Evaluation of Ceiling Lifts in Health Care Settings

Patient Outcome and Perceptions

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RESEARCH ABSTRACT

Ceiling lifts have been introduced into health care settings to reduce manual patient lifting and thus occupational injuries. Although growing evidence supports the effectiveness of ceiling lifts, a paucity of research links indicators, such as quality of patient care or patient perceptions, to the use of these transfer devices. This study explored the relationship between ceiling lift coverage rates and measures of patient care quality (e.g., incidence of facility-acquired pressure ulcers, falls, urinary infections, urinary incontinence, and assaults [patient to staff] in acute and long-term care facilities), as well as patient perceptions of satisfaction with care received while using ceiling lifts in a complex care facility. Qualitative semi-structured interviews were used to generate data. A significant inverse relationship was found between pressure ulcer rates and ceiling lift coverage; however, this effect was attenuated by year. No significant relationships existed between ceiling lift coverage and patient outcome indicators after adding the "year" variable to the model. Patients generally approved of the use of ceiling lifts and recognized many of the benefits. Ceiling lifts are not detrimental to the quality of care received by patients, and patients prefer being transferred by ceiling lifts. The relationship between ceiling lift coverage and pressure ulcer rates warrants further investigation.

Research has shown that health care workers are experiencing higher rates of occupational injury than workers in other sectors (Koehoorn, Lowe, Rondeau, Schellenberg, & Wagar, 2002). Patient handling tasks have been identified as especially hazardous, as they are one of the leading causes of injury among health care workers (Garg, Owen, & Carlson, 1992; Ostry et al., 2003). To promote safe patient handling and to prevent related injuries, mechanical lifting devices have been developed and used in health care settings. Most recently, ceiling lifts have been advocated as effective patient handling equipment, as they can reduce injury rates, are cost-effective, and are acceptable to staff (Alamgir, Yu, Fast, Kidd, & Yassi, 2008; Chhokar et al., 2005; Engst, Chhokar, Miller, Tate, & Yassi, 2005; Ronald et al., 2002; Spiegel et al., 2002; Villeneuve, 1998). Although growing evidence supports the use of ceiling lifts, a paucity of research links these devices to quality of care indicators and patient perceptions of being transferred with such devices. Information on whether ceiling lifts have a direct impact on these outcomes can augment evidence-based decision making regarding ceiling lift interventions.

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The authors disclose that they have no significant financial interests in any product or class of products discussed directly or indirectly in this activity, including research support.

doi:10.3928/08910162-20090826-06

Quality of care is an important indicator of appropriate resource allocation and planning in health care, as the principal goal of this industry is to provide quality health care for patients. It is therefore essential to identify whether an intervention is benefitting or hindering patient care. Quality patient care can be measured through patient outcomes specific to the focus of the intervention. Patient outcomes are an influential indicator of program design and implementation, policy making, and resource allocation for key decision makers in health care.

Patients can develop pressure ulcers after remaining in the same position in bed for a prolonged period. The use of ceiling lifts is assumed to lead to more frequent patient handling and transfers, thus decreasing the occurrence of pressure ulcers among patients in extended care (Lehrer, 2009). Urinary incontinence is another outcome of interest, as more frequent visits to the bathroom, aided by ceiling lifts, may result in improvement. Urinary incontinence has also been linked to pressure ulcers (Lehrer). Additionally, research has shown that the frequency of patient falls may decrease with the availability of ceiling lifts (Brumbeloe, 2009). Patient to staff assault was selected as a patient outcome indicator because it is presumed that close proximity between staff and patients during manual handling may enable patients to assault staff. This risk can be decreased by using ceiling lifts, as care providers do not come into close contact with patients during transferring or repositioning.

