Musculoskeletal Injury Tracking and Prevention

Jurisdictional Review: Literature Review

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EXECUTIVE SUMMARY

Health care workers experience high rates of musculoskeletal injuries (MSI). Occupational activities requiring staff to lift, transfer, and reposition a patient (patient handling activities) are partially related to the risk of developing musculoskeletal injury. In response to this trend, many different types of patient handling intervention programs have been designed to reduce staff injury rates. There is, however, considerable variability in the extent to which existing MSI prevention programs have successfully reduced staff injury rates. This variability is partially explained by differences between elements that make up patient handling interventions, and differences in the level of staff uptake of the program.

Despite recent evidence which suggests multiple outcome measures should be used to measure the uptake and success of a patient handling intervention, no consensus exists on what outcome measures should be utilized. For this reason, the Soteria Strains Working Group commissioned the Nova Scotia Health Research Foundation (NSHRF) to conduct a literature review with the following goals:

1. To determine what outcome measures are most frequently used within the literature; and
2. To provide evidence that these outcome measures have or do not have an impact on the success of a patient handling intervention program.

In total, 44 studies were synthesized, representing a combination of grey, white, and peer-reviewed literature. The results of this review provide evidence that current literature uses multiple categories of outcome measures to characterize the success of patient handling interventions. This finding was consistent across literature that proposed an evaluative framework for the development of a patient handling intervention (termed "recommendation literature"), and literature that evaluated the success of an existing patient handling intervention.

Within these programs, eight key categories of outcome measures appeared, and three of these categories emerged as the most common, these include; measures of staff injury rates, culture of safety, and staff competence regarding safe patient handling. This finding contrasted the work of other contemporary authors, who have suggested that a majority of the literature focuses on staff injury rate. To determine if this finding was the result of the inclusion of more recent literature, a follow-up analysis was conducted to compare the literature included in this review with older literature (pre 2008) reviewed by other authors. This comparison indicated that the outcome measures applied in recent literature differs from measures applied prior to 2008, which primarily focused on injury rates.

The results of this review provide evidence that there is not only a change in the outcome measures used within contemporary literature, but that a majority of current studies incorporate multiple categories of outcome measures to evaluate program outcomes. This is consistent with authors who have recommended multiple outcome measures be used to not only characterize the success of a patient handling intervention, but also to identify barriers that influence the uptake of a patient handling intervention. For example, factors such as ease of access to, availability of, and staff's knowledge of equipment may all act as barriers to use of equipment, which in turn can impact staff injury rates.

An emergence of studies designed to quantify the ability of an individual outcome measure (such as equipment proximity) to influence the success of a patient handling intervention was also identified. Thus, a secondary analysis was conducted to describe how key outcome measures could influence the success of a patient handling intervention. Through this assessment, many outcome measures were characterized as potential key variables, defined by their ability to have a direct influence on the uptake of patient handling interventions. These variables included:

- An organizational management's support, knowledge, and the priority placed on patient handling intervention programs
- Organizational funding
- Uptake of patient handling training
- Presence and strength of no-lifting policies, and accountability measures
- The accuracy and presence of patient mobility assessments
- Positive staff-to-staff communication, culture of safety, and the skill set or presence of peer leader within the workplace
- Availability, accessibility, and maintenance of equipment
- The use of equipment (frequency), separated by types of lifting equipment
- Patient comfort, safety, injury reports and potential health benefits when using patient handling equipment
- Staff knowledge of safe handling procedures, and skill in performing safe lifts in the workplace
- Psychological and physical stressors of job demands including patient to staff ratios
- Staff injury rates (including near misses), separated by the patient handling task that cause them (lift, transfer, or reposition)
- Staff time off work (including modified duty days)
- Financial outcomes such as cost savings, and payback period

The results of this literature review suggest that while no consensus exists on the best approach to evaluating patient handling interventions, there is a trend towards using multiple outcome measures. With the inclusion of multiple outcome measures, the evaluation of patient handling interventions can go beyond measuring only the reduction of injury rates within an organization, to more clearly identifying program strengths and weaknesses.

INTRODUCTION

Health care workers have the highest rates of musculoskeletal (MSI) injuries compared to other occupations (Howard & Adams, 2010). Among the occupational demands associated with health care work, patient handling actives (lifting, transferring, and repositioning) have been identified as significant MSI risk factors (Burdorf, Koppelaar, & Evanoff, 2013; Guthrie et al., 2004; Pompeiiet al, 2009). This is due to the high joint loading (the forces that are applied to a joint through a combination of external loads and internal muscular forces) associated with these activities (Dutta, 2012; Jäger et al., 2013). In turn, joint loading can cause an MSI if a single loading event (generated by patient handling) exceeds a tissue's failure tolerance (Solomonow et al, 2012).

To address the issue of MSIs, patient handling interventions have been developed to minimize joint loading through behavioral and mechanical modifications to patient handling tasks (Dutta, 2012; Jäger et al., 2013; Koppelaar et al , 2012); however, these interventions have mixed success in minimizing patient handling injury rates (Burdorf et al., 2013; Koppelaar et al, 2009). This variability is partially explained by differences between the types of patient handling intervention.

Interventions that focus solely on modifying staff behavior (i.e. safe lift training) have little impact on the risk of musculoskeletal injuries (Tullar et al., 2010). Introducing lifting equipment to work settings alone has been found to have only a minor impact on patient handling injury rates (Restrepo et al., 2013). To incorporate the potential positive effects of these intervention types, multifactorial patient handling interventions have been developed. Multifactorial interventions are interventions that incorporate a combination of elements such as: education, training, equipment purchase, policy change, risk assessment, and team building, all with the goal of changing how patient handling tasks are performed in a workplace (Fray, 2010). Unlike interventions that apply only a single element, there is moderate evidence to suggest that multifactorial interventions reduce musculoskeletal injury rates (Tullar et al., 2010).

Multifactorial patient handling interventions have been demonstrated as more effective than single-factor interventions (Fray, 2010). However, considerable variability has been observed within multifactorial patient handling interventions in terms of the effectiveness of individual interventions at reducing patient handling injury rates (Burdorf et al., 2013; Koppelaar et al., 2009). The key to measuring this variability could be the use of multiple outcome measures to characterize the diverse elements of patient handling injuries. Currently, few studies measure the diversity of barriers and facilitators that can impact the final outcome measure of MSIs (

Koppelaar et al., 2009). Although barriers are identified in the literature, most authors refer to them retroactively, as potential limitations for their research.

In a comprehensive literature review, Fray (2010) appraised peer-reviewed articles published prior to 2008, which analyzed patient handling interventions. Fray found 328 peer-reviewed studies that fit these criteria, with 101 studies analyzing a patient handling intervention program employed in a hospital setting. The objective of Fray's review was to determine which outcome measures are typically used to quantify patient handling activities. The key finding of this study echoed the findings of others in that 45% of the outcome measures represented staff injury rates, staff absence, and the financial cost of staff injuries. Fray suggests that a disparity exists between the metrics used in scholarly research and those deemed most important by experts who suggest the measures of safety culture, compliance with policy, and patient outcome measures should be included as outcome measures to evaluate a patient handling intervention. However, Fray identified the emergence of measures such as staff competence between 2003 and 2008, implying a change in the outcome measures reported in the literature.

To date, there is no consensus on the most effective means of evaluating patient handling intervention programs (Kay, Glass, & Evans, 2012a). The outcome measures used to evaluate a patient handing intervention are important features, as they can go beyond quantifying the success of a program and aid in the identification of program components that require improvement (HCHSA, 2003; WSBC, 2006).

The present literature review represents part of a larger project initiated by the Soteria Strains Working Group in the Spring of 2013. Broadly, this literature review is intended to provide evidence on the best methods for evaluating patient handling interventions, and to identify outcome measures recommended by experts in the field of MSI prevention, as well as those utilized in scholarly literature. This paper builds upon a similar review published by Fray in 2010, and focuses on studies published between January 2008 and June 2013 that assessed patient handling interventions. To characterize the benefits of particular outcome measures, a further objective of this literature review is to summarize the potential benefits and challenges associated with quantifying particular outcomes.

METHODS

LITERATURE SEARCH STRATEGY

The terms indicated in Table 1 were used to search relevant databases including PubMed. Peer-reviewed articles were included if they were published in English journals since 2008, and reported on a patient handling intervention. Abstracts were screened to ensure that each paper met the inclusion criteria. Once an article was identified, Google Scholar was utilized to identify

articles that cited this article. In addition, the reference section of each included paper was scanned for any novel studies that might also meet the inclusion criteria.

This review also included grey and white literature written since 2003. These reports were identified through web searching, in text citations in other literature, and through direct correspondence with key informants. Most of the grey literature included in this review did not assess a patient handling intervention. Instead, this literature described evaluative frameworks that could be used to assess patient handling interventions. From this point on these papers will be referred to as "recommendation literature."

Table 1: Key words used for literature review

Workers Compensation	Accident Prevention	Moving and Lifting Patients
Patient Transfer	Musculoskeletal Injury	Low Back Pain
Back Pain	Back Injury	Shoulder Pain

DATA EXTRACTION

Outcome measures were categorized according to the 24 categories suggested by Fray (2010), and a frequency count for each type of measure was tabulated. A paper capturing a variety of outcome measures could potentially be counted in several categories. However, in the event that a single paper used more than one outcome measure to describe a particular category (for example, if both staff injury numbers and self-reported injuries were used within the category "staff injuries"), only one outcome measure was counted for the respective category. Separate frequency tables were created for academic and recommendation literature in order to permit comparison between literature types.

RESULTS

OUTCOME MEASURES RECOMMENDED OR UTILIZED IN THE LITERATURE

This literature review identified 44 studies, which represented 20 out of the 24 possible categories of outcome measures defined by Fray (2010). Due to overlap in the content captured

by some categories, these 20 categories were combined into eight compound categories as shown below. Fray's respective outcome measure categories shown in brackets:

1. Organizational Factors (Risk Assessment, Training Numbers, Audit Performance, Staff Competence within Organizational Framework; including culture of safety)
2. Equipment (Equipment, Time to Complete Task)
3. Patient Factors (Patient Perception, Patient Injuries)
4. Staff Competence/ Compliance (Staff Competence, Staff use of Equipment, Staff Knowledge and Skill)
5. Psychological Well-Being/ MSI Exposure (Psychological Well Being, Number of Staff, Physical Workload)
6. Staff Injuries (Staff Injuries, Incident/Accident, Absence)
7. Financial (Financial)
8. Staff Perception

Outcome Measures from Recommended Patient Handling Intervention Literature

Thirteen of the 44 reports included in this review were considered recommendation literature. From these reports, 96 instances of individual outcome measures were identified. Each of these 96 instances were categorized into one of the 8 compound categories, with the rate of occurrence of these outcome measures presented in rank order in Table 2. The top three variables identified in the recommendation literature are consistent with the top three recommended outcome measures suggested during a focus group conducted with patient handling experts from the European Union (Fray, 2010). It should be noted that in the recommendation literature, organizational factors include culture of safety, whereas the outcome measures identified by the experts in the European Union explicitly focused on a culture of safety as a separate variable and ranked it as the third most important feature to measure (Fray, 2010).

