

Psychophysical assessment of assistive devices for transferring patients/residents

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Received 2 February 1998; accepted 19 February 1999

Abstract

This article reports the psychophysical assessment of nine battery-powered lifts, a sliding board, a walking belt, and a baseline manual method for transferring nursing home patients/residents from a bed to a chair. A separate article reports the biomechanical evaluation of the same task and devices. The objectives of the psychophysical assessment were to investigate the effects of resident-transferring methods on the psychophysical stress to nursing assistants performing the transferring task, and to identify transfer methods that could reduce the psychophysical stress reported by nursing assistants. Nine nursing assistants served as test subjects. Two elderly persons participated as residents. The results indicated that the psychophysical stresses on nursing assistants were significantly lower when performing resident transfers with some of the assistive devices than when performing transfers with the baseline manual transfer method. The nursing assistants generally preferred the basket-sling lift and stand-up lift to other methods. The residents' comfort and security ratings indicated the comfort and security with most of the assistive devices were greater than or equal to the baseline manual method. Most of the comments of the nursing assistants and residents on the assistive devices were favourable. Published by Elsevier Science Ltd.

Keywords: Patient-handling devices; Psychophysical assessment; Back injury

1. Introduction

Nursing home workers face the third highest rate of occupational injuries and illness among all US industries (US Department of Labor, 1994). Between 1980 and 1992, the injury and illness rate for nursing home workers increased from 10.7 to 18.2 per 100 workers among the nation's 1,506,000 nursing aides, orderlies, and attendants (US Department of Labor, 1994). A significant proportion of these are back injuries. Other studies have shown that nursing professionals have both a high prevalence rate of back pain (Biering-Sorensen, 1985) and

a high incidence rate of workers' compensation claims for back injuries (Klein et al., 1984; Jensen, 1987; Personick, 1990).

Patient/resident-handling tasks have been identified as one of the main causes of back injury among nursing personnel (Bell et al., 1979; Jensen et al., 1989; Owen, 1987; Owen et al., 1992; Stobbe et al., 1988; Leighton and Reilly, 1995). Stobbe et al. (1988) used four statistical procedures to test the possible relationship between frequency of patient lifting and risk of having at least one episode of back pain. The survival analysis by Stobbe et al. (1988) indicated that infrequent lifters survived longer than frequent lifters, i.e., worked for a longer time without back injury. Kumar (1990) reached a similar conclusion when he studied the cumulative spinal compressive load (a combination of the lifting frequency, the years of lifting exposure, and the posture related lifting forces) in health care personnel. He found that both

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cumulative spinal compressive load and cumulative generic load were predictive of low back pain. He also found that the longer a person worked in patient-handling activities, the more likely they were to experience low back pain.

Several researchers have suggested that assistive devices could reduce back stress for nursing personnel and may be effective in controlling back injury (Harber et al., 1985; Jensen, 1985; Owen, 1988; Stubbs et al., 1981; Stobbe et al., 1988; Owen et al., 1992). However, a laboratory study of six assistive devices revealed that only two assistive devices were helpful and four were not helpful in reducing nursing personnel's back stress (Garg et al., 1991). During the last 6 yr, many new assistive devices have become commercially available due to technological advances in lifting equipment (e.g., battery powered or ceiling mounted). A comprehensive evaluation of these resident-handling devices would be a practical undertaking for the research community and very valuable to the healthcare industry.

A laboratory study was conducted to perform biomechanical evaluation and psychophysical stress assessment of nine battery-powered lifts, a sliding board, a walking belt, and a baseline manual method for transferring nursing home residents from a bed to a chair. The objectives of the psychophysical assessment were: (1) to investigate the effects of resident-transferring methods on the psychophysical stress to nursing assistants performing the bed-to-chair transferring task, (2) to collect patient comfort and security data, and (3) to identify transfer methods that could reduce the psychophysical stress perceived by nursing assistants and residents. The transferring task was defined as transferring a resident from a supine position, i.e., lying on the back on a bed, to an upright seated position in a chair. The study hypothesized that the use of assistive devices would result in lower biomechanical and psychophysical stresses to nursing assistants when performing the resident-transferring task than the baseline manual method.

The results of the biomechanical evaluation are reported separately (Zhuang et al., 1999). This paper presents the results of the psychophysical assessment portion of this study.