Factors related to the quality of patient care can also be associated with the risk of injury to health care workers. Models evaluating patient and employee safety include similar input and analytical processes (Carayon et al., 2006; Karsh, Holden, Alper, & Or, 2006). A review by Lundstrom, Pugliese, Barley, Cox, and Guither (2002) of factors impacting worker safety and patient outcomes suggested that the organization of work and physical environments have a direct effect on workplace performance and an indirect effect on the quality of patient care. Yassi and Hancock (2005) also proposed that the organizational culture and safety climate affect both the quality of patient care and workplace performance and hazards. Therefore, it is reasonable to predict that an intervention that enhances the health and safety of health care workers will have an effect on the quality of care patients receive.

The appropriate allocation of resources has been shown to directly impact patient care quality. Higher staffing levels have been shown to increase patient safety and reduce falls and pressure ulcers (Cho, Ketefian, Barkauskas, & Smith, 2003). Furthermore, Needleman, Buerhaus, Mattke, Steart, and Zelevinsky (2002) found an association between increased nurse staffing levels and quality of patient care. Lower nurse staffing levels have been linked to increased risk for exposure to blood and body fluids, a serious health hazard among health care workers (Clarke, Stone, & Aiken, 2002). Indicators of quality patient care can reflect the occupational injury risks for health care workers. Charney and Schirmer (2007) proposed a link between occupational injuries and patient outcomes (i.e., occupational injuries lead to inadequate patient to staff ratios that reduce the quality of care received by patients).

Applying Research to Practice

Ceiling lifts are not detrimental to the quality of care patients receive, and patients prefer being transferred by ceiling lifts. Ceiling lifts may even improve care, reducing the risk of pressure ulcers. Programs designed to promote worker safety should examine patient care and patient perceptions.

Patient perception is an important tool for evaluating the effectiveness of mechanical lifting devices, providing insight into the quality of care. However, it is often difficult to elicit this information, as institutionalized patients' health may limit their ability to communicate their perceptions. Patient perception of ceiling lifts may influence how staff view and use these devices. Patients' acceptance of transfer devices increases if they are satisfied and comfortable during a transfer; patients' acceptance thereby increases use (Nelson et al., 2006; Ronald et al., 2002). Furthermore, de Castro, Hagan, and Nelson (2006) suggested that mechanical lifting devices can increase the quality of care patients receive by providing a more secure transfer, thus reducing associated risks of falls, skin tears, and other injuries and patient anxiety. A retrospective study by Nelson et al. involving the implementation of ceiling lifts in an extended care facility found lower levels of depression, less risk for falls, less urinary incontinence, increased engagement in activities, and higher levels of alertness during the day among residents. These researchers also proposed that ceiling lifts increase the frequency of and decrease the difficulty in patient handling.

Collins, Wolf, Bell, and Evanoff (2004) found a reduction in the number of patient to staff assaults after the implementation of a safe patient handling program that included ceiling lifts. These researchers attributed this to the larger physical space between patients and staff and increased comfort for patients. Although the reasons for patient anger and hostility can be complex, the approach to patient transfer or lift can act as a trigger. Patients may not perceive every transfer or lift as a desired activity at that time; they may experience pain that is triggered or exaggerated by the transfer or lift.

Although patient perceptions can be a useful tool for evaluating transfer devices in terms of patient safety and comfort, the authors had limited information on the impact of these devices on patient outcomes. To the best of their knowledge, few studies have compared ceiling lift coverage rates and patient outcomes or elicited patient perceptions to evaluate such interventions. This study evaluated the implementation of ceiling lifts in the health care setting in two distinct ways. Primarily, it explored ceiling lift coverage in relation to the incidence of

Table 1

Association of Beds Covered by Ceiling Lifts With Patient Risk of Pressure Ulcers for Extended Care Facilities