Table 2: Number of occurrences of outcome measure categories proposed within recommendation literature

Outcome Measure	Number of Occurrences	Percent Total Outcome Measures
Competence/Compliance	25	26

Organizational Factors	19	20
Staff Injuries	18	19
Staff Perception	8	8
Financial Outcome	8	8
Equipment	6	6
Psychological, Physiological Well-being	6	6
Patient Factors	4	4

Outcome Measures from Patient Handling Intervention Studies

Twenty-four of the studies included in this review reported on the evaluation of patient handling interventions in hospital settings. These studies are henceforth referred to as "patient handling intervention studies." These studies were longitudinal pre-post designs, and/or attempted to capture cross-sectional differences between facilities. These papers include academic literature, white papers, and progress reports. Within these papers, 128 instances of individual program outcome measures were identified. Each of these 128 instances was categorized into one of the 8 compound categories used in this review. The frequency count for each category is displayed in Table 3.

Table 3: Number of occurrences of outcome measure categories in literature evaluating the success of patient handling intervention programs

Outcome Measure	Number of Occurrences	Percent Total Outcome Measures

Staff Injuries	30	23
Competence/Compliance	25	20
Staff Perception	14	11
Financial Outcome	14	11
Organizational Factors	13	10
Psychological, Physiological Well-being	12	9
Equipment	10	8
Patient Factors	5	4

When the frequency of outcome measure categories reported in patient handling intervention studies (Table 3) is compared with those reported in recommendation literature (Table 2), a discrepancy can be identified between the rank order of the most common categories of outcome measures. In particular, staff injuries became the most commonly evaluated outcome measure in patient handling intervention studies, whereas it was ranked third within the recommendation literature. In both types of literature the number of studies considering the competence of workers is high, suggesting this is an important metric. However, for patient handling interventions the order of the top three outcome measure categories changes with few current studies evaluating organizational factors, such as culture of safety. The implication of this tendency suggests that measures of culture of safety may be difficult to capture within an organization. However, it may also imply that current evaluative studies do not consider this to be an important feature to measure (to be discussed in the next sections).

The findings from the current review contrasts the findings of previous literature reviews, which have indicated that peer-review literature primarily used staff injury rates as their only outcome measure (Fray, 2010). To determine if this change is a consequence of the inclusion of current literature (2008 and later) rather than older literature (up to 2008), the work of Fray (2010) was summarized. To conduct this analysis, a table in Fray's thesis (Appendix B) that summarized the intervention outcome measures used in 101 studies was analyzed using the methods applied in this review. Once the instances of outcome measures were tabulated for each paper, they were assimilated into the 8 compound categories. Within the 101 studies identified by Fray, 189 instances of outcome measure categories were reviewed (Table 4). Comparing Fray's literature to the current patient handling intervention literature (Table 3), it is apparent that older literature includes fewer outcome measure categories (1.8 categories/paper) compared to more recent literature (5.3 categories/paper).

Table 4: Number of occurrences of outcome measure categories in Fray's literature evaluating the success of patient handling intervention programs

Outcome Measure	Number of Occurrences	Percent Total Outcome Measures
Staff Injuries	81	43
Competence/Compliance	26	14
Psychological, Physiological Well-being	24	13
Financial Outcome	19	10
Staff Perception	17	9
Organizational Factors	10	5
Patient Factors	8	4

Equipment	4	2

In comparing the rate of occurrence of Fray's (2010) outcome measures categories relative to current literature, it is apparent that patient handling intervention studies conducted prior to 2008 focused primarily on staff injuries. Factors such as organizational characteristics are not commonly used during this time. Even in older literature, worker competence remained an important measure. This suggests that worker competence is an important measure for assessing outcomes of patient handling interventions. While incidence of psychological and physiological well-being outcomes measures are more frequently reported in older literature, the rate of individual outcome measure categories within this compounded measure differ between older and current literature. Fray's data indicate that in studies published between 1982 and 2008, this category primarily focused on physical stress, which was often measured using a rating of perceived exertion. In current studies, psychological factors such as stress represent the most common metric within the psychological and physiological well-being category.

By contrasting the frequency of occurrence of each category of outcome measure included in both older and current literature, this review provides support to other literature reviews, suggesting that many studies capture a limited number of variables to quantify patient handling interventions (D'Arcy, Sasai, & Stearns, 2012; Koppelaar et al., 2009). However, the results of the current review suggest that this conclusion is generated by the inclusion of older literature. In general, current literature published after 2008 captures a greater number of outcome measure categories. This represents an increased diversity in the quantification of patient handling intervention programs. There appears to be a trend of studies establishing a relationship between multiple evaluation measures and their ability to influence patient handling injury rates. Included in the current literature review, seven studies went beyond simply identifying potential barriers, including risk analysis (often using odd ratios, or correlation) to quantify the ability of an outcome measure to act as a barrier or facilitator to the success of a patient handling interventions.

Outcome Measures from Studies that Focused on Barriers to Patient Handling Programs

Six studies reported on the results of focus groups or staff interviews that sought to identify perceived barriers (on the part of health care workers) that limit the utilization of safe patient handling techniques, particularly the use of equipment. These studies depicted 4 of the 8 compound outcome measure categories used in this review. While this is a relatively small number of outcome measures, these studies highlighted the benefits of including these particular outcome measure categories. Thus, these papers were included in the synthesis of information in

order to discuss why these particular outcome measure categories should be evaluated in a patient handing intervention programs.

IMPACT OF KEY OUTCOME MEASURE CATEGORIES

Current literature indicates an emergence of studies using multiple outcome measures to evaluate patient handling interventions. Many factors can influence the ability of a patient handling intervention to reduce staff injury, though all of these variables are often not measured (D'Arcy et al., 2012; Koppelaar et al., 2009). Unmeasured variables may explain the variability in the success of patient handling intervention programs (Burdorf et al., 2013). Collecting data on multiple variables both before and during a patient handling intervention program allows for comparison of changes in key variables throughout the tenure of a program. Pre-intervention data may provide useful information to identify what areas within an organization require improvement (WorkSafe, 2003). The literature included in this review identifies multiple factors that can impact the outcome of patient handling interventions. These factors can be broken down into smaller sub-categories. The potential impact of these outcome measures on staff injuries will be discussed in the following sections, as will the relevant limitations or recommendations to characterize an outcome measure category. There are many ways to measure the variables within each outcomes measure category; however, a comprehensive analysis of measurement approaches is beyond the scope of this literature review. That being said, tools that are mentioned are summarized in Appendix A.

ORGANIZATIONAL FACTORS

A medical care facility is composed of many individuals, staff and management, who work together to accomplish a variety of goals. In an organization such as this, the highest level of management plays a key role in patient handling interventions through the allocation of funding, policy development, performance management, priority setting, staffing, and other organizational functions. The assessment of an organization can be considered at multiple levels, from upper management, unit management, and seniority amongst staff members. As such, many organizations are hierarchical in nature and consist of multiple levels of control. Staff working at each level within this hierarchy can support or inhibit the uptake of patient handling interventions. However, for the purposes of this review the definition of an organization extends beyond hierarchy of control and includes the influence of social interaction of employees within the workplace, such as teamwork and communication (Duke et al, 2007). Interactions among staff, and between staff and management, are key components of safety culture. Culture of safety is defined as the focus of an organization and its individual staff members toward the promotion of safe practices within their workplace (Cloutier, Thomas-Olson, & Helal, 2012). Since an organization represents a large body, many organizational-level variables can be measured to provide insight into the uptake of a patient handling intervention.

For patient handling interventions, there is a cost associated with the development, implementation, and maintenance of program components. The initial and ongoing funding that supports a patient handling intervention is an important measure to consider. Several ongoing

evaluations of patient handling interventions identified a gradual rise in staff injury rates despite initial program success. Continued success of these programs was reportedly limited by decreased funding during their operation (Martin, et al 2009; Matz, 2007). A positive correlation has also been demonstrated between the initial level of funding within a facility, and staff compliance regarding the use of equipment (Koppelaar, et al 2013). However, nurses do not perceive organizational funding as representing managerial commitment to a patient handling intervention program (Harvey, Culvenor, Martin, & Else, 2004). Therefore, funding levels may impact factors such as staff knowledge and skill regarding safe patient handling (via training), and accessibility of equipment (to be discussed in later sections). For these reasons, both the level of funding and the allocation of funding should be monitored, as these factors influence the uptake of patient handling intervention programs (Park et al 2009).

An organization has considerable influence on patient handling intervention through the development of no lift or minimal lift policies. These policies suggest that the organization has a focus on minimizing the loading involved with patient handling activities, and that alternative methods (such as equipment) should be used. Organizations with a policy in place report lower injury rates than organizations with similar equipment but no policy (Restrepo et al., 2013; Zadvinskis & Salsbury, 2010).

Barriers do exist at the policy level: minimal-lift policies were described as weak and were shown to permit staff to choose when to manually lift patients (Schoenfisch, Myers, Pompeii, & Lipscomb, 2011a). While some studies identify an improvement in the success of a patient handling intervention program if integrated with organizational policy, focus groups identified that organizational policy would be ignored for patient comfort and safety (Holman, Ellison, & Maghsoodloo, 2010). For these reasons, some authors have recommended that organizations find ways to hold staff accountable for non-compliance (Kay, Glass, & Evans, 2012a; WorkSafe, 2003). With these barriers in mind, one could use existing safe patient handling policies to determine criteria for identifying compliance and non-compliance with safe patient handling procedures.

Mandatory training programs are often developed and assessed at the organizational level. Organizations have input on the development of training programs, and the timelines associated with review sessions. If training is utilized, organizations should determine the efficacy of the training program in order to assess whether or not priority areas were missed or unclear (Nelson et al., 2005). Such information could be collected immediately after a training program via a quiz, or through a demonstration of newly acquired skills. Immediate training outcomes can be combined with incident/accident reports, and compliance measures. When conducted in regular longitudinal intervals, these measures could aid in the identification of training program components that were not transferred to the workplace. These data can guide decisions on which areas should be given priority in future training (Nelson et al., 2005). The literature puts emphasis on training, as staff knowledge and skill level influences their compliance to safe patient handling interventions (to be discussed in later sections). These data support

recommendations that annual training, and/or training on site (train the trainer approach) using a peer leader who prioritizes safe lifting (Cloutier, Thomas-Olson, & Helal, 2012) be included in a patient handling intervention, and that the efficacy of training be monitored, along with the percentage of employees that have completed training.

