THE EFFECT OF A TRANSFER, LIFTING AND REPOSITIONING (TLR) INJURY PREVENTION PROGRAM ON MUSCULOSKELETAL INJURY RATES AMONG DIRECT CARE WORKERS

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Abstract

Problem Statement: The burden of musculoskeletal injuries among workers is very high, particularly so in direct care workers involved in patient handling. Efforts to reduce injuries have shown mixed results. Strong evidence for intervention effectiveness is lacking.

Specific Aims: The goal of this study was to evaluate the effectiveness of a patient handling injury prevention program implemented in the Saskatoon Health Region (SHR) comparing it with a non-randomized control group, Regina Qu'Appelle Health Region (RQHR), in a pre-post design. Injury rates, lost-time days, and claim costs were the outcomes of interest.

Intervention: A Transfer, Lifting and Repositioning (TLR) program, consisting of engineering and administrative ergonomic controls, was implemented in SHR hospitals from 2002-2005.

Methods: Data on time loss and non-time loss injuries, lost time days, and claims costs were collected from the SHR and RQHR for corresponding time periods one year pre and one year post-intervention. Age, length of service, profession, and sex were selected as covariates. Full Time Equivalents (FTE) data were collected for each time period. Univariate and multivariate Poisson regression were performed.

Results: Rates for all injuries (number of injuries/100 FTE) dropped from 14.68 pre-intervention to 8.1 post-intervention. Control group all injury rates, while overall lower in absolute value, dropped to a lesser degree, from 9.29 to 8.4. Time loss injury rates decreased from 5.3 to 2.51 in the SHR, while they actually increased from 5.87 to 6.46 in the RQHR, for the same intervention periods. Poisson regression showed the greatest reduction in injury rate, both time loss (Rate ratio=0.48, 95% C.I: 0.34-0.68) and non-time loss (Rate Ratio=0.25, 95% C.I: 0.15-0.41) in the smaller long term care facility controlling for hospital size. Analysis of injury rates, incidence rate ratios, and incidence rate differences showed significant differences between the intervention and comparison group for all injuries and time loss injuries. Mean claim cost/injury decreased from $3906.20 to $2200.80 and mean time loss days/claim decreased from 35.87 days to 16.23 days for the SHR.

Conclusions: The study provides evidence for the effectiveness of a multi-factor TLR program for direct-care health workers, and emphasizes their implementation, especially in smaller hospitals.

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Dedication

This work is dedicated to my wife Lisa and my sons Ben and William, to whom I owe an enormous debt of time, energy and gratitude and to my parents, sister, and family members, who all have always encouraged me to challenge myself and to persevere.

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List of Abbreviations

BLS – Bureau of Labor and Statistics
CCOHS - Canadian Centre for Occupational Health and Safety
CI – Confidence Interval
FTE – full time equivalent
GDN – general duty nurse
HCA – health care aide
LPN – licensed practical nurse
LRT – Likelihood Ratio Test
MS – musculoskeletal
MSD – musculoskeletal disorder
MSI – musculoskeletal injury
NIOSH – National Institute for Occupational Safety and Health
NORA – National Occupational Research Agenda
N - Newtons
OH&S – occupational health and safety
OR – odds ratio
OSHA – Occupational Safety and Health Administration
OHSAH - Occupational Health and Safety Organization for Healthcare
OSACH – Ontario Safety Association for Community and Healthcare
OHN – occupational health nurse
OT – occupational therapist
PRC – Parkridge Centre
PH – Pasqua Hospital
PT – physical therapist
RCT – randomized clinical trial
RR – rate ratio
RTW – return to work
RT – respiratory therapist
RUH – Royal University Hospital
RQHR – Regina Qu'Appelle Health Region
RGH – Regina General Hospital
RN – registered nurse
RPN – registered psychiatric nurse
SHR – Saskatoon Health Region
SCH – Saskatoon City Hospital
SCA – special care aide
SAHO – Saskatchewan Association of Health Organizations
TLR – Transfer, Lifting, and Repositioning
WMSD – workplace musculoskeletal disorder
WRC – Wascana Rehabilitation Centre

1. INTRODUCTION

1.1 Study Purpose

The purpose of this study was to evaluate an injury prevention program aimed at reducing injuries related to patient-handling in Saskatoon Health Region direct-care personnel.

1.2 Rationale for Study

The Saskatoon Health Region had conducted an evaluation of the Transfer Lifting and Repositioning (TLR) injury prevention program in 2004. This examined the change in number of injuries during the program. However the implementation of the program had not yet been completed in Parkridge Centre (PC) or even begun at Royal University Hospital (RUH). They did not calculate injury rates, nor use statistical methods. They did use a questionnaire to evaluate aspects of program compliance, acceptance, and effectiveness to nurse managers and program participants (n=702).

This study provided an opportunity to perform a more rigorous evaluation of the TLR program effectiveness. Evidence of effectiveness would also provide further justification for program cost. Positive results would provide an incentive for other health regions to implement similar programs, if they have not done so already. Finally, this study would possibly reveal weaknesses or deficiencies that could be improved to enhance program effectiveness and thus reduce Workers' Compensation Board (WCB) claims, disability and direct and indirect costs of patient handling injuries.

1.3 Literature Review

There is a large volume of literature that has been published on the topic of musculoskeletal injuries in health care workers. As there are several excellent reviews of the current literature available, this review does not attempt to include all papers written on the subject exclusively, but rather provides an overview of the topic, with emphasis on recent musculoskeletal injury (MSI) intervention research in the nursing field. Relevant papers on MSI prevention from outside the health care field are included for comparison and summary tables of relevant intervention studies and recent review papers are provided for reference. Review papers, with a specific focus or results, have been included in the appropriate section.

1.3.1 Musculoskeletal Injuries

Musculoskeletal injuries, or MSI, are characterized by damage to the various structures involved in producing force for movement of the human body such as soft tissue (muscle, tendons, ligaments, nerves) and bone, collectively known as the musculoskeletal system. These are distinguished from structures in metabolic systems, (cardiovascular, excretory, digestive) that play a supporting role but do directly produce or transmit biomechanical forces. MSI can be divided into acute or chronic injuries, the latter also being synonymous with overuse injury, repetitive strain injury, cumulative trauma disorder, occupational overuse syndrome or repetitive motion syndrome.[1]

The basic mechanism for MSI occurs when the forces or workload induced on a structure exceeds the tissue tolerance. In acute injuries, where the structures are suddenly exposed to extraordinary, usually traumatic, forces, the etiology are clear and may be manifest by bone fractures, partial or complete tears in ligaments, tendons or muscles and peripheral nerve disruptions. The subsequent pathophysiological events involved in healing follow complex but well understood pathways.[2] The etiology of soft tissue repetitive strain injury (RSI) is not as well understood, is more multifactorial, and controversial.[3,4] Other ergonomic risk factors that may contribute to RSI are awkward postures, repetitive tasks, vibration, and cold.[5, 6] In bony tissue, the principle is well illustrated by stress fractures which occur over a period of time when high forces, below the bone's immediate failure limit, can eventually produce a small crack or fracture that requires modification of activity in order to heal. Proposed mechanisms for the etiology of RSI involve the concept of "micro-trauma" where small areas of injury occur, but not being given enough rest to heal, eventually becoming symptomatic (painful) and clinically observable as the signs of inflammation: swelling, increased warmth, redness.[3] The most common description of this phenomenon is "tendinitis" or inflammation of the tendon; however, the problem can occur in any of the soft tissues under the right mechanical circumstances. Other distinct types of chronic MSI involve mechanical changes in the intervertebral discs and entrapment symptoms of peripheral nerves, the most common being Carpal Tunnel Syndrome (inflammation and compression of the median nerve at the wrist). Other common maladies include, Cubital Tunnel Syndrome (inflammation and compression of the ulnar nerve at the elbow), Rotator Cuff Syndrome (inflammation and/or tearing of the rotator cuff muscles at the shoulder, Lateral and Medial Epicondylitis (inflammation of the common extensor or flexor muscular origin at the elbow), Trigger Finger (inflammation and binding of the finger flexor tendons), Intervertebral Disc Bulges or Herniations (abnormal protrusion of the spinal disc material) and the related problem of Nerve Root Irritation/Compression or "Sciatica".[7] These diagnostic entities, if linked to occupational exposure, may be collectively referred to workplace musculoskeletal disorders (WMSDs). These injuries continue to be a worldwide problem and contribute significantly to reduced productivity and increased health care costs. [6, 8]

1.3.2 Magnitude of the Problem

1.3.2.1 International

Globally, the burden of musculoskeletal injuries, while apparently decreasing, continues to be high; estimated to represent 40% of all occupational and work-related disease by cost.[8, 9] In addition, the attributable fraction of disease burden due to occupational exposure to ergonomic stressors, with low back pain as an outcome, is estimated at 37%. [8] A group of 269 Swiss nurses, followed for 8 years, showed an annual prevalence of low back symptoms was from 73-76% with over half reporting recurrent symptoms of the same intensity.[10] A survey of 120 Turkish nurses revealed 90% of them reporting a musculoskeletal complaint, and 36% reporting three complaints within 6 months. In this study, low back complaints were very prevalent (69%), neck and shoulder less so (46% and 54%, respectively).[11]

A comprehensive review of back pain prevalence studies in nursing personnel worldwide, based on symptom surveys, indicated a similar pattern of prevalence rates: Sweden (64%), Greece (75%) and Netherlands (47%), although comparisons must be made cautiously due to differences in measurement tools, back pain case definitions, and occupational groups included in the studies.[12] In Great Britain, MSI symptom prevalence rates of 59% in nurses have been reported, as well as high injury rates , while others indicated lower back pain prevalence rates of 46% with no differences between health care occupations.[13,14,15] Menzel documents the course of investigation into low back pain, citing prevalence studies in particular, since its beginning in the

1970s until 2004, noting the appearance of randomized control trials (RCT) on this topic, in 2001.[12]

1.3.2.2 North America

Morse et al. reported musculoskeletal disorder (MSD) rates of 133.1 cases per 10,000 employees in the state of Connecticut. They indicated that MSD rates do not appear to be declining compared to Bureau of Labor and Statistics (BLS) data that are widely quoted, and that this may be due to underreporting of claims to Worker's Compensation Boards.[16, 17] Underreporting has been estimated to be as high as 90% for upper extremity disorders.[16, 17] The health care sector ranked 5th overall in total recordable non-fatal injury and illness incidence rates in 2004-2005. Within the education and health services industry group, nursing care and residential care facilities had the highest injury incidence rate (9.1/100 FTE) followed by hospitals (8.1/100 FTE). Hospitals and nursing and residential care facilities were the top two industries with the largest number of reported cases (281,500 and 209,100, cases respectively).[18] In the USA, Nurses ranked 6th overall for the number of work-related MSI in private industry with prevalence rates of 47% for low back symptoms.[19]

In Washington State, a study of claims frequency, injury incidence rates and costs, in health care workers, for the entire state, showed that health care employers had the highest claims incidence rate when compared to all other industries combined.[20] While the claims incidence rate was declining overall, it was declining faster in the health care sector. Average annual claims incidence decrease was 8.6% from 1996-2000. Claims for back disorders constituted a large proportion of the claims in all occupations with upper extremity disorders, in particular carpal tunnel syndrome, placing second. Nurses and nursing aides had a high share of injuries compared to the rest of employees in the health sector. The compensable back injury claims rate was 162.5/10,000 FTE for health care workers compared to 41.4/10,000 FTE for all other state insured employers.[20] Nursing care facilities placed 4th on a prevention index ranking for spinal and upper extremity WMSDs in a study of Washington State data from 1999-2003.[21]

The state of affairs in regard to health care worker injuries in the USA has been described in florid terms as a "crisis" and "human sacrifice approach".[22, 23]

1.3.2.3 Canada

A report released by the Canadian Nurses Association examined absenteeism from 1987-2005 using Canada Labor Force Survey data. Registered nurses (RN) in Canada have the second highest rate of absenteeism, second only to the standard occupational classification "assisting occupations in support of health services". Absenteeism due to illness and injury in RNs was equivalent to 9,754 FTE positions in 2005. This had been increasing from 1987 to 2002, followed by a 10% decline from 2002-2005. The number of hours absent per nurse had been declining however the total number of nurses absent increased.[24] Interestingly, the absenteeism rate for full-time nurses that was 50% greater than that for part-time nurses.[25] This finding is echoed in other work where full time work was positively associated with an increased risk of back injuries.[26, 27]

Yassi et al. analyzed WCB data and occupational health and safety (OH&S) trends for healthcare workplaces across Canada and found decreasing time loss injury rates from 4.3 in 1998 to 3.7 in 2002. The majority of claims were MSI in all provinces. Time loss injury rates ranged from 1.6-8.0/100 person years across different provinces. Ontario and British Columbia showed the greatest decreases in injury rates temporally corresponding to implementation of injury prevention measures, commonly the provision of lifting equipment, MSI prevention programs, and return to work (RTW) programs. [28]

The 2005 National Survey of the Work and Health of Nurses by Statistics Canada examined many aspects of the health and work environment of regulated nursing professions (RN, LPN, RPNs).[29] Lifting and transferring as part of the job was most common in LPNs (84.5%), vs. RNs (75.6%) and RPNs (50.6%). Twenty five percent of female nurses reported back problems as opposed to 19% of females in general population. No such differences in reported back pain were seen for male nurses. 33.5% of all nurses reported at least one musculoskeletal condition, this being significantly higher than the general population. 77% of all nurses reported that lifting and transferring patients was part of their job and 33% of these respondents reported that mechanical devices were "not always available". Nurses indicating "always" access to lifting devices reported 24.8% prevalence of back pain vs. 28.9% of nurses reporting "not always" having access to lifting devices. Whether these were statistically different was not indicated.[30] Access to lifting devices varied by setting: 95% of nurses in long-term care facilities, vs. 65% in hospitals. Saskatchewan respondents were among the most likely to indicate access to lifting devices (80%) compared with Alberta (63%). Interestingly, Saskatchewan respondents also had the highest frequency of reported back problems (30.1%) and other musculoskeletal problems (40.6%). They also indicated high physical demands most frequently (68.9%). They reported the second highest average age (45.2 years) after British Columbia and the highest average number of years worked in nursing (19.7).[29] The average age (44.7 years) of Saskatchewan RNs is slightly lower than the national average RN age.[31] These elevated MSI symptom reports are interesting given the fact that Saskatchewan nurses report lower requirements for patient handling and better access to lifting equipment.

1.3.2.4 Saskatchewan

Saskatchewan WCB data from 2007 indicate that nurse aides, orderlies and patient service associates had the highest number of claims reported (1721 claims) for all occupation groups. Health Authorities, Hospitals and Care Homes had the highest number of claims for any Industry Rate Code group (5177 claims), which represented 6.26% of all workers injured with time loss. This had decreased from 7.2% in 2003. Average number of days lost/injured worker for this Employer Group went from 29.1days in 2003 to 23.0 days in 2007.[32] WCB data from 2006, detailing "Accident Event by Occupation", for "nurse aides, orderlies and patient service associates" indicated "bodily reaction and exertion" made up 61% of injury claims, the next highest being "contact with objects and equipment" at 11.2% (total claims 1609).[33] For Registered Nurses the same data revealed a similar pattern at 42% and 26.6% respectively (total claims 810). For both these occupational groups, back injuries predominated followed by shoulder injuries.[34]

In an internal study, the Saskatoon Health Region (SHR) reported the number of injuries yearly, for all facilities under their jurisdiction: 592 (2000), 625 (2001), 694 (2002) and 639 (2003). "Over 80% of the annual Workers' Compensation costs were attributed to back, neck or shoulder injuries, and the majority were related to transferring, repositioning and lifting" The WCB claims costs were $2,849,293 in 2002. This did not include other direct costs or indirect costs, which when added, were estimated at 5-10 million dollars, representing a substantial burden to the employer.[35]

1.3.3 Risk Factors for MSI and Work Related Disability in Health Care Workers

1.3.3.1 Biomechanical Factors

Patient handling activities subject workers to high biomechanical loads.[36, 37] In an extensive review of studies dealing with the relationship between low back disorders and ergonomic work factors, strong evidence for association of low back disorders with lifting and a positive dose-response relationship was found.[6] Risk ratio estimates ranged from odds ratio (OR) of 1.2-5.2 for studies using subjective measures and odds ratio of 2.2 -11 if objective measures were used.[6]

Biomechanical studies specific to patient handling tasks have identified high spinal loads during these activities. Marras (1999) found that all manual transfer and repositioning techniques posed an increased risk based on spinal loading. Fifteen to twenty percent of the two person transfers exceeded safe spinal loading limits. The number of persons performing the lift was more influential than the type of technique used. The authors indicated that this study was performed under ideal, but realistically recreated, conditions with a light (50 Kg), cooperative subject and that loads in actual health care facility working conditions may be higher.[37]

A similar study by Zhuang et al. (1999) evaluated biomechanical spinal loads during patient handling using mechanical devices and compared these to manual techniques, revealing spinal loads that exceeded the National Institute of Occupational Safety and Health (NIOSH) safe limit of 3400 Newtons (N) during manual and belt assisted transfers. These values were compared to spinal loads using 9 different battery powered lifts (stand up lifts, basket sling and overhead or “ceiling” lifts). While the mechanically aided transfers decreased spinal loading overall, there were still some activities (10% or more) of every category that exceeded safe limits. These occurred while preparing the patient for use of the mechanical lifts. Overall the lifting stress exposure was reduced by two-thirds. Rolling patients to position the sling for the basket lifts was best performed by pushing rather than pulling to reduce spinal loading.[36] This is consistent with general biomechanical demands of pushing and pulling.[38]

In a follow up study, Zhuang et al. (2000) evaluated the psychophysical attributes of different transfer devices for both nursing assistants and patients.[39] Ceiling lifts were the least accepted by the nursing assistants due to slow speed, lack of maneuverability, and lack of simplicity in hooking up the sling. In examining performance times for the different methods, manual patient handling methods were found to be the quickest.[39] This may be an important aspect of resistance to use of manual lifts in a busy, understaffed facility.

If standard manual patient handling techniques continue to be used, possibly because they are more time efficient, then they can be improved to reduce the biomechanical hazard. Nelson (2003) examined 9 patient-handling tasks identified as "high-risk" using modern biomechanical analysis techniques. These included activities that involve sustained stooping and trunk twisting, that are frequently ignored or only mentioned briefly in other studies.[40] Trunk flexion over 45 degrees has been associated with increased risk of disabling low back pain.[41] While other studies have focused on the NIOSH spinal compression guidelines, Nelson (2003) found that most of the excessive biomechanical forces were not in compression but in lumbar anterior-posterior shear. They did not use the NIOSH guidelines in evaluating their results. These forces and others including erector spinae muscle activity and shoulder force moments were significantly reduced, from 25-69%, when tasks and procedures were modified.[40] A guideline limit of 1000 N has been proposed as a limit on lumbar shear forces.[37] As Nelson does not report the absolute values of the forces they measured, no comparison can be made to this 1000 N guideline to predict the potential impact on injury prevention that these changes to practice may have. Nelson also examined the forces required when using a ceiling lift (without moving the patient into sling) and new technology to transfer from bed to stretcher. Based on these results they advocate the use of ceiling lifts to reduce biomechanical forces however, ceiling lifts have their own set of disadvantages and may not be well received by patients or caregivers.[39] Until these technologies are more accepted, floor mounted mechanical lifts and standard techniques may continue to be preferred.

Reduction of risk for MSI related to patient handling requires not only the reduction of biomechanical forces involved with each activity, but also the reduction of the overall exposure to patient handling. Frequent lifting has been shown to be associated with earlier onset of back injury compared to infrequent lifting, irrespective of nursing occupation.[42] Frequent patient handlers were also seven times more likely to have had previous back injuries.[42] An increased risk of back injury was found in nurses who transferred patients more than once per shift.[26] Other tasks such as moving occupied beds, moving other heavy equipment, and holding patient limbs while applying anti-embolism stockings, add to the biomechanical stresses endured by nursing personnel.[43] The nature of the patients being transferred is not a useful predictor of shoulder and back injuries in nursing home workers.[44] Despite the known dangers of manual lifting, techniques such as the under-axilla method of transfer are still being frequently taught in nursing schools, even when popular nursing texts do not mention this lift, or do not recommend it. Use of hydraulic lifts is only being taught "often" or "very often" in 51% of a sample of nursing programs.[45]

1.3.3.2 Psychosocial Factors

Back pain and resulting disability are not a purely biomechanical phenomenon but are multi-factorial in nature.[6] In the general population, there is evidence that psychosocial factors, such as characteristics of the worker (fear-avoidance beliefs, coping ability and catastrophizing), work environment (job strain, low social support and job satisfaction), and environment outside of work, are associated with length of disability and return to work due to MSI.[46] However, there is only modest support in the literature, of these factors as etiological agents in MSI.[6, 46] Specific to work factors and low back pain, Hartvigzen (2004), concluded that there was moderate evidence for no association between organizational aspects of work, social support and perception of work and back pain.[47] Many of the previous studies examining this association had methodological flaws.[47] Job strain (high psychosocial demands and low decision latitude) have been found to have little association with back injury in one study.[26] Association was not found between low decision authority and high work demands and disabling low back pain.[41] A meta-analysis showed strong associations between job satisfaction and mental health particularly burnout, lowered self-esteem, anxiety and depression.[48] The lowest correlations were found for cardiovascular disease and musculoskeletal disorders.[48] Significant psychosocial predictors of disability due to carpal tunnel disorder in the general population were identified as low income, low education, no offer of job accommodation, low recovery expectations, low mental health score, catastrophizing and high fear-avoidance scores.[49] Psychosocial and other factors not associated with patient handling (postural stresses), work organization issues may impact injury and disability outcomes.[44, 50-52]

Findings from these studies may point to the importance of managing psychosocial factors in preventing excessive disability after MSI or onset of symptoms rather than as a part of primary prevention efforts. Ultimately, ergonomics may provide a more fruitful avenue for prevention of back disorders in nurses.[53]

1.3.3.3 Organizational Factors

Staffing and work organization factors may play a part in MSI. Nursing staff shortages can lead to an increase in workload for other nurses or patient handling personnel. One study found an 80% increased risk of back injury for nurses on the Monday day shift, which was thought possibly to be due to weekend staffing shortages.[26] Staff turnover and being new to the workplace have been associated with increased risk of injury.[44]

In a study of 1551 nurses in 13 hospitals, low self report scores of several organizational climate characteristics such as professional practice, nurse/physician collaboration, nurse management, opportunity for advancement and unit decision making have been associated with increased risk for MSI.[52] Poor availability of leadership and lack of leader support, lack of organizational support such as lack of rapid substitute for replacement workers, and lack of medical expertise were shown to be risk factors for disability in home care workers.[51] Organizational factors may be more important in the implementation and maintenance of ergonomic intervention programs.[54, 55] The use of "peer leaders", "Ergocoaches", "Ergo Rangers" or "Back Injury Resource Nurses (BIRNS)" seems to be a common recommendation as a component of successful patient handling ergonomics programs.[54-57]

