

WHEELCHAIR WITH DROP DOWN ARMREST FOR SLIDING TRANSFERS BY USER

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INTRODUCTION

Between the early 1990s and 2003, wheelchair related injuries increased by roughly 100% from approximately 50,000 to 102,300 cases. Of these cases, the greatest number and greatest rate were in the 65 years or older group (Xiang, 2006). Nyberg & Gustafson, (1995) found that 37% of all falls in a stroke rehabilitation setting occurred during transfers or while changing position between standing to sitting.

Many wheelchair users possess the lower body strength, trunk coordination, and balance to stand and pivot to and from their wheelchairs. If they are lacking any of these qualities, either permanently or at the time of a transfer, there are three other transfer options: (i) manual lifting assistance from a caregiver; (ii) use of an overhead lifting system (mobile wheeled lifting systems or permanently mounted lifting systems); or (iii) use of a transfer board (with or without assistance).

Transfer boards permit more freedom than mechanical lifts. They, however, require adequate hand and upper body strength. For wheelchair users who lack upper body strength, a transfer board is utilized with someone's assistance for set up. Transfer boards by their very nature are portable and are not affixed to the wheelchair or the surface being transferred to. As a result, they are unstable and may slide off of the wheelchair causing the user to fall. Clinical experience of health care providers has indicated that nearly all transfer board users

experience a fall while transferring to and from the wheelchair. Also, transfer boards are often not used because they cannot be located quickly when needed. Since they are small and portable, they are often borrowed, misplaced or even stolen.

The specific aim of this project was to develop and demonstrate the feasibility of a wheelchair with an integral transfer board (SAFESLIDEBOARD (SSB)). The purpose was to eliminate the need for transfer boards that can fall from the wheelchair and provide an option that decreases the time, effort and, risk involved with transfer board usage.

METHODS

The two main Tasks undertaken in this phase of the research project were:

Task 1 – Development of a new prototype of the transfer wheelchair.

In collaboration with Invacare®, a transfer wheelchair having an integrated transfer board, was developed. The prototype, equipped with armrest/transfer boards on both left and right sides, was designed to meet all of the performance specifications of a mass produced product. Figure 1 shows a prototype with a transfer board attached on the left side.

Finite element analyses were done on the initial design and modifications were made as necessary. Following successful simulations, fatigue testing was done with two male subjects (body weight 275 pounds and 305

pounds), who repeated 50 and 100 cycles on and off the board respectively. Both trials were full weight bearing, with feet briefly leaving the ground. The trials were completed without any mechanical problems or safety concerns.



Figure 1: SAFESLIDEBOARD prototype

Task 2 – Comparison of transfers using the SSB and a standard transfer board (STB).

The goal was to determine the feasibility of SSB in terms of the users' level of independence, safety and difficulty as subjects transferred to a toilet and a tub transfer bench using the SSB and STB. Toilet and tub transfers were evaluated using a transportable, full-scale mockup as described by Sanford et al. (1995, 1999).

All study and informed consent procedures were approved by the Georgia Tech IRB. Procedures were explained to all participants and the IRB-approved informed consent was signed prior to participation. 11 wheelchair users (7 manual and 4 power wheelchairs), mean age 77.7 years, comprised the User Group (UG) and 9 therapists (expert test subjects), mean age 31.9 years, comprised the Therapist Group (TG). The protocol consisted of 8 test trials in a 2x2x2 design. In each trial a subject transferred to/from a wheelchair (their own with a STB or the test chair with the SSB) to/from a piece of equipment (toilet or tub transfer bench). The order of the trials was randomized to counterbalance the effects of learning and fatigue. Subjects were asked to approach and get on the toilet and transfer bench; remain in place for a few seconds; and

transfer back to their wheelchairs. Subjects were instructed to get on and off the toilet and transfer bench in any manner that they feel most comfortable and safest (including use of caregiver assistance, if required), but using a sliding board. Both the groups (UG and TG) rated each transfer board for independence, safety and difficulty during the toilet and bench transfers. A repeated measures ANOVA was used to test for significant differences between the groups for the two transfer devices.

Subjects were also asked open-ended questions about preferences and general feedback about the design of the devices. Responses were coded and categorized using content analysis into positive and negative aspects of each device.

RESULTS

There were no significant differences between the two transfer devices in either test group for outcomes of independence, safety and difficulty. This was not surprising with the small N used in a feasibility study. Nonetheless, despite the lack of significant effects due to transfer device, the trend in 5 of the 6 UG outcome ratings and the 2 TG ratings demonstrated more positive outcomes with the SSB compared to the STB. Moreover, when toilet and bench transfers were aggregated to increase the N, there were significant differences in observed safety for both the UG ($p = .027$) and the TG ($p = .012$). More importantly, data indicate large effect sizes for each of the 3 outcomes in UG toilet transfers, while there small to medium effect sizes for tub bench transfers.

The positive aspects of the SSB for both the groups were: convenience, safety, security and ease of use; as it was permanently fixed to the wheelchair. However, the negative aspects of the device were also related to having a fixed board on the wheelchair. These included the physical characteristics of the board which were too short, thin and narrow, its connection to the wheelchair which was a little flimsy and wobbly, its configuration with the wheelchair which made it difficult to get over the wheel and having to sit too far forward in the chair and its use which needed directions on stowage and an option for removal to be used as a standard

board. In contrast to the SSB, the positive aspects of the standard board were its physical characteristics which were wider, longer and thicker which made it feel stronger, while its negative qualities were its being separate from the wheelchair which made it feel less safe.

Table 1: Mean (SD) scores for the 3 outcome measures by each group

Outcomes	User Group (Score)	Therapist Group (Score)
Independence Toilet STB	2.22 (0.65)	3.0 (0.0)
Independence Toilet SSB	2.44 (0.66)	3.0 (0.0)
Safety Toilet STB	2.28 (0.61)	2.59 (0.22)
Safety Toilet SSB	2.54 (0.62)	2.66 (0.27)
Difficulty Toilet STB	2.44 (0.49)	3.0 (0.0)
Difficulty Toilet SSB	2.5 (0.54)	3.0 (0.0)
Independence Bench STB	2.53 (0.55)	3.0 (0.0)
Independence Bench SSB	2.58 (0.52)	3.0 (0.0)
Safety Bench STB	2.61 (0.43)	2.78 (0.16)
Safety Bench SSB	2.65 (0.46)	2.82 (0.27)
Difficulty Bench STB	2.56 (0.49)	3.0 (0.0)
Difficulty Bench SSB	2.54 (0.49)	3.0 (0.0)

DISCUSSION

Despite the repeated measures analyses, the small N used in a feasibility study made achieving significant differences between the new SAFESLIDEBOARD and the standard transfer board difficult. Nonetheless, trends may be all that is possible with the small N and the trend in virtually every comparison was for more positive outcomes with the SSB compared to the STB. Finally, and most importantly, the data indicates large effect sizes for the primary hypothesis that manual wheelchair users will transfer more independently, safely and easily using SAFESLIDEBOARD than the currently available non-attached transfer boards.

The open-ended responses about the design and usability of the SSB clearly suggest that having a transfer board fixed to the wheelchair

is not only safer and more secure, but also more convenient and easier to use. In fact, these positive qualities paralleled the negative aspects of the standard transfer board, which, because it was not attached, made it less safe and harder to use. However, the negative feedback is particularly useful for redesign in Phase II.

CONCLUSION

Although improvements can be made to the design of the working prototype, overall, observational and self report data from both older wheelchair users and therapists demonstrate that the attached transfer device is not only highly feasible, but has the potential to have significant effects on the independence, safety and ease of transfer for older users.

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