INTELLIGENT POWER WHEELCHAIRS FOR RESIDENTS IN LONG-TERM CARE FACILITIES: POTENTIAL USERS' EXPERIENCES AND PERCEPTIONS

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ABSTRACT

The objective of this study was to explore what effect an intelligent power wheelchair would have on the daily lives of potential users. Ten older adult manual and power wheelchair users with cognitive impairment who were living in long-term care facilities participated in qualitative interviews before and after trialing a smart-wheelchair prototype. Our analysis revealed three overarching themes: 'an ounce of prevention', 'I might get out more', and 'it gives you a little bit of independence' highlighting the importance of safety, participation, and independence related to mobility for individuals living in long-term care. Findings from this study support and inform the continued design and development of intelligent power wheelchairs.

INTRODUCTION

Most older people who live in residential care use a wheelchair as their primary means of mobility (Shields, 2004). Unfortunately, many of these individuals are unable to self-propel these devices and, therefore, must rely on others for assistance with mobility (Shields, 2004). Given low staffing levels in these facilities and a limited number of visitors and volunteers, these residents may need to wait for extended periods of time for assistance, which may cause them frustration (Mortenson, Oliffe, Miller, Backman, 2012). Their lack of self-mobility also prevents them from exploring their environments, which is a fundamental human propensity (Nilsson, 2011). It may also limit their ability to take part in spontaneous activities and social interactions, which may help to alleviate some of the boredom and loneliness that is frequently experienced in these settings (Slama & Bergman-Evan, 2011).

Power wheelchairs are a potential means of mobility for residents who are unable to propel manual wheelchairs; however, many residents lack the motor and cognitive skills necessary to enable their safe operation (Mortenson et al, 2005). For example, travelling at speed whereby the user is not able to stop the power wheelchair in time to prevent contact with another person or object is a serious concern. Accidents may cause injuries to drivers and others (residents, staff and visitors) and damage to property (Mortenson et al., 2006). In some cases fatalities have

resulted from power wheelchair use (Mortenson, Hurd Clarke, & Best, 2013).

To enable increased use of power mobility there has been ongoing work in the development of intelligent power wheelchairs. This technology uses different types of sensors (sonar, laser, vision-based, etc.) to prevent the driver from making contact with things within the environment, or to allow the wheelchair to autonomously transport the user between locations (Simpson, 2005). Our research team has been developing intelligent power wheelchair prototypes for use with residents with cognitive impairment (Viswanathan, et al., 2013). Specifically, these wheelchairs aim to prevent collisions with obstacles, with the Navigation and Obstacle Avoidance Help system providing additional wayfinding assistance (Viswanathan, Little, Mackworth, Mihailidis, 2011).

In order to circumvent the technical challenges faced during development and testing of these systems, we used a Wizard of Oz approach whereby intelligent wheelchair behaviors (such as stopping and turning) were simulated by a human remotely operating the wheelchair rather than implemented by a computer program (Viswanathan, Wang, Mihailidis, 2013). Our current prototype offered three intelligent wheelchair modes: (1) speed correction where the wheelchair slowed down and/or stopped to avoid obstacles; (2) heading and speed correction where the wheelchair steered away from obstacles and also provided audio direction prompts; and (3) automatic driving completed the specified driving task without driver input while avoiding obstacles. The above modes thus offered varying levels of intervention (minimal collision avoidance assistance in mode 1 to automatic driving behaviour in mode 3). The Wizard of Oz method allowed us to quickly test user performance and satisfaction with the various modes, a key component of the design process given that these wheelchairs have not yet been available for this user group and thus their needs and preferences are unknown. Incorporation of their feedback will allow us to streamline the development process in order to optimize resource use.

OBJECTIVE

The objective of the main study was to test user performance and satisfaction with the intelligent power

wheelchair modes and to gather new design requirements (that will be reported elsewhere). As a sub-study, we also explored users experiences and perceptions regarding the effect that an intelligent power wheelchair would have on their daily lives. We present the sub-study details in this report.

METHODS

Design

Semi-structured interviews were used as the primary means of data collection for this sub-study, which was approved by local university ethics boards and the test facilities.

Participants

To be included in the study, participants needed to be at least 50 years of age, be able to communicate in English, have a mild to moderate cognitive impairment as indicated by assessments conducted at the test sites (Modified Mini Mental State Exam or Cognitive Performance Scale), and live in one of the three residential care facilities that were participating in the study.