1.3.3.4 Worker Factors

Age has been reported to have a protective effect for MSI in nurses, possibly due to higher experience and skill, seniority which places older workers in safer jobs, better ability to obtain help and holding job positions with fewer patient handling requirements.[44, 58, 59] However the risk of disabling low back pain in nurses has been positively associated with age, especially over age 50.[41]

1.3.3.5 Effect of Health Care Setting

Alamgir et al. (2007) examined trends in work related injuries in direct care occupations in various healthcare settings in British Columbia. MSI comprised the majority of all injuries for each profession and setting. Relative risk of MSI and other injuries varied by profession and setting. Generally Care Aides had the highest risk overall and the highest risk for injury when working in acute care facilities and nursing homes. By setting, the highest risk for MSI was shown to be in nursing homes followed by community care and acute care sectors and thus prevention efforts should be targeted at care aides, nursing homes and community care facilities.[59]

Further study and knowledge of all risk factors for patient-handling related MSI and associated disability is essential to help guide intervention research studies and both primary and secondary prevention efforts

1.3.4 Injury Prevention Efforts in Health Care

In the United States, the "Handle with Care" campaign, developed by the American Nurses Association and rolled out in September 2003 is designed to stimulate and motivate the health care industry to reduce patient handling related musculoskeletal injuries in health care workers. The main components are to develop partnerships with nursing associations, health care systems and the academic community; education and training for nurses and health care administrators; an outreach program advocating safe patient handling programs including the use of assistive equipment; and advocacy for changes in student nurse education around patient handling.[60]

Efforts to pass legislation that enforces ergonomic modifications and standards for patient handling practices have largely failed. The Occupational Safety and Health Administration (OSHA) ergonomics rule was developed to protect health care workers but was repealed in 2001. OSHA is also barred from developing another ergonomics standard without federal approval. In Washington State, the Department of Labor and Industries developed a similar ergonomic rule that was also defeated in legislature.[61] A similar bill was vetoed in California in 2004. In response, the OSHA published Guidelines for Nursing Homes: Ergonomics for the Prevention of Musculoskeletal Disorders.[62] However, in Texas, a first ever legislation for safe patient handling was signed into law in June, 2005. This legislation covers hospitals, nursing homes and facilities employing health care workers and requiring employers to assess control the risk associated with patient handling tasks, eliminating handling all or most of a patient's weight except in exceptional circumstances.[63] With the passing of this legislation, similar bills are being introduced or reintroduced in Massachusetts, Ohio, New York, California and Washington State.[63] Changes to the Workers' Compensation system, in the United States, to make employers more accountable for workplace injuries is also advocated.[22]

The United Kingdom has implemented policies to eliminate manual patient handling under more general material handling legislation. Australian nurses, having more specific manual handling regulations in place for more than 10 years, still had a high rate of injuries compared to other countries.[22]

In Canada, funding for healthcare is largely under Provincial Jurisdiction with some exceptions.[64] The Canadian Centre for Occupational Health and Safety (CCOHS) is the federal government organization disseminating occupational health and safety (OH&S) information. Specific research on MSI generally occurs at the provincial level. British Columbia has an Occupational Health and Safety Organization for Healthcare (OHSAH) which conducts research.[65] The Ontario Safety Association for Community and Healthcare (OSACH) serves as a resource for employers to aid in injury prevention efforts and reduce claim costs, although they do not appear to be involved in experimental or evaluative scientific research.[66] In Saskatchewan, specific OH&S legislation (OH&S Act, section 470(1)) exists that deals with lifting patients.[67] This specifies development of written programs, provision of mechanical devices, education in injuries and use of mechanical aides and in manual handling techniques, patient evaluation system and visual indication, of the type of handling they require such as a placard by the patient beside, review of injuries resulting from patient handling activities, and prevention. As such, they do not mandate the use of mechanical devices, but only where they are identified as necessary to safely move the patient. In 2008, a new injury prevention program called "Misson Zero" has been implemented by the Saskatchewan Worker's Compensation Board, with the purpose of reducing Saskatchewan's work-related injury rate which remains the second highest in Canada compared to other provinces.[68]

Ultimately, prevention of injuries will help to keep nurses in the workforce. With nursing shortages predicted in the future, this becomes ever more important. Prioritization of heavy physical work was identified as a significant barrier to retaining staff in nursing homes.[20] Reduction of physical demands is an important component for retention of older nurses.[69]

1.3.5 Intervention Research

MSI injury prevention interventions may be classified as multifactorial or single factor. Tables 1.1, 1.2 and 1.3 provide information on several relevant intervention studies and literature reviews. Several systematic literature reviews examining studies of MSI prevention interventions in health care workers have been recently published.[23, 50, 70-73] Many of the intervention studies showed one or more attributes which limit the study power and generalizability of their findings: (1) weak study design (none or non-randomized control group), (2) small sample sizes, (3) limited explanation of interventions, (4) short follow-up periods, (5) multiple interventions (limiting studies ability to detect causative factors), (6) no measurement of compliance, (7) wide variety of outcome tools used especially for symptoms and psychosocial variables, and (8) difficulties in case definition and repeat injuries. This however is reflective of the reality of workplace-based research where intervention based RCTs and cohort studies are difficult to implement, partly due to: (1) work organization factors, (2) staff turnover or migration, (3) lack of stakeholder buy-in, and (4) limited health care financial resources. The most common factors in injury reduction intervention programs have been identified as: (1) equipment provision/purchase, (2) education and training, (3) risk assessment, (4) policies and procedures, (5) patient assessment systems, (6) work environment redesign, and (7) work organization/practices change.[74]

1.3.5.1 Program Development

Evanoff (1999) examined workplace MSI in hospital orderlies after the implementation of a participatory ergonomics team and showed a significant and dramatic reduction in injury rates when compared to other workers in the facility.[75] The intervention was also inexpensive but could not be sustained in some areas, pointing to the importance of organizational factors in implementing and sustaining such a program.[76] The applicability of this type of intervention to different health care groups remains to be seen.[76]

Stetler (2003) describes the design a patient handling injury prevention program for the Baystate Medical Centre.[71] The program was designed using the author's model for development of an evidence-based injury prevention program. This model includes use of: (1) external data from systematic literature review, (2) internal data collected in the facility using research techniques, (3) development of an evidence-based plan for change, and (4) collection of internal data for program evaluation. Details of the literature search were not provided. This method makes interpretive decisions regarding the synthesized evidence with consideration for degree of fit with the local setting. The program focused on: (1) multiple strategies, (2) shift in language to a culture of prevention, (2) patient assessment, (3) competency-based education program, (4) team patient handling, (5) new patient handling products, and (6) gathering of internal evidence such as department patient handling needs assessments, supplementary post injury data, and summary injury statistics.[71] The author indicates that injury prevention programs should be based on more than evidence from the literature if this evidence not of a sufficient level or strength.[71]

1.3.5.2 Single Factor Interventions

Moderate evidence for effectiveness of single factor interventions including provision of lifting equipment or a lifting team approach has been found.[74]

1.3.5.2.1 Mechanical lifts

Several studies have examined MSI rates, costs and economic benefits health care facilities following the installation of mechanical lifts using a pre-post study design.[77-80] Evanoff et al. (2003) used a control group of other hospital workers to detect general trends in injury rates and found decreases in MSI risk ratios post-intervention in both acute and long term care facilities.[77] Lost time days were reduced and the authors indicated that this may have been due to the reduction of physical demands that allowed injured workers to return to work faster. However, this finding may have also been due to a decreased severity of injury initially after installation of equipment. Chhokar (2005) showed that there may be latency in reduction of claims after installation of mechanical lifting devices.[81] Compliance with mechanical lift usage was monitored as the equipment was able to count the number of lifts performed. Lift usage by the workers was enforced with a mandatory policy in the long term care facilities but not the acute care hospital, which could have biased their results.

Ronald et al. observed a decrease in patient handling related MSI after the installation of overhead ceiling lifts.[79] A further decline was also seen after a subsequent training program which included training on lift usage, general patient handling, a no manual lift policy and transfer belt policy. The small sample size limited the power of this study and lack of control group limited the internal validity of the findings. The specific advantages of ceiling lifts have been addressed by Zhuang.[36] Silverstein et al. (2005) indicated that ceiling lifts have been well received due to easy availability and smooth movement and that the most physically demanding part of using floor and ceiling lifts is putting the sling under the patient.[20] The barrier to ceiling or other mechanical lift usage is a perceived increase in the extra time required to use them, even though the majority of workers believe they help to prevent injury.[20] Economic benefits of ceiling lifts have been shown to be substantial, with a cost benefit ratio of 6:1.[81, 82] Engineering controls and ergonomics programs for back pain seem to have good cost vs. benefit when examined in developing countries.[83]

Studies of lifting equipment interventions for patient handling have generally shown favorable results for MSI injury reduction. Owen (2002) found that these benefits could be sustained in a five-year follow up study.[80] Subjects in this study indicated high levels of shoulder stress with some of the tasks. Ergonomic interventions that use engineering controls such as the addition of patient handling equipment must be designed such that one ergonomic risk is not increased while decreasing another by transferring high loads or repetitive movements from one body part to another. The consistent availability of mechanical devices and personnel as well as a high level of program compliance are also required to ensure program effectiveness.[77] The frequency of body part injured pre and post intervention has been mentioned but not discussed extensively in the literature.

1.3.5.2.2 Educational Training and Organizational Interventions

Educational programs, designed to reduce low back injuries or other MSIs in the general population, have yielded little success.[58, 84] This seems to be echoed in the health-care field and in direct patient care populations. Pure educational interventions or those combined with simple, non-mechanical equipment do not appear to reduce injuries nor reduce reports of back pain. [50, 85, 86] Evidence for effectiveness of back pain educational programs “back school” is mixed.[87, 88] There is strong evidence that indicated technique training alone has no impact on injury rates or work practices and; moderate evidence that these interventions can have mixed or positive, short term, outcomes.[74]

Bos and Krol et al. (2006), using procedures developed by the Cochrane Collaboration, examined 13 papers that included occupational interventions in nursing primarily aimed at the reduction of musculoskeletal symptoms.[72] All the studies included theoretical and practical training as part of the interventions, and some included mechanical equipment, physical exercise, and organizational changes. In some studies, absenteeism, numbers of injury claims as a result of back incidents, technical performance of transfers, frequency of manual lifting or working in poor postures, or knowledge of risk factors were used as outcomes. Of the thirteen studies, 11 were rated as high quality, 3 being RCT design, and a control group being present in the other eight. The results echo other reviews where training and education interventions showed no decrease in musculoskeletal symptoms but some effectiveness when combined with ergonomic interventions. This did not seem as effective in reducing absenteeism. The authors argue that the link between training-based interventions and the reduction of symptoms is more direct due to the improved technical performance of patient handling tasks. However this may not translate into reduction of absenteeism due to organizational factors. The definition of what constitutes a “complaint” is cited as a difficulty in comparing studies and more specific outcome variables are deemed necessary.[72] Due to issues of under-reporting, some argue that symptom prevalence studies are more useful in measuring the true magnitude of WMSDs.[12, 17]

A recent review by Martimo et al. (2008) investigated the effect of advice and training on working techniques and lifting equipment in preventing back pain in heavy lifting jobs.[50] Cochrane methodology and meta-analysis using odds ratio and controlling for clustering was applied to data from 11 studies (6 RCT and 5 cohort studies). All studies were from the health care field, except three with study populations of postal workers, cargo handlers, or fleet service clerks. Effective sample size was 2727. The authors indicate that the ability of previous studies to detect significant intervention effects has been hampered by small sample sizes. Training interventions in each study were described and categorized as least engaging (lectures, pamphlets, videos), moderately engaging (programmed instructions, feedback interventions) or most engaging (training in behavioral modeling, hands-on training). Four of the 11 studies had an "unclear" intervention engagement rating and none met the "most-engaging" standard. Training time spans ranged from single 1 hour session to two years. Five of the studies had interventions that encouraged the use of assistive devices. The "intensity" of training methods, as measured by the number and duration of sessions varied between 1 x 1 hr. and 104 x 1hr. Training "intensity" did not seem to be linked to more positive outcomes. Overall, the odds ratios for these trials were all equal to 1 with the exception of Yassi (2001) that showed a beneficial, but not statistically significant, improvement.[50] Management commitment was only identified in three studies and this has been suggested as important to sustain an effective program.[20] This most recent review, focusing on RCT and cohort studies worldwide, points to a lack of high quality intervention studies to evaluate reduction of injuries related to patient lifting and handling in health care workers, despite the preponderance of this population as a study group. Of the 5 high quality cohort studies involving nurses, all of them used frequency or prevalence of back pain or musculoskeletal symptom reports as the outcome measure.

Secondary prevention efforts aimed at reducing disability and work time loss after injury can be effective.[89, 90] Interestingly, the majority of studies that examine MSI incidence in nurses and also subsequent time loss and claims costs make little mention of post injury disability management, which can impact these outcomes. Employer factors including availability of light duty programs are significant predictors of RTW in general industry.[91, 92]

1.3.5.2.3 No-lift Programs

Garg et al (1999) demonstrated a reduction in MSI following implementation of a "zero lift" policy in 7 nursing homes and one hospital.[93] This was a pre-post evaluation and appeared to be primarily an ergonomic intervention with mechanical lifting and transferring equipment.

Silverstein et al (2003) conducted an evaluation of a state-wide injury prevention program that targeted patient handling injuries in nursing home facilities.[94] Three main evaluations were "Getting to Zero" training materials which introduced a "zero-lift" injury prevention program, a Workers' Compensation job modification incentive and a Workers' Compensation premium discount pilot program. Surveys and site visits along with WCB data from 1995-2001 were gathered. This was a complex evaluation and general results indicated that injury rate reductions, initially seen over the first two years, could not be sustained. High management and staff turnover were cited as one reason for the program's lack of sustainability.[94]

1.3.5.3 Multifactor interventions

Multifactor interventions have some evidence of success from the general literature on WMSD prevention. Silverstein (2004) reviewed 20 RCTs, 17 quasi-experimental studies with control groups and 36 case studies relating to primary and secondary prevention of WMSDs. The most common interventions were educational programs, with little evidence for sustained effect. Ergonomic program elements showed some evidence for positive effect from non-RCT studies. [58] Stetler (2003) identified multiple injury prevention strategies in the literature including: elimination of risk factors (exercise programs), engineering controls (lift teams, lifting device), administrative controls (no-lift policy), and training/education.[71]

In a review paper, Hignett (2003) outlines the gradual abolishment of controversial lifting techniques that have been in common practice and suggests that current techniques should be subject to scrutiny based on available evidence.[74] They reviewed 2796 papers published from 1960-2001, identifying 63 dealing with intervention strategies. Papers were grouped into 3 categories: Multi factor, single factor and technique training based interventions. This widely cited paper indicated moderate support from 10 papers for success of multifactor interventions based on risk assessment and moderate evidence from 4 papers for improvement after multifactor interventions, not based on risk assessment, with contradictory evidence from one, high quality, paper indicating no improvement.[70]

Yassi et al. (2001) conducted a randomized clinical trial to evaluate patient handling injury prevention interventions at the Winnipeg Health Sciences Center.[95] The study design evaluated two different interventions with a control group, giving a 3 arm study. One intervention "no strenuous lifting arm" consisted of increased availability of mechanical equipment, the second "safe lifting arm" received the same equipment but with increased availability of transfer belts and sliders. Both intervention groups received intensive training on back care, and patient handling techniques. The control group received education on safe lifting by request only. Wards were randomly assigned to one of the groups. The three types of wards, medical, surgical and rehabilitation all had high injury rates and were evenly distributed between groups. Outcomes measured were WCB injury data including injury frequency, time loss days, and direct claims costs, along with self report measures of symptoms, work fatigue, and work load. 346 nurses in 9 wards were studied with measurements taken at baseline, 6 month and 12 months. Results showed some change in patient lifting behavior, increased use of mechanical lifts and other equipment, decrease in non-mechanical patient handling techniques, and decreases in musculoskeletal symptoms; however some of these changes were not sustained. Injury rates did not change significantly. There was a lowered statistical power of this study to detect changes in injury rates due to low number of injuries and a possible low sensitivity of the outcome measures chosen. The authors point to difficulties in conducting RCTs in workplace settings and to the importance of staffing and work organization factors. This study was given a low methodological rating in the review by Martimo et.al. [50] but represents the seemingly only RCT conducted in Canada on this topic to date.

A pre-post design study of 1728 nursing staff was conducted by Collins et al. (2004) to evaluate a "best practices" MSI prevention program in 6 US nursing homes.[96] This multi-factorial intervention consisted of mechanical lifts (full body and stand-up), friction reducing sheets, written zero lift policy, skill based training in the equipment use and patient handling assessment, and a medical management program (pre-existing) including modified duty program. WCB, OSHA and employee injury reports were measured 3 years pre-intervention and 3 year post-intervention. Resident handling injuries decreased significantly as measured by all three data sources. Non-resident handling injuries were used as a reference group and changes in these injuries were only significantly decreased when using workers compensation data. Comparison of the reference group indicated a significant reduction in resident handling injuries across all covariates: nursing home, age group, job tenure, and work status (full or part-time). Resident assaults and violent attacks were also reduced. Contradictory evidence for effectiveness of mechanical lifts and training were found in one study which used back pain symptoms and a weaker cross sectional survey, pre and post intervention design.[97]

Nelson (2006) in a review, reinforced the findings of other reviews for the need to move towards practices which have support for effectiveness, identified as: patient handling equipment, patient care ergonomic assessment protocols, no lift policies, training on proper use of patient handling equipment and patient lift teams. Further research into high risk tasks such as trauma and emergency care, home care and setting specific high risk tasks, such as repositioning or turning patients in bed is suggested. A new peer leader model is advocated. Clinical tools and algorithms for patient handling assessment, developed in Britain, Canada, Australia and USA are highlighted.[23]

A multi-factor ergonomics program in a pre-post study with no control group was evaluated by Nelson et al (2006). MSI rates and number of modified duty days decreased significantly but not the total number of lost workdays. Some measures of job satisfaction also improved. This intervention focused on elements taken from a review of international literature from inside and outside the healthcare field. Intervention elements were ergonomic assessment protocol, patient handling assessment and decision algorithms, peer safety leaders, patient handling equipment supplied after a needs review, an “after action” review process (injury debrief) and a no-lift policy. While not a strong study design, this paper explores several important issues in injury prevention intervention research. Some of their results were surprising in that out of 23 units in the study, 7 reported increased injury rates. This was explained as result of increased awareness which created an increased willingness of employees to report injuries. Another important point raised was the issue of data maturation. To fully capture all time loss and claims cost information, a 5 year post-intervention follow up period is generally recommended, as some claims can become very chronic and take many years to close. Nursing turnover rates are also difficult to control and can impact the results as nurses’ move between units. They estimated the turnover rate in some units to exceed 65%.[98] This problem is not mentioned frequently in these types of studies. The lack of technology to address patient repositioning tasks, which are high-volume and high-risk was also underlined. Other authors have found that some lifts can be used for repositioning, but report that they are frequently underutilized for that task.[79]

Table 1.1 provides a summary of intervention studies focusing on those which used injury rates as an outcome measure, had ergonomic or multi-factor interventions and were in health care settings. They are grouped according to health care setting as much as possible to allow for comparison of results between studies and with results of our study. Only one of these studies (Yassi 2001) is a RCT. Three used a non-randomized control group, two an internal control group, and five had no control group. Interestingly, all the studies conducted in long-term care facilities, nursing homes, or identified high risk units in hospitals showed positive results. The two of the three studies conducted in large acute care hospitals showed no improvement in outcome measures. The summary shows the wide variety of interventions especially with respect to the amount and type of training provided, from a single 1 hour session to 1 hour/week for 2 years. Summary of studies in Table form allows for rapid comparison of results and for detection of gaps in the research literature.

Table 1.2 provides a critical appraisal of systematic reviews included in this section, using AMSTAR (Assessment of Multiple Systematic Reviews) criteria reported by Shea et al.[99] Narrative reviews were not included in this Table. The majority of the reviews meet most, or all, of the criteria. Table 1.3 provides a basic description summary of the review articles for easy comparison.

