FEATURE ARTICLE
Program Evaluation

Effectiveness of Installing Overhead Ceiling Lifts

Reducing Musculoskeletal Injuries in an Extended Care Hospital Unit

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Abstract

The effectiveness of replacing floor lifts with mechanical ceiling lifts was evaluated in the extended care unit of a British Columbia hospital. Sixty-five ceiling lifts were installed between April and August 1998. Injury data were abstracted from injury reports for all staff musculoskeletal injuries (MSI) occurring in the unit during a 3 year period prior to installation and a 1.5 year follow up period. Descriptive statistics were calculated for injuries pre- versus post-installation. Rates were calculated as number of injuries per 100,000 worked hours. Rates for three pre- and three post-installation intervals were compared using Poisson regression. The rate of MSI caused by lifting/transferring patients was significantly reduced (58% reduction, $p = .011$) after installation, but rates of all MSI and MSI caused by repositioning did not statistically decline ($p > .05$). Further follow up is necessary to determine whether or not ceiling lifts also can be effective for decreasing injuries related to repositioning patients on this unit.

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The high rate of musculoskeletal injuries (MSIs) among health care workers is well documented (Cato, 1989; French, 1997; Fujimura, 1995; Garg, 1992; Harber, 1985; Leighton, 1995; Smedley, 1997). Lifetime prevalence rates of back pain greater than 70% have been reported (French, 1997; Fujimura, 1995), and higher incidence rates of MSI have been observed in health care workers compared to the general population (Leighton, 1995) and to other occupational groups (Jensen, 1987; Ono, 1995). Workers' compensation data in British Columbia (BC) reflect these findings: The overall injury rate for BC health care workers in 1998 was higher than the provincial average, with overexertion during patient handling the major cause (Workers' Compensation Board of British Columbia, 2000).

Patient handling is a documented risk factor for MSI (Cato, 1989; Engkvist, 1998; Hignett, 1996; Jensen, 1990; Leighton, 1995; Yassi, 1995). Health care workers often are exposed to heavy loads and awkward working postures during patient handling tasks (Lagerstrom, 1998). Biomechanical loads during patient handling have been shown to exceed permissible limits set by the U.S. National Institute of Occupational Safety and Health (NIOSH) and others (Laflin, 1995; Marras, 1999). Health care workers who frequently lift patients (Jensen, 1990) and who manually lift patients from the ground (Smedley, 1995) have higher rates of MSI, but manual transfers are also a risk factor for MSI (Engkvist, 1998; Smedley, 1995). This is particularly true when patients lose their balance during transfer or resist the move (Engkvist, 1998). Lifting patients also has been identified as a major determinant of residual back pain (Cooper, 1998) and of greater time loss (Tate, 1999) among injured health care workers.

In an effort to decrease the number of patient handling injuries, some organizations have adopted no manual lifting policies (Monaghan, 1998) and the need for mechanical lifting devices has been emphasized (Blue, 1996; Ljungberg, 1989; Marras, 1999). Little documentation exists about the effectiveness of ceiling mounted lifting equipment. Studies examining staff perceptions about ceiling lifts as compared to floor lifts have reported reductions in perceived effort (Holliday, 1994; Villeneuve, 1998) and in the number of staff required to perform lifts (Holliday, 1994).

Comparisons between a ward with traditional floor lifts and a modern ward with ceiling lifts reported that nursing aids on the modern ward spent less time lifting per shift and that less time was required per lift (Ljungberg, 1989). A substantial decrease in back compressive forces when using a ceiling lift as compared to manual methods has also been reported (Zhuang, 1999). This study was conducted to assess the impact of replacing a traditional floor lift system with overhead ceiling lifts on MSIs in an Extended Care Unit (ECU) of a BC hospital.

METHODOLOGY

Setting

At the initiation of the Resident Lifting System Project, there were a total of 124 residents in the unit (plus one respite), with 68 residents designated as requiring lifts. Equipment on the unit included five mechanical floor lifts, one manual transfer aid, and four beds serviced by two ceiling lifts. Staff included 30 RNs, 73 long term care aides (LTCAs), and 5 activity aides.

