

QUALITATIVE METHODS IN POWER WHEELCHAIR DESIGN FOR OLDER ADULTS WITH DEMENTIA

Rosalie H. Wang^{1,2}, Pia C. Kontos^{1,2}, Anne Carswell³, Gary Naglie^{1,2,4},
Alex Mihailidis^{1,2} and Geoff R. Fernie^{1,2}

¹Toronto Rehab, ²University of Toronto, ³Dalhousie University, ⁴Baycrest

INTRODUCTION

Mobility is essential to the quality of life of older adults living in long-term care homes [1]. Few solutions exist to enable the mobility of those physically unable to self-propel manual wheelchairs and who have cognitive impairments that preclude safe use of power wheelchairs. These residents present a challenge to clinicians who wish to enable mobility independence and protect the safety of others [2]. Designing safe and usable power wheelchairs for these residents is challenging evidenced by the absence of research regarding mobility devices for this population. User-centered design is an approach that focuses on user needs and specifications for technology and promotes user participation in design [3]. There may be difficulties with engaging people with dementia in the design process, and it is thus essential to include others such as staff and other residents in the care home setting who may be impacted by new technology. The use of qualitative methods may be ideally suited to address the above concerns and assist technology developers to gather the required information to guide and improve design.

PURPOSE

The purpose of this paper is multifold: 1) to discuss our experiences with using qualitative methods in two studies to design and clinically test new power wheelchair technology for older adults with cognitive impairments; 2) to explore the strengths of the methods; and 3) to discuss limitations to the use of these methods to guide technology design.

OVERVIEW OF STUDIES

Qualitative methods applied

Two exploratory studies using a mixed methods approach were conducted. The

discussion will focus on the qualitative methods used in data collection, including participant observation, focus groups, and interviews. Participant observation involves observations made in the real-life context and the investigator participates to varying degrees in the situations being observed [4]. In focus groups, group discussion is facilitated by a moderator, and there is variability in the degree of structure or involvement in directing the discussion [5]. In interviews, an investigator asks questions and respondents may describe elements of their lives, their life situations and actions, and the meanings they attribute to experiences [6]. Data from participant observation and transcripts from audio recordings (of focus groups and interviews) were analyzed using thematic analysis techniques [7]. In thematic analysis, data reduction and analysis involve a process where data are "segmented, categorized, summarized, and reconstructed in a way that captures the important concepts within the data set" [8].

Study 1 - Enabling safe and independent power wheelchair mobility with long-term care home residents with cognitive impairment: Use of an anti-collision power wheelchair

The first study is published in Wang, Gorski, Holliday and Fernie [9] and Wang, Kontos, Holliday and Fernie [10]. A prototype anti-collision power wheelchair with a novel contact sensor skirt and indicator lights to guide user movements was developed and evaluated. Refer to [9] for further details. If demonstrated to be safe, operable and acceptable by resident users after training, and acceptable to others in the care home, the device was intended to be left with the residents to use as a primary means of mobility. Resident independence and well-being were anticipated to be enhanced with use.

Six residents with mild or moderate cognitive impairment (according to the Mini-Mental State Exam) tested the device. Participant observation data were collected over the duration of the residents' participation in the study, and included observations of daily activities and power wheelchair driving sessions. Noted were their activity participation, contextual information, resident behaviors, and comments made by residents or others. Interviews were conducted with each resident at the beginning and at the end of the study. Focus groups with staff (n=37, three pre-study, two post-study) were performed. Interviews were completed with those associated with the residents testing the device. They included staff (n=18) and other residents who lived on the same nursing unit as residents testing the device (n=6) and one spouse.

Only two of the six residents tested were able to operate the device. One of these residents declined using it as his primary means of mobility. The other resident used it beyond the duration of study. This resident reported improved well-being with device use. In spite of this, he eventually discontinued use for various reasons. An additional resident with observed potential to operate it chose to stop using the device during the training period and discontinue participation in the study.

Qualitative exploration using participant observation and interview data from these three cases revealed technological and environmental factors that impacted device acceptance by resident users. The design did not meet the functional and aesthetic requirements of users. Considerations for improvement included the capability to drive on uneven and outdoor surfaces, effort-reducing driving modes, a more usable interface, options for faster driving speed, and a more attractive appearance. The care home environment also influenced the independence achievable with mobility technology and hence the acceptability. Rigid care routines and practices restricted resident autonomy and the risk for social isolation influenced the perception of gains from mobility device use [11].