Table 1.1: Summary of Intervention Studies

Author	Study Population	Setting	Intervention	Study design	Measurement period	Outcome measures	Primary Results
Lynch and Freund [100]	Patient care staff N=374	Acute care hospital	Patient transfer devices, train the trainer program, and a 1 hr training session consisting of 30-40 min lecture and 20-30 min of hands on practice.	pre-post design with an internal control group	4 yrs during and 6 mo. following program implementation	Injury rate, # lost time injuries, ergonomic knowledge, back pain symptoms, work practices,	30% reduction in lost time injuries, 73% reduction in lost time work days, improved knowledge,
Yassi et al. [95]	Nurses, N=346	Acute care hospital	(1) Increased patient lifting equipment, 3 hr training (2) increase lo-tech equipment, 3 hr training (3) Control- no equipment changes, training on request	RCT, cluster randomized by ward into 3 study "arms"	Measurements at baseline, 6 mo and 12 mo.	Injury rates, frequency of patient handling tasks, self-perceived work fatigue, symptoms, safety,	No change in injury rates between arms, improved comfort levels for arm 1
Smedley et al. [97]	Female nurses and health care assistants N= 837	2 acute care hospitals	Revision of manual handling policy, lifting and handling equipment, sliding sheets, transfer belts, resource nurses, 2 day training course	Pre-post with non-randomized control group	Baseline survey, follow-up at 32 mo.	Postal survey of back symptoms and psychosocial stressors	No change in back pain prevalence
Owen et al. [80]	Nurses, N=37	Small rural hospital	Mechanical equipment, patient sliders and transfer belts, patient handling protocol, 2.5 hr training	Pre-post, with non-randomized control group	18 mo pre-intervention and 5 yrs post-intervention	Number of injuries, number of lost workdays, number of restricted workdays, worker perceived exertion, patient comfort and security	40% reduction in injury rates, other changes variable, improvement on subjective measures
Li et al. [78]	Nursing personnel N=61 for survey only, N= 138 total	Small community hospital	Mechanical lifts, one-time nurse training	Pre-post with no control group	4 years for injuries, 6 mo for symptom survey	Symptom surveys, injury rates, lost day injury rate, WCB costs	Injury rate RR= 0.50, Lost day injury rate RR = 0.35, 69% reduction in WCB costs/claim

Author	Study Population	Setting	Intervention	Study design	Measurement period	Outcome measures	Primary Results
Nelson et al. [98]	Nurses N =166	High-risk units in hospitals and nursing homes.	Ergonomic assessment protocol, Patient handling algorithm, peer leaders, equipment, after action reviews, no-lift policy, equipment training	Pre-post without a control group	9 months pre and post-intervention	Injury rates, lost work days, modified work days, job satisfaction, staff and patient acceptance, program effectiveness, program costs/savings	Injury rates reduced 30%, modified duty days reduced 70%, no change lost work days
Collins et al. [96]	Nursing staff N=1728	6 nursing homes	Mechanical lifting equipment, employee training and a zero-lift policy which consisted of a standardized patient handling needs assessment	pre-post design study without a control group	3 yrs baseline, 3 yrs follow-up	Injury rates from WCB, OSHA logs and worker reports, lost work day and restricted work day rates	Rate ratios: 0.39 WCB claims, 0.54 OSHA logs , 0.65 worker incident reports
Garg [93]	Health care workers N=1124	7 nursing homes, 1 long term care hospital	Replace manual lifts with powered lifts	Pre-post with no control group	30 mo pre-intervention, 51 mo post-intervention	Number of patient transferring injuries, lost workdays, restricted workdays, WCB costs	62% decrease in patient handling injuries, 86% decrease in lost workdays, 64% decrease in restricted workdays, 84% decrease in WCB costs
Evanoff et al. [77]	Health-care personnel N= 6835 FTE N=190 interviews	4 acute care hospitals, 5 long term care facilities, 36 intervention units	Patient lifting equipment, 2 hr hands on training in lift operation	Pre-post with internal control group	1 or 2 yrs pre-intervention, 1-2 yrs post-intervention	Injury rates, lost time injury rates, lost workday rate, lift usage interview	All injury RR 0.71-0.86 Lost workday RR 0.28-0.67, Dependent on facility
Ronald et al. [79]	RN, Long term care aides, activity aids, N=108	Long term care unit in	Replace floor lifts with ceiling lifts, MSI prevention training, “no manual lifting” policy, new transfer belt policy	Pre-post, no control group	3 yrs pre-intervention, 2 yrs post intervention	Injury rates, TLR injury distribution, staff and resident surveys	No decline in overall MSI rates, 50% decline in lifting and transferring MSI rates
Hartvigsen et al. [86]	Nurses and nurse aides, N=255	Home care	Training 1 hr/week x 2 years, lo-tech ergonomic aides (slider sheets, transfer boards)	Pre-post, non-randomized control group	Baseline and follow-up after 2 yrs.	Musculoskeletal symptoms using Nordic Questionnaire, and low back pain	No reduction in MS symptoms

Table 1.2: Critical Appraisal of Systematic Review Articles

Author	Review Type	Was an a Priori design provided?	At Least Two Independent Assessors ?	Comprehensive Search?	Inclusion And Exclusion Criteria Stated?	Study characteristics provided?	Scientific quality assessed and reported?	Scientific Quality of the included studies used to formulate conclusions	Methods used to combine findings appropriate?	Likelihood of publication bias assessed?	Was conflict of interest stated?
Bos, et al. [72]	Systematic (Cochrane Methodology)	Yes	Yes	Yes	Yes	Yes	Yes, Used Checklist	Yes	?	No	No
Hignett[70]	Systematic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	No	No
Martimo et al [50]	Meta-analysis (Cochrane Methodology)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Faragher et al.,[48]	Meta-analysis (Cochrane Methodology)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Hartvigsen et al.[47]	Systematic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Silverstein and Clark[58]	Systematic	Yes	No	Yes	Yes	Yes	Study design only	Study design only	N/A	No	No

Criteria from Shea et al.[99]

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Author	Number of Studies Reviewed	Types of Studies Reviewed	Time Frame	Study Question	Overall Conclusions
Bos, et al. [72]	13	RCT, Controlled Clinical Trial, Clinical Trial	1985-2005	What are the effects of occupational interventions for primary prevention of musculoskeletal symptoms in healthcare workers?	Training and education, combined with ergonomic intervention effective in reducing MS symptoms
Hignett[70]	63	Intervention studies related to reduction of risk factors for patient handling injuries	1960-2001	What are results of available research on patient handling tasks, equipment and interventions and how do they compare with current guidelines?	Strong evidence that training alone is not effective. Moderate evidence to support multifactor interventions. Moderate evidence to support provision of equipment or lifting teams.
Martimo et al [50]	11	RCT, Cohort Study	Up to 2005	Do advice and training on working techniques and lifting equipment prevent back pain in heavy lifting jobs?	No evidence to support effectiveness of training, with or without ergonomic equipment, in preventing back pain.
Faragher et al.,[48]	485	RCT, Cross-sectional/correlational cohort, Case-control	1970	Is there a link between job satisfaction and measures of health?	Strong relationship between job satisfaction and health.
Hartvigsen et al.[47]	40	Prospective cohort studies	1990-2002	What is the association between poor psychosocial work environments and the presence of LBP or its consequences?	Insufficient to strong evidence for no association between various psychosocial work factors (stress, work organization, perception of work, social support) and LBP or its consequences
Silverstein and Clark[58]	88	Literature Reviews, RCT, Quasi-experimental studies with control groups, case studies	1990-2003	No specific question provided. Authors aim to improve knowledge base.	Combination of engineering and administrative controls have greatest effect to reduce WMSDs.

Table 1.3: Summary of Systematic Review Articles

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1.3.6 Research Issues and Future Directions

1.3.6.1 MSI Research in Health Care Settings and General Work Settings

Issues in health care worker MSI prevention research are substantial: (1) variations in outcome measures used, (2) inconsistent quality in study designs, (3) lack of statistical power, (4) different follow up periods, (5) variation in the type, complexity and implementation of the interventions, and (6) lack of study replication. These issues contribute to a lack of clarity in what constitutes best practice for patient-handling MSI prevention. Stetler (2003) identified issues with the body of research as: many narrative reports, no replication of well conducted research, and the lack of sustainability of reportedly successful interventions.[71]

In a review of general occupational injury prevention studies, Goldenhar (1996) indicates that generally these studies lacked theoretical basis, had small samples, used quasi or non-experimental designs, and used weak interventions.[101] As of 2004, a review of the general literature on work related MSI prevention interventions did not contain any RCT trials of ergonomic intervention components.[58] There seem to be no high quality studies that have examined the effect of behavioral modeling or "hands-on" training interventions.[50] Goldenhar suggests that a better description and understanding of causal processes is required, a sentiment shared by other authors.[50] Further, Goldenhar (1996) points to the NIOSH (1988) recommended hierarchy of ergonomic control implementations: engineering controls preferred initially, followed by administrative controls and then behavioral controls.[101] This approach does not always appear to be consistently applied. Several newer equipment designs and technologies exist and deserve detailed evaluation as to their ability to reduce biomechanical loading and prevent injury during patient handling in controlled trials.[40, 102]

1.3.6.2 Outcome Measurement

Musculoskeletal symptoms do not always lead to disabling injuries and these injuries do not always lead to WCB lost time claims. In particular, the selection of outcomes that are to be evaluated needs to be rationalized. Outcomes from exposure to ergonomic hazards in patient handling exist along a continuum and may range from: (1) transient symptoms, (2) chronic symptoms, (3) temporary disability (with or without an MSI WCB claim), (4) permanent disability resulting in job accommodation, change in profession, or (5) permanent disengagement from the workforce (disabled from all occupations). Those outcomes that constitute the greatest burden to society should direct research and injury prevention efforts. Several pre-post design studies have used both symptom reports and injury rates as outcomes and have been able to draw some conclusions regarding the sensitivity of both types of measures.[77, 78, 81, 98] While musculoskeletal symptoms are generally considered the more sensitive measure, they are subject to several potential problems such as recall bias, definition and stability over time and wide variability of the measurement instruments.[12, 72] The need for standardized outcome measures has been emphasized.[50]

1.3.6.3 Type of Health Care Setting

One area, with limited attention in the literature, is the effect of setting. It is possible that many studies, showing limited intervention effects have been targeted at facilities where the potential for improvement is limited. Studies in hospitals and long-term care facilities predominate over those carried out in home-care, private residential care homes, and critical care. Home health care workers have reported injury rates of 52/1000 workers per year, lying somewhere between nursing home worker and hospital worker injury rates.[103] Meyer et al. (1999) indicated that average indemnity payments and time loss durations were higher in this worker population than hospital or nursing home workers and suggest that of this may be due to a higher rate of compensable motor vehicle accidents than other health care workers.[103] Shah (2006) recommended that smaller facilities should be targeted for intervention.[104] Critical care patient handling has been identified as an understudied and high-risk setting.[73] Patients in this area pose more of a challenge as they are frequently more dependent, require sustained positions for operative procedures, frequently have equipment that interferes, require more horizontal transfers rather than vertical transfers.[73]

1.3.6.4 Future Research

While there are abundant studies on patient handling injuries in health care workers gaps still remain. The NIOSH National Occupational Research Agenda (NORA) identifies, among others, the following areas requiring further research: evaluation of the risk of musculoskeletal disorders related to patient handling or working in awkward postures in different health care work settings; evaluation of the efficacy of safe patient handling and movement programs to reduce the risk of MSDs; and evaluation of the costs and benefits of these programs.[105] More specifically, patient handling and MSIs in home health care workers has not been sufficiently addressed.[60] The applicability of injury prevention programs to different healthcare settings, and the synergistic relationships between components of multi-factorial intervention programs need to be further explored.[105]

1.3.7 Summary

MSIs among health-care workers as a result of patient handling activities continue to be a cause for concern and deserve ongoing research. Biomechanical factors for patient handling related MSI have been well established, while the influence of psychosocial and organizational factors is less well understood. Large scale patient handling injury prevention programs have met with legislative resistance, however this is changing slowly. Of the single-factor interventions, engineering controls, primarily consisting of mechanical patient lifting devices, appear to be effective although this evidence is generally from weaker study designs. This indicates the need for rigorous evaluation of patient-lifting equipment and engineering based ergonomic interventions in high quality studies. Strong evidence is present to indicate that educational interventions, alone, are not effective in reducing patient handling injuries. The research to date provides moderately strong evidence in support of the effectiveness of multi-factorial injury prevention interventions. Further research into the interaction of program components in different health care settings such as critical care and home care is required.

2. METHODOLOGY

2.1 Intervention Description

2.1.1 What is TLR?

TLR programs aim to reduce MS injuries by defining, optimizing and standardizing the patient handling (transfers, lifts and repositioning) requirements and procedures for each individual patient to ensure both patient and worker safety.

2.1.2 Program Development

The TLR program was introduced to Saskatoon Health District in 1999 by the Saskatchewan Association of Health Organizations (SAHO), stimulated by provincial OH&S legislation that made specific reference to patient handling safeguards. The Saskatoon Health Region had previously had a back education program in place for their workers, but did not observe any improvements in back injury rates. An initiative, based on literature, current at the time, was developed to implement a comprehensive MSI prevention program related to patient handling, a TLR program. Critical components of were identified as:

1. *Commitment at all levels.*
2. *Adequate and ongoing training, coaching and evaluation.*
3. *Proper, sufficient and well maintained equipment.*
4. *Leadership.*
5. *Policies and procedures to ensure consistent application and compliance.*
6. *Competent and continual patient assessment* [35]

The program consisted of both engineering and administrative controls:

2.1.3 Engineering controls

In 2001 a review of patient handling equipment needs was undertaken and subsequently $200,000 was invested in new equipment including total body lifts, sit-stand lifts, ceiling track lifts, slings, slider sheets, repositioning sheets, turning sheets and transfer belts. Specialized bariatric equipment was provided as needed. Appendix 1 shows examples of equipment similar to what was supplied.

2.1.4 Administrative controls

This component consisted of education on anatomy, injuries, body mechanics, personal health, lifting and patient handling procedures, standardized patient handling needs assessment and patient handling algorithms. A patient-handling skills development ("hands-on") component was included as part of the one-day educational sessions to allow for skills based learning in equipment usage and to provide feedback on patient-handling technique. The educational session was an eight hour, one-time training session. A course booklet and training materials were given to the workers for their later reference. Participation in these training sessions was mandatory for all direct care workers. As of August 2004 there were 37 trainers, some of whom acted as TLR on-ward coaches as well.[35]

A standardized patient handling needs assessment and management system was also implemented concurrently. The hardware for this system was the patient handling placard that gives the specific handling requirements and techniques to be used for each patient. These instructions were mounted in plain view at the patient's bed. Notwithstanding these instructions, the direct-care personnel were expected to do ongoing assessment before each patient handling maneuver to assess if the patient needs had changed. Appendix 2 shows the patient handling algorithm and Appendix 3 shows the Mobility Assessment Form that was used. Definitions and descriptions of the standardized patient handling procedures from the training manual are shown in Appendix 4.

TLR committees were established at Parkridge Centre and Saskatoon City Hospital to promote acceptance of the TLR program. The TLR policy was developed in cooperatively by management, focus groups and joint union-management Occupational Health Committees. The TLR Policy was formally adopted in the Saskatoon Health Region in April 11, 2002.

2.1.5 TLR Program Implementation in Saskatoon Health Region

Implementation in the Saskatoon Health Region was staggered due to logistical and resource restraints. Time frame for implementation of the administrative controls was follows:

- Saskatoon City Hospital (SCH): Sept 2002-June 2004
- Parkridge Centre (PRC): Sept 2002-Sept 2004
- Royal University Hospital (RUH): Jan 2005-Dec 2005
- St. Paul's Hospital: Feb 2005-June 2006
- Home Care: Feb 2003

Parkridge Centre and specific wards in Saskatoon City Hospital were targeted first due to high claims rates. All employees involved in patient handling were trained. New employees were trained as they entered the SHR. There was a survey conducted of the nurse managers in 2003 to qualitatively evaluate the progress of the TLR program. Workshop participants (n=702) were also asked to complete an evaluation survey related to the educational sessions and their ability to conduct patient assessments and apply the appropriate patient-handling techniques correctly. This occurred from January 2002 to June 2004 and only SCH and PRC were canvassed. TLR at RUH had not been implemented as yet. Ratings were generally favorable amongst the majority of the respondents.

2.2 Research Questions

In this study we have asked the following three research questions:

(i) What was the effect of the TLR program on the rate of MSI, length of disability and claim costs for healthcare workers in SHR hospitals (RUH, SCH, and Parkridge Center)?

(ii) Was the effect of the TLR program on MSI rates, length of disability, and claim costs different for different hospital types (RUH, SCH and Parkridge Centre)?

(iii) Was there a difference in how workers are injured or what body part is injured after the TLR program?

2.3 Study Design

This study can be classified as a retrospective, pre-post intervention design, utilizing a non-randomized, historical, control group. The study used administrative data extracted from the OH&S databases of the Saskatoon Health Region and the Regina Qu'Appelle Health Regions. The RQHR was selected as the control group as it was not implementing a program at the time. Injury data in the period 5 years prior to the intervention to provide a baseline and one year post-intervention were to be collected. The shorter post-intervention evaluation period was chosen due to time restraints in finishing the study.

In order to investigate the effect of the intervention on different hospital types, the data were analyzed in both grouped format and by individual hospital, where data was available. Similar hospital types were paired. Parkridge Centre and Wascana Rehabilitation Centre (WRC) were similar in that they both have long-term care and specialized rehabilitation caseloads. Saskatoon City Hospital and Pasqua Hospital (PH) were paired as they were similar in their focus and services as community hospitals. Royal University Hospital and Regina General Hospital (RGH) were both considered tertiary care hospitals. The size of the hospitals, as measured by the at-risk worker FTEs (Table 3.8) also corresponded to the above pairings. Specific data to quantify characteristics of the hospitals such as caseloads, number of beds, or factors such as patient handling frequency were not available and thus size was used as a proxy for hospital type in the analysis. General descriptions of the hospitals, taken from the corresponding Health Region websites, are presented in Appendix 5.

2.4 Study Development

The study was developed along the following timeline:

- Project initially conceived - Dec 2004
- Initial meetings with OH&S Managers for the SHR and the RQHR – Oct 2005
- Project officially proposed - Nov 2005
- Ethics approval from University of Saskatchewan - Nov 2005
- SHR Operational approval received - Nov 2005
- Ethics and Operational approval received from RQHR - May 2006
- Raw datasets received from RQHR - Feb 2007 and SHR - May 2007

2.5 Operational and Ethics Approvals

The Occupational Health and Safety department managers for the Saskatoon Health Region and the Regina Qu'Appelle Health Region were approached to determine the interest level in and feasibility of the study. Discussions expanded to include the Director of Organization Health and Development for the Saskatoon Health Region. Initial conversations identified the need to rigorously evaluate the TLR program and present these findings to other health districts that might possibly be contemplating development of a similar a program. The study rationale and data collection needs, including a list of variables were presented. The RQHR manager identified some possible limitations in their ability to collect data due to limited human resources and changes in their data collection methods, specifically an electronic system being implemented within the period for data collection that this study required. Extensive manual data extraction was not an option without external financial resources being made available.

Operational approval documents were drafted, submitted, and approved. The SHR application process required that ethics approval be obtained prior to operational approval, while the RQHR process was integrated. Appendix 6 shows the relevant operational approval and ethics approval documents.

2.6 Data Collection and Extraction

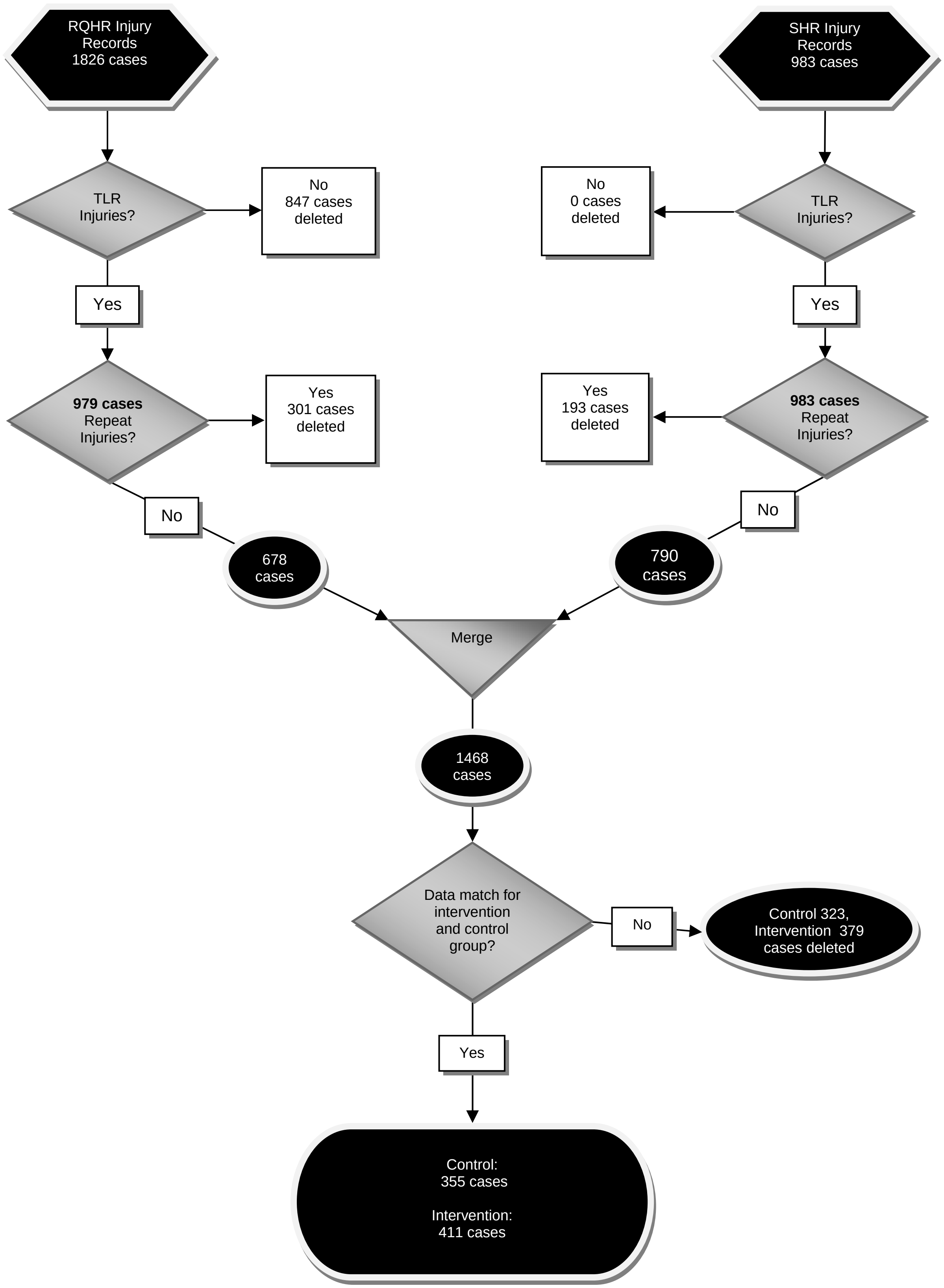
De-identified data sets were received from the SHR in May 2007 and from the RQHR in Feb 2007. Data was collected by health region personnel and de-identified. Data were received in Excel format. Data in all Excel spreadsheets were converted to STATA (ver. 10 StataCorp LP 4905 Lakeway Dr. College Station, Texas 77845 USA) format using STATRANSFER (ver., 9. Circle Systems, 1001 Fourth Avenue, Suite 3200, Seattle, WA 98154). Eighteen separate Excel injury data sets and 6 payroll data sets were received in total. Data were cleaned, organized, and appended while in string format and then encoded to make them available for statistical routines. Date variables in string format were converted to date formats using STATA date commands.

Repeat injuries were deleted from the datasets as follows. SHR employee identifier numbers were used. For RQHR, because each individual was not identified as a unique employee, date of birth and/or the previous injury variable was used where available. In other RQHR data sets, birth date, department worked, profession, and body part injured were available. Data for all time periods was sorted by date of birth, then profession, department, date of injury and body part injured for all time periods. If the date of birth and profession were different, these were treated as unique unrelated cases. If the date of birth, and profession were the same, but the department was different, then these were treated as unique unrelated cases. If the date of birth, profession, department and body part injured were the same, then the dates of injury were examined. If the dates of injury were clustered within several months, as was the pattern seen in the SHR data where the repeat injuries were very clear, then the subsequent injuries were treated as repeat injuries and deleted. The possibility however would still exist that injuries in distinct workers were deleted, but the chance of this was judged to be small. By this method, the estimates for the number of injuries for RQHR may be underestimated by over-deletion of cases. If this is the case then the injury rates would be underestimated. If the repeat injuries are over or under-estimated, this would likely be the same across the time periods measure and thus should not bias the injury rate change results in the control group.
As a final step, cases with injury dates that occurred before the one-year pre-intervention period were deleted as the FTE and covariate data were incomplete and injury rates could not be calculated. In figure 1.1 this is indicated as the last step in case deletion.

Throughout the data extraction process, random cases were selected and the data compared back to the original Excel spreadsheets to ensure the integrity of the data. All data transformations were recorded using STATA log files and intermediate datasets were retained.

The data extraction flowchart (figure 1.1), indicates the number of cases and deletions during the extraction process. A total of 411 injury cases in the intervention group and 355 cases in the control group were eligible for analysis.