The Resident Lifting System Project

The Resident Lifting System Project was initiated in a hospital ECU through funding provided by the Workers' Compensation Board of British Columbia, with the objective of reducing musculoskeletal injuries to staff and improving the quality of care for residents. As the major component of the project, mechanical ceiling lift devices were fitted within existing structures in all patient bed and bathing rooms, replacing a traditional floor lift system. Ceiling lifts could not be fitted into patient toilet rooms because of incompatibility with the existing doorway structures (see Figure 1).

Figure 1. Lifting a resident using the overhead ceiling lift.

At the completion of the Resident Lifting System Project, there were a total of 124 residents on the unit (plus one respite), with 81 residents designated as requiring lifts. Equipment on the unit included three floor lifts, one manual transfer aid, 125 beds serviced by 62 ceiling lifts, and three tubs serviced by ceiling lifts. Staff included 34 RNs, 87 LTCAs, and 8 activity aides. Approximately 60 new slings of four different types were obtained for the project (i.e., universal, hammock, hygiene, positioning). Preliminary use of the positioning slings suggested that the slings were of limited use for repositioning residents in long term care and were moved to a different unit in the hospital. (Repositioning slings, which are wider and have a greater number of attachment points, have since been developed and are being pilot tested at the ECU.)

Training in the use of the ceiling lifts began on an ad hoc basis, with training conducted as needed by the ceiling lift supplier and by personnel already familiar with the use of the equipment. A Musculoskeletal Injury Prevention Program course was offered to RNs in June 1999 and to LTCAs between September and November 1999. The course covered all aspects of patient handling and emphasized new policies, including a no manual lifting policy initiated in March 1998 and a new transfer belt policy establishing the use of transfer belts during patient transfers.

Injury Outcomes

Injury reports for all musculoskeletal injuries were examined, retrospectively, from April 1, 1995 to March

Table 1

Injured Worker Demographics, Pre- Versus Post-intervention Periods

	Pre-Intervention, Period 1 (April 1, 1995 to Sept. 19, 1996) N = 61		Pre-Intervention, Period 2 (Sept. 20, 1996 to March 31, 1998) N = 95		Post-Intervention Period 1 (Aug. 21, 1998 to March 31, 2000) N = 81	
	n	%	*n*	%	*n*	%
Age of Injured Worker						
< 25 years	1	2%	5	5%	7	9%
25 to 45 years	35	57%	55	58%	45	56%
> 45 years	23	38%	29	31%	27	33%
Unknown	2	3%	6	6%	2	2%
Number of Years Injured Worker Employed at the Hospital						
< 1 year	2	3%	11	12%	4	5%
1 to 5 years	29	48%	35	37%	25	31%
> 5 years	28	46%	47	49%	46	57%
Unknown	2	3%	2	2%	6	7%
Occupation of Injured Worker						
RN	8	13%	12	13%	7	9%
Long-term care aide (LTCA)	49	80%	78	82%	65	80%
Other	2	3%	4	4%	7	9%
Unknown	2	3%	1	1%	2	2%
Employment Status of Injured Worker						
Full time or Part time	42	69%	73	77%	52	64%
Casual	19	31%	22	23%	29	36%

31, 1998 preceding the installation of the ceiling lifts and from August 21, 1998 to March 31, 2000 post-installation. A coding form was developed to systematically code the information available in the historical injury reports. The coding form included fields for recording details about the injured worker and the incident. Fields indicating whether the ceiling lift was "installed and functioning in the area where the accident occurred" were dropped because injury reports did not record room numbers where the incident occurred.

Three periods of similar time lengths were identified: pre-intervention period 1 (April 1, 1995 to September 19, 1996), pre-intervention period 2 (September 20, 1996 to March 31, 1998), and post-intervention period 1 (August 21, 1998 to March 31, 2000). Injuries occurring during the intervention period (April 1, 1998 to August 20, 1998) were excluded from the analyses because it could not be determined if the injury occurred before or after installation of the ceiling lifts at the location of the incident. The MSI rates were calculated for the three study periods based on the number of MSIs per 100,000 worked hours. The full study period was then further divided into six time intervals (three pre- and three post-intervention periods) and pre- versus post-intervention rates were compared using Poisson regression, with the level of statistical significance set at $p = .05$.