	Crude RR (95% CI)	*Adjusted RR (95% CI)*
Fiscal year		
2003	1.00 (ref.)	1.00 (ref.)
2004	0.80 (0.59-1.09)	0.80 (0.58-1.10)
2005	0.52 (0.37-0.71)*	0.51 (0.38-0.67)*
2006	0.44 (0.31-0.63)*	0.44 (0.29-0.66)*
Beds covered by ceiling lifts (cumulative for 100 beds)		
0	1.00 (ref.)	1.00 (ref.)
0.88 to 10.10	0.95 (0.68-1.32)	1.28 (0.85-1.92)
10.53 to 47.06	0.50 (0.36-0.69)*	0.94 (0.64-1.39)

Note. *RR = relative risk; CI = confidence interval. Beds covered are cumulative beds covered by ceiling lifts for 100 beds. RR, 95% CI, and* p *were derived from Poisson regression modeling with "facility" as a clustering variable in the model.*
**p < .05.*

Table 2

Association of Beds Covered by Ceiling Lifts With Patient Risk of Falls for Extended Care Facilities

	Crude RR (95% CI)	*Adjusted RR (95% CI)*
Fiscal year		
2002	1.00 (ref.)	1.00 (ref.)
2003	1.11 (0.97-1.28)	1.10 (0.95-1.27)
2004	1.04 (0.86-1.26)	1.02 (0.83-1.24)
2005	0.96 (0.79-1.17)	0.90 (0.71-1.14)
2006	0.89 (0.72-1.10)	0.82 (0.61-1.09)
Beds covered by ceiling lifts (cumulative for 100 beds)		
0	1.00 (ref.)	1.00 (ref.)
0.88 to 10.10	0.98 (0.81-1.19)	1.06 (0.91-1.23)
10.53 to 47.06	0.92 (0.76-1.13)	1.11 (0.86-1.43)

Note. *RR = relative risk; CI = confidence interval. RR, 95% CI, and* p *were derived from Poisson regression modeling with "facility" as a clustering variable in the model.*

facility-acquired pressure ulcers, falls, incontinence, and assaults (patient to staff) in extended care facilities and falls in acute care facilities, thus identifying a possible relationship between ceiling lift coverage rates and quality of care measures. In addition, it explored patient perceptions of the care received in relation to ceiling lift use in a complex care facility.

METHODS

Ceiling Lift Inventory

For the extended and acute care facilities, the index of annual cumulative beds covered by ceiling lifts per 100 beds was constructed to represent yearly coverage rates. Information on the number of beds and ceiling lifts installed by year was provided from an inventory by the health authority and also verified by contacting the vendors supplying the equipment. The number of newly installed ceiling lifts for a year was added to that of previous years. The ratio of the number of beds to the number of ceiling lifts was used to represent the yearly coverage rate. Ceiling lift coverage rates were divided into three groups of equal size: low, intermediate, and high coverage.

Patient Outcomes

This study compared patient outcomes in relation to ceiling lift coverage rates. For extended care facilities, the PointClickCare (WESCOM) database was used. For acute care facilities, the Vancouver Acute Falls Reporting System (QUIST) database was used.

Extended Care Facilities. Patient care outcome data (e.g., pressure ulcers, falls, assaults [patient to staff], urinary infections, and urinary incontinences) from 2002 to 2006 were extracted from WESCOM for 12 extended care facilities with ceiling lifts. All patient outcome indicators were reported as a rate per 100 residents.

Acute Care Facilities. Patient outcome data from April 1, 2004, to March 31, 2006, were extracted from QUIST for seven acute care facilities. The patient outcome data obtained from QUIST are related to patient falls per 100 residents.

The association between ceiling lift coverage and risk of various patient outcome indicators was examined using Poisson regression modeling with "facility" as the clustering variable in the model. Relative risks, 95% confidence intervals, and *p* values from both univariate and multivariate analyses are presented. The analyses were conducted using SPSS software, version 14.0. The level of statistical significance was set at .05.