Figure1.1: Data Extraction Flowchart



2.6.1 Time Frames:

Data on all patient-handling injuries in the Saskatoon Health Region and Regina Qu'Appelle Health Regions were collected by SHR and RQHR personnel for two years pre-intervention and one year post-intervention for each hospital requested. The requested 5 years of pre-intervention period injury data could not be collected due to human resource limitations in their OH&S departments. Initial inspection of the data revealed that RQHR was unable to gather FTE data prior to 2001. This made calculation of injury rates prior to the one year pre-intervention period for PH and WRC impossible. Thus a one year pre-intervention period was used for all hospitals and the data was organized accordingly. The data collection time-frames, used for analysis, were as follows:

WRC and PRC: Sept. 1, 2001 to Sept. 1, 2002 and from Sept. 1, 2004 to Sept. 1, 2005

PH and SCH: Sept. 1, 2001, to Sept. 1, 2002 and from Jun. 1, 2004 to Jun. 1, 2005

RGH and RUH: Jan. 1, 2004 to Jan. 1, 2005 and from Dec. 1, 2005 to Dec. 1, 2006

Data for St. Paul's' Hospital (SHR) and Home Care (SHR, RQHR) were not available.

2.6.2 Covariates

SHR data were complete for all variables requested except number of previous claims (which could be derived from the unique identifier) and diagnosis. However, no covariate data for age or sex were provided initially from the RQHR. A later request yielded data for these covariates for all intervention periods for RGH but only approximately half of the required pre-intervention time period and all of the post-intervention period for PH and WRC. The control group data set was also missing length of service, classification of injuries by TLR cause, time loss days and claim cost.

Due to a change in the way the RQHR collected their OH&S data during the study time frame, the formatting of the data was significantly different in the early intervention periods for PH and RGH. Date formats were inconsistent and had to be reconciled manually. Variable names were changed to provide consistency across data sets and to allow datasets to be appended. RQHR data included all injury claims received by their OH&S department, including non-direct patient care departments. RQHR supplies information on whether an injury report incurred time loss or not, and SHR further differentiated between no time loss claims that required health care or not, a factor which influences the employer's duty to report to WCB. SHR reported only injuries sustained in TLR trained personnel. The RQHR injuries in personnel that did not correspond to SHR TLR trained personnel were deleted.

2.6.3 Exposure Data:

Payroll data from RQHR included worked hours and FTEs for all departments whereas SHR data included only departments in which workers were TLR trained. Thus, the RQHR payroll data were cleaned to correspond to the SHR payroll data as much as possible. The two health districts each had used 1950 hrs = 1 FTE as their conversion formula.

2.6.4 Inclusion and Exclusion Criteria:

All SHR and RQHR direct care health-care workers, who were employed as such in the study time periods, were eligible for inclusion into the study. Disease incidence is a better measure of risk than prevalence.[106] Once an injury occurs in a musculoskeletal structure, then the subsequent risk of injury in that body part is increased, especially for spinal injuries.[53] Thus, we excluded subjects with a previous injury that occurred within the study period in both the intervention and control group, as described previously.

2.6.5 Study Variables

The outcome measures and covariates were selected to provide rigorous analysis of the research questions. Meetings with the health regions were held and some reservations were expressed, particularly in the RQHR regarding their ability to collect all the covariates and injury data, for the time frames requested. In consideration of these limitations, it was decided to proceed with the study, due to its potential importance, and modify the scope of the project as data allowed. The variables that were requested for analysis are detailed in table 2.1.

Table 2.1: Variable List

Variable Category	**Variable**	**Variable Description**
Variable Category	**Variable**	**Variable Description**
Demographic	Health Region	SHR or RQHR
	Hospital Name	SCH, PH, PRC, RUH, RGH, WRC
	Date of birth	Worker date of birth
	Occupation	Occupation at time of injury
	Sex	Male or female
	Place of work	Hospital working in at time of injury
	Length of service	Months from date of hire to date of injury
Injury Data	Date of Injury	Date on which injury occurred
	Age	Age of worker at time of injury
	Body Part Injured,	Part of body listed as injured in OH&S database
	Mechanism of Injury,	A text description of the circumstances surrounding the injury
	Patient handling maneuver attributed to injury (TLR)	Transfer, lift or repositioning maneuver
	Time Loss/No Time Loss Injury	Indicator of whether the injury report had lost time, health care only, or neither
Outcome	Time- loss Days per Injury	# of days off work and/or on modified duties
	Claim cost per injury	Direct $ costs/ injury in dollars, for each injured worker, derived from WCB cost statements provided to employer.
Exposure	# of worked hours	Number of hours worked, in each hospital, for the durations indicated in the data collection timeline document, for the population of health care workers only i.e. those involved in patient care who would have taken the TLR course. Converted to FTE at 1 FTE = 1950 hrs.
	Hospital size	Number of FTEs for exposed population in each hospital
	Length of intervention period	Months from start to end of intervention

2.7 Hypotheses

2.7.1 Primary Hypotheses

Hypothesis 1.1: Health care workers, trained in a TLR program, will report a significant decrease in incidence rate for patient handling related MSIs as compared to before completing the program (pre and post).

Hypothesis 1.2: Health care workers, trained in a TLR program, will report a significant decrease in incidence rate for patient handling related MSIs as compared to health care workers in a control group.

Hypothesis 1.3: Health care workers in different hospital sizes (small, medium and large) will report differing reductions in incidence rate for patient handling related MSIs after training in the TLR program when compared to health care workers in similar size control group hospitals.

2.7.2 Secondary Hypotheses

Hypothesis 2.1: Health care workers will report a significant decrease in incident claim costs/injury before and after completing the TLR program as compared to health care workers in the control group.

Hypothesis 2.2: Health care workers will report a significant decrease in number of time loss days/injury for incident claims after completing the TLR program as compared to health care workers in the control group.

Hypothesis 3.1: Health care workers will show a significant difference in the distribution of the types of patient handling maneuvers that cause MSIs, after completing the TLR program.

Hypothesis 3.2: Health care workers will show a significant difference in the distribution of body part that is injured, after completing the TLR program.

2.8 Statistical Analysis

All analysis was performed using STATA (ver. 10 StataCorp LP 4905 Lakeway Dr. College Station, Texas 77845 USA) unless otherwise noted. Significance level for all tests was set at 0.05.

2.8.1 Descriptive Statistics

Descriptive statistics were used to summarize the data. Mean, median, and standard deviation were calculated for continuous variables and frequencies were calculated for categorical variables. For continuous variables, Student's independent t-test was used to compare the two groups.[107] For categorical variables, Chi-square test or Fisher's exact test were used to compare the groups.[107] Outcome data (claim cost and time loss days) were analyzed with non-parametric methods, specifically Mann-Whitney U test as these data were not normally distributed.[107] Analysis for variables occupation, sex, age, length of service was not possible as data were not available for uninjured workers. Thus demographic risk factors for the entire at-risk worker population could not be determined.

2.8.2 Calculation of Injury Rates

Injury rates as calculated in this study are based on the number of injured workers in the numerator and the number of worked hours totaled for all TLR trained employees, or their counterparts in the control group, converted to full time equivalents (FTE) as the denominator. The denominator was standardized to FTEs, where one FTE = 1950 worked hours, to adjust for the differences in the exposure between and within groups. We were not able to obtain individual exposure data for each individual worker (person-time). This is the conversion that was used by both health districts. This does not necessarily reflect repeated measures as there were undoubtedly some workers who did not work in both time periods.

2.8.3 Significance Testing

As the data were grouped by hospital, the sample size was only 3 for each intervention period and group combination. This did not allow for use of t-test as the distribution of injury rates in the different size hospitals could not be determined to be normal. Thus a summary statistic was reported. For further exploration, we used non-parametric methods to test the hypothesis that the injury rates in the pre-intervention period were different than those in the post-intervention period. As the data are paired (before and after measurements in the same hospitals) the Wilcoxon Signed- Rank test was also used. However, with sample sizes below 5, such testing is not reliable.[108]

An alternative method, described by Robson et al. uses injury rates, calculated by dividing number of injured workers by the number of worked hours or FTEs in the denominator.[109] This is not a true epidemiological rate as it does not have person–time as the denominator. If one considers that the denominator, when converted to FTEs, has a time component, as these were measured over a specific time period (one year pre and post-intervention), then these measures may be considered rates and rate ratios may be calculated as estimates of the relative rate of injury. The analysis then is based on comparison of rate ratios. The rate ratio can be calculated by dividing the post-intervention injury rate by the pre-intervention injury rate. The rate difference can be calculated by subtracting post-intervention injury rate from pre-intervention injury rate. The analysis then uses the z-test for two independent proportions to compare either the rate ratio or the rate difference in the intervention and control groups. These calculations were done by hand due to the lack of an available computer program to perform these electronically. P-values were calculated from the z-scores using a web-based calculator available from Claremont Graduate University.[110] The calculations were performed for both paired hospitals and pooled data for each health region. Calculations were repeated for all injuries and time loss injuries using the general method as shown in Appendix 7.

2.8.4 Univariate Analysis

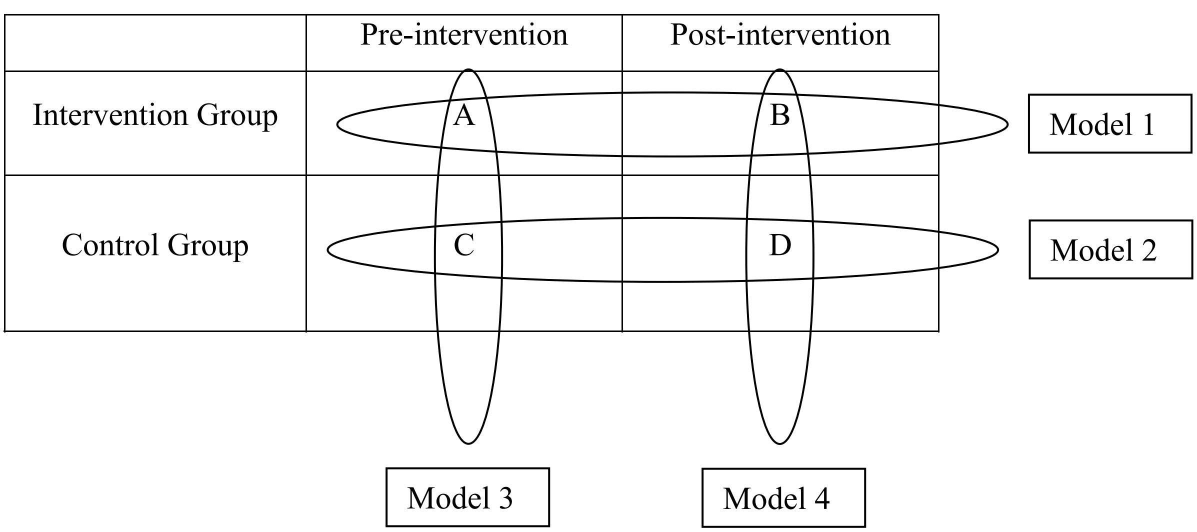
Poisson regression is applicable for analysis of count and rate data, where the outcome variable is a non-negative integer.[111, 112] Assumptions of Poisson regression are that the probability of the events occurring over time is small, that the events are independent, and that the expected value is equal to the mean and to the variance.[113, 114]

Due to the level at which the data were collected, only the variables: (1) group (intervention or control), (2) intervention period (pre or post-intervention), (3) hospital size (small, medium, or large, based on FTE of at-risk workers), and (4) length of intervention (months) were available for analysis. Each variable was analyzed individually for significance (α=0.05) and included in the multivariate analysis. Univariate Incidence Rate Ratios were then calculated that compared the pre and post-intervention injury rates for the intervention and control groups separately. This was performed for both all injuries and time loss injuries. The reduced model contained the primary variable of interest (intervention period or group) and other variables were added in stepwise fashion. Reduced models were compared with the full model using Likelihood Ratio test.[111] Interaction terms were generated, added to the model and retained if significant below 5%. Variables group or intervention period were always retained in the models, even if non-significant, to answer the study hypotheses.

2.8.5 Multivariate Analysis

Four regression models were analyzed to evaluate changes in rate ratios as indicated in Figure 2.2. This allowed us to look at relative rates separately for each group and intervention period. The pre and post-intervention periods were analyzed by groups yielding two models (1 and 2). These were used to answer Hypothesis 1.1. The groups were then analyzed by pre and post-intervention period, giving two models (3 and 4) to answer Hypothesis 1.2. Hypothesis 1.3 was answered by the multivariate regression model including hospital size. Covariates, collected at the level of the individual, could not be incorporated into the multivariate analysis, but were instead compared separately. For model goodness of fit, Hosmer-Lemeshow statistics were checked.[111]

Figure 2.2: Regression Analysis Strategy



In order to answer secondary hypotheses, mean time loss days/injury and claims cost/injury changes pre and post-intervention in the intervention group only were calculated because the data were not available for the control group. Distribution of this data was plotted and normality testing with Q-norm and P-norm plots using STATA was conducted. The data distribution was highly skewed and was roughly the same in both groups. The samples were independent and the variables were continuous. Thus the Mann Whitney U test was used for analysis.

3. RESULTS

3.1 Characteristics of Injured Workers

3.1.1 Age

Injured worker age data from each hospital was pooled by Health Region. Age data for the Control Group pre-intervention period was incomplete and the mean was calculated from the available data. Table 3.1 shows no difference between the mean age of workers in pre and post-intervention periods for either the intervention group (p value = 0.647) or the control group (p value = 0.946)

Table 3.1: Age of Injured Workers

	Saskatoon HR		Regina Qu'Appelle HR	
	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Mean	40.49	40.97	39.16	39.08
sd	10.41	10.20	10.08	10.69
Total # of Injuries (n)	260	151	138*	165

* Incomplete age data in pre-intervention time period for RQHR; sd = standard deviation

3.1.2 Length of Service

Length of service data was not available from RQHR. Hospital data for this variable was pooled for the intervention group and compared by intervention period. Table 3.2 shows the mean length of service in months for pre and post-intervention periods for the SHR. Means for this variable were similar (p-value = 0.495).

Table 3.2: Length of Service by Intervention Period for Intervention Group (SHR) (months)

Pre-intervention			Post-intervention			t-test p-value
Mean	sd	n	Mean	sd	n	
128.558	97.7	260	136.3	112.8	151	0.495

(Data for RQHR not available for length of service.); sd = standard deviation

3.1.3 Sex

Data on the sex of injured workers was available for both health regions in the post-intervention time period but data was missing for the control group in the pre-intervention period. Sex ratios were calculated and are indicated in Table 3.3. The proportions were similar when comparing the pre to post intervention periods for the SHR (p-value = 0.239), but not for the RQHR (p-value = 0.016). Comparing the pre and post-intervention periods between the SHR and RQHR the proportions were the same (p-value = 0.843 and 0.114 respectively). A decrease in the ratio of males/female injured workers was seen both groups. This indicated that relatively fewer men were injured in the post-intervention period in both health regions and even more so in the control group.

Table 3.3: Sex of Injured Workers

	Intervention Group (SHR)		Control Group (RQHR)	
	Pre-intervention	Post-intervention	Pre-intervention*	Post-intervention
# Females	236 (91%)	142 (94%)	127 (91%)	161 (98%)
# Males	24 (9%)	9 (6%)	12 (9%)	4(2%)
Sex ratio M/F	0.102	0.063	0.094	0.025
Total # of Injuries (n)	260	151	139*	165

* Data not available for all injured workers.

3.1.4 Occupations of Injured Workers

Table 3.4 indicates the number of injured workers by occupation for both pre and post-intervention period and for the control and intervention groups. The number of injuries in each occupation was compared to the total number of injuries in that time period and calculated as a percentage. In the control group, the distribution remained unchanged with the exception of therapies (physical therapists, occupational therapists, respiratory therapists) where a 6 fold increase in injuries was seen. This trend is echoed, to a lesser extent, in the intervention group. There was a slight decrease in the proportion of nurses injured in the control group and an increase in the intervention group although the differences are small. The most dramatic change was seen in the decrease in injuries in Attendants (from 25.4% to 0%) and increase in injuries in Nurse Aides (from 1.1% to 11.3%) in the intervention group.

Table 3.4: Number of Injured Workers by Occupation, Health Region and Intervention Period n=number of injured workers									
Occupation		Intervention Group (SHR)				Control Group (RQHR)			
		Pre-intervention		Post-intervention		Pre-intervention		Post-intervention	
		n	%	n	%	n	%	n	%
Nursing	GDN/RN	138	53.1	94	62.2	84	47.7	63	38.2
	LPN	31	11.9	23	15.2	44	25.0	47	28.5
	RPN	0	0.0	0	0.0	2	1.1	2	1.2
Nurse Aides		3	1.1	17	11.3	32	18.2	32	19.4
Attendants		66	25.4	0	0.0	3	1.7	4	2.4
Therapies		1	0.4	2	1.3	2	1.1	10	6.1
Clerks/Unit Assistants		7	2.7	7	4.6	1	0.6	1	0.1
Other		14	5.4	8	5.3	8	4.5	6	3.6
Total Injured Workers		260	100.0	151	100.0	176*	100.0	165	100.0

* Data not available for all injured workers

3.2 Outcomes

3.2.1 Body Part Injured

Table 3.5 indicates the relative proportion of injuries by body part for each group and intervention period. In the post-intervention period, proportion of injuries seen in the neck, shoulder, and upper extremity increased in both the intervention and control groups. Proportion of back injuries increased only 1.6% in the intervention group but decreased 8.7% in the control group. The relative proportion of multiple site injuries and other injuries decreased in both intervention and control groups. Data collected showed differences in the level of detail given for this variable. Statistical analysis using Chi-square test indicated that these proportion changes from pre to post intervention period were significant at the 5% α-level for the control group (p-value = 0.012) but not the intervention group (p-value = 0.189).

Table 3.5: Body Part Injured by Health Region and Intervention Period n=number of injured workers								
Body Part Injured	Intervention Group (SHR)*				Control Group (RQHR)**			
	Pre-intervention		Post-intervention		Pre-intervention		Post-intervention	
	n	%	n	%	n	%	n	%
All Back Injuries (except neck)	112	43.1	67	44.4	120	63.2	90	54.5
Neck	12	4.6	10	6.6	16	8.4	24	14.5
Shoulder	31	11.9	21	13.9	36	18.9	44	26.7
Upper Extremity (excl. shoulder)	24	9.2	22	14.6	2	1.1	4	2.4
Multiple Sites	40	15.4	15	9.9	9	4.5	2	1.2
All Other Body Parts	41	15.8	16	10.6	7	3.8	1	0.6
Total Injured Workers	260	100.0	151	100.0	190	100.0	165	100.0

* pre to post intervention: Pearson chi2 (df=5) = 7.4497 p = 0.189; Fisher's exact, p = 0.187

** pre to post-intervention: Pearson chi2 (df=5) = 14.6189 p = 0.012; Fisher's exact, p = 0.010

3.2.2 Patient Handling Maneuvers Producing Injury (TLR Injuries)

Table 3.6 indicates a decrease in all types of injuries relating to different patient handling maneuvers. The greatest improvement was seen in lifting injuries with a 72% decrease, followed by transfer injuries at 30%, and repositioning injuries at 20%. Chi-square analysis indicated that these differences were statistically significantly between transfers and lifts (p-value = 0.001), repositioning and lifts (p-value <0.0001) but not between transfers and repositioning (p-value = 0.557).

Table 3.6: TLR Injuries by Intervention Period in Saskatoon Health Region*					
Injury Type	Pre-intervention Period		Post-Intervention Period		% Change (post-pre)
	n	%	n	%	
Transfer	73	28.1	51	33.8	-30.1
Lift	95	36.5	26	17.2	-72.6
Repositioning	92	35.4	74	49.0	-19.6
Total # of Injuries	260	100.0	151	100.0	

* Data for control group (RQHR) not available for this variable)

3.2.3 Injury Rates

Table 3.7 shows overall injury rates and rate differences for all injuries and time loss injuries in pre and post-intervention periods for the control and intervention group. Substantial injury rate reductions post-intervention were seen in the intervention group for all and time loss injuries, 44.8% and 52.8%, respectively. The control group showed a much smaller decrease in rates post-intervention in the all injuries category of 9.7%, and an increase in time loss injury rates of 9.5%.

Table 3.7: Injury Rates and Rate Differences by Health Region														
	Pre-intervention period						Post-intervention period						Rate Difference*	
	All Injuries			Time Loss Injuries			All Injuries			Time Loss Injuries			All Injuries	Time Loss
	n	FTE	Rate*	n	FTE	Rate*	n	FTE	Rate*	n	FTE	Rate*		
INTERVENTION GROUP SHR	260	1771.3	**14.7**	94	1771.3	**5.3**	151	1871.1	**8.1**	47	1871.1	**2.5**	-6.58 (-44.8%)	-2.80 (-52.8%)
CONTROL GROUP RQHR	190	2044.7	**9.3**	120	2044.7	**5.9**	165	1964.8	**8.4**	127	1964.8	**6.46**	-0.9 (-9.7%)	+0.56 (+8.75%)

* per 100 FTE; rate difference = post minus pre

Table 3.8 shows injury rate data for each individual hospital. The most significant injury rate reductions were seen in the intervention group hospitals especially at Parkridge Centre for all (75%) and time loss (71%) injuries. Injury rate reductions for Saskatoon City Hospital and

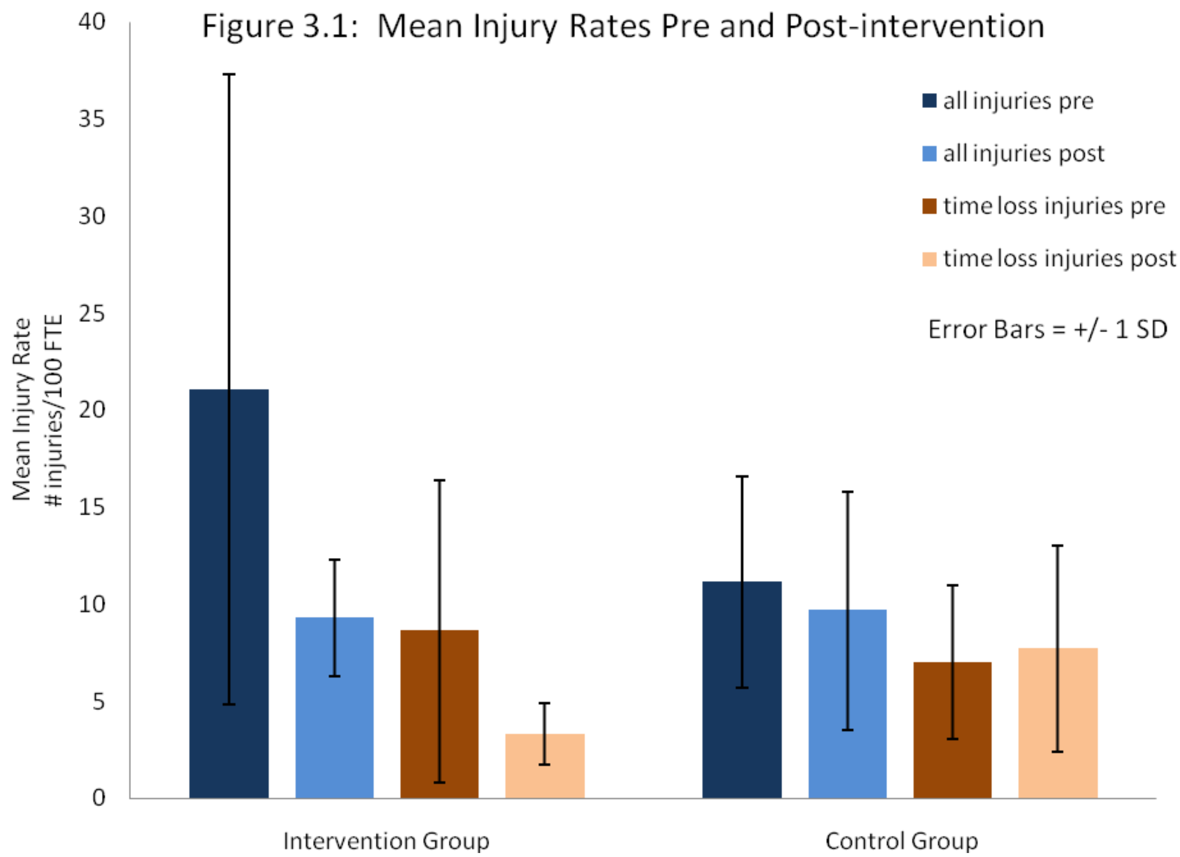
Royal University Hospital were more modest but still substantially decreased (23% and 38% respectively). Greater reductions were seen in the time loss injury rates than all injury rates except at Parkridge Centre. The control group hospitals generally had smaller injury rate reductions, or increases depending on the hospital. Pasqua Hospital had injury rate reductions approaching those in the intervention group.

