Department of Veterans Affairs

Journal of Rehabilitation Research and
Development Vol. 38 No. 1, January/February 2001
Pages 135–139

CLINICAL REPORT

Reduced push forces accompany device use during sliding transfers of seated subjects

Peter Grevelding, MSPT and Richard W. Bohannon, EdD, PT, NCS
University of Connecticut, School of Allied Health, Storrs, CT 06269; Institute of Outcomes Research, Hartford Hospital, Hartford, CT 06102

Abstract—PURPOSE: Research verifying the ability of various devices to reduce the forces required for transfers is virtually nonexistent. Therefore, we compared the push forces required to move passive seated subjects across a horizontal surface when four different methods were employed. SUBJECTS: 10 men and 14 women (weight 49.1–96.8 kg) served as subjects. METHODS AND MATERIALS: Passive subjects were moved horizontally across a treatment table that had a vinyl-covered foam mat on top. They sat either directly on the mat or on a vinyl sliding board (Ross Easy Glide), on a fabric tube (Ross Mini-Slide), or on a fabric tube on top of a sliding board on top of the mat. Subjects were pushed horizontally by each of the two authors via a hand-held dynamometer that was placed over their greater trochanter. ANALYSES: To examine interrater reliability of push forces, intraclass correlation coefficients (ICCs) were calculated for each transfer method using the two authors' measurements. Validity was confirmed using Pearson correlations to test the relationship between subjects' weights and the forces required to push them. A repeated measures analysis of variance (ANOVA) and pair-wise post hoc tests were used to compare the forces associated with the four methods. RESULTS: The ICCs for push forces ranged from 0.77 to 0.91 depending on the transfer method. The push forces associated with the four transfer methods (no device=200.7±40.8 N, sliding board=120.5±27.7 N, fabric tube=105.8±26.1 N, fabric tube and sliding board=84.2±13.4 N,) differed significantly ($F=273.9$, $p<0.001$). CONCLUSIONS: This study demonstrates that assistive devices can greatly reduce the forces required to move seated subjects horizontally. The sliding board and the fabric tube were most effective when used together. Such devices have the potential to make transfers easier for individuals performing seated transfers and to reduce the risk of injury among individuals assisting them.

Key words: *assistive devices, back injury, dependent subjects, transfers.*

Address all correspondence and requests for reprints to: Dr. Richard W. Bohannon, EdD, PT, NCS, Professor of Physical Therapy, School of Allied Health, U-2101, University of Connecticut, Storrs, CT 06269-2101; email: bohannon@uconnvm.uconn.edu.

INTRODUCTION

Limitations in the ability to transfer influence the mobility and independence of patients with a variety of pathologies and disabilities (1). When the patients' ability is limited sufficiently, they become reliant on assistance from others. Caregivers who provide this assistance are at a high level of risk of injury (2–4). Evidence of this is demonstrated by the fact that nurses rank fifth nationally in compensable back strains/sprains (5). This high percentage is due in part to the methods they use to transfer patients. Ready et al. found that the majority of nurses' injuries occurred during patient transfers and lifts (2).

Given that the compressive forces in the back during transfers often exceed the limit established by the U.S. Health Department (greater than 3,400 N), this is not surprising (3).

Despite the high risk and related occurrence of injury, caregivers often do not use assistive devices. Garg et al. found that nursing assistants used manual lifting 98 percent of the time to transfer patients. Reasons often cited for not using assistive devices include expedience of need, concern for patient safety, personal preference, and maneuverability of device (3,4). Further complicating this problem is the fact that 75 percent of American nursing programs seldom or never teach the use of assistive devices other than the Hoyer lift (6).

Thus, methods of transfer need to be examined in order to decrease the risk of injury and to document the effectiveness of assistive devices to diminish forces. One such device is the sliding board. While there are many transfer methods available, for patients in a seated position, the sliding board is often most appropriate (7–10). Alison stated, “There have not been any substantial advances in the development of assistive devices in transferring following the development of the sliding board” (1). While we do not agree with his statement, we were able to identify only two studies that address the force-reducing abilities of transfer methods, and these examined only transfers of supine subjects (11,12).

The purpose of this study was to compare the push forces required to move passive subjects across a horizontal surface using four different methods, incorporating two devices (a sliding board and a more recent innovation—a fabric sleeve). Prior to this comparison, the reliability and validity of the push forces of the study were examined.