Patient Interviews

Qualitative methods were used to gain perspective on the patients' experiences of being transferred by floor and ceiling lifts. A member of the research team conducted 12 semi-structured interviews with patients at a complex care facility. This facility is home to adults with severe disabilities. The residents who live here require specialized assis-

Table 3

Association of Beds Covered by Ceiling Lifts With Risk of Patient to Staff Assault for Extended Care Facilities

	Crude RR (95% CI)	*Adjusted RR (95% CI)*
Fiscal year		
2002	1.00 (ref.)	1.00 (ref.)
2003	0.78 (0.58-1.04)	0.76 (0.61-0.95)*
2004	0.68 (0.48-0.96)*	0.63 (0.46-0.87)*
2005	0.98 (0.74-1.30)	0.85 (0.59-1.24)
2006	0.31 (0.07-1.46)	0.27 (0.07-1.09)
Beds covered by ceiling lifts (cumulative for 100 beds)		
0	1.00 (ref.)	1.00 (ref.)
0.88 to 10.10	0.92 (0.58-1.46)	1.15 (0.76-1.74)
10.53 to 47.06	0.95 (0.80-1.12)	1.19 (0.85-1.66)

Note. *RR = relative risk; CI = confidence interval. RR, 95% CI, and* p *were derived from Poisson regression modeling with "facility" as a clustering variable in the model.*
*p < .05.

Table 4

Association of Beds Covered by Ceiling Lifts With Patient Risk of Urinary Infection for Extended Care Facilities

	Crude RR (95% CI)	*Adjusted RR (95% CI)*
Fiscal year		
2002	1.00 (ref.)	1.00 (ref.)
2003	1.36 (0.98-1.88)	1.39 (0.99-1.95)
2004	1.29 (0.99-1.69)	1.36 (1.01-1.83)*
2005	1.24 (1.00-1.55)	1.45 (1.03-2.06)*
2006	1.16 (0.74-1.83)	1.41 (0.84-2.37)
Beds covered by ceiling lifts (cumulative for 100 beds)		
0	1.00 (ref.)	1.00 (ref.)
0.88 to 10.10	0.99 (0.87-1.13)	0.84 (0.64-1.11)
10.53 to 47.06	0.96 (0.80-1.15)	0.82 (0.66-1.02)

Note. *RR = relative risk; CI = confidence interval. RR, 95% CI, and* p *were derived from Poisson regression modeling with "facility" as a clustering variable in the model.*
*p < .05.

tance as a result of disabilities including multiple sclerosis, spinal cord and traumatic brain injury, and cerebral palsy. A list of patients capable of providing insight into this research who had experienced transfers by both ceiling and floor lifts was prepared by staff. Due to the small sample available and access to them, the emerging trends found through these interviews may not be representative of all patients using transfer lifts in acute care, mixed care, and extended care. Patient interviews were tape recorded and then individually transcribed and reviewed by research staff to identify themes. Questions were asked regarding the patients' comfort, safety, areas for improvement, and general satisfaction with transfer equipment.

Ethics approval was obtained from the Ethical Board of Simon Fraser University. Consent was gained from all patients who participated in the study.

RESULTS

Patient Outcomes

Extended Care Facilities. Twelve extended care facilities were included in the study. From 2002 to 2004, the average ceiling lift coverage rates were low (0.9 cumulative beds covered per 100 beds in 2002, 1.2 in 2003, and 2.6 in 2004). In 2005, this rate increased to 14.9. It increased to 23.3 in 2006. Table 1 presents the association of cumulative beds covered by ceiling lifts (per 100 beds) with risk of pressure ulcers for extended care facilities. The crude relative risk of pressure ulcers decreased over time (significant for 2005 and 2006 with relative risk of 0.52 and 0.44, respectively) and was lower with increased bed coverage by ceiling lifts (significant with highest coverage relative risk of 0.50). When adjusting for ceiling lift coverage to examine the rate of pressure ulcers by year in multivariate models, the resulting adjusted relative risk of patient falls remained lower by year (significant for 2005 and 2006 with relative risk of 0.51 and 0.44, respectively). The variable of year was then included to examine pressure ulcer rates by ceiling lift coverage in multivariate models; the relative risk for pressure ulcers with increased ceiling lift coverage was no longer significant (relative risk of 1.28 and 0.94, respectively). Additional patient outcome indicators such as fall risk, assault, risk of urinary infection, and risk of urinary incontinency measured in extended care facilities were examined, but no significant association with ceiling lift coverage was found (Tables 2, 3, 4, and 5).