Success of patient handling interventions is determined in part by the level of support provided by management and organizational structure. Black et al (2011) reported that smaller hospitals experience greater success with patient handling interventions. These authors discussed that the increased proximity between management and staff resulted in greater management involvement in the promotion of safe patient handling. Many programs recommend a model of participatory ergonomics, which allows staff to collaborate with management on tasks such as equipment selection and the collection of patient handling intervention program feedback. This process is designed to promote accountability and respect between these groups, and encourage a mutual investment towards safe patient handling (Nelson et al., 2005; Robson et al., 2004). Other factors associated with staff perception of commitment on the part of management include; the presence of a full time peer leaders (Cloutier et al., 2012); maintenance of equipment; and team meetings to address issues pertaining to patient handling (Koppelaar et al., 2013). Though a difficult metric to capture, management support should be considered as communication between staff and management is associated with successful uptake of patient handling knowledge (Mustard, 2011).

In addition to organizational and managerial support, the overall priorities of the organization, and those of management and supervisors can influence the uptake of patient handling interventions. Manager's perceptions of the priorities of productive time must be captured and addressed (HCHSA, 2003) before they can influence staff use of safe lifting techniques. Staff who perceived their supervisor as being supportive of safe patient handling equipment have greater compliance to its use (Koppelaar et al, 2011; Kurowski, Gore, & Buchholz, 2012b). Staff are less compliant in the use of patient handling equipment if they perceive their work environment as being "fast paced" (Holman et al., 2010; Kurowski et al2012a; Schoenfisch et al., 2011a), or that management prioritizes rapid completion of patient care tasks (Schoenfisch et al., 2011b).

Managers' attitudes towards safe patient handling practices may be a result of their knowledge of safe patient handling. Staff injuries have been shown to decrease as increases are reported in managerial knowledge of and attitudes towards safe patient handling techniques and equipment. (Restrepo et al., 2013; Schoenfisch et al., 2011a). Potential outcome measures from this information include management's knowledge of safe patient handling, and staff's perspective of organizational priorities.

Within a hospital setting, staff-to-staff communication and teamwork is essential (Cloutier et al., 2012). Many new staff and students are mentored by more experienced staff to learn essential skills (Cornish & Jones, 2010). These interactions influence patient handling interventions. Staff

involved in patient handling would rather fit in with peers than question the unsafe behavior of other staff members (Cornish & Jones, 2010; Kneafsey et al, 2012; Schoenfisch et al., 2011a). This is particularly true for students, who may feel reluctant to question the behaviours of older staff (Cornish & Jones, 2010) despite evidence that experienced staff may be resistant to safe patient handling procedures (Guthrie et al., 2004; Kutash, Short, Shea, & Martinez, 2009). However, other authors express that experienced staff do not use patient handling equipment as they do not want to take the additional time to prepare equipment when they ask for assistance from team members (Schoenfisch et al., 2011a). For this reason, the attitudes of staff towards patient handing should be captured, as these attitudes influence adherence to safe patient handling principles in the workplace. Therefore, increasing positive staff-to-staff interactions represents a potential means of improving patient handling interventions. A measure of these interactions are associated with decreased physical workload and an increase in formal lifting knowledge (Duke et al., 2007; Kurowski et al, 2012b; Mustard, 2011).

Many programs recommend that organizations include patient-specific care plans to address the barriers associated with weak staff-to-staff communication, inadequate staff knowledge and skill level, weak subjective policies (that is, minimal lift), and the use of appropriate patient handling equipment. This care plan should include a patient mobility assessment and identify mobility aids best suited for handling the patient in question (Fray, 2010; WSAB, 2008; WorkSafe, 2003). To maximize the effect of these mobility assessments, several authors suggested that care plans be positioned on the patient's bed (Cornish & Jones, 2010; Koppelaar et al., 2011; 2013). This strategy addresses two challenges: it reduces the complexity of assessing a patient's mobility (Matz, 2007), and it acknowledges that staff often do not mention patient mobility needs to one another during shift changes (Schoenfisch et al., 2011a). Patient care plans reduce the complexity of selecting appropriate equipment for patient mass and other unique mobility needs (Matz, 2007). Mobility care plans positioned on the patient's bed have been considered successful in increasing compliance of equipment use and decreasing injuries (Cornish & Jones, 2010; Koppelaar et al., 2011; 2013). There is a limitation to using care plans: if the mobility assessment of a patient is inaccurate, or there is a sudden change in patients' mobility that is not observed by the patient handling staff, staff may perform an inappropriate lift, increasing their risk of injury (Koppelaar et al., 2011). The accuracy of patient handling care plans should be regularly assessed in order to determine how often they need to be updated, and what training is necessary to improve their accuracy (Fray, 2010; Whales, 2010; WorkSafe, 2003).

Another factor that must be approved at the organizational level is the creation of peer leader positions. Peer leaders are staff members trained extensively in patient handling skills and the education of other staff (Cloutier et al., 2012). The peer leader position is designed to increase compliance by facilitating staff-to-staff interactions that promote the use of lifting equipment. Studies have demonstrated that peer leaders have a positive impact on staff use of equipment (Zadvinskis & Salsbury, 2010), and increase overall staff knowledge regarding safe patient handling (Mustard, 2011). Patient handling staff have indicated that the presence of a peer

leader may improve the success of a patient handling intervention by demonstrating organizational support and increasing awareness regarding equipment use (Cloutier et al., 2012). However, one study identified that peer leaders have no influence on patient handling programs (Koppelaar et al., 2013). This may be related to how the position is developed, as peer leaders can experience barriers to performing their duties. When a peer leader is trained, many state they do not have sufficient time to perform tasks associated with the role of peer leader in addition to other occupational duties (Martin et al., 2009; Matz, 2007; Schoenfisch et al., 2011b), or that they have received inadequate training to educate other staff on equipment use (Schoenfisch et al., 2011b).

To address these barriers, studies suggest that peer leaders receive retraining, and that the individuals occupying these positions change periodically (Harvey et al., 2004; Kutash et al., 2009), particularly if a peer leader no longer wishes to maintain their duties. By doing this, an organization can maintain an optimal peer leader to staff ratio (Schoenfisch et al., 2011b). This exact ratio has not yet been identified in literature. To address the time barrier imposed by additional occupational duties it is recommended that peer leaders be allocated time to fulfill the requirements of their position. Following this recommendation would reduce the likelihood that the peer leader role would eventually disappear or become disorganized during the continuation of a patient handling program(Kutash et al., 2009; Matz, 2007; Zadvinskis & Salsbury, 2010). If a peer leader is included in the health care team, some measures to consider are: confidence, competence, and the perception of peer leaders' ability to perform their duties.

It is advised that organizations perform annual audits of intervention elements (Fray, 2010). These audits can include an overview of accident reports which, combined with other measures, could identify what areas within a current patient handling program framework require revisions. The inclusion of an audit process would show staff that management have an interest in a patient handling intervention and wish to monitor its success (Nelson et al., 2005; Whales, 2010). These audits could include a number of the key outcome variables such as: equipment accessibility and maintenance, workers compliance, and other variables that will be discussed in the following sections.

The findings of this section outline that organizations have the opportunity to influence the success of patient handling intervention programs. One study used a combined metric, "the safety index," to assess the presence of policy, attitudes of directors of nursing staff, the presence of risk assessments, and overall emphasis within the organization on training. This study found that higher safety index scores were negatively correlated with staff injury rates (Restrepo et al., 2013). Despite the complexity of capturing the multiple outcome measures that exist at the organizational level, these data should be considered as they represent factors that impact the total success, and reduction in staff injury of a patient handling intervention.

EQUIPMENT

Patient handling equipment is often used in tandem with patient handling policy. The function of equipment is to minimize the magnitude of joint loading, and reduce the need for awkward postures (such as bending) that can result in joint injuries (Kurowski et al,2012a; Kurowski et al, 2012b). In some circumstances, the introduction of equipment alone can reduce injury rates, provided it is used by employees (Alamgir et al., 2008). However, using equipment with other types of patient handling interventions, such as policy change and training, has been proven to be more effective than only having equipment on site (Restrepo et al., 2013; Zadvinskis & Salsbury, 2010). This may be related to challenging barriers that prevent staff from using patient handling equipment, and changes in staff compliance (to be discussed in later sections). For this reason some studies recommend that a pre-assessment of the workplace is performed before the implementation of a patient handling program (HCHSA, 2003; WorkSafe, 2003), so that any potential barriers to the use of equipment can be addressed.

Patient handling staff cited the physical structure of a work environment as a potential barrier to safe patient handling, as some settings do not permit equipment use (Holman et al., 2010; Kneafsey et al., 2012; Koppelaar et al., 2013; Koppelaar et al., 2012). This can be due to a range of characteristics of the patient's room, including its dimension (such as small rooms and bathrooms), and the presence of clutter (other medical equipment or furniture, for example). These factors can be assessed by collecting feedback from staff, or checking dimensions of equipment relative to those of the room.

Both the availability and accessibility of equipment can act as a barrier to equipment use. Availability is defined by sufficient equipment stock so that it can be used by staff when necessary, and accessibility is defined by the proximity of equipment storage relative to where it needs to be used during patient handling tasks (Schoenfisch et al., 2011b). Both of these factors have been demonstrated to impact the use of equipment (Cornish & Jones, 2010; Kneafsey et al., 2012; Kurowski et al, 2012b; Martin et al., 2009; Schoenfisch et al., 2011a). Equipment accessibility can be assessed by observing the proximity of equipment to the beds of patients requiring mobility aids, or observation of the storage space of equipment (Schoenfisch et al., 2011b). Despite the complexity of measuring equipment accessibility, this metric should be considered as it is associated with staffing injuries and physical loading during patient handling activities (D'Arcy et al., 2012; Koppelaar et al., 2012; Kurowski et al, 2012b). Measures recommended to aid in the capture of equipment availability include rations of equipment to staff, equipment to beds, and/or equipment to patients needing mobility aid (Guthrie et al., 2004; Schoenfisch et al., 2011a). An expansion to equipment availability includes the maintenance of equipment. If patient handling equipment is not properly sanitized, restocked, maintained (eg. charged), staff cannot use it. In one study, the level of equipment storage and maintenance (battery charge) was audited to ensure that the equipment was not only accessible but that it would be operational when necessary (Schoenfisch et al., 2011b).