Table 3.8: Injury Rates and Rate Differences for Individual Hospitals

INTERVENTION GROUP SHR	Pre-intervention period						Post-intervention period						Injury Rate difference (%)	
	All Injuries			Time Loss Injuries			All Injuries			Time Loss Injuries			All Injuries	Time Loss Injuries
	n	FTE	Rate*	n	FTE	Rate*	N	FTE	Rate*	N	FTE	Rate*		
Parkridge Centre	78	194	**40.25**	34	194	**17.54**	20	200	**10.01**	10	200	**5.01**	-30.23 (-75%)	-12.54 (-71%)
Saskatoon City Hospital	78	504	**15.46**	26	504	**5.15**	62	523	**11.84**	16	523	**3.06**	-3.62 (-23%)	-2.10 (-40%)
Royal University Hospital	104	1073	**9.69**	34	1073	**3.16**	69	1150	**6.01**	21	1150	**1.83**	-3.68 (-38%)	-1.34 (-42%)
CONTROL GROUP RQHR														
Wascana Rehabilitation Centre	67	391	**17.13**	45	391	**11.51**	64	383	**16.72**	54	383	**14.10**	-0.41 (-2%)	+2.60 (23%)
Pasqua Hospital	48	488	**9.84**	26	488	**5.33**	28	511	**5.48**	22	511	**4.31**	-4.36 (-44%)	-1.02 (-19%)
Regina General Hospital	75	1166	**6.43**	49	1166	**4.20**	73	1071	**6.81**	51	1071	**4.76**	+0.38 (6%)	+0.56 (13%)

* per 100 FTE; rate difference = post minus pre

Figure 3.1 shows the mean injury rates in the pre and post-intervention periods for all injuries and time loss injuries. Comparison of the intervention group to the control group shows decreases in means for all and time loss injuries in the intervention group and much smaller decrease in the mean for all injuries and an increase in mean time loss injuries in the control group.



3.2.3.1 Testing for Injury Rate Changes

Table 3.9 shows the results of formal statistical testing giving the test statistic type, Z-scores and p-values from the analysis of rate changes for both all injuries and time loss injuries. Statistical comparison of the rate ratios and rate differences was carried out for pooled data comparing the intervention and control group and for each pair of hospitals based on hospital size (FTE of at-risk worker population). Comparisons for pooled hospital data showed statistical significance of the injury rates reductions in the pre and post intervention periods in the intervention group, when compared to the control group injury rate changes. By hospital size, all comparisons were significant (p-values < 0.049) except those for the medium sized hospitals, Pasqua Hospital and Saskatoon City Hospital (p-value = 0.276). Here both rate ratios and rate difference analyses produced non-significant results indicating that the changes in injury rate ratios were similar and not greater than that expected by chance. The rate ratio analysis for time loss injuries in the large hospitals was significant (p-value = 0.049).

Table 3.9: Significance Testing of Injury Rate Changes in Intervention and Control Group

	Injuries	Test Statistic	|Z| score	p value (2-tailed)
By Health Region	All	Z-test rate ratio	3.40	**0.001**
		z-test rate difference	3.92	**<0.0001**
	Time loss	Z-test rate ratio	3.82	**<0.0001**
		z-test rate difference	3.27	**0.001**
By Hospital Size				
Small (WRC-PRC)	All	Z-test rate ratio	4.47	**<0.0001**
		z-test rate difference	5.06	**<0.0001**
	Time loss	Z-test rate ratio	2.40	**0.017**
		z-test rate difference	3.50	**0.001**
Medium (PH-SCH)	All	Z-test rate ratio	1.10	0.276
		z-test rate difference	0.02	0.980
	Time loss	Z-test rate ratio	0.72	0.472
		z-test rate difference	0.57	0.568
Large (RGH-RUH)	All	Z-test rate ratio	2.37	**0.018**
		z-test rate difference	2.30	**0.021**
	Time loss	Z-test rate ratio	1.97	**0.049**
		z-test rate difference	3.30	**0.001**

Bolded p-values are significant at 0.05 level

3.2.3.2 Univariate Analysis: Comparison of Injury Relative Rate between Pre and Post Intervention Periods

Univariate analysis using Poisson regression indicated that all variables, when considered individually, were significantly associated with injury rates. Then, to evaluate the strength of effect, Poisson regression was used to generate univariate incidence rate ratios with p-values and confidence intervals. Table 3.10 indicates the analysis results. The reference category chosen for the intervention group variable was the pre-intervention period. A rate ratio of less than one indicates a decreased relative rate of injury in the post-intervention period. For the intervention group, rate ratios indicated a 45% reduction in relative rate of all injuries and a 53% reduction of relative rate of time loss injuries in the post-intervention period. These reductions were statistically significant (p-value < 0.0001).

For the control group, there were non-significant changes in injury rates, pre to post-intervention, for all injuries and time loss injuries (p-values = 0.342 and 0.448, respectively). These results correspond to the Z-test results for the rate ratio and rate difference calculations for the grouped injury rates.

Table 3.10: Univariate Injury Rate Ratios - Pre and Post Intervention

	Injuries	Rate Ratio	95% CI	P value
Intervention Group* Saskatoon HR	All	0.55	0.450 - 0.672	<0.0001
	Time Loss	0.47	0.333 - 0.670	<0.0001
Control Group* Regina Qu'Appelle HR	All	0.90	0.733 - 1.113	0.342
	Time Loss	1.10	0.858 – 1.410	0.448

*Reference category is pre-intervention period

3.2.3.3 Multivariate Analysis: Comparison of Relative Rate between Pre and Post Intervention Periods for Intervention and Control Groups

Covariates available for this analysis were limited due to the level of the data collection. Data were collected at the level of the hospital and this was primarily due to limited resources being available. Variables analyzed were intervention period (pre or post), hospital group (intervention or control), hospital size (small, medium and large) and intervention length (peri-intervention period).

The intervention implementation was variable in length for each hospital in the intervention group. One hospital, RUH, was able to implement the program in an 11 month period whereas PRC and SCH took 24 and 21 months respectively. This variable was included in the model after hospital size for analysis. It appeared to be collinear with hospital size. Adjustment procedures attempted were: conversion to a categorical variable (peri-intervention period long or short), reversal of the reference category, and centering of the continuous values around their means using the mcenter command in STATA. No change in the collinearity was seen. The peri-intervention variable was thus dropped from the analysis as the hospital size variable was judged as the more important variable for the study.

The analysis compared differences in injury rate ratio from pre to post intervention in both the intervention and control group and then looked at the difference in injury rate ratio between intervention and control groups for the baseline (pre-intervention period) and then the post intervention period. Analyzes were duplicated for all injuries and time loss injuries. Interaction terms were checked.

Table 3.11 shows the comparison pre and post-intervention all injury rates for the intervention and control group. Addition of size to the model was significant for both the intervention (LRT value p-value = 0.0004) and control groups (LRT p-value <0.0001).

Table 3.11: Multivariate Analysis - All Injuries
Comparison of Pre-Post Intervention Periods by Group

Saskatoon HR	β (S.E)	95% CI (β)	Rate Ratio***	95% CI (RR)	p-value
Intervention period*	-1.391 (0.251)	-1.882, -0.900	0.249	0.152, 0.407	<0.0001
Hospital size small	0	---	1.00	---	---
Hospital Size medium	-0.956 (0.160)	-1.270, -0.643	0.384	0.280, 0.526	<0.0001
Hospital size large	-1.424 (0.150)	-1.720, -1.130	0.241	0.179, 0.323	<0.0001
Size medium*Intervention period	1.124 (0.303)	0.530, 1.720	3.08	1.700, 5.573	< 0.0001
Size large*Intervention period	0.913 (0.295)	0.335, 1.490	2.49	1.400, 4.442	<0.002
Regina Qu'Appelle HR	β (S.E.)	95% CI (β)	Rate Ratio†	95% CI (RR)	p-value
Intervention period**	-0.108 (0.106)	-0.316, 0.101	0.898	0.729, 1.106	0.311
Hospital size small	0	---	1.00	---	---
Hospital size medium	-0.797 (0.144)	-1.080, -0.515	0.451	0.340, 0.600	<0.0001
Hospital size large	-0.941 (0.120)	-1.180, -0.706	0.390	0.308, 0.506	<0.0001

* Reference category is pre-intervention period
** Intervention period retained in model due to importance
*** The model with interaction terms is not straightforward in generating CI from e^{β}. Additional calculations are needed (see page 53 for details)
† Calculation (in model without interaction term) is similar to Table 3.12 and 3.14

The final Poisson regression model in Table 3.11, for all injuries in the control group (RQHR) was as follows:
Where y = Poisson count, μ = injury rate

$$E(y) = \mu = e^{\{-0.108(\text{period})-0.797\,(\text{size medium})-0.941(\text{size large})\}}$$

Controlling for hospital size small (reference group), where the dummy variable value for size medium and large were both 0,

Rate of injury/FTE in the pre-intervention period = e^0 (reference category for period) = 1
Rate of injury/FTE in the post-intervention period = $e^{\{-0.108(1)-0.797\,(0)-0.941(0)\}} = e^{-0.108}$

Rate Ratio = $e^{(\text{post-pre})} = e^{(-0.108\,-\,0)} = 0.898$
95% CI for e^{β} = $\exp[\beta \pm 1.96\,(S.E_{\beta})] = (e^{-0.316}, e^{0.101}) = (0.729, 0.903)$

This value is equivalent to the computer generated rate ratio in Table 3.11. The relative rate of all injury in the post intervention period for the control group decreased 10.2 % (RR=0.898, CI. 0.729, 0.903) compared to the pre-intervention period. Similarly, relative to the small hospital, the relative rate of injury was 59.5% less for the medium size hospital (rate ratio 0.451, 95% CI=0.340, 0.597), and 65% less for the large hospital (rate ratio 0.390, 95% CI 0.307, 0.494). Here the larger hospital size had more reduction in relative rate.

For the SHR, the analysis revealed that hospital size and interaction term (size x intervention period) were significant and they were added to the model. It is not straightforward to interpret as they do not take into account the effect of the interaction terms. The final model for all injuries in the intervention group (SHR) was as follows, in Table 3.11:
Where y = Poisson count, μ = injury rate

$$E(y) = \mu = e^{\{-1.391(\text{period})\,-0.956(\text{size medium})\,-1.424\,(\text{size large}) + 1.124\,(\text{size medium} * \text{period}) + 0.913(\text{size large} * \text{period})\}}$$

Interpretation of the final model requires calculation of the injury rates while taking into account the effect of the interaction terms. The calculation of the rate ratios was as follows:

Where pre-intervention period and small hospital size were the reference categories (0) and large hospital size (1), and medium hospital size (0) were the dummy variable values,

Rate of injury in large hospital in the pre-intervention period=

$e^{\{-1.391(0) - 0.956(0) - 1.424(1) + 1.124(0*0) + 0.913(1*0)\}} = e^{-1.424} = 0.2407/\text{FTE}$

Rate of injury in large hospital in the post-intervention period =

$e^{\{-1.391(1) -0.956(0) -1.424(1) +1.124(1*0) + 0.913(1*1)\}} = e^{-1.902} = 0.1493/\text{FTE}$

Rate ratio = $e^{(\text{post-pre})} = e^{\{-1.902-(-1.424)\}} = e^{-0.478} = 0.620$

95% CI for e^{β} = $\exp [\beta \pm 1.96 (S.E._{\beta})]$ = (0.310, 1.239)

Thus the observed relative rate of all injury in the large intervention hospital decreased 38% in the post-intervention period as compared to the pre-intervention period. However this change was not statistically significant.

In a similar fashion, rate ratios were calculated comparing the pre to post-intervention period for medium size hospital which showed a 52.1% reduction in relative rate of injury (RR=0.479, 95% CI= 0.205, 1.12). For the small size hospital the relative rate reduction was 75.1% (RR=0.249, 95% CI=0.196, 0.316). Thus the reduction in relative rate for all injuries in the intervention group (SHR) was only statistically significant in the small size hospital (PRC).

Table 3.12 represents the same analysis for time loss injuries. In the intervention group, controlling for hospital size, the relative rate of time loss injury decreased significantly by 52% (RR=0.477, 95% CI=0.336, 0.677) in the post intervention period. In comparison, the relative rate for the small size hospital in the control group increased 9% (RR=1.09 95% CI=0.853, 1.405) over the same period. The rate ratios for the different hospital sizes showed a decrease in relative rate of time loss injury for the medium and large size hospitals in comparison with the smaller hospitals. This trend is similar in both the intervention and control groups. All changes in relative rate were statistically significant except for the small control group hospital. While the intervention period confidence interval included one, this variable was retained in the model due to its importance as the main comparator. Interaction terms in this model were not significant.

Table 3.12: Multivariate Analysis - Time Loss Injuries
Comparison of Pre-Post Intervention Periods by Group

Saskatoon HR	β (S.E.)	95% CI (β)***	Rate Ratio†	95% CI (RR)††	p-value
Intervention period*	-0.740 (0.179)	-1.090, -0.390	0.477	.0336, 0.677	<0.0001
Hospital size small	0	---	1.00	---	---
Hospital size medium	-1.005 (0.216)	-1.430, -0.582	0.366	0.240, 0.558	<0.0001
Hospital size large	-1.501 (0.202)	-1.900, -1.104	0.223	0.150, 0.331	<0.0001
Regina Qu'Appelle HR	β^ (S.E.)	95% CI (β^)	Rate Ratio	95% CI (RR)††	p-value
Intervention period**	0.091 (0.127)	-0.159, 0.340	1.09	0.853, 1.405	0.477
Hospital size small	0	---	1.00	---	---
Hospital size medium	-0.98 (0.176)	-1.320, -0.635	0.375	0.266, 0.530	<0.0001
Hospital size large	-1.050 (0.142)	-1.330, -0.772	0.350	0.265, 0.462	<0.0001

* Reference category is pre-intervention period
** Intervention period retained in model due to importance
*** 95%CI (β) = $\beta \pm 1.96(S.E.)$
† RR = e^{β}
††95% CI(RR) = $e^{[95\% \, CI(\beta)]}$

3.2.3.4 Multivariate Analysis: Comparison of Injury Relative Rate between Groups in Pre-and Post-Intervention Periods

Rate ratios were calculated to compare the difference in all injury relative rate between the intervention and control groups in the pre-intervention and post-intervention groups separately. Table 3.13 shows the analysis of all injuries for both the pre and post intervention periods. Addition of hospital size to the model was significant for both the post-intervention (LRT p-value<0.0001 and pre-intervention periods (LRT p-value<0.0001). In the pre-intervention period, there was a 77% higher relative rate of injury in the intervention group. There was a general trend of decreasing relative rate for larger hospitals. Interaction terms were not significant for this model and thus were not included.

The same analysis for the post-intervention period revealed that hospital size and interaction terms size by group were significant and these were retained in the model. Rate ratios were calculated taking into account the effect of interaction terms. This showed a 40% decrease in relative rate (RR= 0.599, 95% CI=0.579, 0.620) in the small intervention group hospital as compared to the small hospital in the control group. The relative rate of all injuries was 116% increased (RR=2.16, 95% CI=1.70, 2.75) in the intervention group compared to the control group medium sized hospitals. The large intervention group hospitals showed an 11.5% decrease in all injuries relative rate (RR=0.885, 95% CI=0.791, 0.990). Thus all changes in relative rate, in similar sized hospitals, were significant.

Table 3.13: Multivariate Analysis - All Injuries
Comparison of Groups by Pre and Post Intervention Period

Post-Intervention Period	β (S.E.)	95% CI (β)	Rate Ratio**	95% CI (RR)	p-value
Group (intervention and control)*	-.512 (0.256)	-1.014, -0.010	0.599	0.363, 0.990	0.045
Hospital size small	0	---	1.00		---
Hospital size medium	-1.11 (0.227)	-1.556, -0.671	0.328	0.210, 0.511	<0.0001
Hospital size large	-0.900 (0.171)	-1.233, -0.562	0.408	0.291, 0.570	<0.0001
Size medium*group	1.283 (0.343)	0.612, 1.954	3.610	1.842, 7.060	<0.0001
Size large*group	0.390 (0.306)	-0.213, 0.987	1.470	0.808, 2.684	0.206
Pre-Intervention Period	β (S.E.)	95% CI (β)	Rate Ratio***	95% CI (RR)	p-value
Group *	0.569 (0.097)	0.380, 0.760	1.767	1.462, 2.136	<0.0001
Hospital size small	0	---	1.00		---
Hospital size medium	-0.771 (0.123)	-1.013, -0.530	0.462	0.363, 0.588	<0.0001
Hospital size large	-1.218 (0.112)	-1.440, -0.997	0.296	0.237, 0.369	<0.0001

* Reference category is control group
** The model with interaction terms is not straightforward in generating CI from e^{β}. Additional calculations are needed (see page 53 for details)
*** Calculation (in model without interaction term) is similar to Table 3.12 and 3.14

Table 3.14 shows the same analysis for time loss injuries. Interaction terms were not significant for either the pre or post-intervention periods. There was a statistically significant 55% reduction of time loss injury relative rate in the post-intervention period for the small size intervention group hospital when compared to the control group (RR=0.442, 95% CI=0.315, 0.620). These reductions were similar for the medium sized (RR= 0.377, 95% CI=0.252, 0.564) and the large sized hospitals (RR=0.336, 95% CI=0.239, 0.471).

Table 3.14: Multivariate Analysis - Time Loss Injuries
Comparison of Groups by Pre and Post Intervention Period

Post-Intervention Period*	β (S.E.)	95% CI (β)***	Rate Ratio†	95% CI (RR)††	p-value
Group (intervention and control)*	-0.816 (0.172)	-1.153, -0.478	0.442	0.315, 0.620	<0.0001
Hospital size small	0	---	1.00	---	---
Hospital size medium	-0.976 (0.206)	-1.379, -0.572	0.377	0.252, 0.564	<0.0001
Hospital size large	-1.091 (0.173)	-1.431, -0.752	0.336	0.239, 0.471	<0.0001
Pre-Intervention Period	β (S.E.)	95% CI (β)	Rate Ratio	95% CI (RR)	p-value
Group**	0.031 (0.139)	-0.242, 0.305	1.031	0.785, 1.356	0.822
Hospital size small	0	---	1.00	---	---
Hospital size medium	-0.952 (0.180)	-1.305, -0.600	0.385	0.271, 0.550	<0.0001
Hospital size large	-1.300 (0.158)	-1.610, -0.987	0.273	0.200, 0.373	<0.0001

*Reference category is control group,
**Group retained in model due to importance
*** 95%CI (β) = $\beta \pm 1.96$(S.E.)
† RR = e^{β}
†† 95% CI (RR) = $e^{[95\%\ CI(\beta)]}$

By the Hosmer-Lemeshow method, model fit was checked.[111] Model fit was adequate for all models (p-value >0.05) except for the two with interactions terms: all injuries model for the SHR pre-post-intervention period comparison, and all injuries model for the post-intervention period comparing intervention and control groups (p-value <0.0001). With very small sample size (n=6) it is hard to satisfy goodness of fit for these two models with interaction terms present. With larger sample size, goodness of fit would not likely be a problem.

