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A biomechanical and ergonomic evaluation of patient transferring tasks: wheelchair to shower chair and shower chair to wheelchair

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A laboratory study was conducted to evaluate five different manual techniques (two-person manual lifting; rocking and pulling the patient using a gait belt with two persons; walking belt with one and two persons) and three different mechanical hoists (Hoyer lift, Trans-Aid and Ambulift) for transferring patients from wheelchair to shower chair and shower chair to wheelchair. Six female nursing students with prior patient transfer experience served both as nurses and as passive patients.

Static biomechanical evaluation showed that the mean trunk flexion moments, erector spinae muscle forces and compressive and shear forces at the L_5S_1 disc for the four pulling methods ranged from 92 to 125 Nm, 1845 to 2507 N, 1973 to 2641 N and 442 to 580 N, respectively, as compared to about 213 Nm, 4260 N, 5050 N and 926 N for two-person manual lifting. Perceived stress ratings for the shoulder, upper back, lower back and whole body were significantly lower for pulling methods than those for lifting the patient ($p \leq 0{\cdot}01$).

Patients found pulling techniques, except the gait belt, to be more comfortable and secure than the lifting method ($p \leq 0{\cdot}01$). However, most of the nurses believed that Medesign and the one-person walking belt would not work on those patients who cannot bear weight and those who are heavy, contracted or combative. A two-person walking belt was the most preferred method. Two out of three hoists (Hoyer lift and Trans-Aid) were perceived by the nurses to be more stressful than one- and two-person walking belts. The patients found these two hoists to be more uncomfortable and less secure than with three of the five manual methods (one- and two-person walking belts and Medesign). Pulling techniques and hoists took significantly longer amounts of time to make the transfer than manually lifting the patient ($p \leq 0{\cdot}01$).

The two-person walking belt, using a gentle rocking motion to utilize momentum and a pulling technique, and Ambulift are recommended for transferring patients from wheelchair to shower chair and shower chair to wheelchair.

1. Introduction

Owen and Garg (1989) reported that toileting and bathing transfers were ranked in the top six on a list of 16 patient handling task categories for perceived physical stresses by the nursing aides; these patient transfers received an average

low-back stress rating of more than 13 on the Borg scale. Bell *et al.* (1979) concluded that the current manual lifting methods are unsatisfactory and that priority should be given to a detailed study of five different patient transfer tasks. Both lifting patients on and off toilets and in and out of baths were included in this list. Lloyd *et al.* (1987) cautioned that a patient should not be lifted manually out of a bath, except in an emergency situation, because of the awkward body posture and the possibility of slipping. These authors recommended that a dependent patient should be washed in a shower cubicle or on a shower trolley if proper hoists or aids are not available.

Generally, the toileting involves transferring a patient from wheelchair to toilet and then toilet to wheelchair in a confined workspace of a lavatory. The bathing process involves transferring a patient from wheelchair to a bathtub or chairlift (water pressure lift in shape of chair attached to bathtub) and then bathtub or chairlift to wheelchair. Thus, the combined toileting and bathing process requires four patient transfers, usually in a confined workspace. Bathtubs are often mounted either on the floor or on a low platform (15 cm high in one nursing home). Personal observations in a nursing home show that the bathing process takes about 15 to 20 min and requires excessive stooping, bending and kneeling with outstretched arms. This results in significant postural stresses, especially to the low back (Baty and Stubbs 1987). Further, these patient transfers usually occur in a confined workspace; this has been found to be important to back stress in relation to the duration of each lift and the asymmetrical lifting in awkward body positions (Kilbom *et al.* 1985).

A preliminary laboratory study showed that the number of patient transfers can be reduced from four to two with the use of a shower chair. A patient can be transferred from a wheelchair to a shower chair either in the patient's room or in a hallway, thus avoiding transfers in the confined workspace of a lavatory. The shower chair can be pushed over the toilet for toileting the patient. After toileting the patient, the shower chair can be pushed into a nearby shower. The patient can be washed, dried and then transferred back to the wheelchair. The use of a shower chair also reduces bending and stooping as the patient sits on a shower chair (seat height about 57 cm) as compared to being in a reclining position in a bathtub on the floor.

The objective of this study was the same as that of the previous study (Garg *et al.* 1991), i.e., to find a manual method and a mechanical hoist for transferring patients from wheelchair to shower chair and shower chair to wheelchair that would produce relatively low physical stresses to the nursing personnel and result in high levels of comfort and security for patients. The same five manual methods and three mechanical hoists, as employed in the previous study, were used to determine biomechanical and perceived physical stresses to the nursing personnel and comfort and security of the patients. In addition, different shower chairs were studied to select a shower chair that would make these transfers relatively easy.

