KEY WORDS
- cognition
- dementia
- interpersonal relations
- mobility limitation
- socialization
- wheelchairs

OBJECTIVE. This case study describes an occupational therapy intervention to increase the self-mobility and social participation of a nursing home resident with dementia using a power wheelchair equipped with a collision-prevention system.

METHOD. We used an exploratory case study design. Data sources included the medical record, standardized assessments, interviews, observations of daily activities, and a driving log.

RESULTS. During driving sessions, changes in affect such as smiling and attempts to socialize were noted. The resident required ongoing prompting to operate the modified power wheelchair.

CONCLUSION. The resident was unable to achieve self-mobility with an intervention involving a modified power wheelchair. However, this study demonstrates that even supervised mobility can have a positive impact on affect and social participation. Observations from this study are being applied to the design and testing of the next generation of power wheelchairs intended for use by nursing home residents with dementia.


Many older adults have chronic health conditions that limit their mobility. For those who live in institutions, independent mobility is essential to quality of life (Bourret, Bernick, Cott, & Kontos, 2002) and a fundamental action that enables engagement in self-care, leisure, and social participation. Occupational therapists often promote mobility by providing wheelchairs, and for residents who do not have the physical capacity to move a manual wheelchair, therapists may recommend power wheelchairs. Various reports have described the benefits of power wheelchairs for older adults (Brandt, Iwarsson, & Stable, 2004), the assessment (Dawson, Chan, & Kaiserman, 1994) and training (Hall, Partnoy, Tenenbaum, & Dawson, 2005) of nursing home residents for power wheelchair use, and safety concerns related to use of these devices in nursing homes (Mortenson et al., 2005). Despite the research and practice knowledge available, residents who are physically unable to move a manual wheelchair, yet have dementia or other conditions that limit them from safely operating a power wheelchair because of inadequate attention, learning capability, safety awareness, and judgment, still present a challenge to therapists. To date, no effective interventions have been developed to assist these residents, and they remain dependent on others to move them from place to place.

Advances in technology offer the possibility of power mobility for people not normally considered capable of driving power wheelchairs by compensating for physical and cognitive deficits. A review by Simpson (2005) described ≥46 “smart” power wheelchair projects at various stages of development, but to date, only a few have focused on the needs of those living in nursing homes. Wang, Gorski, Holliday, and Fernie (2007) reported that a power wheelchair adapted with a contact sensor skirt helped residents with cognitive impairment to compensate for
delayed reaction times and prevented injury and property damage. Mihailidis, Elinas, Boger, and Hoey (2007) suggested that intelligent collision avoidance and navigation assistance for power wheelchairs have the promise to enable mobility and decrease caregiver dependence for residents with cognitive impairment.

This new technology means that therapists will be involved in evaluating novel interventions to enhance occupational performance and engagement. In examining how a new power wheelchair intervention can improve mobility and enable goal achievement, a conceptual model of practice such as the Canadian Model of Occupational Performance–Engagement (CMOP–E; Townsend & Polatajko, 2007) may be used to frame interventions. The CMOP–E defines the dynamic interactions of the: person, environment, and occupation. Therapists assess physical, cognitive, and affective performance components of the person and analyze physical, social, cultural, and institutional environmental factors. Using this framework, therapists may modify the person, the environment, or the occupation to enable performance or engagement. A power wheelchair may be viewed as an environmental modification that alters how an occupation is performed.