2. Materials and Methods

2.1. Subjects

Nine nursing assistants (two males and seven females) were recruited from local nursing homes to participate as test subjects. The following criteria were established to select and protect the nursing assistants serving as research subjects in the study. Nursing assistants must: (1) perform resident-handling tasks as part of their work activity; (2) have no history of back injury or pain within

the last year or chronic episodic back pain that was symptomatic within the last three years; and (3) have passed a medical screening exam. Their mean age, height, and body weight were 45.8 yr (range = 20–69 yr), 168 cm (157–183 cm) and 76.2 kg (45.5–132.3 kg), respectively. Their mean experience as a nursing assistant was 33.2 months (2–71 months).

Nursing assistants were trained in the proper use of the assistive devices by the manufacturers' representatives. The initial training was reinforced prior to each session with a review of the manufacturers' written instructions and video tapes. Prior to performing each transfer, the nursing assistants practiced the technique with feedback from the researchers. Each nursing assistant spent about 50 h on training and data collection. On the average, about one-half of the nursing assistants' time were spent in training. Of this, two and one half to three hours were spent in training on each method.

Two female volunteers served as simulated nursing home residents. One resident was 51 yr old, 152 cm tall and weighed 58.2 kg. The other resident was 67 yr old, 160 cm tall and weighed 77.3 kg. Both residents passed a medical screening exam.

2.2. Description of transfer methods

Twelve transfer methods (nine battery-powered lifts, a walking belt, a sliding board, and a baseline manual transfer [i.e., no assistive device]) were evaluated in this study. The assistive devices are commercially available. The selection criteria for the lifting devices used in this study were: (1) the device was designed for commercial rather than home use; (2) the device could be lowered to lift residents from the floor in a seated or lying position; and (3) the device could be equipped with scales to weigh totally dependent residents. All methods were evaluated using the same standardized task of transferring a resident from a bed to a chair. All transfers were conducted following the manufacturers' recommended operating procedures. All transfer methods were described in detail previously (Zhuang et al., 1999) and a brief description of the transfer methods follows.

A basket-sling lift device uses battery power to lift residents. The resident is placed in a basket sling, centered over the device base, gently raised, moved over the chair, and lowered into it (Fig. 1). Four brands of basket-sling lifts that have wheels that make them portable were evaluated in this study. A battery-powered overhead lift that travels on a ceiling-mounted track was also evaluated. The track was installed diagonally over the bed to perform a bed-to-chair transfer. A basket-sling is integrated into the system to perform the resident-transferring task.

A stand-up lift has many features similar to the basket-sling lifts. The residents place their feet on a foot-plate, bend their knees, and lean them against a soft knee-pad

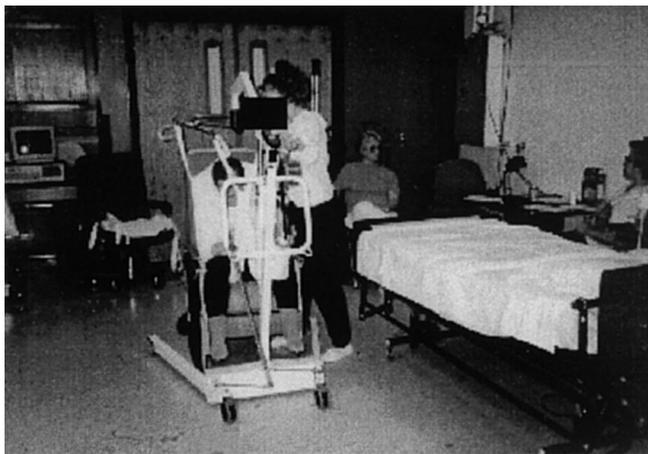


Fig. 1. A basket-sling lift.



Fig. 2. A stand-up lift.

support. A belt-sling is placed under the arms and around the resident's back. The resident is elevated to a near standing position (Fig. 2), and then transferred to the chair. Four brands of stand-up lift were evaluated in the study. The sliding board tested in this study is 102 cm long, 30 cm wide with a 1.3-cm thick seat which slides on a 2.5 cm thick board. The total unit weighs 2.9 kg.

The baseline manual transfer method required two nursing assistants to slowly lift and rotate the resident to assume a sitting position on the edge of the bed. Both assistants then helped the resident to stand (Fig. 3), pivot, backup to the chair, and sit down. The walking belt is approximately 10 cm wide, is wrapped around the resident's abdomen-hip area, and provides handles for nursing assistants to grip during the transfer.



Fig. 3. Baseline manual transfer method.