The remaining three of the six residents were unable to use the prototype device. Participation of one resident was discontinued

because of verbally aggressive behavior while using the device, which presented risk for psychological harm to other residents. The final two residents were unable to operate the device without ongoing prompting or other assistance. The device did not compensate for their cognitive limitations, including decreased initiation, motor planning and new learning for one resident, and lack of awareness or understanding of obstacles for the other. With these residents, more advanced control strategies and a more reliable system with better obstacle coverage may be necessary to enable them to benefit from power mobility, if at all. Features, such as automated prompting strategies and a more usable interface for the user, may also assist these residents.

Additionally, qualitative analysis conducted using all of the data allowed a better understanding of how the device was perceived by resident users, staff and other residents. Exploration of usefulness of the device indicated that everyone was supportive of the purpose and concept of new power wheelchair technology to enable safe and independent mobility with residents with dementia. Findings also showed that the device was generally perceived as safe by resident users, however, features related to the appearance including size, form, and construction required modification to improve the perception of safety particularly for resident bystanders.

Study 2 - Usability of a multimodal feedback user interface for a collision-avoidance power wheelchair

The second study is discussed in Wang, Mihailidis, Dutta and Fernie [11]. This study aimed to address some of the acceptance issues identified by residents in the first study. Acceptance of the device was impacted by the appearance, driving speed, and usability of the user interface, which offered limited feedback to residents to navigate away from obstacles. In this study, a simulated collision-avoidance power wheelchair was used and allowed development and testing of an improved user interface with multimodal (auditory, visual and haptic) feedback. Refer to [11] for further details. This second study examined the usability of the interface, which included effectiveness, efficiency and user satisfaction.

Five residents with mild to moderate cognitive impairments tested the device over six driving sessions. Participant observation was conducted over the course of the residents' study involvement. Documented were residents' behaviors, contextual information and comments made by residents or others. Interviews were conducted following completion of all the driving sessions.

Findings indicated that it was effective in enabling residents to achieve basic driving performance tasks and self-identified indoor mobility goals. Regarding efficiency, residents were capable of operating the power wheelchair within six driving sessions; however, further practice was required for them to perform more complex driving tasks. Also, workload was perceived to be low for learning to operate and use the device. Satisfaction with the device was high, and four of five users wished to have a device like the one they tested. Driving speed remained the main criticism of the device. Residents did not report concerns with the appearance of the device. Residents felt that the additional feedback was useful to help them to navigate away from obstacles. Three of the five residents indicated that all the modes of feedback were helpful. Auditory feedback seemed to be the overall preferred mode. One resident did not think the visual feedback was useful. Haptic feedback was observed as an effective mode to guide users away from obstacles. However, one resident indicated that she did not notice the haptic feedback. Another resident felt the haptic feedback was too controlling and that warning prompts prior to a full stop of the power wheelchair would be helpful. Overall, a multimodal feedback interface on a joystick controller appeared to be a promising approach to improve usability and acceptance.

STRENGTHS OF METHODS

In the early stages of the development of new power wheelchairs for a population whose mobility needs have been largely neglected, use of qualitative methods was found to be a valuable starting point to broaden our understanding of the complex relationships between users, their needs, and the environments of technology use. A mix of data

collection strategies elicited information on different facets of users' and others' experiences that are useful to inform device design in a user-centered approach. Participant observation, focus groups, and interviews were found to be tremendously helpful to facilitate a comprehensive understanding of the underlying reasons for residents' behaviors and decisions to accept or not accept the new devices being tested. Different strategies compensated for limitations of individual methods and were useful to corroborate information.

Participant observation, involving direct observation, participation in the resident's lives, and informal interviewing, allowed collection of vast quantities of data on personal behaviors and the environment. Experiences with testing the devices were documented from detailed observations of contexts and circumstances surrounding residents' behaviors. Observational methods enabled the investigator to document information that may be more objective, as focus group and interview data are based on subject report. This method was vital as many residents were expected to have memory or other cognitive limitations. Observed actions and behaviors, and information offered spontaneously at the time of using devices were valuable and less accessible during summative interviews.

Focus groups were one of the strategies to collect data from staff in the first study. This approach is useful for analyzing the context and multi-faceted environment of the care home setting and influence of the environment on new interventions. The approach is convenient and captures experiences of many staff at one time. Moreover, the discussion-oriented format enables ideas or concerns raised by individual participants to generate further discussion and sharing of thoughts and experiences. This can yield richer data than what may be possible from individual interviews.

Individual interviews were used to collect information from resident users, staff, family members and other residents. In interviews, participants may be more candid about potentially sensitive issues than in focus groups because of group norms. In the studies, they were opportunities to hear how respondents described their life situations, or responses to

the devices tested, their actions, and the meanings they attributed to their experiences.

