's IDM framework informed the interview protocol consisting of *information*, *comprehension*, and *voluntariness*. In addition, we added a *peer mentoring* element to explore older adults' perceptions about sharing their experiences related to sensor technologies with age

peers (Appendix). All study procedures were approved by the Institutional Review Board.

### Participants and setting

We recruited participants using convenience sampling methods from one retirement community in Seattle, WA. Inclusion criteria were: aged 65 or older, a resident of the participating community, and English fluency. Participants ranged in age from 79 to 86.

### Procedure

Open-ended semi-structured interviews were conducted to determine participants' perceptions of technology during visits to each participant's home. Interviews were audio-recorded and transcribed verbatim. Transcripts were analysed using a theory-driven coding approach<sup>5</sup> based on the IDM framework and age-peer training literature.<sup>6,7</sup>

## RESULTS

### Validation of the IDM framework

In this study, participant responses supported Bruce's IDM framework about adopting sensor technologies. Table 1 lists several aspects that were validated or not by participants as well as additional points identified in this study.

## DISCUSSION

### What does this paper add?

- This study uses an existing theoretical framework to provide information about how community-dwelling older adults think about privacy issues and concerns that they may have related to obtrusiveness when in-home sensors are used.
- A potential area for extending the IDM framework is perceived usefulness of technologies.
- Older individuals can function as peer mentors to assist other with making informed decisions by ensuring their comprehension and providing empowerment.

### Principal findings

Overall, our analysis provides preliminary support for Bruce's framework and new information related to IDM by older adults for their potential use of sensor technologies. Participants addressed the importance of communicating the purpose and benefits of the technology as well as privacy issues to age peers to ensure comprehension and voluntariness. Most of the participants were willing to share their technology experiences with age peers. Participant comments elicited an additional factor that should be considered before making a decision: perceived usefulness of the technology. Perceived usefulness of in-home sensors influences how older adults communicate their understanding of technology to others and can influence the process of making an informed decision.

**Table 1 Validation of the IDM framework**

Elements	Aspects validated in this study	Aspects not supported by participants	Additional aspects identified by participants
<b>Providing information</b>	<ul style="list-style-type: none"> <li>Participants were interested in potential benefits and main purpose of sensor technology: 'The thing that would make me decide whether to take it or not would be what is coming out of it. What's the purpose and what comes out of it. That's going to tell me something'. (P4)</li> <li>Participants regarded health care professionals as a possible source of information for decision making: 'The social worker just brought them around..... they have it and they suggested it and we were certainly in favor of it'. (P5)</li> </ul>	<ul style="list-style-type: none"> <li>Participants did not seem interested in discussing risks and uncertainties associated with sensor technology.</li> </ul>	<ul style="list-style-type: none"> <li>One participant noted that information about how technology works would not affect his decision to use it: 'I don't think information about the technology would affect my decision, it might be a matter of personal interest to me because I like to know how things work, but not in deciding'. (P4)</li> </ul>
<b>Ensuring comprehension</b>	<ul style="list-style-type: none"> <li>Participants were able to understand information about the technology's purpose, benefits, and limitations: 'I have heard several people just flat out turn the thing down and I think it's probably half misunderstanding of the purpose of it, they seem to look at it as an intrusive sort of thing and the big brother spying instead of looking at what the benefits might be to themselves,..'. (P4)</li> <li>Participants were able to relate the information about sensor technology to their own goals and values: 'I don't think there is anything intrusive about it, if you want to find out something about your long run long time behavior'. (P7)</li> </ul>		<ul style="list-style-type: none"> <li>There was an expressed need for evidence about potential benefits of technology and how to use it (e.g. data visualisation): 'I think maybe after I saw some relationships on the graph I might be able to talk about it with some sense, but as it is now I have no idea'. (P3)</li> <li>Participants assessed appropriateness and the amount of information provided: 'If it were able to give me the information I need, there's—it's less risky, it's less bothersome' (P8)</li> <li>Participants appreciated technology that could be relevant to individual health status: 'If they're at the point of falling at times or worried about falling at times... [The technology] certainly is beneficial...it certainly does not alter what you are doing or those kinds of things'. (P5)</li> </ul>
<b>Ensuring voluntariness</b>	<ul style="list-style-type: none"> <li>Participants recognised the issues of obtrusiveness and privacy with regard to voluntariness, but in a positive way: 'I'd say never has this bothered me, it's not that intrusive, it's not as though there is a sound effect with it and they listen to conversations or anything of that sort, no it's just motion, it's great'. (P7)</li> </ul>		<ul style="list-style-type: none"> <li>Participants emphasised non-obtrusiveness of the technology as it relates to privacy concerns: 'Nobody's looking at you or anything like that it's just a matter of alerting someone as to what your problem is' (P5)</li> <li>Participants were willing to communicate their perceptions of the relationship between privacy concerns and technology acceptance: 'I would tell them all it does is monitor your activities, not setting any data as to your private information or anything like that, it just tells you, as far as I know, when you walk by and back and forth,...'. (P6)</li> </ul>
<b>Peer mentoring</b>			<ul style="list-style-type: none"> <li>Most of the participants responded positively when asked about their willingness to share their experiences with sensor technologies. 'I'd encourage them to do it'. (P7) 'I could give them a few minutes and tell them what I know about it'. (P6)</li> </ul>

Note: The first three elements of protocol questions are derived from Bruce's<sup>2</sup> IDM framework.