Patient handling is a broad concept that represents multiple activities (lifting, transferring, and repositioning), each of which must account for the mobility level of individual patients. As a

result, a wide range of patient handling equipment exists. Some types of equipment may be preferred over others due to policy, training, personal preference, and/or ease of use (Alamgir et al., 2009; Koppelaar et al., 2011). In particular, staffs normally prefer ceiling lifts to floor lifts; although each of these lift types are associated with unique barriers. For example, floor lifts are difficult to move into and out of a patient's room (Koppelaar et al., 2011), whereas celling lifts are more expensive to install. Due to the diversity of handling aids, some authors have suggested that uptake of each type of equipment be measured separately. By using this methodology, two studies found that slider sheets (a repositioning aid) were underutilized by staff, whereas lifts were often used (Koppelaar et al., 2012; Kurowski et al, 2012b). Accounting for the differences among handling aids can also provide a means of assessing the uptake of each equipment type, and aid in the development of training programs targeted at increasing utilization of underused equipment. The difference between handling aids also contributes to the observed range of patient handling injury types (to be discussed in later sections).

In general, the use of patient handling equipment is considered to be slow and cumbersome by staff, suggesting a barrier to use (Cornish & Jones, 2010; Kurowski et al, 2012b). Studies evaluating the time to use equipment confirm that some equipment types slow down the patient handling process, with this delay increasing if the time needed to retrieve and put away equipment is also measured (Alamgir et al., 2009; Garg & Kapellusch, 2012; Koppelaar et al., 2012). By improving equipment accessibility, this time of retrieval can be minimized. One study found that with continuation of a patient handling program staff changed the location of equipment, which improved accessibility of the equipment (Schoenfisch et al., 2011b). For example, staff placed lifts near patients who required use of this equipment. Furthermore, the time necessary to use some kinds of equipment decreases as nurses become more competent in its use (Kurowski et al, 2012b). Thus, measuring the time required to use equipment can aid in equipment selection, and this data can be used to supplement measures of equipment accessibility.

PATIENT FACTORS

Staff / patient interactions can complicate safe patient handling. Patient perception and acceptance of handling techniques and devices can influence staff decision-making, and in part determine what lifting techniques are performed (Nelson et al., 2005). This can be a problem if a patient dislikes equipment designed to minimize the risk of injury of patient handling staff. In this scenario staff must decide who's safety to prioritize, however, most patient handling staff rank patient safety and comfort above their own (Holman et al., 2010; Kneafsey et al., 2012; Schoenfisch et al., 2011b). When patient handling staff were asked why they would not use patient handling equipment, some identified that this was because a patient or family member expressed dislike of patient handling equipment (Kurowski, Boyer, Fulmer, & Gore, 2012a). This perception is inconsistent with interviews and observations of patients during patient handling tasks who identified the lifting equipment as or more comfortable and secure compared to other methods (Alamgir et al., 2009; Garg & Kapellusch, 2012). This inconsistency may be

partially explained by the subjectivity of staff perception. It may also suggest different levels of competency of patient handling staff regarding the use of equipment (to be discussed in later sections). Comparing patient opinions about a lifting team to other patient handling staff using equipment, Kutash et al., (2009) identified that patients feel more secure in patient handling equipment when it is used by the lift team. Beyond subjective measures of patient comfort, patient safety can be evaluated by monitoring the occurrence of patient injuries that result from inappropriate patient handling, such as friction burns and falls (Garg & Kapellusch, 2012).

Use of lifting equipment may have positive health benefits for patients, with a recommended outcome measure of patient skin breakdown (Fray, 2010). In one study it was believed that through the use of equipment, patients were repositioned more often, which resulted in a reduction of skin breakdown (Kutash et al., 2009). However, the condition of the patient may also influence how workers go about handling the patient. One study identified that intravenous lines act as a barrier which limited staff use of some equipment (Schoenfisch et al., 2011a). Thus, to gain patient support of a handling program, it may be important to evaluate the benefits to patient health which result from the use of patient handling devices.

COMPETENCE/ COMPLIANCE

Staff competence is defined by an employee's knowledge and skill in order to perform safe patient handling activities (Kay & Glass, 2011). The application of safe patient handling techniques in the workplace has been shown to be influenced by employee competence with and attitudes toward safe patient handling activities (Koppelaar et al., 2011). Staff competence is a potential barrier towards the use of safe patient handling techniques (Kneafsey et al., 2012), as staff who feel they do not know how to use patient handling equipment indicate they will not use it in the workplace to avoid appearing incompetent in front of peers, and to ensure they do not harm patients (Cornish & Jones, 2010; Matz, 2007; Schoenfisch et al., 2011a). Training aimed at increasing staff knowledge and skill can be used to address this issue. Increased staff knowledge has been associated with increased use of patient handling devices Koppelaar et al., 2013), and a reduction in back injury rates (D'Arcy et al., 2012). While this relationship can be assessed with a test of formal knowledge (such as a survey or exam), it is ideal to also perform an observational assessment of staff behavior (Whales, 2010). Providing staff with safe patient handling knowledge does not always translate to the application of safe handling techniques, particularly once staff returns to their workplaces. For this reason it is suggested that the skill of patient handling staff be assessed within the workplace (Matz, 2007). Thus, evaluations of staff competence should include both formal testing, and observational assessments of safe patient handling within the workplace. This is particularly true since measures of self-reported use of patient handling equipment is often inaccurate relative to actual workplace practice and knowledge (Kay & Glass, 2011).

Employee compliance and competence can change throughout a patient handling intervention. Patient handling skill and knowledge will decline if the skill is seldom used within the workplace (Kneafsey et al., 2012; Schoenfisch et al., 2011a), while increased use of equipment will speed

up the patient handling process (Kurowski et al, 2012b). This change in skill over time supports the recommendations of annual refresher training (Koppelaar et al., 2013; Matz, 2007; Mustard, 2011). If possible, these refresher courses should use evaluation measures of the patient handling intervention to find and target program limitations.

Psychological Well-Being, MSK Risk Exposure

Psychosocial stress among patient handling staff is a known risk factor for the development of musculoskeletal injuries (Mitchell et al., 2009). Time constraints are one potential psychological stressor. Staff who feel they do not have adequate time to complete their work duties have increased injury rates and joint loading (D'Arcy et al., 2012; Kurowski et al, 2012b). A metric to identify time constraints includes the number of under-staffed work shifts, during which a sub-standard number of employees must share increased workload (Matz, 2007). This problem is exacerbated in the circumstance of worker absenteeism, or staff performing modified duties (Matz, 2007), where remaining staff face greater time constraints to achieve increased workloads. Examining understaffed shifts has demonstrated that these shifts are associated with decreased use of patient handling equipment, which is in part due to higher patient-to-staff ratios (Holman et al., 2010) and increased joint loading (Koppelaar et al., 2012; Kurowski et al, 2012b). This information supplements findings that a high patient-to-staff ratio is associated with increased injury rates (Park, Bushnell, Bailer, Collins, & Stayner, 2009). This suggests than an important outcome measure for comparing accident reports between facilities would be the number of staff on ward, and whether or not nurses feel they have sufficient time to complete their duties.

Physical risk of injury should also be measured. The frequency with which staff engage in patient handling activities is positively associated with the odds of developing a musculoskeletal injury (Burdorf et al., 2013). This relationship exists regardless of efforts directed at minimizing joint loading, as tissue failure tolerance decreases through repetitive loading, eventually resulting in failure of a joint structure (Solomonow et al., 2012). Thus, the frequency of patient handling activities should be measured, as more frequent patient handling could result in more frequent injuries (Kutash et al., 2009).

Staff Injuries

Measuring staff injury rates represents the final outcome measure of a patient handling intervention program (Green, Nelson, Leib, Matz, & Cohen, 2010; Lipscomb, Schoenfisch, Myers, Pompeii, & Dement, 2012). The goal of a patient handling intervention is to minimize staff injuries;, however, uptake of the intervention (evaluated using the categories above) influences overall injury rates (Kay et al, 2012a). By measuring injury rate alone, one makes an assumption that the intervention results in a change in behavior which supports reduced injury rates (Fray, 2010). Without including measurements of multiple program components, it is difficult to identify specific components that require revision in the event that a program fails to attain injury reduction goals (Kurowski,etal, 2012a). In addition, a large number of participants

and/or a long follow up period would be necessary to identify a significant reduction injury rate once a patient handling intervention is implemented (Burdorf et al., 2013).

Evaluators often use incident/accident reports, worker compensation claims, and self-reported injuries to capture staff injury rates. However, these measures have some limitations. Worker compensation data often have a unique definition for injuries that includes a certain threshold for the cost and/or number of days of a workers absence from the workplace (Alamgir et al., 2008). For this reason worker compensation claims represent an underestimate of injury prevalence (Garg & Kapellusch, 2012; Kay et al, 2012a). This problem is compounded by the suggestion that many patient handling staff may not report injuries (Matz, 2007).

A second limitation in using these data is that most accident reports do not include measures of lost time on modified duty days (Kutash et al., 2009; Nelson et al., 2005). These data are important, as days lost may act as a surrogate of the severity of the injury (Black et al., 2011; Kutash et al., 2009). By using workers compensation claims, one is limited in determining the cause of a patient handling injury. While workers compensation data uses coded data to identify the cause of an injury (such as lifting) (Restrepo et al., 2013) and, in most circumstances, these data do not allow for further separation based on patient handling activity type (lift, reposition, transfer) (Alamgir et al., 2009). This is a limitation since patient handling injury rates differ at baseline between patient handling types (Pompeii et al., 2009). In studies that have separated injury rates by patient handling activity type, it has been shown that the reduction of injury rates is not uniform across all patient handling activity types (Black et al., 2011; Garg & Kapellusch, 2012; Kutash et al., 2009; M Matz, 2007).

For these reasons, most authors provide recommendations to strengthen the quantification of staff injury rates. These recommendations include: separation of injury by type of patient handling activity (Koppelaar et al., 2011; WSAB, 2008), including near miss injuries (Kay et al, 2012a), and inclusion of follow-up process to capture information, such as lost time and modified duty days. Nelson et al. (2005) suggest that this information is best captured through accident reports overseen by supervisors, which should be conducted shortly after the injury occurs. Finally, data should be collected in a manner that permits identification of the unit where the injury since the uptake of patient handling intervention programs varies between individual units within an organization (Lipscomb et al., 2012; Martin et al., 2009; Schoenfisch et al., 2011b).

Financial Outcome Measures

Financial outcome measures serve an important role in evaluating patient handling intervention programs as positive reports can promote management buy-in for a program (Lim, Black, Shah, Sarker, & Metcalfe, 2011). These outcome measures include the cost of implementation of a patient handling intervention, and savings in workplace expenses that exist due to patient handling injuries (Garg & Kapellusch, 2012). Financial savings from a patient handling program are thus impacted by any factor that can modify patient handling injury rates (Lipscomb et al.,

2012). For this reason, financial measures often display a time lag to when a patient handling intervention program is first introduced and when patient handling injury rates begin to show change. This lag period is amplified by delays in filing worker compensation claims (Lahiri, Latif, & Punnett, 2013).