METHODS

This was a prospective explicatory experiment. It was approved by the Institutional Review Board of the University of Connecticut. A convenience sample of 10 men and 14 women participated after providing written informed consent. Their weights were between 49.1 and 96.8 kg (mean 70.1, SD 13.4 kg) and their heights were between 154.9 and 188.0 cm (mean 171.5, SD 9.6 cm). The range of their ages was from 19 to 53 (mean 26.2, SD 8.5 years) years of age. Two adult males (81 kg, 172 cm and 68 kg, 177 cm) each transferred all 24 subjects.

A Chatillon dynamometer (model DFM 100CE; Ametek-Chatillion, 8600 Somerset Drive, Largo, FL 34643), placed over the left greater trochanter of each seated subject, was used to measure the push force of the horizontal translation (**Figure 1**). The dynamometer registers the peak force to the nearest 0.1 pound. However, forces were later converted to newtons. All transfers were conducted across a horizontal surface using either no assistive device, the Ross Easy Glide, the Ross Mini-Slide, or both (both devices manufactured by Scan Medical, P.O. Box 1089, Belvedere, CA 94920). The horizontal surface was a patient examination table with a vinyl-covered foam mat of 2-cm thickness. The Easy Glide (**Figure 2**) is a plastic sliding board (60×32.5×0.31cm). The Mini-Slide (**Figure 2**) is a tube of low-friction fabric (57.5×60cm). All transfers were performed twice (once by each tester) while the subject was seated directly on the mat or on one of the devices on top of the mat. The tester gradually increased the force through the dynamometer, placed on the trochanter, until the subject was moving slowly. An effort was made to control deviant forces by minimizing acceleration and keeping the dynamometer as horizontal as possible while subjects were pushed approximately 20 cm. The opposite hand of the examiner was placed on the lateral aspect of the knee to control rotation of the subject and only transmitted small amounts of force (**Figure 1**). The four transfer methods were tested in the same manner, but in random order. The second tester followed the same protocol and sequence as the first.

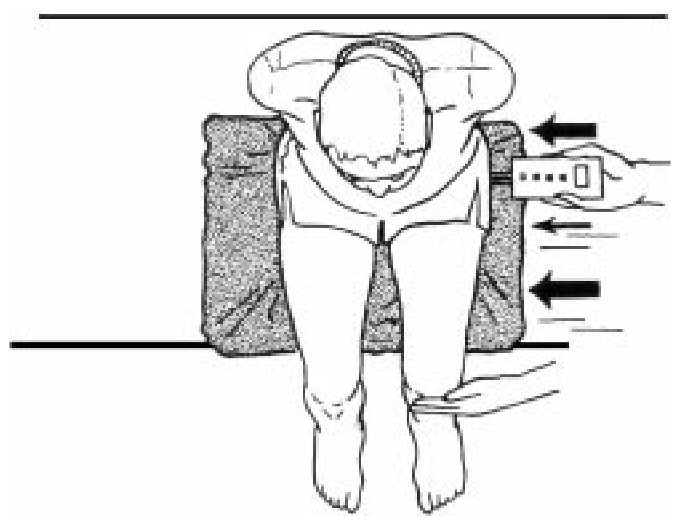

Figure 1.
Overhead view of procedure for measuring push forces associated with transfer of seated subjects across the fabric tube (Mini-Slide). Note that the dynamometer is applied over the left greater trochanter.

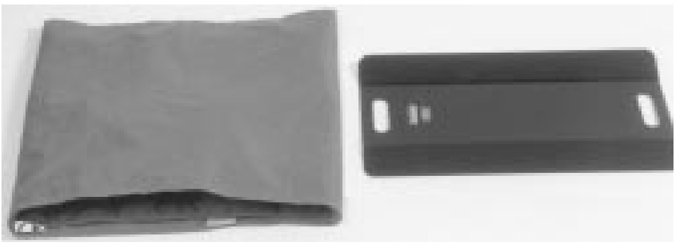

Figure 2.
Photograph of assistive devices used to reduce push forces. The fabric tube (Mini-Slide) is on the left and the vinyl sliding board (Easy Glide) is on the right.

All statistical analyses were performed using Systat 8.0 and SPSS 9.0 software. After descriptive statistics were calculated, intertester reliability of the forces obtained by the two testers was examined using intraclass correlation coefficients (ICC, equation 2.1). Validity was verified by calculating the Pearson product moment correlation between the mean push forces and body weight associated with each subject. The mean forces associated with each transfer method were compared using a repeated measures analysis of variance (ANOVA). Post hoc, pair-wise comparisons were then made using further ANOVAs.