Staff and resident survey

A staff survey was designed to determine history of pain and injury, preferred patient handling techniques, and perceived exertion during various patient lifts and transfers. This survey was administered as voluntary to all RNs and LTCAs in February 1998, 3 months prior to the installation of the ceiling lifts, and re-administered again 15 months post-installation. The surveys were distributed with paychecks, and staff members were encouraged to complete them by the charge nurses and by the occupational therapist. Descriptive statistics were calculated to compare caregiver demographics, recent pain and injury history, perceived workload, and perceived exertion before and after overhead ceiling lift installation. Surveys assessing patient's perceived levels of comfort while being lifted also were distributed to residents and family members of residents pre- and post-intervention, and some descriptive statistics were calculated.

RESULTS

A total of 237 MSIs were documented during the 5 year period (excluding 24 MSI occurring during the 4 month installation period). As shown in Table 1, the majority of injured workers were 25 years or older, employed at the hospital for a period of greater than 1 year, LTCAs, and employed on a permanent full time or part time basis. No

Table 2

Injury Demographics, Pre- Versus Post-intervention Periods

	Pre-Intervention, Period 1 (April 1, 1995 to Sept. 19, 1996) N = 61		Pre-Intervention, Period 2 (Sept. 20, 1996 to March 31, 1998) N = 95		Post-Intervention Period 1 (Aug. 21, 1998 to March 31, 2000) N = 81	
	n	%	*n*	%	*n*	%
Number of Injured Workers						
Not reporting previous similar injury	34	56%	54	57%	43	53%
Reporting previous similar injury	25	41%	34	36%	31	38%
Unknown	2	3%	7	7%	7	9%
Number of Reports Listing the Following Body Areas as Being Injured*						
Neck	4	7%	8	8%	9	11%
Shoulder	21	34%	21	22%	31	38%
Back	24	39%	43	45%	23	28%
Upper back	1	2%	4	4%	4	5%
Mid back	4	7%	5	5%	2	2%
Lower back	20	33%	35	37%	18	22%
Other or unspecified	26	43%	44	46%	31	38%
Time When Pain or Discomfort First Noticed						
Midnight to 6 AM	8	13%	10	11%	6	7%
6 AM to 10 AM	9	15%	11	12%	9	11%
10 AM to 2 PM	22	36%	30	32%	23	28%
2 PM to 6 PM	11	18%	12	13%	20	25%
6 PM to Midnight	5	8%	25	26%	11	14%
Unknown	6	10%	7	7%	12	15%
Number of Workers Involved In Task at Time of Injury						
1	30	49%	50	53%	44	54%
2+	27	44%	33	35%	20	25%
Chronic (no acute event listed)	1	2%	6	6%	10	12%
Unknown	3	5%	6	6%	7	9%
Areas Where Injuries Occurred (patient-related)						
Patient rooms, repositioning patient in bed	16	26%	30	32%	25	31%
Patient rooms, other	30	49%	36	38%	20	25%
Patient bathing rooms	1	2%	3	3%	1	1%
Other areas	4	7%	7	7%	12	15%
Unknown, non patient related or chronic	10	16%	19	20%	23	28%

**Multiple listings possible per individual, therefore category totals may exceed 100%.*

major changes were noted in these distributions in the pre- versus the post-intervention intervals. Comparisons of the injured worker population to the limited data available for the entire ward staff population (including injured and noninjured workers) suggest that the ratio of LTCAs to RNs employed did not shift markedly pre- versus post-intervention (i.e., RNs represented 28% of the staff pre-intervention and 27% post-intervention). At this unit, a greater proportion of LTCAs were injured than were RNs in both the pre- and post- intervention periods.

The majority of workers injured during the study period experienced pain in the shoulder and back regions, particularly the lower back. A slight decline in the proportion of injuries to the lower back and an increase in injuries to the shoulder region occured following intervention (see Table 2). The majority of injuries occurred between 10 a.m. and 6 p.m., likely reflecting periods with higher patient handling demands, and a greater proportion of injuries occurred when tasks were unassisted. A decreasing trend was noted in the proportion of injuries occurring in patient rooms (other than repositioning in bed). An increasing trend was noted in the proportion of injuries occurring in areas other than patient bed or bathing rooms (i.e., where ceiling lifts were not installed).