Acute Care Facilities. Seven acute care facilities were included in the study. In 2004, the average ceiling lift coverage rate was 36.2 cumulative beds per 100 beds. This increased to 47.6 in 2005 and to 51.6 in 2006. Table 6 illustrates the association of cumulative beds covered (per 100 beds) with risk of patient falls. The relative risk of patient falls was significantly higher with increased coverage, and significantly decreased over time. When

Table 5

Association of Beds Covered by Ceiling Lifts With Patient Risk of Incontinency for Extended Care Facilities

	Crude RR (95% CI)	*Adjusted RR (95% CI)*
Fiscal year		
2002	1.00 (ref.)	1.00 (ref.)
2003	1.04 (1.00-1.09)	1.05 (1.00-1.10)*
2004	1.11 (1.01-1.22)*	1.13 (1.02-1.25)*
2005	1.17 (1.01-1.34)*	1.26 (1.10-1.44)*
2006	1.17 (0.99-1.38)	1.30 (1.08-1.57)*
Beds covered by ceiling lifts (cumulative for 100 beds)		
0	1.00 (ref.)	1.00 (ref.)
0.88 to 10.10	1.07 (0.99-1.16)	0.96 (0.90-1.02)
10.53 to 47.06	1.06 (0.91-1.23)	0.87 (0.74-1.03)

Note. *RR = relative risk; CI = confidence interval. RR, 95% CI, and* p *were derived from Poisson regression modeling with "facility" as a clustering variable in the model.*
*p < .05.

relative risk for falls by ceiling lift coverage was adjusted by year in the multivariate model, the resulting relative risk remained higher with increased coverage, but not significantly. The variable of ceiling lift coverage was also included in the relationship of fall risks by year in the multivariate model. The resulting relative risk of patient falls decreased over time, but, again, not significantly.

Patient Interviews

Twelve patients were interviewed at a mixed care facility; nine preferred ceiling lifts to floor lifts, two were indifferent, and one preferred floor lifts. When they were asked to report their overall satisfaction with ceiling lifts from 1 to 10, ceiling lifts scored an average of 8.5 (from 10 ratings), while floor lifts scored an average of 7.3 (from four ratings). The major themes identified from the interview transcripts were that all interviewed patients felt safe and were not afraid during ceiling lift transfers and believed that ceiling lifts were safer and less strenuous for staff. Patients identified improved personal hygiene because of individual slings, increased comfort, and more maneuverability of their wheelchairs as their main reasons for accepting and preferring ceiling lifts. The expertise and experience of the staff using the device was identified as an important factor in the overall comfort of a transfer.

Table 6

Association of Beds Covered by Ceiling Lifts With Patient Risk of Falls for Acute Care Facilities

	Crude RR (95% CI)	*Adjusted RR (95% CI)*
Fiscal year		
2004	1.00 (ref.)	1.00 (ref.)
2005	0.84 (0.79-0.89)*	0.85 (0.70-1.02)
2006	0.87 (0.82-0.93)*	0.89 (0.78-1.02)
Beds covered by ceiling lifts (cumulative for 100 beds)		
1.0 to 37.5 (Tertile 1)	1.00 (ref.)	1.00 (ref.)
37.6 to 53.1 (Tertile 2)	1.85 (1.68-2.03)*	1.40 (0.94-2.07)
53.2 to 80.6 (Tertile 3)	1.77 (1.64-1.92)*	1.22 (0.63-2.38)

Note. *RR = relative risk; CI = confidence interval. RR, 95% CI, and* p *were derived from Poisson regression modeling.*
*p < .05.