LIMITATIONS OF METHODS

Use of qualitative methods in development and evaluation of technology may be new to disciplines that adhere to a more quantitative approach. As with any research method, training is necessary to appropriately conduct qualitative studies in technology research. Research using qualitative methods may be time consuming, as large data volumes may be generated. Advanced storage, coding, and retrieval software programs are available to aid data organization and analysis.

Qualitative studies are often described as having limitations in generalizability to the study population owing to small sample sizes and the subjective nature of results. Qualitative research findings may not be representative of a broader population. Qualitative findings can be theoretically generalizable, however, by generating theoretical perspectives or explanatory frameworks with applicability beyond the immediate context of the study. Findings may also sensitize developers to issues that may arise in subsequent prototypes or evaluation.

CONCLUSIONS

Applying qualitative methods may help to uncover a broad range of user and technological criteria to guide the design of new power wheelchairs for use by older adults with dementia. Incorporating these findings into new prototypes for testing, or targeting findings for future integration into devices can ultimately strengthen the safety and usability of technology.

ACKNOWLEDGEMENTS

We thank the care home residents and staff who participated in the studies. Project funding was provided by the Canadian Institutes of Health Research (CIHR) (MOP 57696) and Toronto Rehab. Toronto Rehab receives funding under the Provincial Rehabilitation Research Program from the Ministry of Health and Long-Term Care in Ontario. Equipment and space

were funded, in part, by the Canada Foundation for Innovation and the Province of Ontario. Funding for the first author was provided by a CIHR Canada Graduate Scholarship Master's Award, an Ontario Graduate Scholarship, Toronto Rehab, and the University of Toronto. The Rocket™ power wheelchairs were donated by Nimble Inc. and the Nomad power wheelchair was donated by Dynamis Mobility.

REFERENCES

- [1] E.M. Bourret, L.G. Bernick, C.A. Cott, and P.C. Kontos, "The meaning of mobility for residents and staff in long-term care facilities," *Journal of Advanced Nursing*, vol. 37, pp. 338-345, 2002.
- [2] W.B. Mortenson, W. C. Miller, J. Boily, B. Steele, E.M. Crawford, and G. Desharnais, "Overarching principles and salient findings for inclusion in guidelines for power mobility use within residential care facilities," *Journal of Rehabilitation Research & Development*, vol. 43, pp. 199-208, 2006.
- [3] J. Rubin and D. Chisnell, *Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests*, 2nd Edition, Wiley Publishing Inc, Indianapolis Indiana, 2008.
- [4] L.E.F. McKechnie, "Participant Observation," *The Sage Encyclopedia of Qualitative Research Methods*, Retrieved 13 May, 2010, from http://www.sage-reference.com.myaccess.library.utoronto.ca/research/Article_n309.html, 2008.
- [5] D.L. Morgan, "Focus groups," *The Sage Encyclopedia of Qualitative Research Methods*, Retrieved 13 May, 2010, from http://www.sage-reference.com.myaccess.library.utoronto.ca/research/Article_n178.html, 2008.
- [6] S. Kvale, *Interviews: An introduction to qualitative research interviewing*, SAGE Publications, Thousand Oaks, CA, 1996.
- [7] M.J. Patton, *Qualitative Research and Evaluation Methods*, 3rd Edition, Sage Publications, London, 2002.
- [8] L. Ayres, "Thematic coding and analysis," *The Sage Encyclopedia of Qualitative Research Methods*, Retrieved 13 May, 2010, from http://www.sage-reference.com.myaccess.library.utoronto.ca/research/Article_n451.html, 2008
- [9] R.H. Wang, S.M. Gorski, P.J. Holliday, and G.R. Fernie, "Evaluation of a contact sensor skirt for an anti-collision power wheelchair for older adult nursing home residents with dementia: Safety and mobility," *accepted to Assistive Technology*, 2010.
- [10] R.H. Wang, P.C. Kontos, P.J. Holliday and G.R. Fernie, "The experiences of using an anti-collision power wheelchair for three long-term institutional care residents with mild cognitive impairment," *Disability and Rehabilitation: Assistive Technology*, Early online, Sep 17, 2010.
- [11] R.H. Wang, A. Mihailidis, T. Dutta, and G.R. Fernie, "Usability testing of a multimodal feedback interface on a simulated collision-avoidance power wheelchair for long-term care home residents with cognitive impairments," *submitted to Journal of Rehabilitation Research and Development*, 2010.