RESULTS

The push forces associated with the four methods are summarized for each in **Table 1**. The mean forces (for each subject) associated with the four transfer methods are presented in **Figure 3**. The ICCs were satisfactory to high depending on the transfer method (no device 0.905, sliding board 0.905, fabric tube and sliding board 0.845, and fabric tube 0.770). Based on the reliability findings, the mean of the two testers' forces for each device was calculated and used in all other analysis. Validity was verified by the high correlations between horizontal translation forces and body weight ($r=0.77–0.91$). In descending order, the mean forces required to transfer subjects on each device were 200.7±40.8N for no device, 120.5±27.7N for sliding board, 105.8±26.1N for fabric tube, and 84.2±13.4N for the fabric tube and sliding board together. The ANOVA comparing the forces associated with the four transfer methods revealed that they were significantly different ($F=273.9$, $p<0.0001$). The follow-up pair-wise ANOVAs demonstrated that the forces associated with each method were significantly different ($F=21.8–425.7$, $p<0.001$) from those associated with every other method.

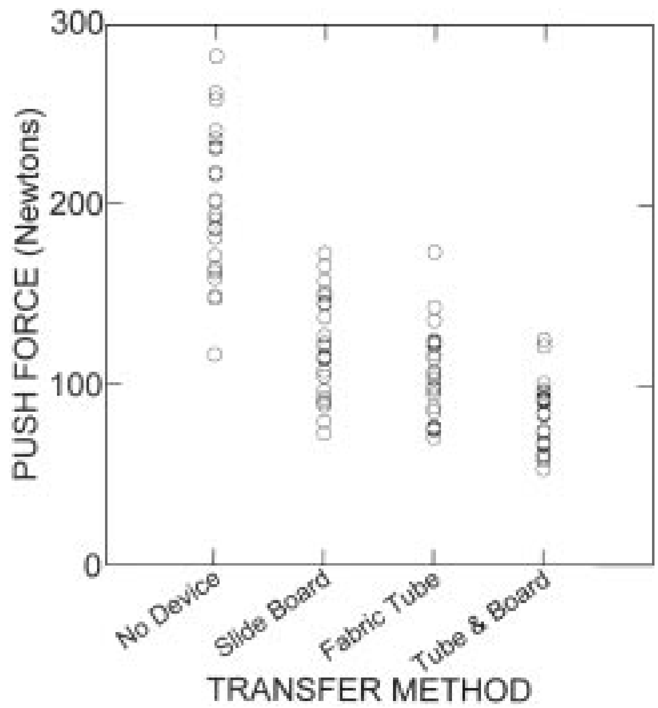

Figure 3.
Mean forces, for each subject, associated with each transfer method.

Table 1.
Push forces required for moving 24 seated subjects

Transfer Method	Tester	Push Forces (Newtons)			
		Mean	**Standard Deviation**	**Minimum**	**Maximum**
No Device	1	198.9	41.3	123.2	283.4
	2	202.5	42.3	110.3	279.4
Fabric Tube (FT)	1	100.5	22.2	69.0	146.8
	2	111.2	32.4	69.0	207.3
Sliding Board (SB)	1	120.7	27.4	68.1	166.4
	2	120.4	29.4	77.8	181.0
FT + SB	1	83.3	18.7	52.9	127.2
	2	85.2	19.6	49.4	126.3

DISCUSSION

With the documented high incidence of back injury among caregivers and the reliance of individuals on stressful transfer methods, alternatives must be sought to maximize the safety and ease of transfers (2–4). A summary of the data gathered by the Uniform Data System for Medical Rehabilitation in 1997 documents that for 249,721 patients, the mean Functional Independence Measure score for bed-to-chair transfers was 3.1 at admission and 4.9 at discharge (13). This demonstrates the reliance of individuals on assistance and/or devices during transfers. Considering that nurses perform an estimated 52 lifting tasks in an 8-hour shift, any use of devices to decrease the workload for caregivers is important (2). This study demonstrated the effectiveness of a transfer method that has had few adaptations recently.

The use of any of the devices tested in this study significantly decreased the forces required to transfer patients. While forces associated with a combination of the fabric tube (Mini-Slide) and sliding board (Easy Glide) were the lowest, the use of either device resulted in significantly lower forces than the use of no device. This, in part, supports the previous research by Bohannon on passive supine subjects (11). These sliding transfers are inherently less stressful than normal lifting tasks, which nurses perform 98 percent of the time (3). The sliding board, while requiring slightly more time than the lift-and-pivot transfer method, causes less compressive force on the low back (4). Moreover, sliding transfers may sometimes reduce the need to use multiple caregivers (Garg et al. (3) found that 79 percent of nursing assistants worked in pairs) and thus may reduce staffing requirements.