2.3. Experimental design

This experiment was an $a \times b \times c$ split-plot design ($a = 9$ nursing assistants, $b = 2$ residents/weight levels, and $c = 12$ transfer methods) with one replication at each factor level combination. Each nursing assistant performed each lifting technique on both residents. The dependent variables were the nursing assistants' ratings of perceived exertion (RPE), ratings of ease of using the transfer methods, method preference, task performance time and total nursing assistance work time, and the residents' ratings of comfort and security. The nine nursing assistants were organized into five pairs. The fifth pair was formed with the ninth nursing assistant and one of the first eight. The method performance order was randomized for each resident/nursing assistant combination in each test session.

2.4. Data collection procedures

Nursing assistants practiced the methods to be performed in each session, and then performed them in

a random order. Each data collection session lasted two to three hours and consisted of alternating work and rest periods 15 and 15–30 min in length respectively. The resident transferring activities were videotaped to determine the task performance time and nursing assistance work time. After completing each method, each nursing assistant was asked to rate the physical exertion/stress felt for the shoulders, upper back, lower back, and whole body using the Borg scale of 6–20 (Borg, 1970). The rating of perceived exertion scale asked the subjects to state, "In general, how hard did each transfer feel in terms of physical difficulty excluding lifting, rolling, or rotating the resident to prepare for a transfer" (because these activities were the same for all stand-up lifts or basket-sling lifts and biomechanically evaluated). Nursing assistants were also asked to rate "how easily each handling method was to perform" on a five-point Likert scale (1 = extremely easy and 5 = extremely difficult). The nursing assistants were directed to complete the ease-of-use rating by evaluating all aspects of the device's use

except physical exertion. They were also asked for their comments about each resident-handling technique.

After nursing assistants performed all of the transfer techniques on both residents, they were asked to rank their method preference from 1 for the most preferred method to 12 for the least preferred method.

After completing each trial, the residents were asked to rate how comfortable and how secure they felt on a five-point Likert scale (1 = extremely comfortable and 5 = extremely uncomfortable; 1 = extremely secure and 5 = extremely insecure). The residents were also asked for their comments about each resident-handling technique.

2.5. Statistical analysis

Data were statistically analyzed using the Statistical Analysis System (SAS) software and linear models for the split-plot designs. Duncan's Multiple Range Tests (Montgomery, 1984) were performed to compare means and detect significant differences in the subjective ratings among methods. A significance level of 0.05 was used for statistical tests.

3. Results

3.1. Ratings of perceived exertion

Ratings of perceived exertion (RPEs) for each method for the shoulders, upper back, lower back, and whole body are summarized in Table 1. The upper back received the lowest RPE ratings (9 of 12 sets) and the shoulders received the second lowest RPE ratings (5 of 12 sets). The walking belt, all four stand-up lifts, and basket-sling lift #3 received statistically significantly smaller ratings of perceived exertion than the baseline manual transfer method for the upper back, lower back, shoulders, and the whole body. The ratings of perceived exertion at upper back, lower back, and whole body for basket-sling lift #2 were statistically significantly smaller than the manual transfer method. However, the sliding board, stand-up lift #1, basket-sling lifts #1 and 4, and the overhead lift received psychophysical stress ratings as high as the baseline manual transfer method. The average RPEs when transferring the heavier resident were greater than those when transferring the lighter resident. These differences were statistically significant.

3.2. Ratings of ease of using the transfer methods

The ease of use ratings for each transfer method are summarized in Table 2. The walking belt, and stand-up lifts #2 through 4, and basket-sling #2 and 3 were considered as easy as the manual transfer method. Their ratings of ease of use were not significantly different from that of the manual transfer method. The mean ratings for