An additional barrier to using financial outcome measures includes the calculation of cost savings. Authors often report direct cost including: lost time, worker compensation claims, and medical payout to capture cost savings. However, authors suggest that numerous indirect costs must also be factored in, as they influence the effect size between longitudinal intervention cost savings, and reduce the duration under which the cost-benefit analysis reports a breakeven period (Alamgir et al., 2008; Lipscomb et al., 2012; Lahiri et al.,2013). In addition to the calculation of compensation cost, one must account for inflation, which has a direct influence on the longitudinal comparison of financial measures. The majority of studies account for inflation by using a cost indexing procedure to adjust cost to a certain year of inflation (Lipscomb et al., 2012; Alamgir et al., 2008; Garg et al., 2012). This allows for the comparison of financial outcomes in pre-post intervention evaluations.

Staff Perception

Unlike the other outcome measures proposed in this section, staff perception does not represent an outcome measure category, but rather a tool that can aid in identification of barriers that limit the effectiveness of patient handling intervention programs (Kay et al, 2012b). A measure of staff perception was included in almost all patient handling intervention studies, and recommendation literature. Staff perception can be collected in multiple ways, such as questionnaires, focus groups, and interviews (Nelson et al., 2005). While measuring staff perception has the threat of bias, it represents a means of assessing subjective outcome measures. These measures include staff perception of management commitment and attitude towards a patient handling intervention program, both of which can influence the uptake of a patient handling intervention program (Garg & Kapellusch, 2012; Koppelaar et al., 2013).

Other Outcome Measures to Consider

Within the literature, other outcome measures were identified that did not fit within the key outcome measure categories utilized in this report. These factors could be considered as they can influence staff MSI rates. Additionally, two other factors to consider would be patient handling staff demographics and separation by hospital type. Demographic factors of patient handling staff are known to change injury rates. Factors such as staff age (Heiden, Weigl, Angerer, & Müller, 2013), previous injuries (Cornish & Jones, 2010), physical fitness (Tullar et al., 2010), and level of experience (D'Arcy et al., 2012) have all been identified as influencing staff frequency of equipment use and injury rate. Staff experience is associated with injury rate in a U-shaped pattern, where at one end inexperienced staff have higher injury rates, and at the other end experienced and older staff are more likely to experience injuries because of age-related changes and reluctance to accept to changes introduced by a patient handling intervention

program (Kutash et al., 2009). Hospital type is also identified to influence injury rates. Typically, acute care hospitals are less likely to adopt safe patient lifting behaviors compared with long-term care facilities (Koppelaar et al., 2013). Consistent with this, smaller medical care facilities (typically nursing homes) experience a greater reduction in injury rates compared to larger tertiary care hospitals (Black et al., 2011).

CONCLUSION

The purpose of this study was to determine what outcome measures are used in current literature to evaluate patient handing intervention programs. This review demonstrated that current literature has moved away from quantifying the change in injury rate after the implementation of a patient handling intervention in isolation towards using multiple metrics to assess the level of success of a patient handling intervention. The findings of this review have established that multiple variables contribute to the success of patient handing interventions by influencing staff uptake of a program. Therefore, capturing multiple variables allows a researcher or organization to move beyond rating the success of a patient handling intervention program, and instead determine which components of the intervention can be improved. While the outcome measures best suited to evaluation of MSI prevention programs have not yet been identified, the results of this review provide evidence that the combination of multiple outcome measures may represent the best practice to monitor the success of a patient handling intervention program.

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APPENDIX- SUMMARY OF AND OUTCOME MEASURES COLLECTED FOR STUDIES INCLUDED IN THE LITERATURE REVIEW

Table 5: Recommended intervention strategies or outcome measures

Paper #	Suggested Intervention Type (Category)	Suggested Outcome Variable (Category)	Suggested Outcome Measure	Rational
(Alex Burdorf et al., 2013)	Equipment provision and or purchasing (2)	Staff use of equipment Staff competence Staff competence (Org)	Accessibility to Equipment # of Lifts with Equipment Hazardous Lifts Observed Staff Compliance with Policy	Uptake of intervention impacts the effectiveness
(D'Arcy et al., 2012)		Equipment	Accessibility to Equipment Lift Types	
(K Kay, Glass, & Evans, 2012b)		Staff Competence Training Content/ Quality/ Sustainability Staff Perception	Measure ability of staff to perform technique, and use equipment correctly Compliance Staff Knowledge Staff Perception of Learning Staff Assessment of Programme Staff Informal/ Formal interviews	If injury persist after intervention program one must understand if intervention is effective or if it is being complied to.
(K Kay, Glass, & Evans, 2012a)		Staff Competence Staff Competence Staff Injuries Staff Knowledge Skill Staff Knowledge Skill Staff Perception Staff use of Equipment Psychological Well-Being Risk Assessment	Compliance with Taught Methods Self Reported Compliance (with barriers) Self report near miss or overuse injuries (under report in WC claims) Staff Knowledge (PH skill) Perception of Learning (training efficacy) Staff Assessment of Programme Staff Evaluation of use of Equipment (barriers) Psycho-social Stressors (MSK Risk) Observational checklist Training Evaluation/ Efficacy Compliance with policy Informal/ Formal interview (barriers)	Nursing perspective must be addressed if they are to implement PH techniques properly. Theory is to hold them accountable in a non-threatening fashion. Identify barriers of conflicting organization goals (productivity vs personal safety)

		Training Numbers Audit Performance Staff Perception		
(Fray, 2010) focus group conducted with experts from the EU		Incident Accident Staff Absence Financial Number of Staff Risk Assessment Management Compliance Equipment Staff competence Staff knowledge and skill Staff use of equipment Psychosocial well-being Staff Injuries Patient Injuries Patient Perception Patient Condition Quality of Care Time for Task Audit Performance	Focus group poor system of data collection. Long 2-4 follow up to see reduction in injury rate Staff patient ratio Provision of Training, audit performance, risk assessment Accessibility, Maintenance Suggest measuring staff behaviour knowledge and use of equipment Frequency of equipment use Time, emotional and physical stress Accuracy of patient care plan, risk assessment	Assumption problem eg. (train= skills and knowledge= compliance= decrease MSK risk) Preferred outcome measures: 1 Safety Culture 2 MS Health Measures 3 Compliance 4 Staff Absence 5 Quality of Care 6 Incident and Accidents 7 Psychological well-being 8 Patient condition 9 Patient perception 10 MSD Exposure measures 11 Patient Injuries 12 Financial
(Whales, 2010)	Equipment provision and or purchasing (2) Risk Assessment (1) Education and Training (5) Audit of Working Practices/ Risk Assessment (15) Peer Leader (23)	Staff Competence Staff Knowledge and Skill Training Numbers Audit Performance	Observed Checklist for Performance Staff Knowledge Perception of Learning (feedback) Training Evaluation demonstrate compliance, audit for retraining Compliance with Audit audit necessary to review accidents and identify areas of inadequate training.	Recommend competency assessments demonstrating both formal knowledge (testable) and observe demonstration of skills in the work place. Recommends refresher courses as training is inadequate unless behaviour is constantly used in the workplace.
(Robson et al., 2004) CDC and NIOSH		Staff competence Staff Injuries Staff Knowledge Skill	Observed Checklist for Performance observational or video Staff Injury Numbers Staff Knowledge survey Informal/Formal Interview including	Allow staff to evaluate and select equipment to promote confidence in staff, and encourage management staff teamwork. Evaluation

		Staff Perception Training numbers Financial Incident/Accident	focus groups Staff/Management Attitudes Survey Staff Assessment of Program strengths, barriers, Efficiency of Training Compensation Cost Staff Incidents/Accidents	period depends on outcome measures training can immediately change knowledge where as injuries may take 3mo- 1 year to assess
(A. Nelson et al., 2005) Tampa VA,	Peer Leader (23) Equipment provision and or purchasing (2) Risk Assessment (1) Education and Training (5)	Staff Perception Staff Perception Risk Assessment Staff Competence Staff Knowledge Skill Staff injuries Staff Perception Staff Perception Incidents/Accidents	Rating of Perceived Exertion Comfort and or Safety Staff Evaluation of Equipment (ease of use etc) gather these as surveys/ questionnaires Formal/ Informal Interview focus group or meetings to talk about barriers to equipment use Documentation Review discuss incidents with nurses as focus group to identify barriers and solutions Observed checklist for performance both at training and as follow up (attachment 10-1) Staff Knowledge after training can be assessed with quiz. Staff Injury Numbers Job Satisfaction Staff Assessment of Program including acceptance (survey tools and focus groups) Staff incidents/ accidents including time off, for report include equipment use, type of task (attachment 11-1) Compensation Cost Financial Evaluation cost savings Patient attitude to equipment Patient satisfaction Patient comfort and or safety Staff evaluation of use of equipment survey on frequency of usage (attachment 11-5)	Have staff participate in evaluate of equipment to purchase Suggest incident accident reports be filed by supervisor using standardized form with required data. Barrier most incident reports do not include lost time or restricted duty days. A comprehensive data collection tool may save time and be more efficient than using multiple different databases Staff acceptance influences compliance Patient acceptance influence staff

		Financial Patient Perception Staff use of Equipment		
(Green et al., 2010) health guidelines revision committee specialty subcommittee on patient movement	Peer Leader (23) Equipment provision and or purchasing (2) Risk Assessment (1) Education and Training (5)	Similar to Nelson 2010 Staff Perception	Similar to Nelson 2010 Perception of risk (Appendix H)	Staff injuries are first outcome measure, but variables effect this measure including: Job satisfaction, patient satisfaction, peer leader activity, use of equipment, perception of risk to patient handling task,
(HCHSA, 2003) Health and Safety Association of Ontario	Equipment provision and or purchasing (2) Risk Assessment (1) patient mobility, frequency of ph task Education and Training (5) Peer Leader (23) on unit to encourage competence, perform audits	Incident accident Financial Risk Assessment Staff Use of Equipment Equipment Staff Competence (Org) Staff Competence Incident Accident	Staff incident accident (determine unit, ph activity type, severity, duration (including modified duty days), time (cumulative workload), staff experience (Table 3)) Financial Values accident cost Accuracy of risk assessment patient mobility assessment (Table 4) Staff Evaluation of use of Equipment frequency of lifts, if equipment is used (log Table 5) Accessibility of Equipment Barriers assessment tool (Table 6-7) Safety culture measure policy demands, time constraints, team work (Table 8) Observed checklist for performance Factors in Accidents interview to determine equipment use, patient mobility change (assessment out of date), worker issues)	Suggest performing all analysis pre-post as barriers to existing equipment may be discovered
(WSBC, 2006) Workers Compensation Board of British Columbia		Audit Performance Incident Accident Staff injuries Incident Accident Staff Competency	Compliance with audit recommend monthly inspection Factors in accidents Staff injury numbers body part Staff incidents accidents Observed checklist for performance ensure technique taught properly	All evaluation included in Appendix 2