DISCUSSION

Research has shown ceiling lifts to be effective in reducing occupational injuries among health care workers (Alamgir et al., 2008; Chhokar et al., 2005; Engst et al., 2005; Ronald et al., 2002; Spiegel et al., 2002; Villeneuve, 1998). The results of this study complement this body of knowledge by exploring the relationship between ceiling lift coverage and patient quality of care measures and by eliciting patient perceptions of ceiling lifts. Overall, ceiling lifts did not lead to any harmful effects on patient outcomes in the extended and acute care facilities examined. The interviewed mixed care patients generally preferred the use of ceiling lifts over floor lifts and manual methods.

Patient outcomes were used to investigate the relationship between safe patient handling measured via ceiling lift coverage and quality of care measures. For extended care facilities, no relationship was found between the majority of patient outcome indicators and the rate of cumulative beds covered by ceiling lifts. The exception was pressure ulcer risk, which was significantly reduced with higher ceiling lift coverage. However, this relationship became insignificant when the variable of year was added to the model. Therefore, the decrease in pressure ulcer risk over time may be attributed to other interventions that may have been implemented during the same period (e.g., advances in bedding).

For acute care facilities, the risk of falls increased with more ceiling lift coverage. However, the relative risk of patient falls was not significantly related to ceiling lift

coverage rates when the variable of year was added to the model. Fall risk may not be related to ceiling lifts, as falls can occur in multiple areas of the facility and for multiple reasons. The patient outcome indicators of pressure ulcer rate and fall risk require further investigation to determine if clinically significant relationships can be established.

Many possible explanations for the lack of significant results can be deduced. It is possible that some patient outcomes may not be directly related to ceiling lift coverage. Health care workers follow set schedules for patient care. The addition of ceiling lifts, affecting only the frequency of transferring and repositioning, may not have had a strong influence. Also, the ceiling lift coverage rate itself may not translate directly into use. Ceiling lift use for repositioning compared to transferring may be lower than coverage rates. Future research should uncover ways to motivate workers to use these devices.

Despite the lack of significant findings, it is promising that no significant negative association was observed between ceiling lift coverage and patient outcomes. This was especially relevant regarding pressure ulcer risk, as the effect of ceiling lift slings on skin integrity has been cited as a concern by health care workers. Nelson, Collins, Siddharthan, Matz, and Waters (2008), studying patient outcomes and an ergonomics program, found improved urinary incontinence and lower fall risk. However, because retrospective data were used, these researchers could not produce a reliable direct link as well. The current study offers some assurance to health care workers that ceiling lifts are not harmful to patients.

The majority of patients interviewed had positive perceptions of ceiling lift use. When they were asked to report their overall satisfaction with mechanical lifts, ceiling lifts had a higher average score than floor lifts. All interviewed patients claimed to feel safe and unafraid during ceiling lift transfers and believed they were safer for and less strenuous on staff. These findings parallel previous research examining patient perceptions of ceiling lifts (Nelson et al., 2006; Ronald et al., 2002). Patients identified personal hygiene, added comfort, and extra space as beneficial features of ceiling lifts. Patients highlighted staff expertise as essential to contributing to a safe and comfortable transfer. The small number of patients interviewed limited the researchers' ability to generalize these findings to a larger population. However, because of the limitations in conducting qualitative research on a representative patient population, especially in extended care, a large sample is difficult to establish. The findings are important because they add a firsthand perspective to ceiling lifts from the recipients of care. Key concerns of patients have been identified, and health care workers have been reassured that patients find ceiling lifts favorable and satisfactory.