Because power wheelchairs have not previously been available to people with dementia, little research evidence is available to guide therapists on how best to facilitate power wheelchair use. A good starting point is assumed to involve a cognitive rehabilitative approach using some fundamental guiding principles, as described by Boccardi and Frisoni (2006). To facilitate performance with people with dementia, Boccardi and Frisoni identified the need to ensure that the person has the motivation to participate and suggested stimulating intact cognitive skills, breaking tasks down into subtasks, and grading activity requirements. Stimulation of intact cognitive skills, particularly procedural memory, may work to help power wheelchair operation. Power wheelchair use can be facilitated by offering the person supported opportunities to drive and by grading the complexity of driving skills to match the person’s abilities. Procedural memory, part of the implicit memory system that pertains to learned skills, is fairly well preserved in people with dementia, and stimulation of these preserved memories is believed to be a viable method to promote skill performance (DeVreese, Neri, Fioravanti, Belloi, & Zanetti, 2001). Residents’ memory for the cause-and-effect relationship of using a joystick to move and the process of navigating through the environment may be intact because they may have operated joystick-controlled vehicles in the past (Hall et al., 2005).

To support correct driving performance, another cognitive rehabilitative strategy such as the system of least prompts may be used (Doyle, Wolery, Ault, & Gast, 1988). Some studies have described the application of the system of least prompts with older adults with dementia to facilitate daily skills performance with some effect (Labelle & Mihailidis, 2006). This strategy involves a progression from minimally intrusive verbal prompting to more involved demonstrations of targeted behaviors to assist performance.

Objective

The objective of this exploratory case study was to evaluate the outcome of an anticollision power wheelchair intervention to enable self-mobility for Mr. Z., a nursing home resident with dementia, thus facilitating his social participation. This case was part of a larger study that examined the effect of anticollision power wheelchair use on nursing home residents with cognitive impairment.

Method

We used an exploratory case study approach as defined by Yin (2003) and used the CMOP–E to frame the intervention. Data sources included the medical record, results from standardized assessments, interviews, structured observations, and driving logs. Mr. Z.’s medical and social histories and previous driving experiences were collected from the medical record. Pamela Holliday administered the Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975), Dementia Rating Scale–2 (Jurica, Leitten, & Mattis, 2001), and FIM® (Uniform Data System for Medical Rehabilitation, 1997). Rosalie Wang interviewed the resident and his caregivers (two nurses, a music therapist, and two recreation therapy staff) to formulate a suitable occupational performance goal. Holliday, Wang, or one of two trained research assistants made structured observations of Mr. Z.’s daily activities at 5-min intervals during five randomly selected 2-hr blocks each week for the duration of the study. Wang conducted the driving training sessions and completed a log that included summaries of the skills instructed; training strategies used; and Mr. Z.’s driving behavior and performance, affect, and social interactions. Wang also documented comments made by others on his driving and the impact of driving during and after completion of the sessions. Observations from others helped to corroborate the findings and minimize investigator bias. We reviewed all data sources and summarized common ideas relevant to the intervention’s outcomes. The study was approved by the research ethics board of the hospital where it was conducted. Informed consent was granted by Mr. Z.’s substitute decision maker and assent was granted by Mr. Z.
Participant

Mr. Z. was an 83-year-old man with a diagnosis of mixed Alzheimer’s and vascular dementia. Mr. Z. was selected purposefully from among participants in the larger study. He had complex physical and cognitive limitations, with dementia at the lower limit of the inclusion criteria for the larger study. His score on the FIM was 26 of 126, indicating maximum to total assistance for daily activities. Mr. Z. had been living in the nursing home for almost 4 years. He was previously an Air Force pilot and had experience with using a joystick. Mr. Z.’s physical, cognitive, and affective performance components are summarized in Table 1.

Environment

The study was conducted in a nursing home in Toronto, Ontario, on a nursing unit that provided maximum personal care support for residents with severe physical and cognitive impairments. He lived in a four-bed room with three others. Mr. Z. spent the majority of his time in the lounge in front of the television. There were no power wheelchairs used on this nursing unit before this study.

Occupation

Mr. Z. enjoyed social contact with others, and while sitting in the lounge he often sought contact by looking at people, reaching out with his arm, or initiating conversation. One staff member stated, “He likes to be with other people. He very much likes to be a part of the group. And he will be as involved as he can be . . . because he has a sense of humor, too.” His access to other people with whom to interact was often limited because he was unable to physically move to others’ locations. His interactions appeared dependent on other people approaching him. On many occasions, he would reach out his hand and speak, but people did not notice him.

