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Taking Control: An Exploratory Study of the Use of Tilt-in-Space Wheelchairs in Residential Care

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Abstract

Tilt-in-space (TIS) wheelchairs are common in residential care, but little empirical evidence exists regarding how they are used by residents and staff in these settings. As part of a larger study exploring the use of wheeled mobility in these facilities, we conducted a substudy to examine how TIS wheelchairs are used in practice and to explore the experiences of the residents who use them. We conducted a series of three participant observations and interviews with 6 residents or their family members and interviewed 10 staff. Our analysis identified *taking control* as the main overarching theme, subsuming two subthemes: *promoting comfort* and *mobilizing to participate*. Findings suggest that power TIS wheelchairs enable user control, whereas manual TIS wheelchairs promote staff control. These findings illustrate how TIS wheelchairs may enable or inhibit occupational engagement and suggest that vigilance is necessary to prevent their use as a restraint.

MeSH TERMS

human activities; patient positioning; personal autonomy; residential facilities; self concept; wheelchairs

Most residents in long-term care depend on wheelchairs for mobility (Shields, 2004), but there are many issues with their use. In many facilities, residents are provided with facility chairs that are not set up to allow independent propulsion or are not fitted to the user's size (Chaves, Cooper, Collins, Karmarkar, & Cooper, 2007; Karmarkar et al., 2012). Users in these settings commonly experience poor posture, discomfort, and impaired mobility (Fuchs & Gromak, 2003; Shaw & Taylor, 1991). Most residents in these situations have a diagnosis

of dementia and rely on care staff for substantial assistance with activities of daily living (Canadian Institute for Health Information, 2010). Although least-restraint policies are the norm in these facilities, many residents are restrained in their wheelchairs through the use of seat belts they cannot self-release and lap trays that may prevent them from moving out of the chair (Chaves et al., 2007).

Tilt-in-space (TIS) wheelchair use is common in residential care. In some facilities, manual TIS wheelchairs comprise 33% of the devices (Bourbonniere, Fawcett, Miller, Garden, & Mortenson, 2007). TIS wheelchairs allow the entire seating system to be tilted forward or backward while the seat-to-back angle remains constant. TIS wheelchairs are commonly prescribed by occupational therapists to help posture, reduce the risk of skin breakdown, and improve comfort (Aissaoui, Lacoste, & Dansereau, 2001; Dewey, Rice-Oxley, & Dean, 2004; Ding et al., 2008; Michael, Porter, & Pountney, 2007), but they are more expensive than nontilting wheelchairs. For pressure reduction, large tilt angles ($>25^\circ$) are required, but this position may limit function (Jan, Jones, Rabadi, Foreman, & Thiessen, 2010). Although little is known about how TIS wheelchairs affect occupational engagement, the provision of powered mobility has been associated with improved social participation in various populations (Auger et al., 2008) and mobility among facility residents (Mortenson, Miller, Backman, & Oliffe, 2011). However, in light of cost and concerns with safety, few residents have access to powered mobility (Mortenson et al., 2005).

Despite the prevalence of TIS wheelchairs in residential care, little is known about how they are used in practice and how this use is experienced. Therefore, we conducted a study to (1) describe how long-term care facility residents, family, and staff use manual versus power TIS wheelchairs and (2) examine the experiences of resident users, particularly those with different abilities.

Method

Design

We drew on data obtained from a larger ethnographic project that explored the use of wheeled mobility in long-term care settings more generally (Mortenson, Oliffe, Miller, & Backman, 2012). The research objectives of the current study were included as part of the larger study from the outset. We used the methodology of interpretive description (Thorne, Kirkham, & MacDonald-Emes, 1997) to inform this small-scale study. This qualitative approach uses repeated interviews as part of an ongoing, iterative approach to data collection and analysis (Thorne, Kirkham, & O'Flynn-Magee, 2004). The University of British Columbia ethics board and Vancouver Coastal Health Authority approved the study. Informed consent was obtained from either the resident or his or her surrogate decision maker. In the latter case, assent was obtained from the resident.

Settings

Residents from two long-term care facilities in Vancouver, British Columbia, took part in the study. Each facility had approximately 200 beds, was multilevel, and offered medical and

personal care. Most residents used a wheelchair as their primary means of mobility and had a diagnosis of dementia. More than one-third of residents had immigrated from China.