Table 1
Ratings of perceived exertion for resident transfer by method

Method	Ratings of perceived exertion			
	Shoulder	Upper back	Lower back	Whole body
Baseline manual method (2) ^b	9.8 ± 2.0 ^a 7–13 ^c (A ^d)	9.6 ± 2.2 6–13 (A)	10.3 ± 2.0 7–13 (A)	10.1 ± 2.0 7–13 (A)
Walking belt (2)	8.5 ± 1.6 6–12 (D, C)	8.3 ± 1.9 6–12 (B, C, D)	9.0 ± 1.7 7–11 (B, C)	8.7 ± 1.6 7–12 (B, C)
Sliding board (1)	9.2 ± 2.2 7–15 (A, B, C)	9.2 ± 1.9 7–13 (A, B, C)	10.4 ± 1.9 7–13 (A)	10.1 ± 2.3 7–14 (A)
Stand-up lift # 1 (1)	8.4 ± 1.9 6–12 (D, C)	8.2 ± 2.0 6–13 (D, C)	8.7 ± 1.8 6–12 (B, C)	8.4 ± 1.8 6–12 (B, C)
Stand-up lift #2 (1)	7.7 ± 1.1 6–10 (D)	7.6 ± 1.2 6–10 (D)	8.0 ± 1.4 6–11 (C)	8.0 ± 1.2 6–10 (C)
Stand-up lift #3 (1)	8.4 ± 1.5 6–11 (D, C)	8.5 ± 1.4 6–11 (B, C, D)	8.8 ± 1.5 6–11 (B, C)	8.5 ± 1.3 6–10 (B, C)
Stand-up lift #4 (1)	8.2 ± 1.7 6–13 (D, C)	8.2 ± 1.8 6–12 (D, C)	8.4 ± 2.0 6–13 (C)	8.3 ± 1.6 6–12 (B, C)
Basket-sling lift #1 (1)	9.7 ± 1.7 7–13 (A, B)	9.8 ± 1.8 7–13 (A)	10.3 ± 1.8 7–13 (A)	9.8 ± 1.8 7–13 (A)
Basket-sling lift #2 (1)	8.8 ± 1.5 7–12 (A, B, C)	8.2 ± 1.2 6–10 (C, D)	8.7 ± 1.3 7–11 (B, C)	8.4 ± 1.2 7–11 (B, C)
Basket-sling lift #3 (1)	8.4 ± 1.4 6–11 (D, C)	8.3 ± 1.3 6–11 (B, C, D)	8.7 ± 1.6 6–11 (B, C)	8.6 ± 1.5 6–11 (B, C)
Basket-sling lift #4 (1)	9.7 ± 2.3 6–13 (A)	9.3 ± 2.3 6–15 (A, B)	9.5 ± 1.8 7–13 (A, B)	9.7 ± 2.1 7–13 (A)
Overhead lift (1)	8.7 ± 1.4 7–13 (B, C, D)	8.9 ± 1.5 7–12 (A, B, C)	9.6 ± 2.0 7–13 (A, B)	9.2 ± 1.9 7–12 (A, B)

^aMean and standard deviation of 9 assistants and 2 residents ($n = 18$ except for the baseline and walking belt methods $n = 20$); the nursing assistants rated from 6 for very, very, light to 20 for very, very, hard.

^bNumber of nursing assistants required by the transfer method.

^cRange of ratings.

^dColumn means with the same letter (A through D) are not significantly different ($p > 0.01$).

the sliding board, stand-up lift #1, basket-sling lifts #1 and 4, and the overhead lift were significantly higher than the mean rating for the baseline manual transfer method.

3.3. Method preference

Overall method preference data are summarized by transfer method in Table 3. Overall, basket-sling lifts #2

Table 2
Ease-of-use ratings by method

Method	<i>n</i>	Mean rating ^a	Standard deviation	Range	Median
Stand-up lift #2	18	1.4 ^E	0.6	1–3	1
Stand-up lift #4	18	1.5 ^E	0.6	1–3	1
Baseline manual method	20	1.8 ^{D,E}	0.6	1–3	2
Basket-sling lift #2	18	1.9 ^{C,D}	0.8	1–4	2
Stand-up lift #3	18	1.9 ^{C,D}	0.7	1–3	2
Walking belt	20	1.9 ^{C,D,E}	1.0	1–4	2
Basket-sling lift #3	18	2.0 ^{C,D}	0.7	1–3	2
Stand-up lift #1	18	2.2 ^{B,C}	0.6	1–3	2
Basket-sling lift #4	18	2.6 ^{A,B}	0.9	1–4	2
Overhead lift	18	2.6 ^{A,B}	1.2	1–4	2
Sliding board	18	2.7 ^A	1.0	1–5	3
Basket-sling lift #1	18	2.9 ^A	1.1	1–5	3

^aThe nursing assistants rated from 1 for extremely easy to 5 for extremely difficult; and mean ratings with the same letter (*A* through *E*) are not significantly different ($p > 0.05$).