We formulated the goal of enabling self-mobility to increase social participation after observing Mr. Z.’s behaviors and speaking with him and the five primary staff who worked with him. Because of his dysarthria, aphasia, and cognitive impairment, he was unable to name a specific goal, but it was apparent that he was motivated by social participation. The nursing, music and recreational therapy, and research staff agreed that participation in the study and the potential to be mobile might increase his social opportunities.

Intervention

We proposed an environmental intervention to compensate for Mr. Z.’s personal limitations and modify elements influencing his social participation performance. Specifically, we proposed that facilitated use of an anticollision power wheelchair that compensated for decreased awareness of, or response time to, environmental obstacles and prevented collisions would allow Mr. Z. to safely and more independently access people with whom to socialize. Mr. Z. would ideally be able to move around safely and freely in his room and the communal areas, although use of the power wheelchair would be restricted to the indoor nursing home setting where staff were available for periodic assistance.

The anticollision power wheelchair used in this study was previously described in Wang et al. (2007). A Nimble Rocket™ power wheelchair (Nimble Inc., Toronto, Ontario) was modified, as in Figure 1, so that a very low force (an estimated 1–N) contact with the sensor skirt surrounding the base of the wheelchair caused movement to stop. The skirt was designed to collapse without applying additional force during the distance required to bring the wheelchair to a gentle full stop. Only movement away from the obstacle was then permitted. Mounted beside the joystick controller were indicator lights that displayed the directions in which movement was allowed, as shown in Figure 2. The

<table>
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<th>Physical</th>
<th>Cognitive</th>
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<tbody>
<tr>
<td>• Blurred vision in right eye, cataracts, strabismus in left eye</td>
<td>• 12/30 on Mini-Mental State Exam (moderate dementia)</td>
<td>• Positive when socializing with others</td>
</tr>
<tr>
<td>• Dysarthria</td>
<td>• 72/144 on Dementia Rating Scale–2 (severe cognitive impairment)</td>
<td>• Smiled often</td>
</tr>
<tr>
<td>• Paraplegia</td>
<td>• Mild to moderate receptive and expressive aphasia</td>
<td>• Slept in wheelchair when not interacting with others</td>
</tr>
<tr>
<td>• Transfer: mechanical lift, assistance of one person</td>
<td>• Fluctuating level of alertness, sleepy after meals</td>
<td>• Displayed discontent by turning his head away or grinning (e.g., occasionally during personal care)</td>
</tr>
<tr>
<td>• Seating: tilt-in-space manual wheelchair</td>
<td>• Alert and responsive during social interactions</td>
<td></td>
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<tr>
<td>• Wheelchair mobility: Did not often initiate mobility, hand propelled short distances at 0.08 m/s (from bed to bedroom door) with verbal prompting and manual guidance, tended to veer to right side and bumped into walls and furniture</td>
<td>• Followed one-step directions with gestures and references to environment</td>
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<td></td>
<td>• Difficulty maintaining attention and retaining information; disoriented to place; staff noted that he was aware of his surroundings</td>
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setting the maximum forward speed of the power wheelchair was set at 0.24 m/s (approximately 20% of an average walking speed). The basic and complex driving skills required to operate the modified power wheelchair in the indoor nursing home setting are shown in Table 2. The performance components or abilities necessary to participate in the driving sessions are listed in Table 3. In a preliminary evaluation of Mr. Z.’s abilities and the driving requirements, we found that Mr. Z. had sufficient capacity to participate in the driving sessions using the modified power wheelchair. Mr. Z.’s strong social tendencies and motivation to be around other people were also important factors in determining his suitability for the proposed intervention.