This study had several limitations. The evaluation involved aggregation by facilities. Although policies regarding patient transfers are similar across facilities within a health region, facilities can have different safety cultures and procedures. These differences can affect ceiling lift use. Safety culture may be influenced by implementation of ceiling lifts and variations in ceiling lift coverage. The ceiling and floor lift models available differed slightly between facilities. Furthermore, staff expertise and experience, mentioned by patients as key to the transfer experience, may differ by facility. Approaches to ceiling lift implementation and use can be better understood when results are compared on a unit-by-unit basis.

Regarding the analysis of patient outcomes, health care is a complex and multifaceted system and numerous factors influence injury (Yassi, Gilbert, & Cvitkovich, 2005). This reality hampered the degree to which direct causation between ceiling lifts and other injury prevention initiatives and outcomes could be described. A natural decline in health status is expected for the majority of patients in extended care facilities. Thus, comparisons over time are influenced by extraneous factors impossible to control. The power calculation resulted in a sample too small to provide the precision required to discern whether differences between coverage rates were significant. The results are still valuable because they explore possible relationships and highlight areas for future research.

IMPLICATIONS FOR PRACTICE, RESEARCH, AND EDUCATION

The effect of worker safety on patient care is an interesting and emerging area of research. The results of this study are encouraging because patients were found to accept the use of ceiling lifts, and ceiling lifts were not found to be detrimental to the quality of patient care. Also, in the case of pressure ulcer risk, ceiling lifts may even improve care. Programs designed to promote worker safety should examine patient care and patient perceptions. Moreover, patient outcomes and quality of care measures must be refined to more accurately produce significant results attributable to specific interventions. This study was exploratory; future research should focus on these indicators in detail.

The addition of ergonomic interventions to improve staff and patient safety simultaneously provides occupational health and safety staff with more accurate assessments of their continued use of and reassurance about adapting technologies. The additional information gained by incorporating patient safety into the equation may motivate staff to adhere to recommendations for changes to work processes.

Replication of this study with a larger, perhaps less homogeneous, sample would be useful in further evaluating relationships between staff and patient safety outcomes.

Finally, nurses may need continuing education regarding how to better adapt to these new technologies and reduce their risk for workplace injury. Policy makers should facilitate use of these interventions by incorporating them into employee health and safety programs.

REFERENCES

Alamgir, H., Yu, S., Fast, C., Kidd, C., & Yassi, A. (2008). Efficiency of overhead ceiling lifts in reducing musculoskeletal injury among carers working in long-term care institutions. *Injury, 39*(5), 570-577.

Brumbeloe, S. (2009). *Providing a lift.* Retrieved April 9, 2009, from www.guldmann.dk/Files/Billeder/Info-pressroom/Casestories%20and%20references/Articles/US/RehabMagazine_Article_Sharon-