Participants

For the larger study, participants were purposively selected for variability in terms of their cognitive ability, cultural background, ability to propel their wheelchair independently, and use of TIS. Residents were not included if they were acutely ill or had <1 mo experience in the nursing home or with a wheelchair. All manual TIS users had a surrogate decision maker, who in all cases in this study was a family member. As described in Table 1, 3 participants used manual TIS wheelchairs and 3 used power TIS wheelchairs. Residents had diagnoses including dementia, stroke, diabetes, and spinal cord injury (SCI). All power TIS wheelchair users and 1 manual TIS wheelchair user (Bob) participated in interviews. Ken was the only participant who did not speak English as a first or a second language (note that pseudonyms have been used to protect the identity of the participants). His son reported he was unable to communicate coherently in his first language (i.e., Cantonese). Single interviews were conducted with 5 staff from each facility. These staff included therapists, nurses, care aides, activity workers, and managers.

Data Collection

The data were collected by the authors, two graduate students (Shankar and Wallace) who were trained in qualitative data collection and analysis, and an established researcher in the area (Mortenson). Over a 6-mo period, three unstructured participant observations were conducted with residents and three semistructured interviews were conducted with residents or their family members, based on evolving interview guides. Each interview lasted 30–90 min. Initial interviews included questions about their reasons for using a TIS wheelchair, their frequency of tilt and preferred tilt position, their experience when tilted, and the amount of assistance they received with tilting. Subsequent interviews explored observations, any changes residents had experienced since the previous interviews, and follow-up questions based on data already collected. Member checking occurred during the final interview through a review of preliminary themes. Data were also collected during one-off interviews with each staff participant. Interviews were digitally recorded and transcribed verbatim.

During each 3- to 4-hr observation, notes were taken on the use of TIS wheelchairs and the residential care environment, including its physical layout and social atmosphere. Observations were made about how the participants interacted with other people and with their environment, in particular how these interactions were mediated through wheelchair use and how staff used these devices. Field notes, which were written immediately after the interviews and observations, described resident behaviors, impressions of TIS use, and details of the built and social environments.

Analysis

Analysis was ongoing throughout the data collection process. As new data were collected, previous transcripts and field notes were reviewed in an iterative process. In keeping with the principles of interpretive description (Thorne et al., 1997), each transcript was first read

and coded independently by each researcher. Through a collaborative process, we identified common codes, which we collapsed into preliminary themes before the final interviews. On the basis of data from final interviews and participant feedback on the preliminary analysis, we identified final codes.

Trustworthiness

We used multiple trustworthiness strategies, including member checking, triangulation, and reflexivity.

Results

The overarching theme was taking control, which described marked differences between residents who used manual versus power TIS wheelchairs. We also identified two subthemes: Promoting comfort described how users' sense of physical ease, positioning, and sitting tolerance were affected by the use of tilt, and mobilizing to participate highlighted how tilt affected where residents went and their engagement in occupations.

Taking Control

The overarching theme of control revealed significant differences in reliance on staff and autonomy between manual and power TIS wheelchair users. Although most residents in both power and manual TIS wheelchairs depended on staff to help them transfer into their chairs, power users were more independent once seated. Zack, a power TIS user because of a high SCI, stated, "I think I am most in control. ... The one thing that I'm not in control of is getting in and out of the chair." For Henry, a resident with diabetes, losing the ability to transfer was a devastating change because he was initially able to transfer independently. Losing the ability to transfer was a huge loss of control for him.

Participants relied on staff to attend to care needs that occurred in the morning and night, and this reliance influenced how users of TIS mobilized in their environment and participated in activities. For instance, Ernie, a user of power TIS because of sequelae related to a longstanding SCI, described getting up later and adjusting his day in response to care aide availability: "I usually get up after breakfast, 10 o'clock? [Because the] care aide is busy, so from 10 o'clock shave and wash and get ready and start rolling around." Staff controlled when residents were transferred into their power TIS wheelchairs and when and how they were positioned and repositioned in their wheelchairs and their care needs were met.

Staff not only controlled when manual TIS users sat in their chairs but also regulated when and for what reasons they were tilted. Peter, an activity worker, observed, "[Manual TIS is] a way to keep control of our residents." Ken's son, Stuart, described the reason his father was given a recommendation for a TIS wheelchair: "When he was admitted, he was trying to get out of the chair, so with the tilt it creates an angle so it's harder for him to get out of the chair." In this case, the TIS wheelchair was provided as a possible restraint device.