3.2.3.5 Interaction Effects

Figures 3.2 and 3.4 graphically represent interaction of hospital size and intervention period for all injuries rate where interaction terms were significant. For comparison, the same representation for time loss injuries where interaction terms were not found to be significant are indicated in figures 3.3 and 3.5. The interaction of effect of exposure to the intervention and size of hospital can only occur in one cell, the post-intervention period for the intervention group. In the model comparing intervention periods, the interaction appears to involve the differential effect seen in the greater reduction of injury rates in the small size hospital for all injuries. While the same effect seems to be present for time loss injuries, it was not statistically significant. In the model comparing all injuries for groups in the post-intervention period, the effect seems most pronounced in the medium size hospitals (Figure 3.4)

Figure 3.2: Intervention Period with Hospital Size for All Injuries in Intervention Group

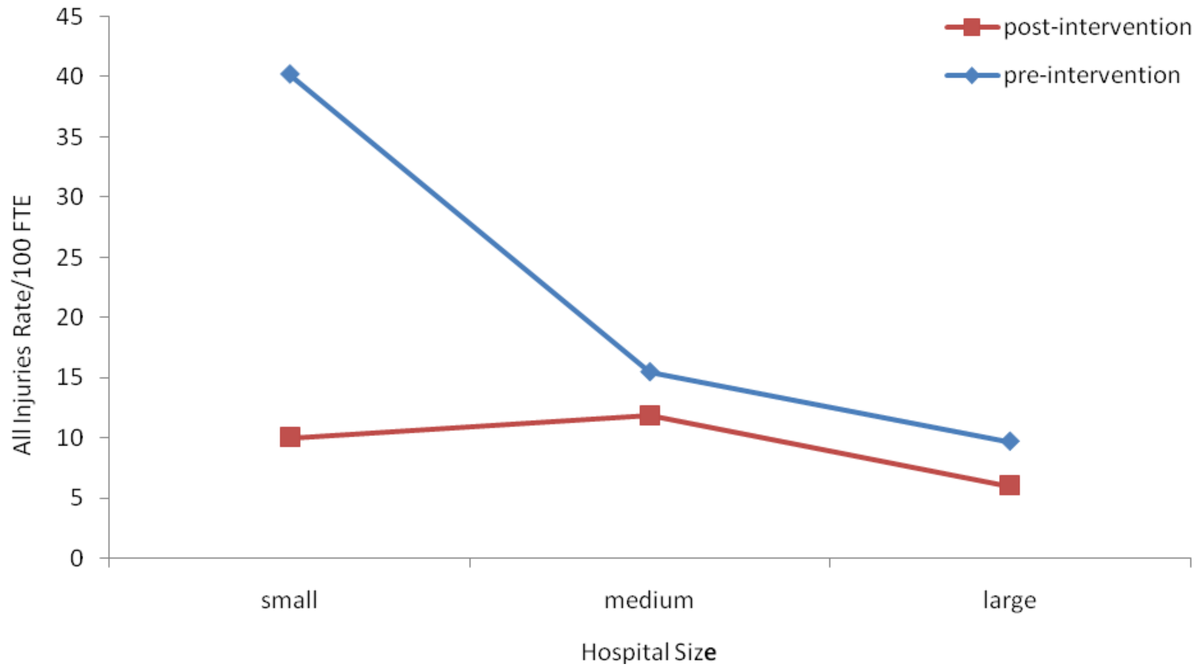


Figure 3.3: Intervention Period with Hospital Size for Time Loss Injuries in Intervention Group

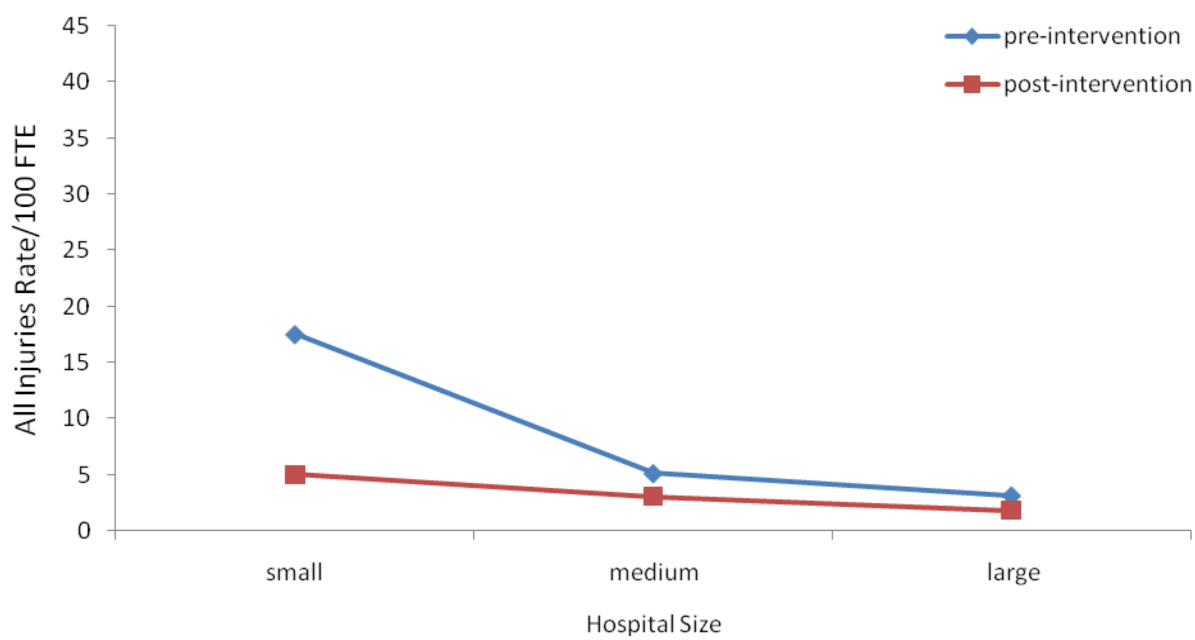


Figure 3.4: Group with Hospital Size for All Injuries in Post Intervention Period

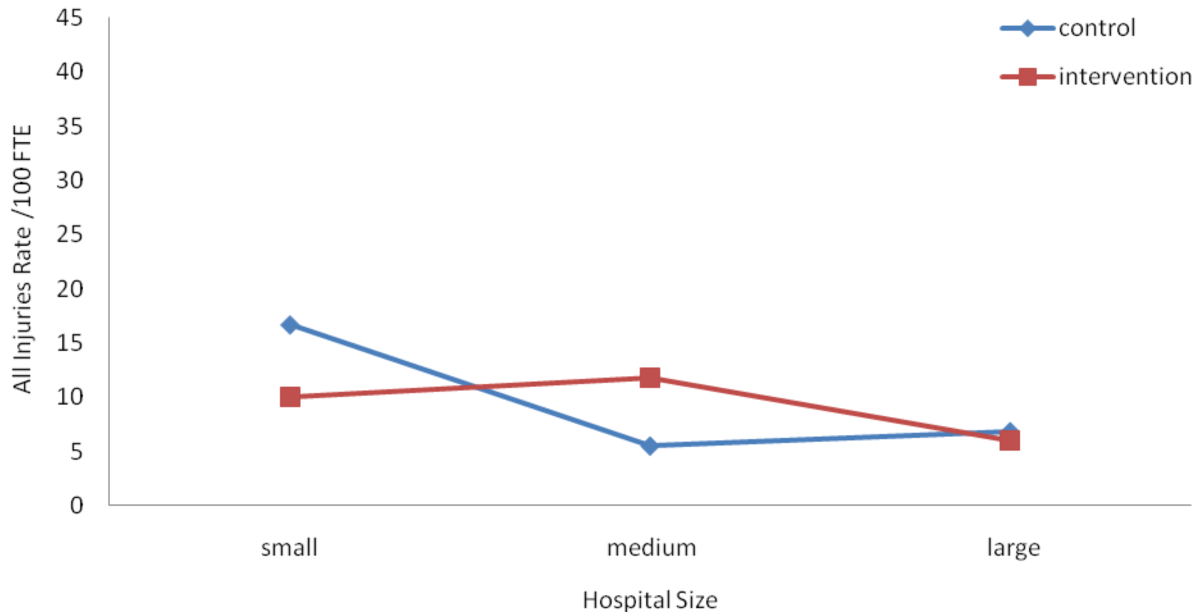
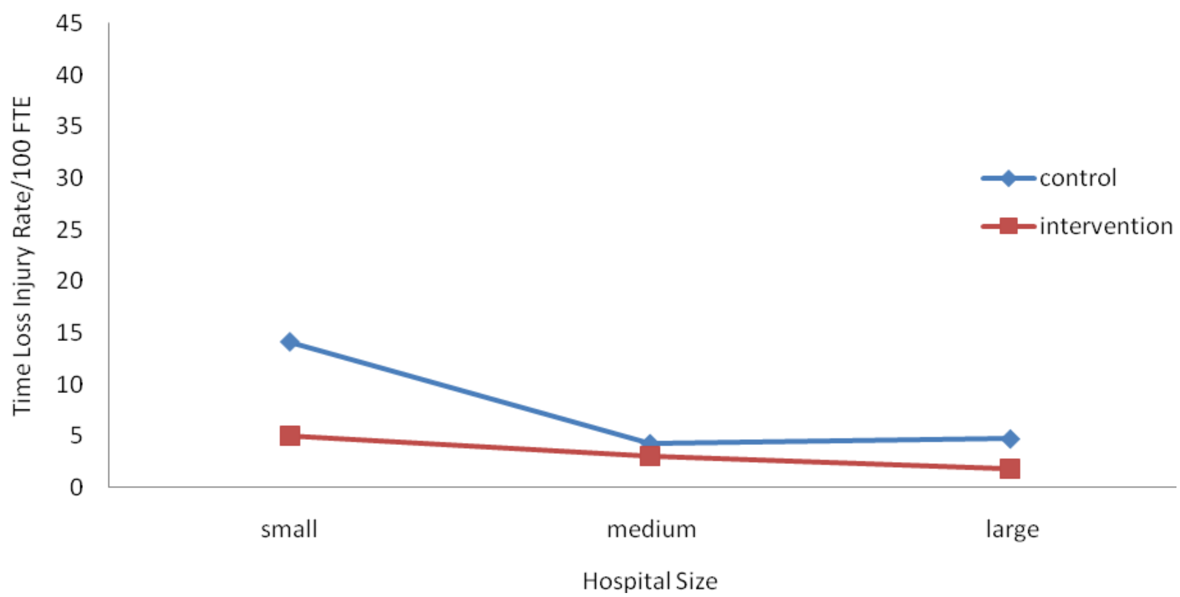


Figure 3.5: Group with Hospital Size for Time- loss Injuries in Post-Intervention Period



3.2.4 Time Loss Days and Claim Cost

Claim cost data, supplied by Saskatchewan WCB to the employer, for each worker, are comprised primarily of wage replacement, medical and rehabilitation costs. These costs tend to rise steadily as the number of time loss days/claim increases. Other factors may influence claim cost/injury however. Means and medians were calculated but the data were not normally distributed as a small proportion of claims with very long durations and high claims costs tended to skew the distribution. The mean number of decreased by 55% in the post-intervention period, while the claim cost/injury decreased by 41%, as shown in Table 3.15. Median time loss days/injury decreased by 48% and median claim cost/injury decreased by 49%. Results indicated a significant difference in time loss days/injury (p-value=0.013) but not claim cost/injury (p-value=0.092), based on non-parametric Mann-Whitney U-test. The mean time loss days/injury and the mean claim cost/injury by hospital are indicated in Figures 3.6 and 3.7 respectively. The greatest improvement for both outcome variables was made in the smallest hospital, Parkridge Centre.

Table 3.15: Outcome Variables Time Loss Days and Claim Cost For Intervention Group (SHR) n=number of injuries**

	Pre-intervention					Post-Intervention					
	mean	sd	Median*	Range	n	mean	sd	Median*	Range	n	% change mean
Time Loss Days/Injury	35.99	42.04	18	0-175.8	92	16.20	17.05	9.3	0-59.2	47	55%
Claim Cost/Injury($)	3891.22	4400.49	2205.13	69.56-16321.65	92	2302.25	2544.70	1121.01	65.83-9041.35	47	41%

* Mann-Whitney U test: Time loss days: p=0.013
* Mann-Whitney U test: Claim cost: p=0.092
** Data not available for RQHR

Figure 3.6: Mean Time-Loss Days/Claim by Facility

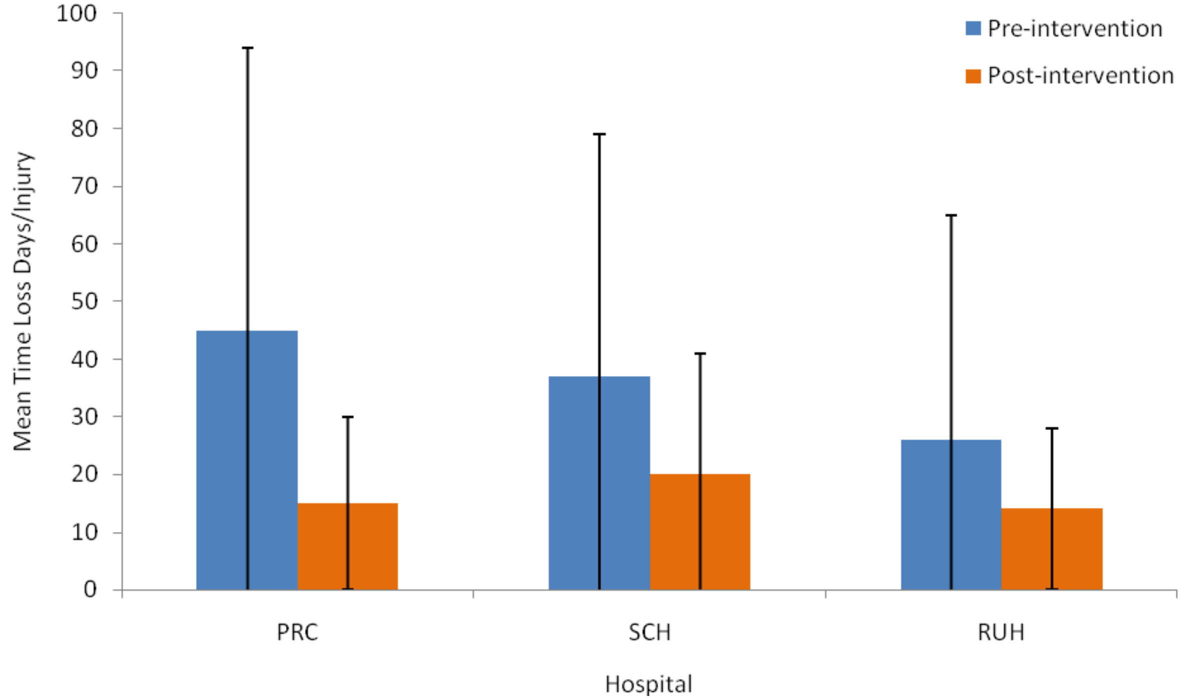
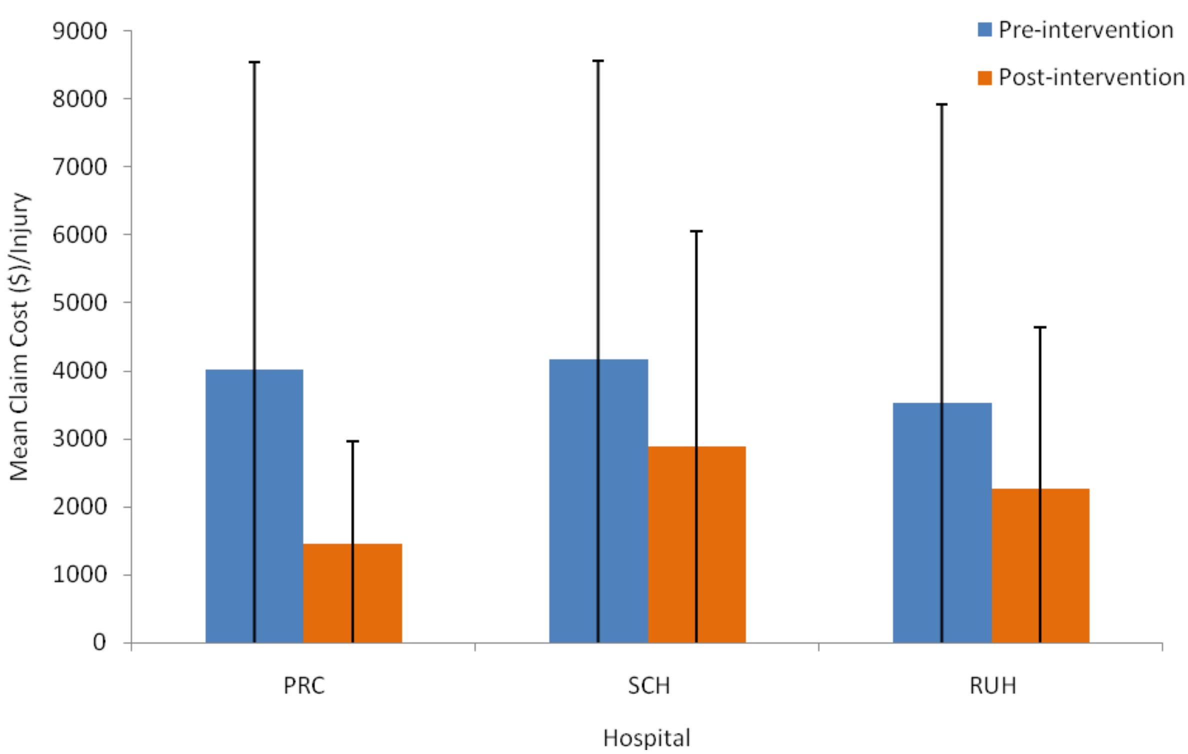


Figure 3.7: Mean Claim Cost/Injury by Facility



3.3 Summary of Results

The covariates age, sex, length of service, and occupation remained unchanged between the pre and post-intervention periods in the intervention and control groups. Significant reductions in all injuries and time loss injuries were seen in the intervention group. Statistical testing and Poisson regression analysis indicated that the relative rate of MSI for patient handling personnel was significantly reduced in the intervention group post-intervention and that the relative rate was also significantly reduced compared to a control group. The relative rate of injury was reduced to a greater extent in smaller hospitals than larger hospitals in the intervention group. Interaction of hospital size and intervention period and hospital size and group was significant. Claim cost/injury and time loss days/injury both decreased, with only the latter decrease being statistically significant. The relative proportion of injuries to different body parts was significantly different only in the control group and not in the intervention group. Lifting injuries showed the greatest decrease followed by transfer injuries and then repositioning injuries.

4. DISCUSSION

4.1 Summary of Findings

This study examined the effectiveness of an administrative and engineering intervention for patient handling in three types of hospitals. Injury rates were compared before and after the intervention in two health regions. Time loss days and claims costs were also examined.

4.1.1 Injury Rates for Grouped Data

The results showed a significant and substantial reduction in the overall rates for all injuries and time loss only injuries associated with patient handling for the Saskatoon Health Region in the year following the intervention. The results support hypothesis 1.1, that health care workers, trained in TLR, will show a significant decrease in patient handling related MSI and hypothesis 1.2 that health care workers trained in TLR will show a significant difference in patient handling MSI compared to health care workers in a control group.

Univariate Poisson regression analysis revealed similar statistically significant injury rate reductions, pre to post-intervention for all and time loss injuries in the intervention group in contrast to the non-significant changes in the control group. The above results also support hypothesis 1.1 and 1.2

These results suggest that there was a real and significant improvement in injury rates and relative rate in the intervention group, before and after the intervention when compared to the control group.

4.1.2 The Effect of Health Care Setting

Injury rate analysis for paired hospitals showed significant reductions in the small intervention group hospital and to a lesser extent, the large intervention group hospital when compared to their control group counterparts. The medium sized hospitals did not show any significant difference in the rate ratio or rate difference changes. These results were similar for both all and time loss injuries.

Examination of the time loss injury rate ratios for the hospital sizes in the multivariate Poisson regression models showed a reasonably consistent gradient in the relative rate of injury, decreasing as the hospital size increases. This gradient was present in both control and intervention, and pre- and post-intervention comparisons, suggesting that this gradient is endemic. The rate ratios for the medium and large sized hospitals tended to be more similar compared to the small hospital reference category. This gradient indicates a generally increased relative rate of injury in smaller hospitals. However, some of these changes were not statistically significant and must be interpreted with caution.

The apparent gradient was not seen in the models where interaction terms were significant. Interaction effects between group and hospital size and intervention period and hospital size were significant in the comparison of the intervention group in the pre and post- intervention periods and the post-intervention period comparison of groups. Interaction has been defined as "the incidence rate of disease in the presence of two or more risk factors differs from the incidence rate expected to result from their individual effects." [106] Rothman provides a further distinction of statistical interaction and biological interaction.[115] The all injury rate for the medium size hospitals was significantly higher in the intervention group than the control group and this was reflected in a 116% increase in relative rate of injury. The interaction of hospital size and group suggests a differential effect of the intervention in the medium size hospitals for all injuries. The rate ratio and rate difference analysis, showed no significant difference between the control and intervention group medium size hospitals. The results of these two different analyses suggest an apparent lack of effectiveness of the intervention in the medium sized hospital.

In the intervention group, pre-post comparison model, the interaction appeared to involve the small size hospital. To explain the apparent increase in intervention effect at PRC we must consider that the exposure to lifting tasks per FTE is likely to be higher at PRC than at the other hospitals due to the nature of the patient population. Thus there may have been more potential for improvement when compared to the other hospitals in SHR. We were not able to determine exposure to patient lifting tasks for individual workers and thus cannot differentiate this effect from other possible explanations.

The intervention seemed to be dramatically effective in the small hospital and not effective in the medium sized hospital. It is possible that the differential effect of the intervention may have been due to differences in how the intervention was received (buy-in), how it was delivered, or the level of management support for the intervention. There are several relevant theories of behavioral change with respect to injury prevention, the Health Belief Model, Theory of Reasoned Action, and Protection Motivation Theory.[116] The Health Belief Model has four main components: (1) perceived susceptibility to the problem, (2) perceived seriousness of the problem, (3) perceived benefits of taking a particular action, and (4) perceived barriers to taking an action. A high injury rate at PRC may create a higher perceived susceptibility and seriousness of the problem in the minds or workers who may see the consequences of injuries more directly in a small hospital. This possibly would have motivated workers to embrace the TLR program and change their behaviors around patient handling. A higher perceived need may have also affected the attitude of managers and reinforcement of the training may have been more prevalent in this environment. Reinforcement has been indicated as an important component of success for injury prevention programs.[54] For some direct care workers who have never been injured, or are in low injury environments, the perceived benefits of changing their patient-handling behaviors may be low. This combined with perceived barriers such as increased time requirements and decreased patient comfort may reduce the intervention effectiveness in larger hospitals. While the implementation of the educational component of the intervention was standardized, there may have been intrinsic differences in how the trainers responded to the workers from different hospitals. There may have also been variation in how line-managers or managers directly supervising health care workers responded to and supported the intervention. The intervention duration varied between hospitals, the medium and small hospitals taking 2 years to implement and the large hospital 1 year. This represents a difference in exposure to the intervention and this may have influenced injury rates. Presumably some of the workers trained early may spread or demonstrate their knowledge to other workers, possibly enhancing the effect of the training component and a longer intervention period would allow more time for this to occur. Also if positive effects of the intervention were observed by workers, this may have increased their buy-in and enhanced their learning when they did take the training. The fact that the medium and large hospitals had different intervention durations, but similar reductions in injury rates, suggests that this may not have had a substantial effect.

Three broad factors combine to create personal injury, the environment, the person, and their behavior.[117] Of these factors, behavior-focused feedback has been shown to reduce work injuries.[118] However, efforts in changing injury-related behavior have shown limited success.[119] It is possible that in a small hospital, there may be closer supervision or opportunity for positive feedback from management. Each hospital had dedicated occupational safety workers and there may have been closer or more frequent contact with workers, and hence more opportunity for feedback and reinforcement in the smaller hospitals.

4.2 Comparison of Outcomes

4.2.1 Injury Rates

There are four other pre-post design studies that are similar to our study in terms of outcome measures, intervention applied, study population and setting.[79, 96, 98, 100] Many cohort studies have used self-report changes in musculoskeletal symptoms as the outcome and other studies with injury rates as the outcome measure only used training, or single factor ergonomic interventions as the intervention or studied a completely different worker population.[50]

Lynch and Freund (2000) evaluated an ergonomic and training intervention at an acute care hospital using a pre-post design with an internal control group.[100] Their injury rate reductions are similar in direction, but not magnitude, to the injury rate reduction in both the large and medium size hospitals observed in our study. It is possible that a larger effect may have been seen if the researchers had extended the post-intervention evaluation period. They reported pre and post-intervention scores of ergonomic knowledge around patient handling in controls and subjects but they did not report separate injury rates for the two groups which reduced the usefulness of this outcome measure. Their study used an internal control group consisting of workers who did not receive the training. These nurses worked in the same departments as the controls and it is difficult to see how there would not be some measure of contamination (controls receiving intervention) occurring as workers could have shared knowledge. The authors also indicate that some of the burden of patient handling may have shifted to the controls due to the change in behavior of the subjects.

