GETTING A MOVING MANUAL WHEELCHAIR OVER A THRESHOLD: A DESCRIPTIVE STUDY

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ABSTRACT

The objective of this descriptive study was to describe the success rate and errors made by new learners during their first attempts to overcome a threshold in a manual wheelchair when using the momentum method. We studied 227 able-bodied students. The study was approved by the Research Ethics Board and each participant provided informed consent. After learning preparatory skills, participants saw the skill demonstrated and described. Each participant was videotaped during his/her first attempt to get the manual wheelchair over the threshold using the momentum method. Two experienced wheelchair skills evaluators together viewed each participant's video-recording (at full speed and sometimes in slow-motion), scored the attempt (using the Wheelchair Skills Test capacity score for individual skills) and described any perceived errors. After all video-recordings had been reviewed, the raw descriptions were coded and organized chronologically. Of the 227 initial attempts, 111 (48.9%) participants passed, 8 (3.5%) passed with difficulty and108 (47.6%) failed. There were 27 types of errors documented: 8 during the approach phase (e.g. "failure to coast"), 13 during the caster-popping phase (e.g. "pops too soon"), 4 during the leaning phase (e.g. "leans too late") and 2 qualitative (e.g. "excessive body movements"). Many people using the momentum method to overcome a threshold in a manual wheelchair are unsuccessful during their first attempts. There are a wide range of errors accounting for their difficulties. These findings have implications for wheelchair skills assessment and training methods.

INTRODUCTION

The World Health Organization (WHO) has recognized wheelchair-skills assessment and training as important elements of the 8-step wheelchair-provision process.[1]Two important elements in this care pathway are wheelchair skills assessment and training for wheelchair users and their caregivers.

Obstacles with heights as little as 2 cm can present a challenge to the wheelchair user. Even overcoming a small obstacle is a skill that many wheelchair users cannot perform successfully.[2] Acquiring the skill of getting a moving manual wheelchair over such an obstacle is an essential step for wheelchair users who wish to use their wheelchairs in the community.

As described in the Wheelchair Skills Program (WSP) Manual[3]for manual wheelchair users who use the 2-hand propulsion method, the momentum (moving) version of this skill has three phases:

1) Coast: In preparation for popping the front wheels while the wheelchair user moves forward, the wheelchair user briefly coasts and places the hands in the power-stroke ready position, to be in the right position when the casters are at the proper distance from the threshold. The power-stroke ready position is when the hands are ready to grasp the hand-rims, behind top dead center (about 11:00 o'clock on the right wheel, using the clock analogy).
2) Pop: Then, the wheelchair user accelerates the wheelchair even faster than it is coasting, by using a stroke powerful enough to pop the casters.
3) Lean: Once the casters have cleared the threshold and have landed on the other side, the wheelchair user leans forward and propels the rear wheels to bring them over the threshold.

Purpose

The purpose of this study was to document the type and frequency of errors encountered when new learners first attempt to overcome an obstacle using the momentum method. Such information will be useful in developing training materials and methods for educating trainers to better identify the skills required to prevent or correct these errors and ultimately enhance the wheelchair user's skills.

METHODS

Design

This was a descriptive observational study.

Setting

The study took place in the wheelchair obstacle course in the Mobility Centre of the Nova Scotia Rehabilitation Centre.

Ethical Issues

Participation in this study exposed the participants to no known adverse effects beyond those that they were subject to as part of the educational experiences that we recorded. The study was approved by the Research Ethics Board of the Nova Scotia Health Authority. Informed written consent was obtained from all participants.

Participants

We studied 227 students and clinicians who were learning the threshold skill as a part of their curricula, a sample of convenience. It has been shown that wheelchair workshops are practical ways to improve knowledge and skills about wheelchair skills.[4-6]

Recruitment and Screening

The program directors and course instructors of the participating programs were informed of the research study and potential for students to choose to participate in the research study prior to their students' training time at the Mobility Centre. We provided information about the study to the students by brief presentations to entire classes and by providing written information to students to avoid missing any students who are not in attendance at the classes. The students' faculty instructors were not involved with the recruitment process, nor were the students' faculty members provided with information about who did or did not agree to be a participant, to minimize any perception of coercion.

Equipment

The wheelchairs were all of ultralight design with rigid frames. The threshold was a piece of wood, 2 cm high and 10 cm in the line of progression.[3] It was anchored to the floor to prevent it from moving when struck by the wheelchair. The video-camera was mounted at a height of 1.5 m (to approximate standing eye position) on a tripod and 3 m to the left side of the threshold. The video-camera was angled downward to center the image at the top of the rear wheels. This camera position was based on pilot work and was intended to capture the entire skill from the time the caster axles of the wheelchair moved within 1.5 m before the threshold until the rear wheel axles were 1.5 m beyond the threshold. The side position was intended to represent the usual point of view of a WSP tester or trainer.