2. Method

2.1. *Subjects*

Six female paid volunteers participated as subjects. They served both as nurses and as passive patients. Physical characteristics of the subjects are summarized in the preceding paper by Garg *et al.* (1991).

2.2. *Manual methods, mechanical hoists and shower chair*
The manual methods and mechanical hoists are described in Garg *et al.* (1991). A number of different shower chairs were considered. Some of them were fragile, unstable and difficult to push and manoeuvre in the confined workspace of a lavatory. Some shower chairs could not be pushed over the toilet. Some did not have footrests leaving the patient's feet dangling, and in others, footrests could not be turned up or removed. A Lumex shower chair (model no. 6876) with four 12·5 cm swivel casters, brakes and a 57 cm high urethane seat with an aperture for toileting was selected. The side arms could be easily released and dropped for easier patient transfer. Footrests could be easily moved up and/or removed to avoid interference with the patient's and nurse's feet. The four wheels were free to move in any direction, making it possible to manoeuvre the shower chair readily in the confined workspace of a lavatory, but difficult to control when pushing the chair. The seat was hard and the front edge of the seat was 8·7 cm behind the front frame making patient transfer more difficult (figure 1). Further, there were two 8·7 cm long plastic protrusions to support the footrests which could interfere with both the patient's and nurses' feet (figure 1). In spite of these limitations, this shower chair was one of the better commercially available chairs for toileting and washing patients.

2.3. *Manually transferring patient from wheelchair to shower chair*
The shower chair was placed with the rear of the chair against a wall, and the wheels were locked. The footrests were put in an upright position. The walking belt was fastened snugly around the lower abdomen/hips of the patient. The wheelchair was perpendicularly placed about 0·3 m from the shower chair. The two nurses stood facing the patient (with one foot facing the patient and the other foot in the direction of the move), grasped the handles of the walking belt with one hand and placed the free hand on the arm of the wheelchair (figure 1). In synchronization using a gentle rocking motion they pulled the patient toward themselves, shifted their weight to the foot facing the direction of the move (toward the shower chair) and pivoted to avoid twisting. They pushed the wheelchair with the free hand away from the work area and transferred the patient to the shower chair without lifting the patient. Similar procedures were used with the two-person gait belt, the one-person walking belt and Medesign. The procedures used with two-person manual lifting and mechanical hoists were similar to those described in Garg *et al.* (1991).

2.4. *Procedures*
The procedures used for biomechanical evaluations, stress ratings by the nurses, comfort and security ratings by the patients, suitability of a manual method for different patient conditions, nurses' overall preferences, and transfer times were identical to those described in Garg *et al.* (1991). Data on manual methods and mechanical hoists were analysed separately. All data were subjected to an analysis of variance (for example, 2 tasks × 5 methods × 6 subjects × 4 body parts for stress ratings on manual methods).

3. Results

Biomechanical evaluations, ratings of perceived stresses from nurses and comfort and security ratings from patients are summarized in tables 1 to 4.

Figure 1. Lumex shower chair employed for toileting and showering patients.

3.1. *Biomechanical evaluations*

Trunk flexion, lateral bending and axial rotation angles for the five manual transfer methods ranged from 50° to 65°, 8° to 11°, and 3° to 9°, respectively (tables 1 and 2). Neither task nor transfer method had a significant effect on these angles ($p>0{\cdot}05$). As expected, pulling the patients required significantly lower forces than lifting the patients ($p\leq 0{\cdot}01$). The pulling forces required with two- and one-person transfers were about 39% (range=37% to 41%) and 79% (range=75% to 85%) of those required with the two-person lifting method. The biomechanical static strength model estimated that about 77% of female workers would be capable of transferring patients from wheelchair to shower chair and shower chair to wheelchair using the two-person gait belt and walking belt, as compared to about 40% using the one-person walking belt and Medesign and about 38% using the two-person manual lifting method. The task had no significant effect on the percentage of capable females ($p>0{\cdot}05$).

The two-person manual lifting method produced significantly larger trunk flexions, lateral bending and axial rotation moments than any of the four pulling techniques ($p\leq 0{\cdot}01$). Trunk flexion moments for two- and one-person pulling transfers were about 46% and 56% of those for the two-person lifting method.