Collins et al. (2004) evaluated a "best practices" (multifactorial) injury prevention program in 6 nursing homes with a pre-post design study without a control group.[96] Their reported reduction in injury risk is similar in magnitude to the reductions seen in our study for the SHR post-intervention period for all and time loss injuries respectively. They used the incidence of "all other" injuries in the at-risk population to gauge the general trend in injuries and found no difference from pre to post-intervention period when using injury reports, or lost-time injury data. Their WCB injury data did show a decline and this rate was judged to be statistically greater than their patient-handling injury rate. The risk in using the personnel as their own controls, by evaluating non-patient handling injuries, is that there is no guarantee that the intervention has not influenced their behavior in ways that would affect their risk of sustaining, or avoiding, non-patient handling injuries. To avoid this, one approach would be to use non-patient care injury rates in other hospital workers, within the same hospital, as a measure of general injury rate trends. These workers would be likely be subject to the same influences resulting from any systemic injury prevention interventions or changes in workplace or regional OH&S policies.

Nelson et al. evaluated an ergonomic injury reduction program in a pre-post design with no control group.[98] The study population was nurses in high-risk units in hospitals and nursing homes. Injury rates in Nelson's study showed less of a decrease than the reductions seen in our study. As they do not detail if the patient handling injury rates included all injuries or just time loss injuries, it is difficult to compare their results with our study.

Other studies, evaluating primarily equipment based interventions, have shown decreases in patient handling MSI rates.[77, 80, 93] In a pre-post design study with a non-randomized control group, Owen et al. evaluated an ergonomics based injury prevention program in two small rural hospitals.[80] The reduction in injuries is similar to our study however the authors did not calculate injury rates nor perform any statistical tests to evaluate the injury data. A longer follow-up period of 5 years was examined and injuries remained low. The study subjects were volunteers and this self referral introduces a source of selection bias. The number of subjects was also very low (n=37 for intervention group and 20 for controls) which limits the ability of the study to detect differences between the two groups). For example, one worker contributed 64 of 67 total lost workdays within the 5 year follow-up period.

Substantial and significant reductions in patient handling injuries/year, lost workdays/year, restricted workdays/year and WCB costs/year were obtained after a "zero-lift program" was implemented in 7 nursing homes and a large hospital.[93] The data are not directly comparable to the all injury rate and time loss days/claim reduction seen in the long term care hospital in the SHR as they did not calculate injury rates based on FTEs or time loss days per injury. The author reported reductions in non-patient handling injuries as well an identified the possibility that other factors may have influenced patient handling injury rates.

Li et al. (2004) and Evanoff et al. (2003) both evaluated single-factor ergonomic interventions of mechanical lifting devices.[77, 78] Both studies found reductions in risk ratio for patient-handling injuries and lost-time injury rates and lost workday rates. However, the confidence intervals for both estimates included one after adjustment. Thus these results were not statistically significant and this may have been due to their small sample size of 138 nurses. Their study was able to address compliance to the intervention via the use of counters on the lifting equipment. This issue is not well documented or mentioned in most other studies. No measure of compliance was available for our study. Evanoff et al. found greater reduction of all injury rate ratio and time loss injury rate ratio in acute care compared to long-term care facilities.[77] Our results comparing all injury and time loss injury rate ratios for small, medium and large hospitals showed a similar trend, however the effect was greater for time loss injures than for all injuries in the intervention group. As we did not generate separate models for each size of hospital, but rather used hospital size as a covariate, the results do not compare directly.

A randomized controlled trial conducted by Yassi et al. found no statistically significant change in injury rates comparing a control group, a group that received technique training only and another group that had extra mechanical lifting equipment with a three hour training session.[95] The setting was a large hospital. The lack of significant findings was attributed to small population size. Their result may have been due to a limited potential for improvement in a large facility or that their interventions were not sufficiently effective. Our results indicate that injury prevention interventions in smaller hospitals may be more effective.

4.2.2 Time Loss Days due to Injury

In our study, overall mean and median time loss days per claim decreased by 52% and 48% respectively. Analysis of the median values indicated that this was a statistically significant reduction. By hospital, the decreases in median time loss days per claim were 36% for both the large hospital, 55% for the medium hospital and 68% for the small hospital. While these results tend to support hypothesis 2.2, we did not do a rigorous analysis of this variable by hospital as control group data were absent.

Many studies have shown reductions in time loss days.[75, 77, 93, 96, 98, 100] Evanoff et al. (2003) reported the number of lost days due to patient handling injuries but did not perform any analysis. Similar pattern of reductions in lost time days to our study were seen in long term care facilities and acute care facilities.[77] In another study, Evanoff (1999) reported reductions in lost days/100 FTE and in the number of lost days/reportable injury (not including modified duty days).[75] Collins et al. (2004) reported decreased lost time days and modified duty days but they did not relate this to the number of injuries.[96] Nelson et al. (2006) showed a decrease in number of modified duty days/injury but not the number of lost workdays/injury.[98] Garg reported decreases in lost workdays/year, restricted workdays/year due to patient handling injuries as well as reductions in overall lost workdays and, overall restricted workdays.[93] Reductions in lost days, post- intervention can apparently be sustained.[81] Lynch et al. (2000) found a reduction in lost-time days/injury over a short follow-up period.[100] Our study variable, number of time loss days/injury including days on modified duties gives a measure of the duration of disability resulting from patient handling injuries and better represents any preventative effects of the intervention than overall time loss days or time loss days/FTE. The observed trend overall is that ergonomic interventions can produce significant reductions in total time loss days and time loss days/injury and this is supported by our study. Besides reducing the initial severity of injury, these interventions may also be able to reduce the lost time days and return workers to graduated or light duties earlier due to the reduced job demands made possible by the modifications provided.[77] This has the additional positive benefit of reducing the risk for chronic disability and length of time off work which has been positively correlated with lower return to work rates.[120]

4.2.3 Claim Costs

Intervention studies report this variable in different forms, such as claims cost/injury, claims cost/FTE, claims cost/year and overall claims cost. Our study revealed overall reductions in WCB claim costs/injury of 47.7%. This reduction was not statistically significant from the pre to post-intervention periods. The median claim cost/injury reductions in small, medium, and large intervention hospitals were 68%, 43%, and 35% respectively. These results do not tend to support hypothesis 2.1. The reductions seen do represent a significant savings to the employer none the less. Many studies have reported claim cost reductions after interventions.[77, 78, 81, 93, 96, 98] Yassi et al. (2001) measured total cost of injuries and cost per time loss injury and their results indicated similar values for the control and intervention groups, however they did not provide statistical analysis of these results.[95]

Li et al, (2004) and Evanoff et al. (2003) reported annual WCB claims cost/FTE reductions.[77, 78] Our study did not calculate claim cost/FTE and thus it is difficult to compare these results. Garg (1999) reported significant reductions in WCB costs/year resulting from patient handling injuries in facility types similar to Parkridge Centre.[93] Nelson et al. (2006) showed a total WCB cost reduction and reductions in cost of medical treatment, cost of lost productivity.[98] Collins et al. (2004) reported a reduction in total WCB expenses.[96] Using trend analysis, sustained reductions of claims costs, three years after installation of overhead ceiling lifts, were observed by Chokar et al. (2005).[81] Where the outcome measures were similar, the above mentioned studies have shown similar results to our study.

In our study, the reduction of claim costs observed in the intervention group represents a significant benefit to the SHR. Without control group data, it is not possible to attribute this reduction to the intervention. General downward trends in claims costs and time loss days over the same period are possibly a result of WCB initiatives and changes to medical injury and disability management. The significant reduction of time loss days but not claim cost/injury may be a result of rising costs for medical treatment between the two time periods. Costs per claim for individual injured workers as reported by the Saskatchewan Workers' Compensation Board, have been steadily rising primarily due to rising costs for medical treatment. Program costs including wage replacement, health care and vocational rehabilitation costs, per time loss claim, rose from $8,883 in 2003 to $11,421 in 2007.[32]

4.2.4 Body Part Injured

Any imposed change to a job task, designed to reduce ergonomic risk in one body part, may inadvertently increase the risk of injury in another area of the body, or increase risk to other workers. Ergonomic interventions should be carefully designed to avoid this phenomenon. It is possible that the effect of providing lifting equipment or using transfer aides may shift the biomechanical forces from one part of the body to another, or create an increased repetitive usage of one body part over another. One example is mechanical patient lifts that decrease back strain yet require repetitive use of the arm to raise the lift. Owen et al. (2002) found some evidence of increases in perceived stress to the shoulder higher than the low back after addition of lifting devices.[80] Our study found statistically significant changes in the proportion of body part injured during patient handling tasks for the control group, but not the intervention group. The pattern of change between the intervention and control group was similar and thus any inference that the ergonomic risk was shifted from one area of the body to another, is not supported. Statistical comparison of proportions between the intervention and control groups is not likely valid as there were no established criteria for defining body part injured for either health region.

Yassi (2001) reported differences in the distribution of body part injured.[95] The group that received more mechanical equipment had fewer back injuries compared to the other groups. This shift is in contrast to our results where the proportion of back injuries was relatively stable between intervention periods and between the control and intervention groups. It is possible that the RCT study design has more sensitivity to detect these changes than a pre-post design as the intervention dosage can be better controlled. In our study, we could not control for any changes in case-load over time (exposure) that might have influenced the types of patient-handling required nor the type of intervention applied. These changes could mask effects of the intervention in reducing, or increasing risk of injuries in a certain body part.

4.2.5 TLR Injuries

Our study found significant decreases in lifting injuries followed by transfers, and then repositioning. A TLR program may help prevent injuries while performing one type of maneuver and not another depending on the emphasis of the intervention. Also some maneuvers may be more stressful, pose a higher risk of injury and thus have a greater potential for improvement. A rigorous analysis of this variable was not possible in this study due to the lack of control group data and the level at which the data was collected.

Ronald et al. (2002) found no significant change in overall MSI rates or repositioning MSI injury rates but did see significant reduction in injury rates related to transferring and lifting injuries.[79] The lack of improvement in overall MSI rates may be due to the mild changes that their intervention made: changes in mechanical lift type, new policy increasing use of transfer belts and a no manual lifting policy. Collins et al. (2004) reported a more detailed analysis of patient handling tasks associated with injuries. Post intervention reductions were seen for injuries associated with unclassified transfers, bed to chair and chair to bed transfers and turning/rolling , toileting or lifting a patient off the floor, breaking a resident's fall and repositioning in bed.[96] These results reflect ours with the exception of transfers and lifts. This may be due to a lack of standardization of what may constitute a lift or transfer.

4.3 Study Design and Threats to Validity

Validity can be defined as: "the best available approximation to the truth of a given proposition, inference, or conclusion."[121] This can be divided into 4 types: conclusion, internal, construct and external and summarized as follows:

1. Conclusion Validity – was there a relationship between the variables?
2. Internal Validity – was the relationship causal?
3. Construct Validity – did the instruments measure what we thought they did and was the program implemented as designed?
4. External Validity – can the effect be generalized to other populations or situations?[121]

4.3.1 Conclusion Validity

The selection of appropriate statistical tests and the ability of the study to recognize the true presence or absence of relationships between the variables are important to any study. Violation of statistical assumptions, reliability of measures and statistical power are critical in this area. Use of Poisson regression is appropriate for analysis of rare count events and rates.[112, 122] Since the Poisson regression also assumes that events are independent, we eliminated repeat injuries, in the same body part, for each worker. As there are no measurement instruments, per se, that were used to collect data, we must comment on the process used to gather injury statistics within the Health Regions. The reliability of the OH&S departments to gather injury reports is influenced by the willingness of the employees to report injuries, the willingness of the OH&S departments to accept such reports (not likely a problem as this is a legislative requirement), and the accuracy of their record keeping (assumed to be acceptable as both Health Regions used computerized systems). The under-reporting of injuries is a known phenomenon [17] and thus all the injury rate estimates are likely to be an under-estimate of the true injury rates. There was no reason to believe that a systemic difference in the rate of reporting between the two Health Regions existed, although it is possible by chance. Without data on musculoskeletal symptoms as a more sensitive standard, this was impossible to ascertain. In consideration of sample size, the 3 hospitals in each group meant that the comparison of mean injury rates might not be reliable with statistical methods.

4.3.2 Internal Validity

Threats to the internal validity of a study are chance, bias, and confounding.[123] Bias is defined as "any systematic error in the design, conduct or analysis of a study that results in a mistaken estimate of an exposure's effect on the risk of disease."[106] There are several validity threats that must be taken into account when attributing changes in the outcome measures to an intervention.

If another external event occurs during the time period of the study, which affects the outcome, this may bias the results (History threat). Such an event in this study might be a directive from WCB to decrease injury rates, or an incentive to do so, or a change in administrative personnel that might influence safety culture within the hospital. No such events were identified in this study.

Extreme values of a measure in a selected group will tend to be closer to the mean on retesting; regression to the mean. The mechanism is that the error component of the test scores, being random, will move some of the extreme scores closer to the mean, bringing the group average closer to the mean on retesting.[124] Certainly, the mean injury rate for the intervention group did decrease in the post-intervention period and the hospital (PRC) with the highest injury rate in the pre-intervention period decreased the most dramatically. With a longer baseline period, it would be possible to see if this high injury rate was an anomaly or not.[109] If the rate was high and stable, and then decreased after the intervention, then regression to the mean would be less important in explaining the result. One strategy to control for this phenomenon would be to establish one group of workers who did not get the intervention, an internal control group subject to all the same influences, and compare outcomes after the intervention.[109]

Naturally occurring changes in the study population as time progresses can bias the results as they result in differences in covariates between study periods (Maturation threat).[109] Normally, this can be controlled for in the analysis for known covariates. Our results indicated very little change in injured worker age or experience between the pre and post-intervention periods. However, not knowing this for the entire at-risk population does not allow us to rule this out as a potential bias. We were not able to determine exposure changes related to possible differences over time in patient characteristics (heavier, more dependent), or organizational factors (changes in job roles, workload changes). These factors may have had an effect on injury rates and may have changed differently in the intervention and control groups. Over time there may also be changes in the proportion of at-risk occupations due to changes in caseload and organizational priorities in the hospitals. We obtained occupation data for only injured workers and were thus not able to see changes in the at-risk group overall. There were some dramatic changes in the proportion of injuries in the intervention group between nurse aides and attendants. Both these groups are at high risk for patient-handling MSI. The proportion of injuries in nurse aides increased and in attendants, it decreased. This change was not observed in the control group. Without corresponding data in the non-injured, at-risk population, it is impossible to attribute this change to the TLR intervention. Full-time, part-time status, and the amount of overtime worked for each worker are factors that potentially influence the risk of MSI due to worker fatigue. We did not collect data for this variable and were thus unable to evaluate its possible effects.

Information bias may be a factor in our study as there did not seem to be uniformity in the way information for the variable body part injured was gathered. The level of detail given for this variable was greater for the control group and thus some of their classifications, for back injury for example, were amalgamated to make comparison with the intervention group meaningful. This did not seem to be a factor with the other variables.

It is possible that our control group was not sufficiently similar to the intervention group (Selection Threat). A differential between the groups in any of the above factors would contribute to selection bias.[121]

The application of any intervention may cause an improvement in the outcome due to the psychology of the participants, even if the intervention is ineffective (Placebo effect). In controlled studies this is dealt with by blinding the subjects.[125] With ergonomic interventions, this control is impossible. Thus the addition of a new injury prevention program may have made some of the workers feel better, and may have influenced worker's job satisfaction and perceptions about their employer and changed injury reporting and RTW statistics.

If subjects know they are being studied, their behavior may be changed and thus affect outcomes (Hawthorne effect).[124] There was a survey of SHR nurse managers performed to assess the acceptance of the TLR program, and a survey of program participants. This evaluation was a one-time survey and not ongoing. As the workers were not being continuously evaluated, Hawthorne effect would likely be low in this study.

Subjects who leave the study are a major threat to internal validity in a cohort study (Dropout threat). If enough subjects dropout, the characteristics of the group may change and bias the results.[106] Our study included the entire worker population and did not collect person-time data and as such the effect of dropouts is unknown. Were person-time data for all workers available, then this would become an issue as workers might leave the workplace for injury or other reasons and not contribute data for the entire study period. This study was also not able to evaluate the effect of staff turnover or migration between hospitals which could have influenced the injury rates. Staff turnover has been shown to be as high as 38% to over 100% per year in some facilities.[93]

Our study was also subject to the effect of clustering.[109] The unit of analysis was the hospital. The workers in the hospitals are related in terms of time and space. Individuals within each hospital may not be considered independent as there may have been systematic differences in how these subjects reacted to the intervention based on the similarity of other workers in their proximity. This may be due to differences in the safety culture, management or worker buy-in to the intervention, or differences in how the educational intervention was delivered in each hospital. While the intervention components were standardized there were different instructors for each hospital. To help mitigate this effect, intervention and control group hospitals with similar size characteristics, were analyzed in pairs.

We were not able to ascertain any measure to gauge compliance with the intervention. It is possible that some of the workers did not use the available equipment or systems in place and these are the workers who were injured. There is evidence to suggest that compliance with use of lifting equipment can be low and that ergonomic interventions are met with resistance. Some of this may be due to unfamiliarity, or perceived barriers in using the equipment such as patient safety and comfort, extra time to use the equipment.[126] Saskatoon Health Region workers received individual coaching and demonstration in how using the equipment took relatively little extra time.

Our study used a non-randomized control group. In controlled studies, randomization helps to reduce the effect of unknown confounding variables on the outcome.[123, 127] Randomization of subjects is not possible in a retrospective, observational study and we were not able to control which workers received the intervention. Thus, other factors may have contributed to changes in the injury rates, time loss days or claim costs. This is a major potential source of bias in this study. One strategy to control this bias is to examine the characteristics of both groups for known potential confounders and/or stratify the analysis. Normally, knowing the characteristics of the entire at-risk population is required to make meaningful comparisons between the intervention and control group. This was not possible in our study and we relied on covariate information in the injured worker population to make any such comparison. Changes in co-variates of age, sex, and length of service and occupation in the intervention group were small. We did not have length of service data, and age and sex data were incomplete for the control group which further compounded this difficulty. The comparability of the hospitals was not able to be quantified in terms of exposure to patient handling activities, nor with other general hospital data as it was not available. However, the initial similarity in time loss injury rates for the intervention and control hospitals, gives an indication of validity for the hospital pairings.

4.3.3 Construct Validity

The construct of "workplace musculoskeletal disorder" can be defined in different ways. [6] Does the presence of symptoms alone constitute a WMSD; does there have to be observable clinical signs; is functional disability a necessary component? There are certain reporting criteria required by insurance companies such as WCB. In Saskatchewan, the WCB act stipulates: "Each employer shall, within five days from the date he becomes aware of an injury which prevents a worker from earning full wages or which necessitates medical aid…"[128] This standard, which is applicable to both health regions, helps to standardize the definition of reportable injuries between the two groups. However, what constitutes a time loss injury may vary by employer, with some reporting only injuries which disable the worker from their employment, and others reporting any absence from work, for medical treatment appointments for example, even if the worker is not disabled. Our study was not able to distinguish a difference in how the Health Regions reported time loss injuries. Besides measurement issues, the construct of an "injury prevention program" can be formulated and described. The intervention that was ultimately delivered may not have corresponded to the original concept and intent of the TLR program. A program evaluation framework would be useful to elucidate this aspect of construct validity.

4.3.4 External Validity

The generalizability of the results is enhanced by the fact that we investigated a variety of settings, large acute care, community, and long-term care and rehabilitation hospitals. We were not able to collect data for home care and thus the results cannot be applied to this group. We were also able to collect injury data for all direct-care occupations that were exposed to patient-handling risks. Thus the results are likely applicable to other workers in these professions working in these settings. The duration of the intervention implementation was relatively short and this reduced the chances of other influences of external factors that could have influenced injury rates. The recent introduction of the "Mission Zero" injury reduction campaign by the Saskatchewan WCB, for example, would have been a major influence, if it had occurred within the study period.

In this study, short pre and post-intervention measurement periods limited our ability to identify general trends in injury rates prior to intervention and latent effects post-intervention such as program sustainability. This measurement span was also not able to capture fully matured WCB claims information (lost time days and claim costs) and thus these measures may be underestimated. The original proposed study design would have given 5 years baseline data and covariate information for all workers in both the intervention and control groups. This would have allowed for a full comparison of the characteristics of the two study groups and the examination of trends in injury rates and covariates over time. A full Poisson regression analysis with covariates, collected at the level of the worker and included in the analysis, would have been possible. The addition of FTE data for each worker, giving person-time denominators, would have allowed for a more exact determination of exposure and control of drop-outs, new worker influx and migration of workers between worksites or departments within a hospital.

4.4 Study Strengths

The use of a control group in our study gives it some ability to evaluate trends in the outcome measures that were not due to the intervention. When subjects cannot be randomly assigned to a treatment or control group for practical or ethical reasons, this design is more powerful than a pre-post study with no control group.

The elements of the intervention were well described, documented and standardized in content for implementation in the intervention group hospitals. Poor descriptions of a study intervention will tend to limit the study's reproducibility and generalizability. The intervention chosen was a multi-factorial intervention and this had the greatest chance of showing an effect, based on evidence from the literature. The intervention was implemented in a variety of sizes of hospitals at relatively the same time allowing us to investigate the differences in the intervention's effect. This also enhances the generalizability of our results. Exposure of the at-risk workers to the intervention was consistent as the program participation was mandatory. Incomplete exposure to the intervention would essentially create two subgroups and potentially bias the injury rate results.

There was reasonable consistency of covariates among injured workers between groups and between intervention periods. This strengthens the attribution of the changes in injury rate to the effect of the intervention within the limitations of this study design and the data available.

Data collection time frames for similar size hospitals were identical in the control and intervention group. This helps to reduce the influence of selection-history threat as events would be occurring simultaneously in both groups. Repeat injuries were accounted for giving a better estimate of the incidence rates of injuries. Injury rates were calculated based on FTEs and this takes into account the change in exposure for the at-risk group of workers. A variety of outcome measures were used, non-time loss injuries, time loss injuries, body part injured, type of maneuver causing injury (TLR injury), lost time days/injury and claim cost/injury. These outcomes are of great interest to hospital administrators and insurance providers. These measures are not perhaps the most "sensitive", but they are not subject to biases resulting from the use of symptom report questionnaires (recall bias, validity and reliability issues with the instrument, obsequiousness bias, and/or poor response rate). They make up the "bottom line" of injury prevention efforts.

5. Conclusions

The problem of patient handling injuries among health care personnel is substantial, pervasive and costly. Multifactorial interventions including engineering and administrative controls are emerging as the best instrument for preventing these injuries. Most research investigating intervention effectiveness in this field has consisted of pre-post designs with or without control groups in a variety of settings using different outcome measures. This study was unique in its ability to examine the effectiveness of a multi-factor ergonomic intervention in relation to hospital size using a quasi-experimental design with injury rates, time loss days and claims costs as outcome measures.

The results of our study are similar to other studies with roughly comparable interventions in many aspects. It provides a more detailed comparison of the effect of an injury prevention intervention in health-care hospitals of different size and setting. The results of this study show that the use of a multi-factorial injury prevention program can significantly reduce both time loss and no time loss injuries and disability related to patient handling. The reductions of claim costs/injury represent a substantial benefit to the Saskatoon Health Region. Our results are especially relevant to smaller facilities and this provides further strong impetus for implementation of this type of program where patient handling injury rates are high.