Table 3

Contributing Causal Factors of Reported Musculoskeletal Injuries (MSIs)*

Contributing Factors in Causing Injury (as described in the injury reports)	*Pre-Intervention, Period 1 (April 1, 1995 to Sept. 19, 1996)* N = 61		*Pre-Intervention, Period 2 (Sept. 20, 1996 to March 31, 1998)* N = 95		*Post-Intervention Period 1 (Aug. 21, 1998 to March 31, 2000)* N = 81	
	n	%	*n*	%	*n*	%
Equipment related factors						
Not functioning properly or broken	5	8%	6	6%	4	5%
Not available at time	—	—	3	3%	—	—
Incorrect attachments on equipment	—	—	2	2%	3	4%
Not adjustable as required	1	2%	2	2%	2	2%
Environment related factors						
Obstacles on path	—	—	1	1%	1	1%
Slippery floors	—	—	1	1%	2	2%
Cramped working area	1	2%	5	5%	5	6%
Necessary assistance unavailable	2	3%	1	1%	—	—
Patient related factors						
Fell or slipped unexpectedly	10	16%	10	11%	6	7%
Resistive	10	16%	24	25%	20	25%
Misunderstood instructions	1	2%	3	3%	4	5%
Heavy	8	13%	14	15%	5	6%
Flaccid or weak	3	5%	10	11%	5	6%
Stiff or rigid	1	2%	5	5%	3	4%
Emergency situation	2	3%	1	1%	2	2%
Caregiver related factors						
Fatigued, distracted, or in pain	4	7%	7	7%	1	1%
Procedural error	25	41%	31	33%	14	17%
Used poor body mechanics	13	21%	19	20%	10	12%
Previous injury	6	10%	13	14%	24	30%
Poor communication or teamwork	2	3%	2	2%	—	—

**Multiple listings possible per individual, therefore category totals may exceed 100%.*

Table 3 summarizes contributing causal factors in reported MSI, with multiple causal factors listed for individual injuries. Neither equipment nor environment related factors represented major causal factors for MSI pre- or post-intervention. Resistive behaviors by patients represented the major patient related causal factor, followed by patients slipping or falling unexpectedly, and patient's heavy weight. A decreasing trend was found in the proportion of injuries attributable to procedural error by staff and use of poor body mechanics, with an increasing trend in the proportion of injuries attributable to a previous injury.

As summarized in Table 4, total MSI rates declined slightly but not significantly (p = .72) with an average total rate of 40.8 MSI per 100,000 worked hours pre-intervention and 38.7 per 100,000 worked hours post-intervention. A marked decline was observed in lifting and transferring MSI rates, from 16.3 pre- to 8.1 post-intervention (p = .011) per 100,000 worked hours, with a specific decline for patient lifting MSI of 7.6 to 4.3 (p = .135). A slight, but not significant (p = .48), increase was observed in rates of repositioning MSI (16.3 versus 17.2). Slight increases pre- versus post-intervention also were observed in rates of MSI from other causes. Time loss injuries followed similar, though less marked, patterns.

As shown in Figure 2, the installation of ceiling lifts appeared to have an independent effect on patient lifting related injuries prior to the training program. Follow up after the training showed a sustained decline in patient lifting related injury rates while patient transferring and patient repositioning related injury rates increased. Because the number of designated lifts after the ceiling lift installation actually had increased (because of changes in patient acuity), the observed rate of decline in patient lifting related MSI is likely underestimated (assuming an increasing trend in such MSI prior to the installation).