Facilities

All of the facilities, which were the home for 100-200 residents, were in the Lower Mainland of British Columbia, Canada. Two of the facilities were multi-floor residences, whereas one facility was a single floor residence that was built on a hill and had sloped hallways that connected different units, which made manual wheelchair propulsion challenging.

Recruitment

Participants were recruited with the help of third party recruiters at each facility. Facility collaborators identified potential participants, liaising with other facility staff as necessary, and obtained consent for the study lead (third author) to contact them. The study lead reviewed the consent form and the study protocol with the potential participants and obtained informed consent to participate in the study.

Procedures

Participants were interviewed before and after testing the three modes of the Wizard of Oz (simulated) intelligent power wheelchair in five realistic driving scenarios (including parking under a table and entering and exiting an elevator). Separate semi-structured interview guides for the pre-driving and post-driving interviews were developed. Data collection and preliminary analysis occurred concurrently. This process allowed modification of the guides as the interviews progressed in order to refine our

content area and capture emerging themes. Each question was open-ended and had a variety of probes. A sample interview question was "How would this intelligent power wheelchair affect your ability to get around?" In the post-driving interviews, participants were shown short video clips of themselves using the intelligent power wheelchair in each driving mode to compensate for memory deficits and facilitate discussion.

The first two authors, who are occupational therapists by training and experienced qualitative researchers, conducted the interviews. For consistency, the same investigator interviewed each participant, except for one participant for whom the original interviewer was unavailable for the second interview.

Upon completion of all interviews, a more in-depth thematic analysis was conducted. Initially the two interviewers independently coded the interviews to identify potential effects that could be attributed to the use of the intelligent power wheelchair. The interviewers then reviewed each other's codes and collaboratively identified three overarching themes that summarized participant's responses.

RESULTS

Participants

Ten wheelchair users from the three long-term care facilities were interviewed. The sample was diverse with respect to age, represented a variety of diagnoses, and included mainly manual wheelchair users. Table 1 presents their specific characteristics.

Table 1: Participant Characteristics

Variable	
Age in years, mean (SD) Range	71.9 (11.6) 62-98
Sex, male (%)	40
Diagnosis (%) Stroke Parkinson's Disease Other	2 1 7
Primary Mobility Device (%) Power Wheelchair Manual Wheelchair	30 70

Findings

Our analysis revealed three overarching themes: 'an ounce of prevention', 'I might get out more', and 'it gives you a little bit of independence'.

'An ounce of prevention'. Seven participants discussed the impact of the intelligent power wheelchair features on safety, specifically related to the prevention of collisions with people and objects. The assertions, "It stops you from

hitting somebody. That's important…" and "It would stop me from running into the walls!" highlight important safety outcomes of intelligent power wheelchair use as perceived by the participants. Even participants who considered themselves to be safe power wheelchair drivers could see the benefits, if not for themselves, at least for other power wheelchair users. In addition to their own personal safety, participants also recognized the improved safety for other long-term care residents, staff, and the general public. Improved safety was described both inside the long-term care facility (e.g., dining room, elevator, hallways), as well as in the community (e.g., parks, sidewalks, malls). Interestingly, one participant discussed how the intelligent power wheelchair could be used as a training tool to allow individuals to learn to drive without the need for constant supervision. In contrast, two participants described how the intelligent power wheelchair safety features would impede function and mobility. For example, one participant commented on how he would not be able to get close to objects for functional purposes, such as a table for eating meals or writing a letter. Another participant described how general mobility would be hindered in situations where there were a number of intelligent power wheelchair users when he stated "… it stopped everywhere… it would be a rat race… oh, it would be terrible… we're all going somewhere and you wanna get there and we wouldn't get to go!"

'I might get out more'. The perceived impact of an intelligent power wheelchair on participation ranged for participants in this study, as evidenced by comments from two different participants, 'I could go anywhere' to 'I might go to the store more often, and go outside more often… It wouldn't be that much different'. Six participants indicated that they would go to new places, such as shopping across the street to "… buy me some cookies" or out on Christmas day to "… see my friends." Five participants commented on how they would go to the same places, but more often, such as visiting a friend on a different ward of the long-term care facility. Others described how use of an intelligent power wheelchair would not alter their habits, but would make participation in various activities easier. For example, getting to the pool and canteen (i.e., coffee shop) would be easier because they could "… travel down the hills better." Regardless of the degree to which participants felt that the intelligent power wheelchair would impact their participation, eight participants recognized that they would need less mobility assistance, which, in turn, would decrease their reliance on staff.