Although both facilities had least-restraint policies, there appeared to be some confusion about their implementation. Wendy, an occupational therapist, explained, "A restraint is

something that is used for a restraint. If it's being used for positioning, it's being used for positioning ... But the policy breaks down what is and isn't considered restraints, what are expected restraints." Manual TIS wheelchairs could be provided as a potential means of restraint that circumvented least-restraint policies.

Although users of power TIS relied on staff to get in and out of their wheelchairs, the power TIS gave them increased control of their daytime activities and when they went back to bed. The overarching theme of control revealed the differences in autonomy that manual and power TIS wheelchairs promoted or provided. Participants used power TIS wheelchairs to control the position of their bodies in space, to improve their comfort, and to facilitate their mobility. Although manual TIS wheelchairs were provided, ostensibly to improve resident comfort and positioning, they also represented an additional means by which staff could control residents. The control residents had over their tilt influenced their comfort and sitting tolerance. Power tilt enabled users to take control by tilting on their own schedule. Henry feared the potential loss of his power TIS wheelchair: "If I did not have it, I don't know what I would do. Be in bed sleeping because I can't get up? If I didn't have this, I would be in bed all day."

Manual TIS users had very little control over their positioning because they could not tilt independently and often had difficulty communicating with staff. Ken was a resident manual TIS user with dementia who could not communicate; his son, Stuart, observed that residents who used a manual TIS could not easily control their own tilt and stated, "They have to ask someone to help them." Zack further explained, "If a person can't really speak for himself or herself, I think they really need a family member or some advocate to get more help." Stuart needed to request assistance for Ken: "I'm kind of speaking on his behalf, too. It's almost like I'm a resident here, so if I see something, I'll mention it to them, and it gets addressed." Users' ability to advocate or request assistance independently affected the control they had in their TIS wheelchair. Compared with manual TIS users, power TIS users had much more control over their comfort, mobility, and participation in activities. Henry explained, "In a [power TIS] chair you have control of everything. You are the control. If you go out and run into somebody, you're at fault. You are in control of it. You got to control it." In this sense, Henry recognized the responsibility that came with power TIS control, such as safely maneuvering the wheelchair.

In essence, power TIS enabled resident control, whereas manual TIS promoted staff control. Tilt affected residents' experience of comfort and mobility, which related to extreme differences in control between residents in manual and power TIS wheelchairs. Ultimately, the ability to control tilt affected various elements of comfort and participation for residents using TIS wheelchairs.

Promoting Comfort

TIS appeared to influence users' comfort. Residents depended on staff to help them get properly positioned in their chairs. Zack, who used a power TIS wheelchair, described how the TIS function helped him get into a comfortable position in his chair and how he would direct staff to facilitate positioning:

I tell them, “Tilt the chair way back so that I can lay right back,” because it’s important that here in the back there not be any gap, because if there is, my feet are going to slip down, and that contributes more to spasms; the legs and feet get tired.

Positioning contributed to the experience of comfort residents felt in their TIS wheelchairs, and proper postural changes enabled by tilt depended on users’ initial position in their chairs. However, positioning and tilt frequency varied considerably between TIS wheelchair types and the extent of staff involvement. Residents using manual TIS wheelchairs were occasionally observed to be positioned improperly; the positioning may have influenced their comfort in the chair. These variations in position may have been the result of lower levels of awareness or users or staff not attending to positioning details.

Bob was occasionally observed sitting in his new manual TIS chair with the sling used to transfer him from his bed underneath him and his pelvis not completely at the back of the chair. The same observation of improper positioning in a manual TIS wheelchair was occasionally seen with residents who were not study participants. Users of manual TIS wheelchairs may have been less able to optimize their comfort because of lower levels of awareness or difficulty communicating, which in turn affected the benefits they received from the tilt function.

Staff or informal caregivers regulated the benefits of tilt for manual TIS wheelchair users by controlling residents’ positioning as well their frequency of tilt. Lana, an occupational therapist, stated, “For people that are dependent in mobility, [TIS wheelchairs] are a big plus because you increase their sitting time.” However, it was observed that the angle of tilt that staff used was not sufficient for pressure reduction (i.e., $>25^\circ$) and that resident tilt angle was rarely adjusted. The dependence on others to operate the tilt function appeared to be a barrier for users of manual TIS wheelchairs; residents had less control over their own comfort, and staff had more control.