Table 4

Injury Rates By Task Being Completed at Time of Musculoskeletal Injury (MSI), Pre- Versus Post-intervention Periods

Task Being Completed at Time of MSI	*Pre-Intervention, Period 1 (April 1, 1995 to Sept. 19, 1996) N = 61*		*Pre-Intervention, Period 2 (Sept. 20, 1996 to March 31, 1998) N = 95*		*Post-Intervention Period 1 (Aug. 21, 1998 to March 31, 2000) N = 81*	
	n	Number of Injuries Per 100,000 Worked Hours	*n*	Number of Injuries Per 100,000 Worked Hours	*n*	Number of Injuries Per 100,000 Worked Hours
All Reported MSIs	61	32.8	95	48.7	81	38.7
Repositioning residents	24	12.9	38	19.5	36	17.2
Lifting or transferring residents	27	14.5	35	17.9	17	8.1
Lifting	13	7.0	16	8.2	9	4.3
Transferring	14	7.5	19	9.7	8	3.8
Other, nonpatient related	6	3.2	9	4.6	10	4.8
Other, patient related	1	0.5	5	2.6	5	2.4
Chronic (no acute event specified)	1	0.5	8	4.1	13	6.2
Not able to determine from injury report	2	1.1	0	0.0	0	0.0
Time Loss MSIs Only	19	10.2	37	19.0	38	18.2
Repositioning residents	12	6.4	17	8.7	18	8.6
Lifting or transferring residents	5	2.7	14	7.2	8	3.8
Lifting	3	1.6	7	3.6	5	2.4
Transferring	2	1.1	7	3.6	3	1.4
Other, nonpatient related	1	0.5	2	1.0	3	1.4
Other, patient related	0	0.0	3	1.5	3	1.4
Chronic (no acute event specified)	0	0.0	1	0.5	6	2.9
Not able to determine from injury report	1	0.5	0	0.0	0	0.0

Staff and Resident Survey Results

A total of 58 staff members (37 LTCAs, 12 RNs, and 9 unspecified) completed the pre-intervention survey and 50 staff members (37 LTCAs, 8 RNs, and 5 unspecified) completed the post-intervention survey. Those staff members reporting "ever having experienced a patient handling injury" decreased from 75.9% pre-intervention to 62% post-intervention. Staff members reporting experiencing "soft tissue pain in the last 6 months which has interfered with their daily routine or lifestyle" decreased from 60.3% to 50% 1 year post-installation of the ceiling lift. Staff members reporting they "have worked at the hospital while in pain" decreased from 72.4% to 66%. Staff members reporting they preferred using mechanical lifting equipment over manual methods for moving residents from bed to wheelchair increased from 39.7% to 64% post-installation.

A total of 20 resident surveys were completed pre-intervention (by 12 residents and 8 family members of residents) and 20 surveys completed post-intervention (by 15 residents and 5 family members). Because the surveys were anonymous, it was not possible to determine how many post-surveys were completed by the same individuals completing pre-surveys. Residents stating they were satisfied with the way they were moved increased from 80% to 95% after the ceiling lift installation, and those who stated they felt comfortable while being moved also increased (65% pre- versus 80% post-intervention).

DISCUSSION

Mechanical lifting equipment has been recommended as an effective tool for decreasing the rate and severity of MSI in health care workers. This study provides supporting evidence for this recommendation because results indicated that the installation of overhead ceiling lifts was followed by a decrease in injury rates associated with lifting and transferring of residents. It is noteworthy that neither overall MSI rates nor repositioning related MSI rates changed pre- versus post-intervention.

Although the ceiling lifts are designed for both lifting and repositioning residents, the ceiling lifts were actually not used for repositioning residents in this unit because of problems with the repositioning slings. The fact that repositioning related MSI rates remained relatively stable and lift or transfer injuries declined supports the conclusion that the intervention was effective in decreasing lift or transfer injuries. Further follow up of the injury outcomes on this unit after the new ceiling

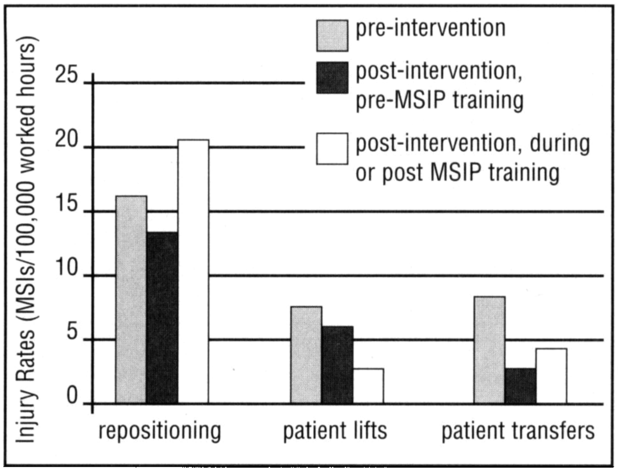

Figure 2. Musculoskeletal injury (MSI) rates for pre-intervention, post-installation (pre-Musculoskeletal Injusry Prevention Program [MSIP] training) and post-installation (during/post-training) periods.

lift compatible repositioning slings are incorporated should be undertaken to assess whether or not repositioning related injuries also decline.