'It gives you a little bit of independence'. Irrespective of participants' current mode of mobility (manual or power wheelchair), eight participants thought that use of an intelligent power wheelchair would improve their independence. Participants expressed a variety of positive emotions related to becoming more independent with use of an intelligent power wheelchair, including feelings of being happy, free, calm, and powerful. In addition, seven participants felt that the intelligent power wheelchair features would decrease their anxiety and/or nervousness related to driving a power wheelchair, decrease their anger and frustration related to waiting for assistance to mobilize or difficulties with mobilizing, as well as improve their confidence while mobilizing. The importance of mobility independence was highlighted by one participant when she said, "Because for me to be confined in a place like this… If anything is going to kill me, that's going to kill me… [being dependent for mobility is] like being in jail". Another participant expressed that in his manual wheelchair, he moved "… by only inches or centimeters… so even though you're in a wheelchair, it's almost like I don't have one". In contrast to the positive views, participants also expressed a fear of the intelligent power wheelchair features malfunctioning (n=2), feeling startled by the system (n=2), frustrated by the constant stopping of the intelligent power wheelchair, and self-conscious (n=3) while using it in public.

Participants also shared their perspectives regarding how others may view their use of an intelligent power wheelchair. Specifically, five participants felt that use of the intelligent power wheelchair would decrease current worries of their friends, family, or staff associated with their wheelchair use. As well, two participants felt that others might be impressed or jealous of them for having the opportunity to use an intelligent power wheelchair.

DISCUSSION

This is among the first studies to evaluate residents' perceptions of intelligent power wheelchair use before and after trialing the device. The findings emphasize the importance of safety, participation, and independence with power mobility, which commercially available power wheelchairs are currently unable to provide to this population.

The participants' comments regarding improved safety with use of the intelligent power wheelchair were in keeping with findings from other studies (Wang, Korotchenko, Hurd Clarke, Mortenson, & Mihailidis, 2013). Concerns about safety are one of the most common reasons that prescribers deny a client a power wheelchair or clinicians remove it (Mortenson et al., 2013). The participant's suggestion to use the intelligent power wheelchair as a training tool may address clinicians concerns about safety and their lack of time to provide adequate training (Mortenson et al., 2013). The participants' views regarding the potential for improved safety are supported by previous research that has shown that intelligent power wheelchair systems can enable individuals with cognitive impairment to perform basic power wheelchair driving tasks (Wang, Mihailidis, Dutta, & Fernie, 2011). However, participants in this study were not universally positive about the potential benefit of an

intelligent power wheelchair, expressing potential drawbacks to the safety features. Similar concerns have been noted previously (Wang et al., 2013).

A primary purpose for the provision of a mobility device is to improve mobility independence and enable individuals to participate in his/her chosen activities. Based on the frequent unavailability of staff to help them move about (Mortenson et al., 2012), intelligent power wheelchairs have the potential to improve participation for individuals with cognitive impairment living in long-term care facilities. Given the constraints and restraints of living in a long-term care facility, having the opportunity to participate in activities that most of us take for granted, such as going across the street to buy cookies or visiting friends, is critical to quality of life. Making mobility easier is important given the difficulties that many power wheelchair users experience (Lofqvist et al., 2012). Decreasing the mobility assistance required by staff may free up resources to enable staff to assist with other tasks thereby decreasing the excessive wait times that are common in these facilities (Mortenson et al., 2012).

There were limitations to this study. First, participants included a small sample of individuals from only three facilities. Second, the participants trialed the intelligent power wheelchair under supervision, for specific tasks, and did not have the opportunity to use it independently in their daily lives. However, this process can also be considered a strength as it mimics current practice around power wheelchair prescription. Finally, the demographic data was collected via self-report and therefore the information may not be completely accurate.

CONCLUSION

Participants in this study identified many potential benefits to use of intelligent power wheelchairs. However, they also expressed concerns about how these devices might affect their daily lives. Both the positive and negative feedback will be incorporated into future design and development of this technology.

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