Table 3
Summary of nursing assistants' overall method preference

Method	Overall ranking			
	Mean ^a (<i>n</i> = 9)	Standard deviation	Range	Median
Basket-sling lift #2	3.0 ^D	2.8	1–9	2
Basket-sling lift #3	3.2 ^D	1.9	1–7	3
Stand-up lift #2	4.0 ^{C,D}	2.1	2–8	3
Basket-sling lift #4	4.6 ^{C,D}	1.9	2–7	4
Stand-up lift #4	5.1 ^{C,D}	2.1	1–8	6
Basket-sling lift #1	5.4 ^{C,D}	3.1	1–9	7
Stand-up lift #3	6.4 ^{B,C}	2.1	3–10	6
Stand-up lift #1	8.0 ^{A,B}	2.1	5–12	8
Walking belt	9.2 ^A	3.0	3–11	11
Overhead lift	9.3 ^A	2.0	5–12	9
Baseline manual method	9.6 ^A	4.2	1–12	12
Sliding board	10.1 ^A	1.4	7–12	10

^a1 = the most preferred method; 12 = the least preferred method; and mean rankings with the same letter (*A* through *D*) are not significantly different ($p > 0.05$).

(3.0) and 3 (3.2) received the best scores. Basket-sling lifts #1 to 4 and stand-up lifts #2 and 4 were preferred by the nursing assistants over the manual transfer method. Statistically, there were no differences in mean rankings among the baseline manual transfer, walking belt, sliding board, and the overhead lift.

3.4. Task performance time and total nursing assistance work time

Task performance time, total nursing assistance work time, and additional nursing assistance work time (nurs-

ing assistance work time for each device minus that for the baseline manual transfer method) are summarized in Table 4. For the baseline manual transfer method and the walking belt technique, task performance time was doubled to obtain nursing assistance work time. The nursing assistance work time for the remaining methods was equal to the task performance time.

The mean task performance times for the baseline manual transfer method, walking belt, and sliding board were significantly shorter than those required by other methods. The overhead lift mean task performance time was significantly longer than any other. Stand-up lifts had the shortest mean task performance times among the lift devices. Nursing assistance work times were shortest for the baseline method, followed by the stand-up lifts. The basket-sling lifts and the walking belt, and the overhead lift took the longest. There were no significant differences in task performance time and nursing assistance work time between the heavier and lighter resident.

3.5. Comfort and security ratings of the residents

The residents' comfort and security ratings are summarized by transfer method in Table 5. The mean comfort rating for the baseline manual method was 2.7. The comfort ratings indicated that the walking belt, stand-up lifts #2 and 4, and basket-sling lift #3 were more comfortable (smaller numerical ratings) than the baseline manual transfer method. Stand-up lift #3 and basket-sling lift #1 were less comfortable than the manual transfer method. The rest of the methods were judged about equal in comfort to the baseline manual method.

The mean security rating for the baseline manual transfer method was 2.1 (Table 5). The security rating of the sliding board, basket-sling lifts #1, 3, and 4, and the overhead lift were significantly less secure (larger numerical ratings) than the baseline manual transfer method. The remaining methods were rated as secure as the baseline manual transfer method.

There were no significant differences between the mean comfort rating for the heavier resident (2.2) and that for the lighter resident (2.1). However, there was a significant difference between the security rating of 2.7 for the heavier resident and the mean security rating of 2.1 for the lighter resident.

4. Discussion

In this study, the nursing assistants felt that the procedures for the walking belt and stand-up lifts were not complicated and using the walking belt and stand-up lifts was as easy as the baseline manual transfer method. Some devices received high stress ratings which may have been caused by the postural stresses which result from

Table 4
Task performance time and total nursing assistance work time

Method	Task performance time (<i>n</i> = 18) ^a (s)	Group label ^b	Total nursing assistance work time(s)	Group label ^c	Additional nursing- assistance work time(s)
Baseline manual method (2) ^e	63 ± 28 ^d (28–118) ^f	G	126 ± 56 (56–236)	F	—
Walking belt (2)	132 ± 27 (103–182)	F	264 ± 54 (206–364)	B	138
Sliding board (1)	176 ± 39 (106–240)	E	176 ± 39 (106–240)	E	50
Stand-up lift #1 (1)	235 ± 51 (132–325)	C	235 ± 51 (132–325)	C	109
Stand-up lift #2 (1)	214 ± 52 (134–292)	D	214 ± 52 (134–292)	D	88
Stand-up lift #3 (1)	213 ± 40 (121–288)	D	213 ± 40 (121–288)	D	87
Stand-up lift #4 (1)	207 ± 43 (123–287)	D	207 ± 43 (123–287)	D	81
Basket-sling lift #1 (1)	258 ± 45 (175–315)	B	258 ± 45 (175–315)	B	132
Basket-sling lift #2 (1)	264 ± 57 (182–380)	B	264 ± 57 (182–380)	B	138
Basket-sling lift #3 (1)	257 ± 44 (180–330)	B	257 ± 44 (180–330)	B	131
Basket-sling lift #4 (1)	265 ± 44 (201–350)	B	265 ± 44 (201–350)	B	139
Overhead lift (1)	324 ± 40 (260–393)	A	324 ± 40 (260–393)	A	198

^a*N* = 18 except for the baseline and walking belt methods, *N* = 10.