Driving training sessions were conducted on Mr. Z.’s nursing unit. The approach to facilitate driving performance was dynamic, interactive, and based on procedural memory stimulation and the system of least prompts. According to the system of least prompts, a simple verbal prompt (e.g., drive forward) was delivered first. If this prompt did not achieve the correct performance, then pointing combined with the same verbal prompt was tested. If this prompt was also unsuccessful, gestures were tried. Maximally assistive hand-over-hand guidance was used if gestures were unsuccessful. In this case, the trainer (Wang) physically guided Mr. Z.’s hand through the appropriate movement sequence. Reinforcements or corrections were provided after correct or incorrect behaviors were observed. Care was taken to limit distractions and to monitor fatigue or sensory overload. Progress was evaluated after 12 sessions to determine whether continued training would be beneficial.

### Results

The intervention as implemented encouraged but did not sustain social participation because Mr. Z. was unable to operate the power wheelchair on his own. He drove for 12 sessions, each approximately 1 hr in duration, over 4 weeks. Although use of the power wheelchair appeared to be a positive experience for him, he required ongoing support to use it.

From his agreement to drive the power wheelchair and heightened level of alertness, frequency of smiling, and attempts to make social contact with others while driving, the research staff and his caregivers inferred that the intervention

<table>
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<td>• Turn power on and off</td>
<td>• Drive in congested areas (e.g., entertainment hall)</td>
</tr>
<tr>
<td>• Drive forward</td>
<td>• Drive in small spaces (e.g., bathroom)</td>
</tr>
<tr>
<td>• Drive backward</td>
<td>• Park (e.g., beside bed or under dining table)</td>
</tr>
<tr>
<td>• Turn right, left, 180°</td>
<td>• Back-in park or back out of small space</td>
</tr>
<tr>
<td>• Navigate around obstacles</td>
<td>• Get on and off elevators</td>
</tr>
<tr>
<td>• Navigate away from obstacle when contacted</td>
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### Results

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Figure 1. Anticollision power wheelchair.

Figure 2. Joystick controller with indicator lights.
Table 3. Performance Components Necessary to Use Modified Power Wheelchair

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<th>Physical</th>
<th>Cognitive</th>
<th>Affective</th>
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<tbody>
<tr>
<td>• Sitting tolerance to drive for approximately 1 hr</td>
<td>• Alertness and awareness of surroundings</td>
<td>• Motivation to participate and to be mobile</td>
</tr>
<tr>
<td>• Upper-extremity coordination, strength, range of motion, and hand dexterity sufficient to operate power button and joystick</td>
<td>• Follow one-step directions (verbal or nonverbal) to participate in driving sessions</td>
<td></td>
</tr>
<tr>
<td>• Vision to see indicator lights on wheelchair controller (not absolute requirement)</td>
<td>• Verbal or nonverbal ability to communicate needs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Attention to immediate task</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Track movement of objects in environment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Conceptual understanding of power button, joystick directions (and indicator lights, but not absolute requirement)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Procedural memory for use of power button and joystick</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Initiation to use joystick to start driving</td>
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</table>

had a positive impact on his affect and social participation. During the sessions, he tended to drive up to staff, initiate greetings, watch what they were doing, listen to them talking, and make jokes. On one occasion, he drove up to the unit clerk and said clearly, “How do I get out of here?” and smiled. On another occasion, he spontaneously waved his left arm in the air and said, “Where is my lasso?” in a joking fashion. The staff also encouraged his driving and offered many positive comments when he drove up to them. Several of the staff commented that they were surprised that he could move the power wheelchair because they rarely observed him moving his manual wheelchair.