The two-person manual lifting method produced significantly larger erector spinae muscle force, compressive force and shear force at the L_5/S_1 disc than any of the four pulling methods ($p<0{\cdot}01$). There were no significant differences in these variables between wheelchair to shower chair and shower chair to wheelchair transfers. The two-person pulling methods required about 2000 N of erector spinae muscle force as compared to about 2400 N required by one-person pulling methods and 4250 N by the two-person lifting method (tables 1 and 2). On average, the compressive forces at the L_5/S_1 disc for two- and one-person pulling transfers were about 41% and 50% of those for two-person manual lifting (tables 1 and 2). The shear forces at the L_5/S_1 disc were about 900 N for two-person manual lifting and 500 N for pulling transfers.

3.2. *Stress ratings*

Separate analyses of variance showed that there were significant differences between the five manual techniques and the three mechanical hoists ($p\leq 0{\cdot}01$). In general, the shoulder was the body part perceived to be most stressed ($p<1{\cdot}01$). The differences in perceived stress between the four body parts were small as compared to the differences in perceived stress relating to the transfer techniques (table 3). The task has no significant effect on stress rating ($p>0{\cdot}05$).

Among the five manual techniques, two-person lifting was perceived to be the most stressful and the two-person walking belt the least stressful. The two-person walking belt was followed by the one-person walking belt, Medesign and gait belt in order of increasing perceived stress. Among the three mechanical hoists, Ambulift was perceived to be the least stressful and the Hoyer lift the most stressful. The Hoyer lift was perceived to be more stressful than all of the five manual techniques except the two-person manual lifting method. Among all eight techniques, the two-person walking belt was pereived to be the least stressful for wheelchair to shower chair transfer and Ambulift for shower chair to wheelchair transfer (table 3).

Table 1. Summary of biomechanical analyses of five different manual methods for transferring patients from wheelchair and shower chair (mean, s.d. and range).

Variable	Manual lifting (2 person)	Gait belt (2 person)	Walking belt (2 person)	Walking belt (1 person)	Medesign (1 person)
Trunk flexion angle (°)	65±4 60–70	61±6 55–70	64+5 60–70	61±4 55–65	65±6 60–75
Trunk lateral bending (°)	9±4 5–15	9±4 5–15	10±0 10–10	9±4 5–15	8±3 5–10
Trunk rotation angle (°)	3±3 0–5	7±3 5–10	9±2 5–10	8±3 5–10	8±3 0–10
Hand force (N)	312±54 263–393	129+25 98–165	127±25 98–156	265±31 214–294	242±46 196–312
% Capable females	40±10 22–51	70±13 52–87	79±11 70–92	39±16 18–63	40±17 19–64
Trunk flexion moment (Nm)	207±19 180–238	100±10 81–109	102±7 93–111	115±15 86–131	114±21 79–136
Lateral bending moment (Nm)	96±12 74–107	12±8 3–20	9±8 2–22	21±9 8–30	16±7 5–23
Trunk rotation moment (Nm)	67±5 59–75	41±9 28–54	40±7 29–48	1±1 0–2	2±1 0–3
Erector spinae force (N)	4140±408 3546–4768	2009±206 1628–2185	2035±135 1855–2221	2302±308 1708–2609	2287±416 1583–2716
Compressive force (N)	4973±323 4464–5414	2138±214 1748–2328	2159±146 1909–2359	2385±345 1762–2770	2374±446 1561–2792
Shear force (N)	918±48 852–990	580±71 482–696	578±47 517–656	465±37 419–513	445±76 326–540

Table 2. Summary of biomechanical analyses of five different manual methods for transferring patients from shower chair to wheelchair (mean, s.d. and range).