While this study does not propose that sliding boards or fabric tubes be used in all patient transfers, it does demonstrate the effectiveness of two innovations. They can be used to significantly decrease forces, and thus work, with persons who regularly participate in seated transfers; that is, caregivers and persons who use wheelchairs. It has been estimated that patients with paraplegia perform sitting transfers 70 percent of the time and approximately 15 times a day (1). Often the operational definition of success for patients with spinal cord injury is the ability to transfer (14). Yet, the percentage of patients with spinal cord injury who achieve functional independence in transfers is often quite low, ranging from 11.8 percent in patients with functioning wrist extensors to 75 percent in patients with functioning triceps brachii (15). Thus, any method that can decrease the work of transfers or diminish the energy demands should help more people achieve functional independence, and in turn, success.

While our research design (involving transfers across a padded table top) provided for control, it does not reflect the manner in which seated transfers are typically conducted. That is, the design did not involve transfers across a gap. Research conducted under such “real life” conditions would have more generalizability. Further research is required to determine the efficiency and energy requirements associated with these transfer methods in persons with impaired upper limb strength and motor control. Preferences and perceived exertion of both patient and caregiver also need to be studied.

SUMMARY

This study contributes research in a much needed, but underdeveloped area: reduction of patient transfer force requirements. We found that use of either of the assistive sliding devices significantly reduced push forces. These results can be applied directly to decrease the strain of transfers, and thus to decrease the likelihood for injury associated with these maneuvers.

ACKNOWLEDGMENTS

The authors thank Scan Medical Corporation for generously providing devices used in this study.

REFERENCES

1. Allison GT. The ability to transfer in individuals with spinal cord injury. Crit Rev Phys Rehab Med 1997;9:131–50.
2. Ready AE, Borkeskie SL, Law SA, Russell R. Fitness and lifestyle parameters fail to predict back injuries to nurses. Can J Appl Physiol 1993;18:80–90.
3. Garg A, Owen BD, Carlson B. An ergonomic evaluation of nursing assistants’ jobs in a nursing home. Ergonomics 1992;35:979–95.
4. Ulin SS, Chaffin DB, Patellos CL, Blitz SG, Emerick CA, Landy F, Misher L. A biomechanical analysis of methods used for transferring totally dependent patients. SCI Nursing 1997;14:19–27.
5. Klein B, Jensen R, Sanderson L. Assessment of worker’s compensation claims for back sprains. J Occup Med 1984;26:443–8.
6. Owen BD, Welden N, Kane J. What are we teaching about lifting and transferring patients? Res Nurs Health 1999;22:3–13.
7. Skarplik C. Patient handling in the community. Nursing 1988;3:13–6.

8. Minor MA, Minor SD. Patient care skills. 3rd ed. Norwalk, CT: Appleton & Lange; 1995. p. 248–9.
9. Pierson FM. Principles and techniques of patient care. 3rd ed. Philadelphia, PA: W.B. Saunders; 1999. p. 125–7.
10. Palmer ML, Toms JE. Manual for functional training. 3rd ed. Philadelphia, PA: F.A. Davis; 1992. p. 281–2
11. Bohannon RW. Horizontal transfers between adjacent surfaces: forces required using different methods. Arch Phys Med Rehabil 1999;80:851–3.
12. Zelenka JP, Floren AE, Jordan JJ. Minimal forces to move patients. Am J Occup Ther 1996;50:345–61.
13. Fiedler RC, Granger CV, Russell BA. Uniform data system for medical rehabilitation. Am J Phys Med Rehab 1998;77:444–50.
14. Bergstrom MK, Frankel HL, Galer IA, Haycock EL, Jones PR, Rose LS. Physical ability in relation to anthropometric measurements in persons with complete spinal cord lesion below the sixth cervical segment. Intern Rehab Med 1984;7:51–6.
15. Welch RD, Lobley SJ, O'Sullivan SB, Freed MM. Functional independence in quadriplegia critical levels. Arch Phys Med Rehabil 1986;67:235–40.
16. Snook SH, Ciriello VM. The design of manual handling tasks: revised tables of maximum acceptable weights and forces. Ergonomics 1991;34:1197–213.

Submitted for publication December 23, 1999. Accepted in revised form March 16, 2000.