A possible future study would be aimed at tracking changes in injury rates and extending the post-intervention follow-up period to examine long-term effectiveness of the intervention. If injury rates remain reduced, this would add to the evidence for effectiveness. If not, then this may indicate the need for subsequent retraining and reinforcement of the program. The baseline injury rate data could also be expanded with adequate resources. This would help to clarify any pre-existing trends in injury rates that would provide an alternative explanation for the changes seen in this study. An analysis of the incidence of repeat injuries in the same body part would also be useful to investigate the preventative effect of this type of interventions.

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7. Appendices

Appendix 1 Examples of TLR Equipment

Ceiling Lift

Reproduced with permission of Sammons Preston Inc.

Total Body Lift

Reproduced with permission of Sammons Preston Inc.

Sit-Stand Lift

Reproduced with permission of Sammons Preston Inc

Slider Sheet

Reproduced with permission of Sammons Preston Inc

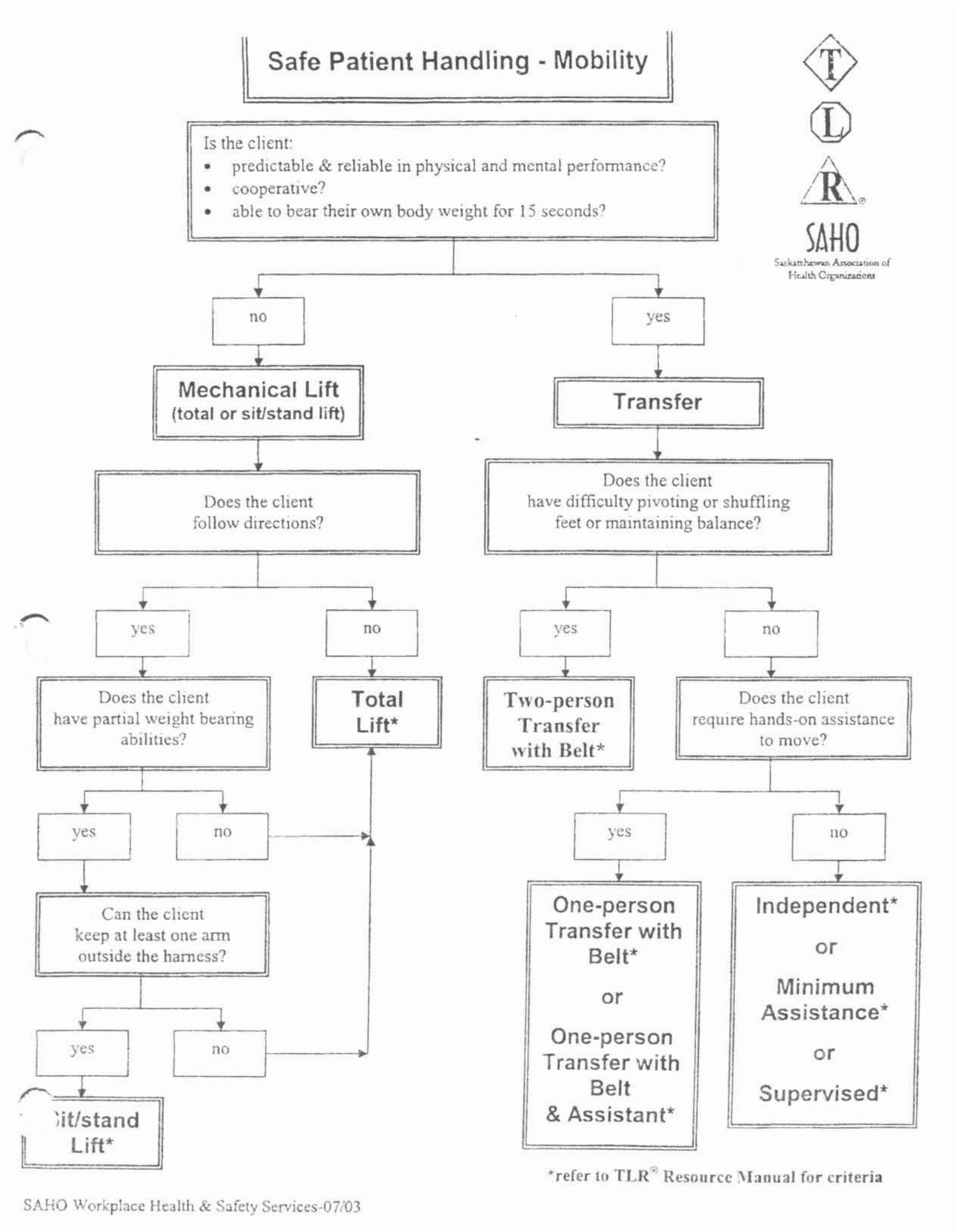
Transfer Belt

Reproduced with permission of Sammons Preston Inc

Transfer Board

Reproduced with permission of Sammons Preston Inc

Appendix 2 patient handling algorithm



Appendix 3: Patient Handling Assessment Form

SASKATOON HEALTH REGION
Saskatoon, Saskatchewan

❑ RUH ❑ SCH ❑ SPH Other ____________

MOBILITY RECORD -
Occupational Health & Safety

Criteria met - ✓
Criteria not met, written note required - ×
Criteria not applicable - n/a

Assessment of the following Health Information Parameters must be done prior to doing Physical / Functional Assessment:

Communication Status	**Emotional/Behavioral Status**
Able to communicate needs	Displays stable moods
Vision is adequate	Demonstrates predictable/cooperative behaviors
Hearing is adequate	**Medical Status**
Cognitive Status	Able to participate in move despite medical condition
Remembers instructions related to the move	Aware of own body position in space
Able to judge own capability to move	Able to move with attachments/appliances
Able to make decisions	Able to move despite pain/fatigue
	Able to participate despite effects of medication

Physical/Function Status

*** Document Physical/Functional Assessment each time patient condition changes**

Date (day/month/year)								
Time								
Pre-Mobilization	Can grip, push & pull in a handshake	rt						
		lt						
	Can bend and straighten knee	rt						
		lt						
	Can lift leg straight	rt						
		lt						
	Can move foot up and down at the ankle	rt						
		lt						
	Can roll from side to side in bed	rt						
		lt						
Sitting Abilities	Can get into sitting position							
	Can sit unassisted for 15 seconds							
	Can right self when gently tipped in all four directions							
Standing Abilities	Can position self for standing							
	Can lift body weight off buttocks/thighs							
	Can stand independently							
	Can remain standing for 15 seconds							
	Balance when lifting one arm at a time to front and side							
Walking Abilities	Can shift weight from one foot to other							
	Can walk on the spot							
	Can walk from one location to another							
Initials								

Word Form # 102325DRAFT 12/05 Category: Care Plan

Appendix 4: Excerpt from TLR Training Manual Patient Handling Technique Descriptions and Definitions

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TLR Participant's Handbook

Repositioning Techniques

Model procedure summary for repositioning in chair (two workers)

The **primary worker**:

- applies the transfer belt.
- assists the client to place both feet flat on the floor with ankles flexed and placed under the chair.
- faces the client, hugging the client's knees with their own knees.
- assists the client to lean forward with their hands on the armrest/worker's hips.
- bends both knees and hips, keeps the trunk upright and grasps the transfer belt toward back or sides of client.
- rocks the client forward to the count of "1-2-3- slide".

The **second worker**:

- stands behind the chair, holding it securely.
- moves the chair forward on the command "slide".

Model procedure summary for repositioning in bed, side to side (same side)

The **primary worker**:

- positions the bed to ensure good body mechanics during the move.
- lowers the near side rail only.
-
- stride stance – front to back weight shift
- grips the sheet safely and effectively.
- counts "1-2-3 slide". On "slide", moves the client toward themselves.
- uses a blended move and turn motion.
- uses several small moves as necessary.

The **second worker**:

- stands on the same side of the bed as the primary worker.
- stride stance – front to back weight shift
-
- grips the sheet safely and effectively.
- uses a blended move and turn motion.
- uses several small moves if necessary.

Model procedure summary for repositioning up in bed (top of bed)

The **primary worker**:

- adjusts the bed height to allow for a safe move. This move requires the bed in a lower position.
- lowers head of bed to flat position.
- ensures side rails are lowered.
- ensures that both the client's shoulders and hips are on the turning sheet.
- instructs the client to lie on their back, bend their knees and cross their arms on their chest.
- instructs the client to keep their chin on their chest.
- places a pillow at the head of the bed.

The **workers**:

- stand on opposite sides of the bed.
- use a safe and effective grip with both hands close to the client.
- place the inner knee on the bed with their back facing the headboard.
- count "1-2-3 slide" as they apply an upward motion on the sheet while sitting back on the heel of the leg that is on the bed.
- repeat this step as many times as is needed to move the client up.

Minimum Assistance Transfer

Criteria for minimum assistance transfer
A minimum assistance transfer is appropriate for the client who:

- can bear their body weight through part or parts of their body
- is co-operative
- is predictable and reliable in physical performance and behaviour to the extent required for the move
- requires minimal assistance with equipment and/or personal items

Moves to a one-person transfer with belt when client requires hands-on assistance to physically move.

One-person Transfer with Belt and Assistant

Criteria for one-person transfer with belt and assistant
A one-person transfer with belt and assistant is appropriate for the client who:

- can bear their body weight through part or parts of their body
- is co-operative
- is predictable and reliable in physical and mental performance and behaviours to the extent required for the move
- requires hands-on assistance from one worker to co-ordinate the transfer
- requires assistance from another worker to manage equipment/attachments

Moves to a two-person transfer with belt when client has difficulty pivoting, shuffling feet and/or maintaining their balance.

Mechanical Lifting Techniques

> Prior to using all equipment, ensure you have read the manufacturers' instructions and have had training specific to the equipment you are using. The model procedures described in this section are common steps but must be adjusted to suit the equipment you are using.

Sit/stand Lift

Criteria for sit/stand lift
A sit/stand lift is appropriate for the client who:

- is able to keep at least one arm outside of the harness
- has limited weight bearing ability through part or parts of the body
- is unpredictable and unreliable in their physical and mental performance during a move
- is unable to pivot or shuffle the feet
- demonstrates poor balance in sitting or standing positions
- is disproportionate to the worker's abilities as indicated by the worker self-assessment

Moves to a total mechanical lift when client exhibits one or more of the following:

- ➞ cannot bear their own body weight; and/or
- ➞ is unpredictable and unreliable in their physical and mental performance; and/or
- ➞ must be moved from a supine position.

Total Lift

Criteria for total lift
A total lift is appropriate for the client who:

- cannot bear their own body weight
- is uncooperative, aggressive or abusive during moves
- must be moved in a supine position
- weighs less than the total lift lifting capacity

The **primary worker**:

- ❑ checks the lift for:
  - ➡ good working order
  - ➡ safe and appropriate attachments
  - ➡ lifting capacity related to client's weight.
- ❑ adjusts the bed to ensure good body mechanics are used.
- ❑ positions the client on the appropriate sling.
- ❑ instructs the client to fold their arms across their chest.
- ❑ widens the base of the lift for stability. Keeps in lowest position possible.
- ❑ applies the brakes depending on manufacturer's instructions.
- ❑ attaches the harness without pulling or tugging with the hooks facing away from the client.
- ❑ verbally prepares the client for the move.
- ❑ monitors the security of attachments throughout the move.
- ❑ positions the client so that minimal repositioning is necessary.

The **second worker**:

- ❑ helps in positioning the client on the appropriate sling.
- ❑ helps attach the sling to the lift without pulling or tugging.
- ❑ turns the client's legs toward the mast during the move.
- ❑ helps to position the client in the chair or on the bed.

Refer to manufacturers' instructions for details related to specific lifts.

Appendix 5: Descriptions of SHR and RQHR Hospitals

Saskatoon Health Region[129]

Saskatoon City Hospital (1909) Saskatoon City Hospital is home to the SaskTel MRI Suite, and the future Breast Health Centre. City Hospital also has the Eye Care Centre, Geriatric Assessment unit and large gynecology and rehabilitation units and is one of the few acute care hospitals in Canada to house a research centre - the Cameco MS Neuroscience Research Centre. General Rehabilitation Services are primarily located at Saskatoon City Hospital and include the following: Inpatient Rehabilitation Centre and the Rehabilitation Day Services Program are located on the 7th floor, Saskatoon City Hospital.
Interdisciplinary clinics include multiple sclerosis, amputee program and specialized seating.

Royal University Hospital: Seven-wing, seven-story hospital linked with the University of Saskatchewan, College of Medicine to deliver a comprehensive health program
Partnership between training and healthcare was in place to create the most important medical centre in the province, one which would raise the standard of medical treatment throughout Saskatchewan.
The hospital serves as the main trauma center for the entire province, houses many maternal and child services, neurosurgery and cardiovascular surgery.

Parkridge Centre is a Long Term Care Facility located on the west side of Saskatoon. It is home to over 240 residents ranging in age from Preschool to over 100 years of age. Parkridge Centre is a heavy care facility and many residents require specialized care.
In addition to the Long Term Care Programs, there are also some short stay programs including:
Within each of the six resident units there are communities providing specific approaches to long-term care.
Short-stay programs include the Geriatric Re-Enablement Unit, Emergency Respite, and Planned Respite.
Parkridge Centre is home to a Community Day Program where clients living in the community come to access support services that help them remain in the community.

Our community is made up of six neighborhoods all located off of the main atrium. Each area is designed to meet the wide-ranging medical conditions and diverse physical and psychological abilities of our residents.

Each neighborhood has their own group of neighbors.

Core to each neighborhood is a dining area, living room area, activity space, and the communication centre.

Community Meal Service provides meals served in a home setting to residents in each of the neighborhoods.

Regina Qu'Appelle Health Region [130]

Regina General Hospital:

This acute care facility serves as a major referral centre for the southern half of the province.

Services:

Ambulatory Care: The Ambulatory Care Clinic handles many non-urgent, scheduled cases.

Burn Unit

Cardiosciences: diagnostic, cardiac care and cardiac surveillance

Critical Care Services

Intensive Care

Medical/Pediatric Intensive Care Unit 12-bed Adult, pediatric, maternity, and critical burn patients are cared for in the Unit. MPICU staff form the Pediatric Transport Team that covers the Southern half of the province.

Surgical Intensive Care Unit. 12-bed

Diagnostic Imaging Services: Magnetic Resonance Imaging (MRI) and Spiral Computed Tomography (CT) scanners

Emergency Services: Emergency Department provides 24-hour-a-day emergency care to patients,

Laboratory Services and Laboratory Collection Services

Mental Health Services: specially-designed, 50-bed inpatient unit that meets the unique safety and functional needs of the services provided.

Neurosciences: Spiral CT scanner and the MRI, along with new enhanced facilities

Radiology

Renal Dialysis Services
Sleep Disorders Centre
Surgical Care Services
Trauma (Major Emergency) Care
Women's and Children's Health: obstetrical, pediatric, neonatal, adolescent and psychiatry services to meet the care needs of children and their mothers.

Pasqua Hospital:
The Pasqua Hospital continues its tradition of care and community service as an integral part of the Regina Qu'Appelle Health Region. The Pasqua Hospital is recognized for provision of quality health care in several specialized areas. Highly qualified physicians and staff, along with advanced diagnostic equipment, have enabled the Pasqua Hospital to stay in the forefront of many programs, such as ophthalmology, orthopedics and cancer services.
New Spiral CT Scanner and advanced nuclear medicine equipment
Renovations to areas such as palliative care, as well as the creation of a new ambulatory care area, are helping the Pasqua Hospital continue to provide a high standard of care and service to clients.
Services
Ambulatory Care: houses the Region's main orthopedic clinic.
Dermatology Clinic
Home TPN (total parenteral nutrition) Clinic
Ostomy and Wound Clinic
Children's Health Services: includes care for children who receive treatment at the Allan Blair Cancer Centre.
Critical Care Services the Intensive Care Unit and the Cardiac Care
Diagnostic Imaging Services: Radiology, Spiral Computed Tomography scanning and nuclear medicine.
Emergency Services.
Eye Centre: general eye care, diagnostic eye tests, patient education and minor eye surgery.

Laboratory Collection Services

Laboratory Collection Services is responsible for collecting client specimens for testing requested by physicians and specialists.

Laboratory Services

Palliative

Surgical Care Services

Therapy Services

Allan Blair Cancer Centre: diagnostic techniques, surgical intervention, chemotherapy and radiation therapy.

Wascana Rehabilitation Centre

Comprehensive medical rehabilitation programs for adults and children, as well as specialized long-term care.

Functional Rehabilitation, Amputee Services, Spinal Cord Injury Services and Orthopedics, Children's Services, Adult Rehabilitation, Extended Care and Veteran's Services. The Centre serves the population of southern Saskatchewan.

Facility size 135,000 sq. ft., total of 307 beds - 43 for rehabilitation inpatients, 205 beds for specialized long-term care clients, five children's beds and 54 beds for clients placed through Veterans Affairs Canada.

Appendix 6: Ethics and Operational Approval Documents

Saskatoon Health Region	Research Services Unit **Strategic Health Information & Planning Services (SHIPS)** Joanne Franko, Manager Suite 300 Saskatoon Square 410 22nd St E Saskatoon, SK S7K 5T6 Phone: 306.655.3356 Fax: 306.655.3373

DATE: **November 22, 2005**

TO: **Tim Black, P.T., Community Health and Epidemiology, U of S**

FROM: **Joanne Franko**
Manager, Research Services Unit

RE: **RESEARCH PROJECT ETHICS COMMITTEE (EC)#: 2005-168**
PROJECT NAME: The Effect of a Transfer, Lifting and Repositioning Program on Musculoskeletal Injury Rates among Healthcare Workers in Selected Facilities within the Saskatoon Health Region.
PROTOCOL #: N/A

Saskatoon Health Region is pleased to provide you with operational approval of the above-mentioned research project.

Please advise me when the data collection phase of the research project is completed. I would also appreciate receiving a summary of the results for this research project. As well, any publications or presentations that result from this research should include a statement acknowledging the assistance of Saskatoon Health Region.

I would like to wish you every success with your project. If you have any questions, please contact our office at 655-3351.

Yours truly,

Joanne Franko

Joanne Franko, M.Sc.
Manager, Research Services Unit

cc: Dr. Syed Shah, Thesis Supervisor, Community Health and Epidemiology, U of S
Judy Metcalf, Manager, Occupational Health and Safety, SPH
Father Marc Miller, Mission Office, SPH

Investing in Ideas U of S Research

Biomedical Ethics Board

Michel Desautels, Ph.D., Chair
Biomedical Research Ethics Board (Bio-REB)
University of Saskatchewan
Room 305 Kirk Hall, 117 Science Place
Saskatoon, SK S7N 5C8 Canada
Phone: 966-4053 Fax: 966-2069
Email: michel.desautels@usask.ca

MEMORANDUM

Bio-REB: 05-168

To: Dr. Syed Shah (T. Black)
Community Health and Epidemiology

From: Michel Desautels, Chair
Biomedical Research Ethics Board (Bio-REB)

Date: November 7, 2005

Re: The Effect of a Transfer, Lifting and Repositioning (TLR) Program on Musculoskeletal Injury Rates Among Healthcare Workers in Selected Facilities within the Saskatoon Health Region

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Article 1.1 (d) of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans, 1998 (with 2000, 2002 updates) exempts from REB review quality assurance studies, performance reviews or testing within normal educational requirements.

The project entitled, "The Effect of a Transfer, Lifting and Repositioning (TLR) Program on Musculoskeletal Injury Rates Among Healthcare Workers in Selected Facilities within the Saskatoon Health Region" is a quality assurance study and as such is exempt from ethics review.

Notwithstanding research investigators must ensure that the project is carried out in keeping with the Saskatchewan Health Information Protection Act (HIPA).

Sincerely,

Michel Desautels, Ph.D., Chair
University of Saskatchewan
Biomedical Research Ethics Board

/bjk

TOTAL P.01

Regina Qu'Appelle
HEALTH REGION

Certificate of Approval
Research Ethics Board

PRINCIPAL INVESTIGATOR	Mr. Timothy R. Black	*Mailing Address:* Community Health & Epidemiology University of Saskatchewan Health Sciences Building 107 Wiggins Road Saskatoon SK S7N 5E5
APPROVAL DATE	May 29, 2006	
RQHR PROJECT #	REB-06-47	
TITLE	The effect of a Transfer, Lifting, and Repositioning (TLR) Program on musculoskeletal injury rates among healthcare workers in selected facilities within the Saskatoon Health Region	

CERTIFICATION

The protocol and consent form for the above named project have been reviewed by the Chair of the Regina Qu'Appelle Health Region Research Ethics Board and the experimental procedures were found to be acceptable on ethical grounds for research involving human subjects.

The Regina Qu'Appelle Health Region Research Ethics Board meets the standards outlined by Canada's Tri-Council Policy Statement for Ethical Conduct for Research Involving Humans.

The Regina Qu'Appelle Health Region Research Ethics Board has met the criteria for purposes of Section 29 of the *Health Information Protection Act.*

Please note that all future correspondence regarding this project must include the RQHR project number.

Best wishes in your continuing research endeavours.

for LPicot

Dr. Elan Paluck, Chair
Regina Qu'Appelle Health Region
Research Ethics Board

/lgp
cc. Ms. C. Klassen, Corporate Services, WRC

This Certificate of Approval is valid provided there is no change in the experimental procedures. Any significant changes to the protocol must be reported to the Chair for the Board's consideration, in advance of implementation of such changes. You are required to provide a status report on an annual basis.

Research and Performance Support
2180 - 23rd Avenue • Regina • SK • S4S 0A5 • www.rqhealth.ca
Phone 306-766-5451 • Fax 306-766-5530 • Email linda.picot@rqhealth.ca • web www.medi-fax.com/rhd/crdp

Appendix 7: Analysis Formulae for Rate Ratios and Rate Differences[109]

Based on a 2x2 table of injury rates:

Period of Injury Rate Measurement		Pre-intervention	Post-intervention
Intervention Group	# Injuries	I_1	I_2
	FTE	N_1	N_2
	Injury Rate /100 FTE	IR_1	IR_2
Control Group	# Injuries	I_3	I_4
	FTE	N_3	N_4
	Injury Rate /100 FTE	IR_3	IR_4

The data is based on injury variables with a Poisson distribution. The estimated rate ratio has an approximate log normal distribution.[131]

For Comparison of Rate Ratios:

In general: Incidence Ratio or Injury 'Rate' = $I_x/N_x = IR_x$

Rate Ratio for Intervention Group = $IR_2/ IR_1 = RR_i$

Rate Ratio for Control Group = $IR_4/ IR_3 = RR_c\ \ = RR_c$

$D = \ln(RR_c) - \ln(RR_i)$

$Z = D/S.E.$ where $S.E. = (1/ I_1 + 1/ I_2 + 1/ I_3 +1/ I_4)^{0.5}$

For Comparison of Rate Differences:

Rate Difference for Intervention Group = $IR_1 - IR_2 = RD_i$

Rate Difference for Control Group = $IR_3 - IR_4 = RD_c$

$D = RD_i - RD_c$

$Z = D/S.E.$ where $S.E. = (\sum I_x/(N_x)^2)^{0.5}$