Mr. Z. was able to use the power button, drive forward continuously, and turn right, left, and 180° with one-step concrete verbal prompts and gestures. He was able to navigate away from some obstacles when driving, but when an obstacle was contacted, he required verbal prompts and hand-over-hand assistance to navigate away. Complex skills were not attempted. Mr. Z. only occasionally initiated movement of the joystick, and prompting was required for most of his driving. He was easily distracted by sounds or other people around him. He demonstrated poor short-term recall for instructions. Although Mr. Z. always wanted to continue driving when asked, for sessions longer than approximately 1.25 hr, he appeared fatigued and slower to respond to prompts or obstacles. Hence, the anticollision power wheelchair, although designed to prevent collisions, was unable to compensate for his decreased initiation, motor planning, and new learning. Including preparation and take-down time, approximately 2 hr of trainer time were required for each driving session. The degree of support required for Mr. Z.’s continued use of the power wheelchair was high.

Discussion

This study is the only one of which we are aware that examines the outcome of a power mobility intervention for a nursing home resident with limited mobility and dementia, primarily because the technology has not previously been available for clinical use. When this study was undertaken, we were uncertain how residents with severe cognitive impairment would respond and whether this type of intervention would be worthwhile to pursue with these residents. This study’s outcomes were intended to guide future work to develop more effective interventions, identify suitable candidates for testing, and develop more rigorous study protocols.

The CMOP–E was a useful framework in which to position this intervention in an occupational therapy context. Because the focus of this case was on examining Mr. Z.’s response to the power wheelchair intervention and determining whether there might be some benefit, we did not explore other avenues to address the goal of increasing social participation.

Mr. Z.’s affective behavior was positive, and his social participation was enhanced while driving. Because he was not able to move himself in the power wheelchair without prompting, observed benefits could not be sustained, and we could not assess the intervention’s longer-term impact. This case illustrates, however, that a resident with complex physical and cognitive limitations can continue to experience positive affect through participation. This result is encouraging and suggests that this intervention may be worthwhile to pursue. However, further study of intervention effects using more rigorous techniques to document behaviors and social participation is recommended.

As anticipated, this study also revealed how the anticollision power wheelchair requires further development to ensure usability for residents with severe cognitive impairment. The ability of the power wheelchair control system to prevent collisions by stopping automatically protected the safety of residents and property but was not sufficient to enable Mr. Z. to drive the power wheelchair on his own. To use a power wheelchair, he required prompting from staff or a more sophisticated wheelchair control system able
to provide automated prompting and guidance. The anti-
collision power wheelchair tested in this study may be of
more benefit to residents with greater initiation and motor
planning abilities.

The foundations for facilitating power wheelchair use
for Mr. Z. were based on a cognitive rehabilitative approach
using procedural memory stimulation and the system of least
prompts. We presumed that when presented with a joystick
that controlled the movement of a vehicle, a resident with
previous use of joysticks such as in piloting a plane
would tap into previously learned skills and use the joystick
to move the power wheelchair. We expected the system of
least prompts to promote correct performance. For the most
part, this case supported these approaches.

Future Research
As a result of this exploratory case study, we have several
recommendations to improve the design of future studies
and the power wheelchair intervention for nursing home
residents with dementia. We did not examine the preserva-
tion of procedural memory for joystick use and driving and
the extent of transfer of these skills, but they warrant further
exploration. Future studies should also address the limita-
tions in the study’s design because we did not collect quan-
titative data for prompts, reinforcements, and corrections
applied during the driving sessions. Subsequent studies
should include video recordings of the driving sessions; cod-
ing of the prompts, reinforcements, and corrections deliv-
ered; and analysis of the performance outcomes.

Suggestions to improve the design of the power wheel-
chair for a clinical group with decreased driving initiation
and motor planning include an automated prompting sys-
tem, enhanced feedback to assist the driver with navigating
around the environment or away from obstacles, and possi-
ably a semiautonomous driving control system.

Conclusion
This case demonstrates that an intervention involving use
of a modified power wheelchair was unable to facilitate sus-
tained social participation for a nursing home resident with
dementia and severe cognitive impairment because self-
mobility was not achieved. However, this resident showed
that even supervised mobility can have a positive effect on
affective experience and social participation. We have gained
valuable information that is being applied to the design and
testing of the next generation of power wheelchairs intended
for use by nursing home residents with dementia. ▲

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