Variable	Manual lifting (2 person)	Gait belt (2 person)	Walking belt (2 person)	Walking belt (1 person)	Medesign (1 person)
Trunk flexion angle (°)	63±3 60–65	55±4 50–60	54±5 50–60	50±4 45–55	51±4 45–55
Trunk lateral bending (°)	11±2 10–15	10±3 5–15	10±0 10–10	10±3 5–15	10±0 10–10
Trunk rotation angle (°)	9±2 5–10	6±2 5–10	7±3 5–10	8±3 5–10	8±3 5–10
Hand force (N)	312±54 263–392	117+13 98–134	119±14 98–138	248±35 196–294	233±49 178–294
% Capable females	36±2 34–40	74±12 52–83	82±11 69–95	42±17 15–62	39±19 15–72
Trunk flexion moment (Nm)	219±6 207–227	97±9 87–111	92±12 80–113	121±15 96–139	125±22 100–158
Lateral bending moment (Nm)	84±9 77–101	11±10 1–22	10±4 4–16	27±9 14–41	29±6 24–38
Axial rotation moment (Nm)	68±1 66–69	33±10 17–45	30±6 23–42	1±1 0–2	1±1 0–2
Erector spinae force (N)	4381±130 4152–4549	1932±176 1739–2221	1845±248 1597–2252	2426±309 1922–2788	2507±432 1998–3153
Compressive force (N)	5128±114 4924–5254	2061±183 1793–2337	1973±258 1708–2413	2626+363 2110–2979	2641±434 2176–3296
Shear force (N)	934±12 914–946	515±72 401–589	500±54 442–593	460±54 375–526	442±67 361–513

Table 3. Stress ratings for the five manual techniques and the three hoists (on a scale of 0=no stress to 9=extremely stressful).

Task	Body part	Manual lifting (2)*	Gait belt (2)	Walking belt (2)	Walking belt (1)	Medesign (1)	Hoyer lift (2)	Trans-Aid (2)	Ambulift (2)
Wheel-chair to shower chair	Shoulder	6·6±1·0 4·8–8·0	4·9±1·5 2·5±7·2	2·9±1·1 1·8–4·8	2·9±0·9 2·1–4·0	3·8±1·2 2·9–6·0	4·7±1·8 1·4–7·0	4·1±1·5 1·6–7·0	3·2±1·3 1·0–5·8
	Upper back	5·8±1·2 4·5–8·1	4·5±1·7 2·6–6·7	2·8±1·2 1·5–5·5	3·1±1·2 2·0–5·0	4·1±1·5 2·6–6·0	4·3±1·5 1·9–6·9	2·8±1·3 0·8–5·0	1·9±1·0 0·0–3·2
	Lower back	5·8±1·4 4·0–8·0	4·8±1·7 2·2–7·5	3·0±0·9 1·4–4·1	3·2±1·4 1·8–5·3	4·7±2·1 2·0–8·0	4·3±1·8 1·2–6·6	2·6±1·8 0·1–5·0	1·6±1·1 0·0–3·5
	Whole body	6·0±1·1 4·8–8·2	4·5±1·2 2·3–6·1	2·5±0·7 1·9–3·9	2·9±1·1 1·8–4·1	4·0±1·6 2·3–6·0	4·2±1·7 1·3–7·0	2·9±1·2 1·3–5·0	1·8±1·0 0·6–3·2
Shower chair to wheel-chair	Shoulder	7·4±0·9 6·6–9·0	5·3±1·3 3·0–7·5	3·1±1·0 1·3–4·1	3·2±1·0 1·9–4·6	4·3±1·3 2·0–5·9	5·4±1·8 1·8–8·0	4·2±1·7 1·5–8·0	2·4±1·2 0·9–4·0
	Upper back	6·5±2·0 2·1–8·6	5·0±2·0 1·0–7·2	2·0±1·0 0·2–3·5	2·8±0·8 2·0–4·0	3·8±1·3 2·0–5·9	4·9±1·8 2·8–8·5	3·4±1·9 1·5–7·4	1·9±1·1 0·4–4·0
	Lower back	6·9±1·3 4·9–8·6	5·3±1·8 2·9–8·0	2·7±1·0 1·1–3·8	3·6±1·7 1·5–5·9	4·1±1·8 1·7–5·8	4·1±1·8 1·2–8·7	3·0±2·1 0·9–6·9	1·4±0·9 0·2–3·0
	Whole body	7·0±0·9 6·0–8·4	5·4±1·4 3·1–7·2	2·6±0·8 1·3–3·6	3·5±1·2 2·0–5·2	4·1±1·8 1·7–5·8	4·3±2·0 1·0–8·0	3·4±1·7 1·3–7·0	1·5±0·7 0·4–2·5

3.3. *Patient comfort and security ratings*
There were significant differences between the five manual techniques and between the three mechanical hoists in patient comfort and security ratings ($p \leq 0{\cdot}01$). Among the five manual techniques, the two-person walking belt was perceived as being most comfortable, followed by the one-person walking belt, Medesign, manual lifting and the gait belt (table 4). The rankings for patient security were the same as those for patient comfort except that manual lifting was perceived as being the least secure (table 4). Among the three hoists, Ambulift was perceived to be the most comfortablde and secure followed by Trans-Aid and then Hoyer lift (table 4). Among all eight techniques, the two-person walking belt was perceived as being the most comfortable and the Ambulift the most secure. Transfers with two- and one-person walking belts and Medesign were rated as being more comfortable and secure than those with Trans-Aid and Hoyer lifts (table 4).