A few limitations were found with this evaluation. The lack of a control group made it impossible to rule out the effects of external confounders. It was also not possible to separate an effect of installing ceiling lifts alone as opposed to an effect of implementing the training program. However, the decline in lift or transfer MSI rates occurred while there was an increase in rates of other MSI post-installation. Because implementation of the training program would have been expected to impact rates of all types of injuries, it could be inferred that the observed decline in lifting injuries could be attributed primarily to the installation of the lift equipment.

Additionally, the observed decline in patient lifting related injuries following the ceiling lift installation, but prior to training, suggests an impact of the ceiling lift equipment on lifting related MSI independent of the effects of training. Declines also were observed in transferring related injuries following the ceiling lift intervention but prior to training, which might be expected because more of the "borderline" patients who were previously transferred were now reported more likely to be lifted because equipment was more readily available.

Following the training program, a further decline was observed in patient lifting MSI. This sustained decline in patient lifting related injuries suggests the impact of the ceiling lift intervention was enhanced by its combination with training in improved patient handling skills. Because more patients were designated as lifts rather than transfers post- versus pre-installation because of changes in patient acuity levels, the observed rate of decline in patient lifting related MSI is likely underestimated—assuming an increasing trend in such MSIs existed prior to the installation. This corresponds with the findings of a recent evaluation at a BC hospital that reported decreases in injuries, time loss, and costs related to patient transfers following a combination of mechanical interventions (including ceiling lift installations) and new policies (Gamble, 1997). A recent, randomized control trial conducted at an acute care hospital in Winnipeg, Manitoba also found that a combined intervention of new equipment and training in safe patient handling was effective in improving the workplace environment for health care workers (Yassi, 2001).

Because of the method of survey implementation, it was not possible to match the surveys to individuals in the pre- and post-intervention periods. However, it was still possible to ascertain a decrease in the perceived level of pain following the intervention, suggesting that installation of the ceiling lifts had a positive impact on perceived well being among staff. Staff also reported a greater preference for using mechanical options as compared to manual options, though it is not possible to rule out an effect of training in this case. Sample sizes for the resident surveys were determined by practical constraints and not by formal power calculations, so it is possible sample sizes were not adequate to detect a strong effect. However, the results still indicated an increase in comfort and satisfaction among residents after the lifts were installed.

This intervention involved installation of ceiling lifts into an older building. Because of incompatibility with pre-existing structures, some rooms (e.g., patient toilet rooms) could not be fitted with ceiling lift tracks. Some indications of an increasing trend in injuries occurring in rooms without ceiling lifts were apparent, suggesting some injuries perhaps could have been avoided if ceiling lifts had been installed in these areas.

CONCLUSION

The results of this evaluation suggest that the installation of ceiling lifts in combination with a training program is effective in reducing the number of MSIs of nurses and LTCAs during lifting or transferring patients in an ECU. Further, this evaluation emphasizes the importance of dividing injury types into tasks performed at the time of the injury, particularly when evaluating the effectiveness of specific types of patient handling equipment. A follow up of this study unit should be undertaken to assess the impact of introducing new ceiling lift compatible slings for repositioning residents.

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IN SUMMARY

Effectiveness of Installing Overhead Ceiling Lifts

Reducing Musculoskeletal Injuries in an Extended Care Hospital Unit

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AAOHN Journal 2002; 50(3), 120-127.

1 Installation of ceiling lifts in combination with an appropriate training program is effective in reducing the number of musculoskeletal injuries (MSI) from lifting and transferring patients in an extended care unit.

2 It is important to divide injury types into tasks being performed at the time of the injury to evaluate the effectiveness of specific types of patient handling equipment.

3 Assessing subjective views of both staff and patients is essential to an effective evaluation.

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