Brumbeloe.pdf
Carayon, P., Hundt, A. S., Karsh, B.-T., Gurses, A. P., Alvarado, C. J., Smith, M., et al. (2006). Work system design for patient safety: The SEIPS model. *Quality and Safety in Health Care, 15*(Suppl. 1), i50-i58.
Charney, W., & Schirmer, J. (2007). Nursing injury rates and negative patient outcomes: Connecting the dots. *AAOHN Journal, 55*(11), 470-474.
Chhokar, R., Engst, C., Miller, A., Robinson, D., Tate, R. B., & Yassi, A. (2005). The three-year economic benefits of a ceiling lift intervention aimed to reduce healthcare worker injuries. *Applied Ergonomics, 36*(2), 223-229.
Cho, S., Ketefian, S., Barkauskas, V. H., & Smith, D. G. (2003). The effects of nurse staffing on adverse events, morbidity, mortality and medical costs. *Nursing Research, 52*, 71-79.
Clarke, S., Stone, D., & Aiken, L. (2002). Effects of hospital staffing and organizational climate on needlestick injuries to nurses. *American Journal of Public Health, 92*(7), 1115-1119.
Collins, J. W., Wolf, L., Bell, J., & Evanoff, B. (2004). An evaluation of a "best practices" musculoskeletal injury prevention program in nursing homes. *Injury Prevention, 10*, 206-211.
de Castro, A., Hagan, P., & Nelson, A. (2006). Prioritizing safe patient handling: The American Nurses Association's handle with care campaign. *Journal of Nursing Administration, 36*, 363-369.
Engst, C., Chhokar, R., Miller, A., Tate, R. B., & Yassi, A. (2005). Effectiveness of overhead lifting devices in reducing the risk of injury to care staff in extended care facilities. *Ergonomics, 48*(2), 187-199.
Garg, A., Owen, B. D., & Carlson, B. (1992). An ergonomic evaluation of nursing assistants' job in a nursing home. *Ergonomics, 35*, 979-995.
Karsh, B.-T., Holden, R. J., Alper, S. J., & Or, C. K. L. (2006). A human factors engineering paradigm for patient safety: Designing to support the performance of the healthcare professional. *Quality and Safety in Health Care, 15*(Suppl. 1), i59-i65.
Koehoorn, M., Lowe, G. S., Rondeau, K. V., Schellenberg, G., & Wagar, T. H. (2002). *Creating high-quality healthcare workplaces: Canadian Policy Research Networks* (CPRN discussion paper no. W/14). Retrieved April 21, 2003, from www.cprn.com/cprn.html
Lehrer, M. (2009). *Pressure ulcer.* Retrieved April 9, 2009, from www.nlm.nih.gov/medlineplus/ency/article/007071.htm
Lundstrom, T., Pugliese, G., Barley, J., Cox, J., & Guither, C. (2002). Organization and environmental factors that affect worker health and safety and patient outcomes. *American Journal of Infection Control, 30*, 93-106.
Needleman, J., Buerhaus, P., Mattke, S., Steart, M., & Zelevinsky, K. (2002). Nurse-staffing levels and the quality of care in hospitals. *New England Journal of Medicine, 346*(22), 1715-1722.
Nelson, A., Collins, J., Siddharthan, K., Matz, M., & Waters, T. (2008). Link between safe patient handling and patient outcomes in long-term care. *Rehabilitation Nursing, 33*, 33-43.
Nelson, A., Matz, M., Chen, F., Siddharthan, K., Lloyd, J., & Fragala, G. (2006). Development and evaluation of a multifaceted ergonomics program to prevent injuries associated with patient handling tasks. *International Journal of Nursing Studies, 43*(6), 717-733.
Ostry, A. S., Yassi, A., Ratner, P. A., Park, I., Tate, R., & Kidd, C. (2003). Work organization and patient care staff injuries: The impact of different care models for "alternate level of care" patients. *American Journal of Industrial Medicine, 44*, 392-399.
Ronald, L. A., Yassi, A., Spiegel, J., Tate, R. B., Tait, D., & Mozel, M. R. (2002). Effectiveness of installing overhead ceiling lifts: Reducing musculoskeletal injuries in an extended care hospital unit. *AAOHN Journal, 50*, 120-127.
Spiegel, J., Yassi, A., Ronald, L. A., Tate, R. B., Hacking, P., & Colby, T. (2002). Implementing a resident lifting system in an extended care hospital: Demonstrating cost-benefit. *AAOHN Journal, 50*, 128-134.
Villeneuve, J. (1998). The ceiling lift: An efficient way to prevent injuries to nursing staff. *Journal of Healthcare Safety, Compliance, and Infection Control, 2*(1), 19-23.
Yassi, A., Gilbert, M., & Cvitkovich, Y. (2005). Trends in injuries, illnesses, and policies in Canadian healthcare workplaces. *Canadian Journal of Public Health, 96*(5), 333-339.
Yassi, A., & Hancock, T. (2005). Patient safety-worker safety: Building a culture of safety to improve health care worker and patient well-being. *Healthcare Quarterly, 8*, 32-38.