		Equipment Staff Perception Training Numbers Financial	Equipment maintenance and supplies Formal é informal interviews monthly meetings Training attendance numbers and retraining Compensation cost	
(WSAB, 2008) Work Safe Alberta		Staff Injuries Incident Accidents Financial Staff Perception Risk Assessment Training Numbers	Staff injury numbers WCB data will not separate (lift, transfer, and reposition) Staff Incidents Accidents WCB claims Compensation cost brake down by type of injury (sprain, inflammation). Types of cost (lost time, medical aid Staff assessment of programme perception survey, on handling, equipment use, risk identification Equipment Maintenance/ Supplies Accuracy of risk assessment patient risk Training attendance numbers schedule for retraining	Require good pre-post program data Injuries and Financial considered (Tier 1-2 data)
(WorkSafe, 2003)		Staff competence (org) Staff Competence Staff Injuries Staff perception Staff use of equipment Physical Workload Psychosocial well-being Number of staff Financial Incident Accident	Safety Culture participation with input Self reported compliance Staff injury Numbers Use of Hoist Equipment Staff Managers attitude survey Staff evaluation of use of equipment easy to use Number of Task Psycho-social stressors Staff patient ratios Compensation Cost Staff incidents accidents Factors in accident Documentation Review patient LITE profile Lost time Sickness absence	

		Risk Assessment Staff absence Equipment Other	Accessibility of Equipment Equipment Maintenance and supplies Equipment Barriers Staff non-compliance measure	

Table 6: Assessment of patient handling non-intervention studies

Paper #	Intervention Type(Category)	Outcome Variable (Category)	Outcome Measure	Results
(Alex Burdorf et al., 2013) literature based model that considered rate of injury from lifting, and reduction of injury from introduction of equipment. Risk factor increases with # of PH activities, and Highly variable reduction in injury rate.	Simulation Modeling Lift Equipment Intervention Equipment provision and or purchasing (2) in addition to others Required Measure of Uptake of Intervention (report decrease number of manual lifts, or use of equipment)	Staff Injuries Staff Injuries Staff Injuries	Staff Injury (% low back pain) MSI Risk Factor from lifting (OR from Lit. Review 1.0-7.5) Depending on number of lifts per day. Staff Injury Numbers Reduction (/100 staff) (From Lit. Review) post intervention (average decrease 6%)	Depending on Impact of Intervention (% reduction MSI) a gradual change in MSI rates would require at least 400 participants to reach a significant difference in the desired outcome measure within 1 year. Using a realistic intervention of 6% at least 1200 participants would be required.
(Alamgir et al., 2009) BC no unsafe lift	Equipment Design/Evaluation (3) (Compare 3 hospitals with different coverage of ceiling lifts or floor lifts) Compare equipment for lifting and repositioning activities (slide sheet, floor lift, ceiling lift, manual lift, soaker pad reposition)	Staff Perception Staff Perception Patient Perception Time for task	Rating of perceived exertion Ranking of Task Patient Comfort (Visual score/ observational) Speed of Transfer and Reposition(Observation, Preparation and	Ceiling lift thought to reduce exertion for lifting and reposition over other methods Ceiling lift thought to be more efficient, less difficult to move, easier to access, and requires less assistance Patient observed more comfortable in ceiling vs floor lift. Ceiling lift faster than

			Movement Time)	floor lift for lifting. Soaker pad faster than ceiling lift but equal to slider sheet.
(Cornish & Jones, 2010)	Feedback (8) (Focus group for nursing students on why PH policy is not complied)	Staff Competence Staff Perception Staff Perception Staff use of Equipment Equipment	Self reported compliance Staff assessment of programme Use of hoist/ equipment Staff evaluation of use of equipment Accessibility to Equipment	Unsafe PH from other staff: Role models, peer pressure, asked to participate in unsafe lift Other factors for un-compliant PH: Limited access to equipment, belief unsafe PH is quicker, inability to use equipment (poor training), difficulty with mobility assessment at staff hand over (better to have lift guides on bed) Factors increasing compliance: Larger patient, previous injury encourage use of lift.
(Kate Kay & Glass, 2011) 100 nurses survey, measure uptake of training, Austrailia	Education and Training (5)	Staff Compliance Staff Competence Staff Injuries	Compliance with taught methods (survey) Self reported compliance Pain reporting	47% of Staff reported pain with patient handling 82% Indicated use of Safe Patient Handling 18% Could correctly answer risk assessment, and Identify safe and unsafe patient handling task.
(Holman et al., 2010) nurse survey/ 1000 sent, 86 returned complete, Alabama		Staff Competence Staff Competence Staff Competence Staff Perception Staff Perception Staff use of	Self reported Compliance Safety Culture Measure Organizational Support Use of Hoist/ Equipment Ranking of Task Staff evaluation of use of equipment	Most difficult task involved transfer from floor or bathtub, to Chair (most in bathroom) Most difficult location for transfer small

		Equipment Staff Perception	Perception of Risk	cluttered environments (bathroom, lobby, patient room). Nurses ranked that they would place patient safety above their own. Asked if in a situation to lift patient alone most said they would (ask for help, use a lifting technique (85%) only 7.8% suggested they would use equipment. Nurses report not using equipment because of (No time, no room to use it, no patient handling equipment available, and room to congested) Rank importance for factors influencing patient handing (Understaffing, patient size and weight most important) Lifting Policy of Facility considered unimportant. Bathroom insufficient for mechanical lifts. With 2/4 reasons not using a lift was the room could not accommodate it. Follow up nurses suggest patient safety is more likely to determine transfer method than policy.
(Kneafsey et al., 2012) focus group with nursing and physio/occupational therapy students. England, 2009 safe patient handling introduced to	Education and Training (5) (students)	Staff Competence Staff Competence Staff Injuries	Self reported compliance Safety culture measure (team member influence) Pain Reporting	Most students felt education prepared them. 13% reported low confidence with PH

school.		Staff Knowledge and Skill Staff Knowledge and Skill	Self Reported Knowledge and Skill Perception of learning	activities citing (lack of time, difficulty remembering safe procedures, and not enough practice) as limiting factors Many students never did a risk assessment (38%) 40% admit using non safe PH (increasing with student year) Reasons: (Lack of staff, Lack of Equipment, Lack of Space, Lack of Time) Safety Culture nearly half would feel confident to refuse in participating in an unsafe lift, and would preferred to fit in with team rather than question unsafe practices. Students would put patients' needs before their own. Physiotherapy and nursing students have some differences in these self reports.

Table 6: Assessment of patient handling interventions introduced in hospital settings

Paper #	Intervention Type(Category)	Outcome Variable (Category)	Outcome Measure	Results
(Alamgir et al., 2008) note slow decrease in MSI rates, BC no unsafe lift program	Equipment provision and or purchase (2) (ceiling lifts, including training introduced 2002)	Staff Injuries Staff Absence Financial Financial	Staff Injury Numbers Lost Time (Days Off) Compensation Cost (Per MSI) Financial Evaluation (Cost-Benefit payoff period)	MSI Rate Decrease (0.16-0.09/bed)* Days lost decrease (5.68-4.07/bed)* Claim Cost Decrease (6026-5319$/claim) Direct Cost 6.18 payback period (1,081,410$ cost of

				installing 110 ceiling lifts) Indirect Cost (Direct Cost *~2) ~2-3 year payback period
(Black et al., 2011) Pre-post and control hospital (matched for size)) *only include injuries from Patient handling and first time in 2 year study period	Equipment provision or purchase (2) (lifts/sheets/slings/transfer belts) Education and training (5) (1 day Sask. TLR program) Change/ introduce patient risk assessment system (13) (posted on patient bed)	Staff Injury Incident/Accident Staff Absence Financial	Staff Injury Numbers (time loss, no-time loss injuries, include: body part, **activity causing injury**) (expressed per full time working equivalent) Lost Time (days) Compensation Cost (claims cost)	Intervention Group 19% reduction in time-loss injuries 33% reduction in all injuries Best results for lifting > transferring > repositioning Small hospitals influenced more by program than medium or large. No Trend in Control Group 55% reduction in Time loss * 40% reduction in claim cost (not sig) attributed to changing medical cost
(Garg & Kapellusch, 2012) pre (~39mo) post (~51mo) intervention design) Addresses Barriers to Implementing a Intervention (Wisconsin hospital)	Feedback (8) Group problem solving/ team building (9) Review and change of policies and procedures/ safe systems of work (no-manual-lift) (10) Discussion of goals with clients (patient) (11) Change/ Introduce patient risk assessment system (card placed on bed) (13) Peer leader, Ergo coach (23) Equipment provision or purchasing (with training) (2) Equipment design/evaluation (3)	Staff Injuries Staff Perception Patient Perception Patient Perception Financial Financial Financial Staff Absence Time for task	Staff Injury Number (/100 FTE) Ratings of Perceived Exertion (Borg) Patient Comfort Patient Security Financial Values Financial Evaluation (payback period) Compensation Cost Lost time/ Sickness absence Speed of Transfer	Pre v post Decrease in PH Injury rate (63%), days lost (86%), and WCB Cost (84%). No change in non PH Injury measures Payback period (54,000$ cost for equipment per facility, 72,000$ per year cost reduction) Nurses perceived workload with equipment to decrease Patients found lifts comfortable and safe (except slider sheet no difference with draw sheet) Transfer time longest with lift, less time with patient transfer belt
(Zadvinskis & Salsbury, 2010) compare 2 cardiac units one with equipment (control), one with equipment no-lift policy and peer leaders (intervention)	Review and change of policies and procedures/ safe system of work (10) Peer Leader, (23) Equipment provision and or	Staff Injuries Staff Perception Financial	Staff Injury Numbers Staff use of hoist/ equipment Compensation Cost	Intervention group reported greater use of floor lift, and standing assist device. Intervention had greater reduction in injury rate (pre vs