3.4. *Patient characteristics and overall preferences*
Practically all nurses felt that all five manual methods would work on weight-bearing patients. The majority of the nurses indicated that the one-person walking belt and Medesign would not work on those patients who could not bear weight or those who were heavy, combative or contracted.

Overall, the nurses preferred the two-person walking belt. Two-person manual lifting was the least preferred manual method. The one-person walking belt, Medesign and gait belt were ranked second, third and fourth in overall preference.

3.5. *Transfer time*
Two-person manual lifting and Medesign required the least amounts of time and mechanical hoists required the largest amounts of time for transferring patients from wheelchair to shower chair and shower chair to wheelchair. It took about 20 s to transfer patients from wheelchair to shower chair and vice versa with manual lifting and Medesign, as compared to about 40 s with gait belt, 47 s with the two-person walking belt, 52 s with the one-person walking belt, 133 s with Ambulift, 200 s with Trans-Aid and 216 s with the Hoyer lift.

4. Discussion

The qualitative summary of the eight different criteria used to evaluate the five different manual techniques and the three different hoists for transferring patients from wheelchair to shower chair and shower chair to wheelchair was exactly the same as in Garg *et al.* (1991). The two-person walking belt using a gentle rocking and pulling motion and the Ambulift are the only techniques which satisfy all the criteria, except transfer time. Assuming adequate staffing, these two methods are recommended for transferring patients from wheelchair to shower chair and shower chair to wheelchair.

This research showed that both objective biomechanical evaluations and subjective stress ratings should be studied to determine various stresses from patient transferring tasks. While biomechanical models are extremely useful in quantifying stresses on different musculoskeletal joints and, in particular, on the low back, they may not be able to address certain stresses due to assumptions made in these models. For example, the static biomechanical model used in this

Table 4. Summary of comfort and security ratings from the patients.

Task	Variable	Manual lifting (2)*	Gait belt (2)	Walking belt (2)	Walking belt (1)	Medesign (1)	Hoyer lift (2)	Trans-Aid (2)	Ambulift (2)
Wheel-chair to shower chair	Comfort rating**	5·4 ± 1·3 3·6–6·7	5·8 ± 1·1 4·0–7·0	1·6 ± 1·1 0·4–3·5	1·9 ± 0·8 0·6–2·9	3·1 ± 1·7 0·6–5·0	4·7 ± 1·3 2·2–5·8	2·9 ± 1·5 1·4–5·0	1·9 ± 1·7 0·4–4·0
	Security rating***	4·6 ± 2·2 0·8–6·2	4·3 ± 1·4 2·0–6·1	1·5 ± 1·2 0·5–3·4	1·6 ± 0·8 0·7–2·9	3·5 ± 1·2 0·5–3·4	4·8 ± 1·6 1·6–5·8	3·0 ± 1·6 0·8–5·0	0·6 ± 0·8 0·0–2·1
Shower chair to wheel-chair	Comfort rating**	6·8 ± 0·9 4·0–6·6	6·2 ± 0·6 5·0–6·6	1·2 ± 0·5 0·6–2·0	1·6 ± 1·2 0·2–3·0	1·8 ± 1·4 0·4–4·0	6·1 ± 1·4 3·4–7·0	3·3 ± 2·3 0·6–6·4	2·5 ± 2·3 0·2–6·3
	Security rating***	5·3 ± 1·7 3·3–7·0	4·4 ± 1·7 1·5–6·8	0·9 ± 0·3 0·2–1·1	1·7 ± 1·3 0·6–4·0	2·5 ± 1·4 1·0–5·0	5·9 ± 0·8 4·3–6·6	3·1 ± 2·2 0·8–5·9	0·6 ± 0·4 0·0–1·0

*indicates number of nurses employed for patient transfer
**on a scale of 0 to 7 with 0=extremely comfortable and 7=extremely uncomfortable
***on a scale of 0 to 7 with 0=extremely secure and 7=extremely insecure

study showed that the two-person manual lifting method produced more than twice the compressive force on the L_5/S_1 disc than those forces produced by two-person pulling methods. However, the compressive forces and other biomechanical responses for the two-person walking belt and gait belt were about the same. On the other hand, there was a considerable difference in perceived stresses between the two-person walking belt and gait belt. While the perceived stresses were fairly low with the two-person walking belt, they were very high with the gait belt, probably due to lack of handholds and the tendency of the belt to slide up on the patient. These issues are difficult to account for in a biomechanical model.