The effect of tilt seemed to vary depending on the type of wheelchair (power TIS vs. manual TIS). There was a perception among both formal and informal caregivers of manual TIS wheelchair users that tilt improved their comfort. Although none of the users of manual TIS were independently able to describe whether they felt more comfortable in a TIS wheelchair, their proxies all described indicators of increased physical comfort with the TIS. Benjamin, the son of a resident with dementia, explained the recommended reason for his father’s use of a TIS: “So, in theory if you were having a little bit of discomfort and you’d been sitting like that for the last four hours, they could just tilt it a little bit and it will feel much better.”

Power TIS wheelchair users described using their chairs for longer periods because of increased physical comfort and improved positioning from the TIS function. Ernie reported he could “relax, even have a sleep, tilt. [In] the manual [wheelchair,] you sit in position, even if you want to [move] you cannot. This [power TIS wheelchair] is comfortable.” Henry indicated that his ability to tilt enabled him to stay up as long as he wanted: “All day, all day. ... From 7:30 [a.m.] to 8:00 [p.m.].” Zack also stated, “Sometimes I tilt back just to relax.” Zack explained that the TIS wheelchair enabled him to better manage spasms: “By tilting back, I can lift my leg up, to break up the muscle spasms that way.” Power TIS allowed users to have more choice about when to go back to bed, which was critical in terms of staff

availability. Compared with manual TIS, power TIS enabled greater comfort for residents through increased resident control.

Mobilizing to Participate

Mobility varied with users of power and manual TIS, and both the tilt function and chair type influenced how TIS was used in the facility and nearby community. Staff and informal caregivers controlled the ability of manual TIS users to mobilize in their environment, whereas power TIS users had more autonomy.

Manual TIS appeared to be more difficult to self-propel and more difficult to maneuver by others. Only 1 participant (Bob) could propel it, but doing so required a great deal of exertion, possibly because of the increased weight of the wheelchair or increased difficulty in accessing the hand rims. Lana, an occupational therapist, emphasized this disadvantage of TIS for residents who could self-propel, stating, “For people who can propel, it is very much a last resort.” TIS also made it more difficult for staff to maneuver; they were observed to lean forward awkwardly to push manual TIS wheelchairs in a tilted position (rather than untilting them). This awkwardness may have deterred staff from moving residents from place to place, especially because none of the manual TIS wheelchairs in these facilities had push handles that could be adjusted ergonomically.

Our observations led us to conclude that manual TIS residents participated in fewer occupations, likely because of the limited availability of staff or informal caregivers to tilt or mobilize them. Staff cared for multiple residents, so the time they had to assist residents with activities or to monitor their tilt was limited. During day shifts, care aides normally assisted 6 residents, except when other staff were on breaks, in which case there was only 1 care aide for every 12 residents. When a resident needed to use a mechanical lift, 2 care aides were required. Additionally, staff availability particularly influenced whether manual TIS users could participate in activities.

Among users of manual TIS wheelchairs, the tilt function appeared to be both a blessing and a curse. For instance, Bob’s son Benjamin commented, “When I’ve been here, Dad will be tilted slightly [so] that his knees will hit the top of the table so I’ll tilt it down.” Bob could not sit at the table when the tilt was engaged, and because he was almost always in tilt and staff rarely changed his position, the tilt function actually made it more difficult for him to sit at the dining table. Unfortunately, this positioning reduced Bob’s ability to engage in dining activities with other residents. In contrast, Rose’s companion Samantha described how the manual TIS gave Rose an opportunity to mobilize and participate in her surroundings: “I can lift her up when she’s more alert to give her more accessibility to looking at different things when we’re out.” Ultimately, it seemed that power and manual TIS wheelchairs differentially enabled residents to mobilize in their environment and participate in occupations. Manual TIS users needed staff or informal caregivers to assist with both mobilization and tilt.