^bMean task performance times with the same group label are not significantly different (*p* > 0.05).

^cMean nursing assistance work times with the same letter (*A* through *G*) are not significantly different (*p* > 0.05).

^dMean and standard deviation of nine nursing assistants and two residents.

^eNumber of nursing assistants required by the transfer method.

^fRange of task performance time.

Table 5
Ratings of comfort and security from the resident during transfers

Method	Comfort			Security		
	Mean ^a (<i>n</i> = 18) ^b	Standard deviation	Range	Mean ^a (<i>n</i> = 18) ^b	Standard deviation	Range
Stand-up lift #2	1.7 ^F	0.5	1–2	1.9 ^F	0.6	1–3
Stand-up lift #4	1.9 ^{E,F}	0.5	1–3	2.1 ^{E,F}	0.5	1–3
Walking belt	1.9 ^{E,F}	0.6	1–3	1.9 ^F	0.6	1–3
Basket-sling lift #3	2.2 ^{E,F}	0.5	1–3	2.7 ^{B,C}	1.0	1–4
Basket-sling lift #4	2.4 ^{D,E}	0.8	1–4	3.1 ^A	0.9	2–4
Overhead lift	2.4 ^{D,E}	0.6	2–4	2.6 ^{B,C,D}	0.7	2–4
Baseline manual method	2.7 ^{C,D}	0.8	1–4	2.1 ^{E,F}	0.6	1–3
Sliding board	3.1 ^{B,C}	0.9	2–5	2.7 ^{A,B}	0.6	2–4
Stand-up lift #1	3.1 ^{B,C}	0.9	2–4	2.1 ^{E,F}	0.3	2–3
Basket-sling lift #2	3.1 ^{B,C}	0.6	2–4	2.3 ^{D,E}	0.5	2–3
Stand-up lift #3	3.4 ^B	0.9	2–5	2.3 ^{C,D,E}	0.6	1–3
Basket-sling lift #1	3.9 ^A	0.8	2–5	2.6 ^{B,C,D}	0.8	2–4

^a1 = extremely comfortable, 5 = extremely uncomfortable; 1 = extremely secure, 5 = extremely insecure; and column mean ratings with the same letter (*A* through *F*) are not significantly different (*p* > 0.05).

^b*n* = 10 for the baseline and walking belt methods.

using the slings, and maneuvering and steering the lift to the chair. It could also be the result of the greater complexity of the activity; i.e., there are only a few steps in the manual transfer method, while the device transfers require the nursing assistants to do a number of sub-tasks. The nursing assistants also identified some minor design problems which could cause high stress.

In the past, limited attention has been paid to the feelings and perceptions of the residents about how they are handled by the healthcare system. In this study, the residents' subjective responses to the comfort and security of the assistive devices were generally favourable. They felt most of the assistive devices were at least as comfortable and secure as the manual transfer method. The device specific comments that follow were obtained from the simulated residents in this laboratory study and from actual residents in a field pilot study (Stobbe, 1999).

Baseline method. Nursing assistants felt fairly comfortable in transferring residents from bed to chair with the baseline method which was achieved more rapidly than the effort involved in putting a belt on the residents. Resident comments about the traditional baseline method were generally positive and the residents' ratings placed the baseline method near the middle of the set of ratings. The residents did find that their arms and sides were very uncomfortable when nursing assistants of different statures were trying to handle them.

Walking Belt. The nursing assistants liked the handles on the walking belt and believed that a rocking motion made the transfer easier. They stated they had better control of the residents. But the nursing assistants stated that the buckle on the walking belt was hard to use. With the walking, the residents felt the increased security of having the nursing assistants actually holding a handle as opposed to their clothes or their body. As a result it received the best security rating of all of the methods, and the second best comfort rating. They also felt the belt gave them some back support.

Sliding Board. The board was quick and useful for certain situations. It moved smoothly and was light, although not as easy to use as some of the other methods. It was difficult to position a resident on the seat of the board and assistants felt a great deal of pressure on their lower backs. The sliding board has no place for the resident to hold on, and so was perceived as insecure. It was uncomfortable to have it placed beneath and removed from under the residents. Its ratings were generally poor.