Procedure

Recruitment, screening and informed consent took place before the training sessions began. The intake questionnaire was completed and a subject number was affixed to the leg. Throughout the educational session, whenever a participant was attempting a wheelchair skill, a fellow student acted as a spotter behind the wheelchair, holding onto a spotter strap.

As part of the educational session during which the study was performed, each participant received brief training on wheelchair skills other than the momentum method for getting over the threshold. These other skills included basic forwards and backwards propulsion, moving turns, managing soft surfaces and how to pop the casters from the floor at rest and while moving. Each participant also learned how to get over a threshold using the stationary method (pop and lean phases only).

For the momentum method, participants saw the skill demonstrated and described by an instructor and co-investigator (RLK or CS), according to the WSP Manual described earlier. Each participant was videotaped during attempts to get the wheelchair over the threshold using the momentum method. If a participant was not successful in getting over the threshold, he/she was permitted another attempt, often with feedback from the instructor unless no further progress was being made.

Analysis

Each participant's video-recording was edited so that only the attempts to perform the threshold were demonstrated. Two experienced wheelchair skills evaluators (RLK and CS) together viewed each participant's video-recordings, using full-speed and/or slow-motion replays as needed to achieve consensus on a Wheelchair Skills Test (WST) score (0 = fail, 1 = pass with difficulty and 2 = pass, as defined in the WSP Manual)[3] for each attempt and a description of any perceived errors. After all video-recordings had been reviewed, the descriptions of errors were coded.

RESULTS

Of the 227 initial attempts, 111 (48.9%) participants passed, 8 (3.5%) passed with difficulty and108 (47.6%) failed. There were 27 types of errors documented (Table 1): 8 during the approach phase (e.g. "failure to coast"), 13 during the caster-popping phase (e.g. "pops too soon"), 4 during the leaning phase (e.g. "leans too late") and 2 qualitative (e.g. "excessive body movements").

Table 1: types of errors observed

Errors (in temporal order)
Approach phase
1. Failure to coast
2. Slow
3. Fast
4. Too close to one side
5. Oblique
6. Braking
7. Persistent forward lean
8. Transient pop (excluding first push)
Popping phase
9. Failure to pop
10. Using backwards trunk lean to pop
11. Too soon
12. Transient forward tip on striking threshold
13. Pops but strikes leading side of threshold
14. Footrests strike threshold
15. Pops too high
16. Full rear tip
17. Casters land on top of threshold
18. Rear wheels over threshold before casters land
19. Caster slap
20. Over-release of hands
21. Stops straddling threshold
Leaning phase
22. None
23. Too soon
24. Too late
25. Excessive in extent
Other
26. Movements non-fluid
27. Excessive body movements

DISCUSSION

Although there is growing evidence about the importance of wheelchair skills training, there are no published data on the most common errors encountered as wheelchair users learn the skill of getting over a threshold. Therefore, we could not compare our results with any other studies. The types of errors were varied, as documented above.

There were a number of study limitations, for instance the use of only 2 experts for the video-recording reviews and the use of young able-bodied participants.

Future analysis of our data will be needed to determine if any of the demographic or other characteristics of the participants could predict the success of the initial attempt. Also, our work will need to be replicated with actual wheelchair users. It remains to be demonstrated whether these new insights will be of use in the assessment and training of the threshold skill.

Despite the study limitations and need for further study, our data on common errors should be useful in developing assessment and training materials and methods for educating trainers to better identify the skills required to prevent or correct these errors and ultimately enhance the wheelchair user's skills.

CONCLUSIONS

Many people using the momentum method to overcome a threshold in a manual wheelchair are unsuccessful during their first attempts. There are a wide range of errors accounting for their difficulties. These findings have implications for wheelchair skills assessment and training methods.

REFERENCES

1. World Health Organization. Guidelines on the provision of manual wheelchairs in less resourced settings. Geneva: WHO Press; 2008.
2. Hosseini, S.M., Oyster, M.L., Kirby, R.L., Harrington, A.L., Boninger, M.L. (2012). Manual wheelchair skills capacity predicts quality of life and community integration in persons with spinal cord injury. Arch Phys Med Rehabil 93, 2237-43.
3. Wheelchair Skills Program Manual. http://www.wheelchairskillsprogram.ca/eng/manual. Accessed December 30, 2015.
4. Kirby, R.L., Crawford, K.A., Smith, C., Thompson, K.J., Sargeant, J.M. (2011). A wheelchair workshop for medical students improves knowledge and skills: a randomized controlled trial. Am J Phys Med Rehabil 90, 197-206.
5. Coolen, A.L. et al. (2004). Wheelchair skills training program for clinicians: a randomized controlled trial with occupational therapy students. Arch Phys Med Rehabil 85, 1160-1167
6. Kirby, R.L. et al. (2014). A one-day practical workshop can improve the knowledge and skills of therapists and research personnel about the Wheelchair Skills Program. Proceedings of the Annual Meeting of RESNA, Seattle WA, June 13-15, 2014, Indianapolis IN, RESNA Press, Arlington, VA.