In contrast, residents using a power TIS wheelchair were more self-sufficient once they were seated in their chairs. Users of power TIS wheelchairs participated more independently in activities, such as frequenting the mall, playing the lottery, visiting friends, smoking, and

listening to music. Zack was observed to buy lottery tickets and chat with friends at the mall, adjusting the tilt of his chair as needed. As Ernie put it, “I decide that I will do things.” The tilt function on both types of TIS wheelchairs had the potential to make outdoor mobility safer because of footplate clearance and stability. Users of power TIS were observed to tilt back slightly when mobile, enabling improved footplate clearance and stability on uneven terrain, such as moving downhill (Dicianno et al., 2009). Users of manual TIS could potentially have benefited from these features of tilt, but residents were rarely observed to leave or be taken outside the facility, except for Rose (a resident who had multiple strokes), who was frequently taken into the community by her companion, Samantha. Instead, manual TIS wheelchair users were often seen sitting between meals in large communal rooms with a television on in the background.

Within the residential care facility, several participants spoke highly of the scheduled group activities and outings, but engagement with this programming varied among participants, particularly among users of manual TIS wheelchairs. As noted by the occupational therapist, Lana, manual TIS wheelchairs seemed to enable residents to be out of bed for longer periods, so they potentially had more opportunities to participate in residential leisure activities. It appeared that manual TIS had the potential to increase mobility and participation; however, because manual TIS users relied on staff assistance to facilitate this engagement, this benefit was rarely realized.

Discussion

This is the first in-depth study of the use of TIS wheelchairs in residential care. For clarity, we have organized the discussion based on the themes identified earlier.

Taking Control

Control was a central theme in describing the use of TIS in residential care, and it illustrated stark contrasts between users of manual and power TIS wheelchairs. Although all participants in the study experienced some degree of loss of control, TIS could be corrective for this loss among users of power TIS; however, TIS could contribute to additional loss of control for users of manual TIS. The experiences of residents in manual TIS wheelchairs were more reminiscent of Smithers’ (1990) research, which emphasized how manual wheelchairs could be used to facilitate staff control over residents. The use of manual TIS as a restraint, or “something that controls or limits somebody or something” (Babinec et al., 2013, p. 3), was particularly disconcerting. Although the use of TIS might reduce the risk of falls, this practice has not been supported by research evidence, which has found that the implementation of restraint-reduction policies has not generally led to an increase in fall-related injuries (Gulpers et al., 2011). It also circumvents least-restraint policies, which would require frequent monitoring and documentation.

In contrast, the positive experiences of power TIS users are similar to those reported by community-dwelling power mobility users (Brandt, Iwarsson, & Ståhle, 2004; Pettersson, Ahlström, & Törnquist, 2007). Given that loss of autonomy is one of the most challenging aspects of moving into residential care (Lee, Woo, & Mackenzie, 2002), the value of power TIS is understandable.

Promoting Comfort

Facilitating comfort through tilt for both power and manual users depended on how tilt was controlled in the residential care facility. Users of power TIS clearly described improvements in comfort using TIS, but the relationship between manual TIS and comfort was less clear. For users of manual TIS, staff availability and staff attentiveness dictated whether and when they were tilted. Although tilt may be beneficial for users of manual TIS if they are able to remain out of bed longer, other advantages are unclear. Given the small tilt angles and infrequent changes in tilt position that were observed, it seemed that these TIS wheelchairs were not being used effectively to prevent skin breakdown (Jan et al., 2010). In light of limited staffing levels in these facilities (Kayser-Jones et al., 2003), this finding likely means that among users of manual TIS wheelchairs, the tilt function of these devices is not used to its full potential. Communication problems likely exacerbate this problem for residents with dementia and those who are unable to communicate in English.

Mobilizing to Participate

Power TIS wheelchairs allowed users more freedom and independence to mobilize in their chairs and also to actively participate in various activities, whereas manual TIS wheelchairs did not appear to provide the same kind of effortless independent mobility. Thus, manual TIS could be a mixed blessing. Although it permitted users to be moved outside their bedrooms, it also caused some challenges related to accessibility that could only be remedied by staff or others, who were frequently unavailable. Residents using manual TIS were at a disadvantage because they were unable to tilt independently and were generally less mobile. In this case, tilt contributed to decreased mobility by making self-propulsion harder and reducing participants' ability to self-transfer. In contrast to users of manual TIS wheelchairs, residents using power TIS wheelchairs had more freedom to access their environment how and when they wanted because their ability to manage their own tilt improved their sitting tolerance and made outdoor mobility safer by reducing the chance of footplate contact during slope transitions (Kirby, Ackroyd-Stolarz, Brown, Kirkland, & MacLeod, 1994).