Stand-up lifts. The residents' perceptions about the stand-up lifts were highly variable. The key to the variability was the sling that went around the back and the type of handholds provided for the residents. The sling needed to support the back and be stable in its location. The residents needed to have handholds to give them a sense of control over what happened to them as they were moved.

Stand-up Lift #1. This lift was the slowest stand-up lift. Attaching a Velcro belt to the knee pads was awkward. Some assistants felt the lift was hard to push and hooking up the sling to the machine was difficult to accomplish. This device put excessive pressure under the arms because it slipped up the person's back as they hung in it. The sling was too narrow, and this caused low back discomfort. The sling that went around the resident did not have a safety belt which was a main concern of the resident being moved.

Stand-up Lift #2. The nursing assistants felt lift #2 was small and not complicated to operate. The loops made it a lot faster to hook up the sling to the support arms. Assistants felt they had a good bit of force on their lower backs when they used the handle to open the legs of the lift base. This was the preferred stand-up lift because the pad was soft, wide, and textured such that it supported the low back without riding up toward the shoulders. This also prevented the pressure on the underarms.

Stand-up Lift #3. This lift had good mobility. However, some assistants felt the sling attachment was bad because they had to bend too much to place the sling around residents. The sling design tended to cause some hyperextension in the low back which was uncomfortable and could be a hazard to frail/arthritis residents. The support arms were acceptable to grasp, but they were too close to the residents' face and this was uncomfortable.

Stand-up Lift #4. The assistants liked lift #4 which was easy to use. The sling was easy to put on the resident because it was removable from the lift. The sling on this lift was stable, but tended to ride high on the back and it chafed uncomfortably under the arms.

Basket-Sling Lifts. Hanging in a basket sling is a helpless feeling. Thus, it takes considerable time getting used to. The residents' response to these devices was a bit more consistent than to the stand-up lifts, and once they were used to them, these devices were acceptable.

Basket-Sling Lift #1. The nursing assistants found it easier to hook a sling to a stationary frame like this lift has. The frame on which the sling hung did not swing. It was easy to steer. However, the sling was too rigid to be comfortable. The residents tended to slide in the sling and felt like they were going to fall out. The head piece was too hard. The sling was very uncomfortable to the back of the thighs, and it cut circulation to the residents' legs behind the knees. Thus, the residents gave this lift the worst comfort rating of all methods.

Basket-Sling Lift #2. The nursing assistants liked this lift because of its size and maneuverability. The lift provided better control because the resident was not swinging around. Nursing assistants liked the way the sling hooked on the lift because the snap fasteners were easy to reach and connect. The tilting stick made it fairly easy to get the resident seated properly; however, the tilting bar was hard for some nursing assistants to push down. The

lifting arm was very stable which made the residents feel secure. The sling on the lift held the head and neck firmly and was comfortable except for the head support stays. The leg pieces pressed into the thighs. The buckles on the sling hurt the back when the resident was rolled into it.

Basket-Sling Lift #3. The lift was small and one of the easiest to move around. The sling attached very easily because of the material and design of the sling. The handle on the back of the sling was not difficult to use in pulling residents into good sitting positions. The magnet on the power switch was very convenient. The assistants did not like the swinging bars which made hooking up difficult and allowed the resident to swing freely. The padded bar on this lift made bumping into it less dangerous. The sling was comfortable and was easily adjusted in all respects. The sling did not rise high enough to easily clear the bed.

Basket-Sling Lift #4. Nursing assistants seemed to like lift #9. The sling on the lift was easy to put on a resident. Seating in the proper position was not difficult. The lift column, however, was too close to the residents' legs when they were completely lifted off of the bed. This lift was hard to manoeuvre with weight on it. The sling was fairly comfortable. The sling swung too freely and did not provide adequate neck support. The lifting arms were too flexible and as the machine went one way, the resident swung the other way.

Overhead Lift. This lift was slow to use, hard to manoeuvre, and generally not liked. Some assistants felt that the sling was too confusing with all the various loops and was not easy to use. The sling was comfortable when adjusted properly. During lowering, the device frame came too close to the resident's face. The sling swung too freely leading to a sense of insecurity and a risk of resident injury.

Nursing assistance work time. Work procedures or equipment that are "perceived" to take too long are often not done (Bell, 1984; Owen, 1988; Takala and Kukkonen, 1987). Task performance and total nursing assistance work times are important considerations when evaluating resident-handling methods/devices. Past studies reported transfer times with a hoist of 120–150 s (Takala and Kukkonen, 1987), 295 s (Bell, 1984), and 124–198 s (Garg et al., 1991). In another study, the walking belt took 49 s more than the manual lifting method (Garg et al., 1991).