## Implications of the findings

This study provides new insights to develop communication guidelines with key points for discussion related to making an informed decision about the use of sensor technologies. This information has practical implications for health care professionals who are considering the use of sensor technologies to help with independent living among older adults. In particular, it is important to communicate potential privacy issues with older adults because monitoring features of sensor technologies may raise concerns related to obtrusiveness and privacy, possibly hindering voluntary participation.

## Comparison with the literature

For some participants in this study, health care providers were considered important sources of information related to sensor technology. In a previous study,<sup>8</sup> older adults showed their trust in health care providers as an information source, and in some cases, preferred delegating the comprehension task of the information to them. Bruce emphasised the importance of explaining functions of sensor-based monitoring technologies, such as data transmission, to older adults.<sup>2</sup> However, our findings suggest that older adults are less concerned with how the technology works than its purpose.

To ensure older adults' autonomy and independence, there is a need for guidelines and tools to help them understand new sensor technologies. For instance, as discussed by our participants, visual displays of sensor data can enhance older adults' understanding on the technology as well as their decision-making process.<sup>9</sup> In addition to the comprehension of information, we found that the purpose of the sensor technology was also important for older adults to make a decision about its use. As Lorenzen-Huber et al<sup>10</sup> stated, if the purpose fits well older adults' perceived need for technology, they would be willing to adopt sensor-based monitoring technologies. This finding resonates with the view of smart home technologies by older adults in a previous study.<sup>11</sup>

This study confirms prior findings that older adults' perceived usefulness of and familiarity with technology or data obtained from sensors affects technology adoption.<sup>12,13</sup> Thielke et al<sup>14</sup> also addressed that older adults will not adopt a health-related technology if it does not fulfil the current levels of need, no matter how the technology is unobtrusive, smart, affordable, or powerful.

While health care professionals play a significant role in assisting older adults in making an informed decision by

focusing on the aforementioned three elements, older adults may also function as sources of information about sensor-based monitoring technologies. Considering the fact that people are likely to decide to participate in research where perceived usefulness outweighs drawbacks,<sup>15–17</sup> researchers may want to consider using age peers as recruiters and/or members of the research team.

## Limitations of the method

The total sample size was relatively small; however, data saturation was reached as no new themes were identified during analysis of the seventh transcript. Given the single-site study setting, findings should be replicated. Because Bruce's framework was used to guide the protocol development, the application to decision making related to all types of sensors cannot be inferred. Despite the limitations, we believe that the IDM framework is appropriate for this study because it specifically focuses on sensor-related decision making in the home setting. Future work should consider incorporating content from and/or comparing with other relevant frameworks (e.g. technology acceptance model or fit between individuals, task, and technology).

## Call for further research

While health care professionals play a significant role in assisting older adults in IDM by focusing on the aforementioned three elements, peers may also function as sources of information about sensor technologies. Future studies should explore how the 'ambassador' role of older adults encourages others to utilise health-related technologies and affects decision making. Further research is necessary to determine additional elements for IDM for the use of sensor technologies among older adults in addition to information, comprehension, and voluntariness. Potential next steps would be an exploration of older adults' decision-making processes with regard to sensor technologies as well as determinants of and barriers to older adults' informed participation in sensor technology-based trials.

## CONCLUSION

Our findings provide insights for future empirical work on IDM and frameworks of how to enhance older adults' informed participation in clinical trials using sensor technologies. Furthermore, the potential exists for older adults to act as peer mentors in assisting others with making an informed decision by ensuring their comprehension and providing empowerment.

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## APPENDIX

### Theory-driven protocol questions

Element	Question
Providing information	Based on your experiences, what types of information would you like to have if considering sensor technology for monitoring your health?
Ensuring comprehension	Assume you were talking to a peer or friend who was interested in sensor technology for monitoring their health, how would you talk about your perceptions of this type of technology so they would best understand it?
Ensuring voluntariness	If this peer or friend were sceptical about privacy and safety, how would you respond to his or her concerns?
Peer mentoring	If you were given the opportunity to share your experiences with someone who had questions about sensor technology, would you be willing to do so?

Note: The first three elements of protocol questions are derived from Bruce's<sup>2</sup> IDM framework.