Although power mobility also has the potential to increase the mobility of people with severe mobility impairments (Buning, Angelo, & Schmeler, 2001), many residents with cognitive impairments are automatically denied access to power mobility (Mortenson et al., 2005). However, some people with cognitive impairments could learn to use these devices safely and could potentially benefit from the mobility they would provide. "Smart" power wheelchairs may enable independent powered mobility for residents with mild or moderate cognitive impairments (Wang, Kontos, Holliday, & Fernie, 2011), but these devices are not yet commercially available.

Because access to the community is a high priority among facility residents (Bourret, Bernick, Cott, & Kontos, 2002), using tilt to facilitate community mobility is an advantage that only users of power TIS are able to fully realize. Because mobility represents a critical means for people to explore their environment (Nilsson, Eklund, Nyberg, & Thulesius, 2011), the manner in which manual TIS wheelchairs are used in residential care represents a serious concern. Although TIS wheelchairs may enhance participation, tilt actually restricted

participation for some users in our study and effectively limited their ability for doing and belonging through occupation (Nilsson & Townsend, 2010).

Ultimately, the study findings raise questions about many facility practices and suggest potential changes that could be considered. Staff may benefit from additional education to ensure that manual TIS wheelchairs in residential care are not being used to restrain residents or constrain their mobility. Although manual TIS may enable residents to remain out of bed longer, the limited use of the tilt function and decreased occupational engagement suggest that the benefits of these chairs may be limited. Given the trade-off between positioning and comfort and mobility among users of manual TIS wheelchairs, their provision needs to be carefully evaluated. Further research is needed to explore these issues more fully, perhaps with a larger, mixed-methods design that combines data logging of TIS usage with interviews and observations. Comparing frequency and degree of tilt use with staff and resident discussions or chart reviews would improve our understanding of how these devices are used in practice and whether they are used as intended.

Strengths and Limitations

This study was exploratory in nature and included only a small, heterogeneous group of residents from two facilities in the lower mainland of British Columbia, so the transferability of the findings may be limited. The use of repeated interviews and purposive sampling, as well as member checking, was a strength of this study. Because the goal of interpretive description is to inform clinical reasoning by providing insight into common clinical phenomena, this methodology was appropriate for the study (Thorne et al., 2004).

Implications for Occupational Therapy Practice

The findings from this study have the following implications for occupational therapy practice:

- Resident abilities need to be carefully considered with the provision of TIS.
- Vigilance is necessary to ensure manual TIS wheelchairs enable rather than prevent occupational engagement in residential care settings.
- Power TIS enables greater occupational engagement for residents.
- Additional resources, including increased staffing and provision of additional education opportunities, are needed to ensure that the devices are used and monitored correctly and that residents have better access to devices and training.
- Given the limited funding that is available for power TIS, residents need monetary support to have improved access to these devices.

Conclusion

In this study, we explored the experiences and use of TIS among 6 residents living in residential care. Our analysis identified two subthemes, promoting comfort and mobilizing to participate, and one overarching theme, taking control. The findings suggest that power

TIS enabled user control, whereas manual TIS promoted staff control. Better monitoring may be required to ensure that TIS wheelchairs are provided and used appropriately in these settings.

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Table 1

Resident Descriptions

Participant (Proxy; Relationship)	Type of TIS Wheelchair Used and Ability to Propel	Age, Yr	Diagnosis	Participant Able to Communicate	Time in Nursing Home	Time in TIS Wheelchair
Zack	Power; independent	72	SCI	Yes	3 yr	3 yr
Ernie	Power; independent	76	SCI	Yes	3.5 yr	2 yr
Henry	Power; independent	67	Diabetes	Yes	1.5 yr	9 mo
Ken (Stuart; son)	Manual; unable to self-propel	75	Dementia	No	2 yr	1 yr
Rose (Samantha; companion)	Manual; unable to self-propel	84	Stroke	No	4 yr	4 yr
Bob (Benjamin; son)	Manual; able to self-propel	91	Dementia	Yes	6 mo	5 mo

Note. Independent = able to propel the wheelchair independently; manual = manual wheelchair with manual tilt; power = power wheelchair with power tilt; SCI = spinal cord injury; TIS = tilt-in-space.