In this study, the task performance times were: (a) 257–324 s for the basket-sling lifts; (b) 207–235 s for the stand-up lifts; and (c) 63 and 132 s for the baseline and the walking belt methods, respectively. The difference between the transfer times observed in this study and the previous studies may be associated with the different definitions of the transferring task. Although it takes more time to handle residents with lift devices, lift devices can save time in other ways. For example, the devices can save transit time because the attended residents walk

slower than pushed devices. In addition, device use will result in less nursing assistant fatigue, thus further possibly reducing their risk of injury, and also helping them to maintain a positive attitude while handling residents. The nursing assistant participants in this study felt that it was a worthwhile trade-off to use the lift devices.

5. Summary and conclusions

The perceived stresses by the nursing assistants were significantly lower when performing resident transfers with some of the assistive devices than when performing transfers with the baseline manual transfer method. The use of the sliding board and basket-sling lifts #1 and 4 did not reduce the perceived stresses to any body part or the whole body of the nursing assistants. The overhead lift only reduced the perceived stress to the shoulders of the nursing assistants. Basket-sling lift #2 reduced the perceived stress to all four body parts except for the shoulders. The use of the other devices including the walking belt resulted in significantly less perceived stress to all four body parts of nursing personnel.

The walking belt, and stand-up lifts #2, 3, 4, and basket-sling lifts #2 and 3 were rated as easy to use as the baseline manual transfer method. The nursing assistants generally preferred the basket-sling lift and stand-up lift to other methods for transferring a resident from bed to chair. When all methods were considered, the nursing assistants preferred basket-sling lifts #2 and 3. The baseline manual transfer, walking belt, sliding board, and the overhead lift were the least preferred methods.

Task and nursing assistance work times were slightly longer for mechanically assisted transfers. This slight increase in time is functionally offset by the decreased fatigue and additional nursing assistant and resident safety which result from device use (Stobbe, 1999). The nursing assistants themselves stated they felt the trade-off was worthwhile.

The residents' ratings of comfort and security indicated that most of the assistive devices were at least as comfortable and secure as the baseline manual method. In a field pilot study, actual residents rated assistive devices as generally equal to or more secure and comfortable than the baseline method.

A qualitative summary of the eight criteria used to evaluate the 12 methods of transferring residents from bed to chair is shown in Table 6. Based on these criteria (except transfer time), the table shows that the walking belt and stand-up lifts #2 and 4, basket-sling lift #2 and 3 are the five methods which were relatively equal to or better than the base line method. Table 6 also shows that stand-up lifts #2 and 4, and basket-sling #2 and 3 not only reduced biomechanical and psychophysical stress to nursing personnel, but were also preferred by the nursing assistants. Stand-up lifts #3 and basket-sling lift #1

Table 6
Qualitative summary of resident transfer methods compared to baseline transfer method

Criteria	Walking-belt	Sliding-board	Stand-up lifts				Basket-sling lifts				Overhead lift
			1	2	3	4	1	2	3	4	
Biomechanical stress	E	B	B	B	B	B	B	B	B	B	B
Perceived stress	B	E	B	B	B	B	E	B	B	E	E
Resident comfort	B	E	E	B	W	B	W	E	B	E	E
Resident security	E	W	E	E	E	E	E	E	E	E	E
Ease of use	E	W	W	E	E	E	W	E	E	W	W
Method preference	E	E	E	B	B	B	B	B	B	B	E
Transfer time	W	W	W	W	W	W	W	W	W	W	W
Favourable comments	B	W	E	B	E	B	E	B	B	B	E

Note: All techniques used one nursing assistant except baseline manual method and walking belt; Worse = relatively high stress or unfavourable ratings as compared to the baseline transfer; Equal = no difference between a technique and the baseline manual transfer; Better = relatively low stress or favorable ratings as compared to the baseline manual transfer.

need to be improved with regard to the comfort of residents, while stand-up lift #1 and basket-sling lifts #1 and 4 and the overhead lift need to address the issue of ease of use.

Acknowledgements

The authors thank the nursing assistants and residents who participated in this laboratory study. Special thanks go to Mrs. Carolyn Lloyd of Monongalia County Vocational Education Centre for her help in understanding resident-handling procedures and acquiring a hospital bed for this study. The authors also wish to thank all the manufacturers for providing their devices and sending their representatives to train the research subjects. Mention of product names does not constitute endorsement by the National Institute for Occupational Safety and Health or West Virginia University.

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