Biomechanically, the mean compressive forces of 1973 N to 2641 N estimated for the four pulling methods are considerably lower than the 3430 N at action limit (AL) recommended by the US Department of Health and Human Services (1981). A comparison of estimated compressive forces with those reported by Chaffin and Park (1973) and Herrin *et al.* (1986) shows that these compressive forces represent nominal risk to most industrial workers. Both of these studies reported that incidence rates for low-back pain were related to compressive forces on the L_5/S_1 disc and increased with an increase in compressive force. Similarly, Anderson (1983) reported a 40% increase in incidence rates for jobs requiring compressive forces above 3400 N vs. below that level. The estimated shear forces of 442 N to 580 N for the four pulling methods are well below the 2000 N to 3000 N failure limits for the articular facets reported in the literature (Cyron and Hutton 1978, Lamy *et al.* 1975, Farfan *et al.* 1976). Similarly, estimated trunk axial rotation moments of 1 to 41 Nm for the four pulling methods are well below the reported 88 Nm torque at failure for an intact, whole intervertebral joint (Farfan *et al.* (1970). The observed mean pulling forces of 119 N and 127 N for the two-person walking belt are well within female pulling strength reported in the literature (Ayoub and McDaniel 1974, Snook 1978, Chaffin *et al.* 1983).

Though the two-person walking belt and the gait belt produced about the same biomechanical responses, the use of gait belt is not recommended as it resulted in high perceived stresses, low patient comfort and security ratings, and it was the least preferred method by the nurses among the four pulling methods. Similarly, the use of the one-person walking belt and Medesign to transfer patients is not recommended because these methods required larger pulling forces (about 250 N) and the nurses believed that these methods would not work for those patients who cannot bear weight. Further, the perceived stress ratings and the patient security ratings with Medesign were relatively high. This shows that various aspects of patient transfers such as objective biomechanical stresses, perceived physical stesses, patient comfort and security, patient characteristics, etc., need to be considered when selecting a patient transfer device.

Generally, it is believed that use of a mechanical hoist to transfer patients in place of a manual technique would reduce physical stesses to nursing personnel. Contrary to this belief, two of the three mechanical hoists studied were perceived by the nurses to be more stressful than the one- and two-person walking belts. Further, these two hoists were rated less comfortable and less secure by the patients than the one- and two-person walking belts and Medesign. This shows that one has to be very careful in selecting a hoist for transferring patients, as the use of a mechanical hoist may not necessarily result in reduced physical stresses

to nursing personnel, or increased comfort and security of patients, while significantly increasing the time required to perform the transfer.

The major disadvantage with the recommended two-person walking belt and Ambulift is that these techniques take much longer to transfer patients from wheelchair to shower chair and shower chair to wheelchair than the existing manual lifting methods used in some nursing homes. This may be a problem as nursing personnel tend to perform patient transfers in the most expeditious manner (Jensen 1989). However, it is believed that a significant decrease in physical stresses to the nursing personnel and a significant increase in perceived comfort and security by patients with the recommended techniques outweigh the disadvantage of increased transfer times. Further, as mentioned earlier, the use of a shower chair may eliminate two transfers and thus may compensate for some of the increased transfer times required by these techniques.

5. Conclusion

Using a gentle rocking motion to utilize momentum and then pulling while transferring a patient from wheelchair to shower chair and shower chair to wheelchair, as compared to manually lifting the patient, results in significantly lower biomechanical and perceived stresses to the nurses and increased comfort and security of the patients. The use of a mechanical hoist in place of a manual technique may not necessarily reduce perceived stresses to the nurses or increase the comfort and security of the patient.

The two-patient walking belt using a pulling technique and Ambulift are recommended for transferring patients who can or cannot bear weight and those who are heavy, combative or contracted from wheelchair to shower chair and shower chair to wheelchair. The use of a shower chair will eliminate the necessity for two transfers for patients who are being both toileted and bathed. Further, transferring patients to the shower chair in their rooms should eliminate transfers in confined lavatory workspaces, thus reducing postural stresses to the nurses.

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