	purchasing (2) Education and training (5) (for peer leaders)			post) Intervention had greater reduction in compensation cost (flaw, small study 1 year follow up)
(Kurowski, Boyer, Fulmer, & Gore, 2012a) Third party company, provide training and follow up 2,4,10,20,30,40,50 weeks) (pre post follow-up 3,12,24, 36 mo) compare at baseline with hospitals with different levels of intervention. (MAS) 2006 intervention	Equipment provision and or purchasing (2) Education and Training (5) Equipment maintenance (4) (provided by third party) Change/ Introduce patient risk assessment system (13) (RN mobility assessment in care plan and as stickers)	Staff Competence Training Numbers Training Numbers Staff Injuries Physical Workload Physical Workload Staff (questionnaire) Staff Perception Psychological Well-Being	Compliance with taught methods (test) Efficiency of training (perform PH technique) Training Evaluation Staff Injury Number (report in 24 hours) Posture Analysis Biomehcanical Model (PATH percent of exposure) Number of Task Breakdown (transfer, reposition, transportation, mobilization) Use of Hoists/ Equipment Psycho-social Stressors	Nurse Types Nursing assistants, more poor trunk posture (flex, twist, lateral flexion, and static posture, with arms raised above 60 degrees) compared to LPN. Baseline to 36 month follow up equipment use increased 10-32% with transfer (57%) using more equipment than reposition (12%). Percentage of time with PH activities decreased at 2 years, and increased slightly at 3 years. Percentage of time repositioning decreased (9.3-3.4%) Percentage of time transferring patients remained the same and increased in year 3. Percentage of time with equipment use (time retrieve to replace of equipment) decreased baseline to 36 month (faster using equipment) Questionnaire 24 mo, 2/3 of nurses (often use patient handling devices) Reasons to not use: Device unable when needed (25%), resident dislike of device (14%), feel they do not

				need them (14%), not enough time (7%), too much effort (5%), some residents do not require lifts, not enough staff, another staff using it. Weight in hands decreased after intervention, primarily for lifting. By 36 month neutral trunk posture became common (31-67%) with a reduction in severe flexion, twist and lateral bend posture. Time spent with arms below 60 degrees increased (38-75%) Low use of repositioning aids suggest changes in training techniques. Not all PH activities need a device. Observations (use of validated tool and ensured high IRR of >.6)
(Kurowski, Gore, & Buchholz, 2012b) 5 facilities accessed at baseline and 3,12,24 mo, 3-21 workers observed at each facility at each time with 30-300 patient handling observations each	Equipment provision and or purchasing (2) Education and Training (5) Equipment maintenance (4) (provided by third party) Change/ Introduce patient risk assessment system (13) (RN mobility assessment in care plan and as stickers) Staff Peer Leader (23) Train new employees	Staff Competence Training Numbers Training Numbers Staff Injuries Physical Workload Physical Workload Physical Workload	Compliance with taught methods (test) Efficiency of training (perform PH technique) Training Evaluation Staff Injury Number (report in 24 hours) Posture Analysis Biomechanical Model (PATH percent of exposure) Forces Applied (calc via PATH) Number of Task Breakdown (transfer, reposition, transportation, mobilization)	2 centers used equipment at baseline. With 4/5 centers having an increase in equipment use. Less initial equipment resulted in greater change in PWI and equipment use. Reduced physical work load for all facilities. But each facility varied with rate of change. Presence of Peer Leaders had no influence on PWI Increase use of equipment decreased PWI Increased access of equipment decreased PWI

		Staff (questionnaire) Staff Perception Psychological Well-Being	Use of Hoists/ Equipment Psycho-social Stressors Staff Turn over rates Employee Satisfaction Survey (include management, supervision satisfaction, social and management support) Under staff (assessed by temporary hires) Time pressure measured with survey	Under staff shifts associated with increase PWI Reduced staff time pressure (feeling they did not have enough time to complete duties) were associated with increased equipment use Perceived supervisor support associated with decreased PWI Increased positive staff-to-staff communication associated with decreased PWI Changes in equipment use associated with factors that effect the facility or equipment factors.
(Kutash et al., 2009) 6 year follow up in 950 bed hospital, 5900 staff (tampa FL 2001)	Risk Assessment (1) –interview managers, staff, and levels of patient acuity for high risk floors Equipment provision (2) 150,000 for lifts (portable ceiling, floor, and lateral transfer) Introduce lifting team programme (17) 6 full time members (8am-7pm M-F, 9am-5:30pm S-Sun), responsible for lifting transferring and equipment evaluation and maintenance. 2 week training program Education and training (5) new patient care staff Peer leader (23) super users (100 trained) trained to use equipment and lift team paging, ensure compliance of other staff with lift use and lift team contact.	Staff Injury Staff Perception Modified Work Patient Perception Financial Incident/Accident	Staff Injury Numbers Staff Pain Reporting Comfort and or Safety Staff assessment of programme Modified Work Staff perception of patient effect Patient security Compensation Cost Staff Incidents/accidents	62% reduction in PH injury rate 97% reduction in WCB cost 91% reduction in lost work days 76% reduction in modified duty days Reduced hospital annual insurance premiums Nurse Survey/ Focus Group: 96% rank lift team extremely important 90% report less back pain 84% report patient transfer safer 59% report more time for other nursing duties. Turning patients reduce skin breakdown. Patients prefer lift team over nurses using equipment as

				they are trained and versed with using equipment. Lift team expanded from 22 FTE staff working 24/7 (3 teams day, 2 teams night) Each team responding to 250 calls a day. Additional equipment purchased (ceiling lifts, sit to stand, slide sheets) Barriers: experience nursed reluctant to use lift team, mandatory education addressed this barrier. Challenge recruitment and retention of lift team Poor follow up with peer-leaders lessened their impact recommend annual update. Strength: Collect comprehensive data, patient handling, monthly date and time of injury, body part, **specific activity**, equipment used, lost work time, and modified duty days. Implement electronic data base to better capture data.
(Lahiri et al., 2013) works with kurowski's data). 110 facilities with at least 3 years of a ph intervention program.	Equipment provision and or purchasing (2) Education and Training (5) Equipment maintenance (4) (provided by third party) Change/ Introduce patient risk assessment system (13) (RN mobility assessment in care plan and as stickers) Staff Peer Leader (23) Train new employees	Financial	Financial Values Financial Evaluation Compensation Cost Lost Time/ Sickness Absence Staff Turn Over Rates	total cost 2.74 million for equipment, with a 4.6 million recovery in 3 years. payback period 1-2 years (depending on turn over cost). 143$ saving per bed 165$ saving per FTE staff member. Facilities with longer post intervention had higher average savings per bed/ FTE. Suggest lag in learning, or

				injury reduction. Cost benefit varied considerably between facilities.
(Lim et al., 2011) (sask TLR program, compare 3 intervention hospitals (large (450 beds),med(240 beds),small(240 residents), with 3 control hospitals of similar size. 2 year pre/ post intervention date	Education and Training (5) including patient handling assessment, algorithms, and use of equipment Equipment provision and or Purchase (2) 2 floor lifts per high risk unit.	Staff Injury Staff Absence Financial	Staff Injury Numbers (repeated injuries) Lost Time (days) Compensation Cost (claims cost)	In intervention group larger hospitals had more repeat injuries than smaller hospitals. Intervention hospital had fewer repeated injuries than control hospitals (sig. for small and medium) Greatest reduction in back injuries. Intervention hospital had pre-post reductions in days lost, and claim cost/ injury.
(H J Lipscomb et al., 2012) intervention 2005 study period 1997-2009. Pre-post comparison, with non PH injuries as a control.	Change of policies and procedures (10) minimal lift environment Equipment provision and or purchase (2) Peer Leader (23) trained to train other staff and champion lift equipment use	Staff Injury Financial	Staff Injury Numbers Compensation cost (treatment and time off)	Staff injury coded in database of MsK injury and category of "patient" for PH injuries. Cost rate decreased after intervention with no lag period. PT/OT aids, and nursing aids highest injury rate Staff age increased cost/claim up to 45-55. 2000-2009 (2152 injuries 72% from patient handling)
(P. J. Martin et al., 2009) Australia intervention period 1998-2000 compare pre (1993-1998), transition (1998-2000), and post (2001-2003) trends	Review and change of policies and procedures/ safe system of work (10) Peer Leader, (23) Equipment provision and or purchasing (2) Education and training (5)	Incident/Accidents	Staff Incidents/ Accidents (# of claims/ 1000 FTE, claim (10 days, or 500$ medical expense) Back injury separated from other injuries	Difference in 3 time periods resulting in a significant 23.1% reduction in claims. Most claim rate reduction was in initial intervention period (23.9% reduction in claim rate) Non-significant increase in claim rate after post intervention (possible threat to sustainability) Barriers:

				Lack of ongoing funding, physical constraints of environment/ storage, time for program coordinators, and staff complacency. Other injuries (wrist, knee, ankle, shoulder) no change with intervention. Recommend evaluation with resolution of ward level.
(M Matz, 2007) white paper follow up of VA intervention (2001-2002) learn why some programs are better. Follow up from Nelson 2006, program loss of success	Peer Leader (23) on each unit Introduce Patient Risk Assessment Program (13) algorithm for lifting	Staff Injuries Psychological Wheel-being Modified Work Staff Absence Financial Staff Perception Staff Knowledge Skill	Staff Injury Numbers Staff Job Satisfaction Modified Duty Days Lost Time/ Sickness Absence Compensation Cost Informal/ Formal Interview injured staff Staff Assessment of Program focus group including managers Perception of learning staff felt training inadequate.	Focus Group: Program not well maintained Increase role of unit peer leader: equipment training equipment accessibility and maintenance, suggest peer leader be full time as time and duty reduces their role. Original intervention not target pushing-and pulling complaint with injuries during this activity associated with repositioning (poor intervention/ equipment lateral transfer devices, ceiling lifts can assist) Equipment accessibility (number of styles/sizes of slings), lack of training (inadequate knowledge results in not using equipment for patient and staff safety) Annual refresher/ competency evaluation (peer leader could facilitate this) Lack of time/ inadequate staffing as a constraint Nurses do not report injuries and discomfort
(Park et al., 2009) Ohio	Equipment provision and or	Staff Injuries	Staff Injury Numbers (back	Back injury rates reduced

bureau of Workers Compensation promoted intervention 2000-2001 (40,000 grant for equipment and training) Injury rates compared before and after intervention in 2004. Observed 887 employees Intervention not controlled just use of grant no control on equipment purchased	purchasing (2) Education and training (5)	Financial Number of Staff	separate of other injuries) Compensation Cost (medical and indemnity) Staff Patient ratio	2001-2004 (3.5/ 100 employees) vs pre 2000 (~3.69/100) Nursing homes with higher patient to staff ratio had higher injury rates (50% more if ratio was > 2), however they experienced a greater reduction if lifting equipment was introduced (45% vs 21% (lower ratio)) Regression results Training resulted in a 1% reduction in back injury rate for 10 hours.
(Ashley L Schoenfisch et al., 2011a) intervention oct 2004-jan 2005. Focus groups May 06-Dec 09. Data transcribed for qualitative data analysis from 13 focus groups (80 participants)	Equipment provision and or purchasing (2) Education and training (5) Peer Leaders (23) train-the-trainers Review and change of policies and procedures/ safe system of work (10)	Staff Perception Staff Knowledge Skill Staff Use of Equipment Training Numbers	Focus Group (semi structured interview) barriers Group meetings with monthly project meetings (management) Staff assessment of Programme feelings to policy Perception of Learning from training Staff evaluation of use of equipment Training Evaluation perceived adequate training	Barriers: Time- work to retrieve, setup, and return equipment, while having pressures to complete task immediately Peer Leaders- Training takes a lot of time, to ensure competence with multiple pieces of equipment. Few peer leaders. Peer leaders no time to train from patient load. Peer-leaders felt training on training was inadequate, and refresher courses would be needed for some equipment Not using equipment results in forgetting how to use it. Using it facilities efficiency Work social pressures (environment)- fast pace other colleagues will perform lift if equipment is being retrieved, plus nurses do not want to waste colleagues time with

				retrieving equipment Time constraint may be from managers to get a task done quickly, thus no time for lifting Many nurses felt ability and knowledge to use equipment from training was not sufficient, did not know when to use equipment, how to use it, or experience with it Nurses will not use equipment if not confident for patient safety, or fear of looking incompetent Barrier of shift changes not properly communicating need for equipment Barrier of patient, lines on patient interferes with lift equipment Barrier different in unit management some encourage lift use others suggest its to much hassle, ultimately this influences staff uptake of equipment. Staff take care of patients at expense of their safety. Final barriers in room dimensions, and equipment maintenance (battery charged/ slings) Barrier of weak policy, unit managers choose equipment, nurses allowed to make patient assessment to choose equipment. Results echo effect of culture of workplace

				Study suggest variability between units although hospital wide intervention may be successful at end point metric (injury rates)
(Ashley Schoenfisch et al., 2011b) intervention Oct 2004- Jan 2005 large tertiary medical center North Carolina. Pre post design (same as liscomb) for reduced injuries. Medical center 54 pieces of equipment in 21 units, community hospital 19 pieces to 7 units.	Equipment provision and or purchasing (2) selected by unit managers Education and training (5) Peer Leaders (23) train-the-trainers (1-11 per unit), equipment use maintenance, and tips for coaching Review and change of policies and procedures/ safe system of work (10) Two ergonomist to attend meetings, address injuries, and to discuss follow-up with nursing unit managers	Training Numbers Risk Assessment Equipment Staff Use of Equipment Financial	Training Evaluation demonstrate competency with equipment with form in their personal file. Observational Checklist 14 items Accessibility of equipment (storage area (accessible no other stuff in front) and available supplies (slings), maintenance (battery charge)) Measures of readiness to us equipment Staff use of equipment net hours recorded on lifting device (limit cannot measure number of lits) Management monthly cost of equipment slings, friction reducing liners	From 2006-2009: Increase in proportion of excellent equipment storage (including labelling and laundering/ maintenance contract info) Increase in stock and visibility of friction reduction sheets. Increase percent of spare battery charged Increase proportion of sling stock (low first year until task delegated to a staff member) Full body sling had increase monthly use/ hour with increasing intervention duration (+.0075h/ 3 months). Considerable variability in unit uptake of lift Barrier equipment maintenance ignored for months Sling purchase increased over time and conformed with lift use. Friction reduction sheet purchase remained constant with 1/3 from 3/21 units (these units used in a pilot study or one having a lift team) Recommend measures (coach/ unit coach-to-staff) Recommend multiple measures to assess uptake

(Elin Koppelaar et al., 2012) analyze patient handling activates in nursing homes (10 full dependence, 7 specific care) with a intervention program in place) 186 participants observed in 735 patient handling activities (transfer, reposition, personal care, and stockings	Ergo Coach (23) National Regulation (25) Guidelines Netherlands Equipment Provision (2) (device for specific handling activates)	Staff Competence Staff Demographics Number of Staff Physical Workload Physical Workload Staff Use of Equipment Time for Task	Observed checklist for performance (high agreement for trunk posture, but only moderate for pushing/pulling and lifting) Compliance with Taught Methods Staff Patient Ratio Posture Analysis Number of task (push, pull, lift) <100, between or >230 N Staff Use of Equipment Speed of Transfer	Staff/Patient Ratio (0.1-3.3) 560/735 observed patient handling used devices (69% compliance) Adjusting bed height high compliance (>85%) Use of Lifts (75%) Use of slider sheet (14%) (reposition vs transfer) (possible lack of time, availability, or knowledge) Use of devices reduced poor back posture, and reduced estimated force category. Use of device increased patient handling activity (10-98%) except slider sheet which reduced time of repositioning. Use of equipment was an important determinate of mechanical load, lowering frequency of forces from 38-95% depending on activity. Higher ratio of nurses per patient associated with less time in awkward posture, and lower frequency of manual lifting patients (force category). Suggest time pressure has a link with loading, time constraint as a barrier. Lifting compliance higher than other studies attributed to government attention to patient handling. Shower aids used less possible lack of space

(E Koppelaar et al., 2011) 19 nursing homes and 19 hospital, 247 nurses doing 690 ph activities requiring a device	Ergo Coach (23) National Regulation (25) Guidelines Netherlands Equipment Provision (2) (device for specific handling activates) Patient risk assessment system (13) Policies and Procedures (10) Equipment maintenance (4) (budget, reserve money) Education and Training (5) (annual update)	Staff Competence Staff Competence Staff Demographics Number of Staff Number of Staff Staff Injuries Staff Competence Staff Knowledge Skill Staff Perception Staff Use of Equipment Financial Equipment	Observed Checklist for Performance Compliance with Taught Methods (use appropriate tool with guideline (lift type and patient mobility)) Patient to Staff Ratio Ergo coach to Staff Ratio Pain Reporting (LBP 1 year) Self reported Compliance Self reported Knowledge Skill Staff Interview (formal) Staff evaluation of use of equipment (observe) Financial values Accessibility of Equipment (distance, equipment/ patient ratio)	Barriers, common to LTC and hospitals (Equipment not close to bed ~90%), hospital no patient specific protocol with guidelines for ergonomic device used (96%), nursing homes poor ratio of slider sheets (62%) Hospital nurses less likely to be in the phase of change maintenance of behaviour Use of PH equipment similar in LTC and hospitals (exception hospitals have lower use of lifts for transfers, and use of adjustable shower chairs) For patient transfers factors (motivation to use equipment, previous back injury, and patient specific guidelines were identified as facilitators to use of PH equipment (OR 1.9, 1.8, and 2.5)) Nurse motivation correlated with (ratio of lifting device per patient, lifting device close to patient, and management support (maintain ergonomic equipment)) (ceiling lift may be better than floor (always in room)) Patient specific protocol may related to mandatory ergonomic device use (65% in nursing homes 4% in hospitals, related to change in patient mobility). Correlated with management support

				(equipment maintenance, purchase new equipment, maintain equipment to non-mobile patient ratio). Change in patient mobility considered an issue but when study corrected for hospital motivation, and patient specific guidelines hospital would use equipment just as often. Separate PH activity (reposition may be different injury rate than transfer)
(E Koppelaar et al., 2013) 19 nursing homes and 19 hospital. Aim to quantify influence of Ergo Coach as a facilitator.	Ergo Coach (23) National Regulation (25) Guidelines Netherlands Equipment Provision (2) (device for specific handling activates) Patient risk assessment system (13) Policies and Procedures (10) Equipment maintenance (4) (budget, reserve money) Education and Training (5) (annual update)	Staff Competence Staff Competence Staff Demographics Number of Staff Number of Staff Staff Injuries Staff Competence Staff Knowledge Skill Staff Perception Staff Use of Equipment Equipment Ergo Coach Assessment	Observed Checklist for Performance Compliance with Taught Methods (use appropriate tool with guideline (lift type and patient mobility)) Patient to Staff Ratio Ergo coach to Staff Ratio Pain Reporting (LBP 1 year) Self reported Compliance Self reported Knowledge Skill Staff Interview (formal) Staff evaluation of use of equipment (observe) Accessibility of Equipment (distance, equipment/ patient ratio) Knowledge manager, linkage agent, capacity builder	More LTC Nurses (2/3) than hospital nurses (1/4) considered to be in maintenance of behaviour stage of change. Nursing home more likely to have patient specific protocol, and higher access to lifting device (equipment/patient ratio) Both low (10%) lifting device close to patient bed Ergo Coach Self report better in nursing homes (50 vs 40% competent across categories) Nursing home more likely to have higher management support (maintain equipment), and supportive management climate (talk about mechanical load in team meetings) **Nurses knowledge of workplace guidelines, patient specific protocols, and ratio of equipment to**

				patients associated with behaviour of using lifts. Management support of equipment funding, influenced ward characteristic of equipment maintenance, influencing nurse use of ph equipment and ensuring patients have specific guideline. Annual PH training, encouraged capacity builder abilities of ergo coach. Training as a first step for knowledge of policy necessary to change behavior. Environment barriers, accessibility and ease of equipment use is very influential. Patient specific protocol important as nurse no longer needs to determine mobility. Ergo coach found to have no influence, contradictory to other studies suggesting peer-leaders as important.
(Mustard, 2011) 2004-2007 Ontario invested in lift equipment (19,000 lifts in 650 facilities) 53 facilities evaluated (48 long term care, 5 chronic care) 2x 1 year follow up questionnaires (1800 caregivers participated)	Education and Training (5) Equipment Provision (2) Policies and Procedures (10) Ergo Coach (23) Patient risk assessment system (13)	Staff Competence Staff Injuries Staff Knowledge Skill Staff use of Equipment Physical Workload Patient Perception Training Numbers	Self Reported Compliance lift use Pain Reporting Staff Knowledge survey on PH technique Staff use evaluation of use of equipment Number of Task PH Staff Perception of Patient Effect Training Attendance Numbers	Equipment availability increased (5.4/100-14.3/100 beds in LTC), and (8.8/100-65.9/100 in Chronic Care) 48% of self report lift and transfers (average 35 per day) performed with equipment Caregivers believed patients preferred mechanical lifts Caregiver knowledge of lift and transfer technique improved between two

				surveys. 5 highlighted hospitals (no-lift policy, Ergo Team (peer coaches), Mandatory Annual Training, Patient Lift Assessment Posted on Bed, Caregiver Competence with equipment, Strong Management Staff Communication)
(J. Harvey et al., 2004) Victorian nurses back injury prevention project implemented 1998. Track 111 facilities that received funding (1999-2003). Suggest effects diluted as policy was not implemented in all wards.	Policies and Procedures (10) No Lift Equipment Provision (2) Education and Training (5)	Staff Injuries Staff Absence Financial Staff Perception Staff Competency Staff knowledge skill Training Numbers Equipment	Staff Injury Numbers Lost Time Sickness Absence Compensation Cost Financial values Staff Managers Attitude Survey survey on staff management on culture. Management survey to include barriers Compliance with taught methods managers id resistance to change Staff Knowledge Staff training numbers (% staff) Accessibility of equipment including barriers of storage, floor design, and time	24% reduction in back injury claims (3.5/1000 to 2.6/1000). 41% Reduction in working days lost (350 days/1000 to 200/1000) 23% reduction in days lost per claim (100 days/claim to 77 days/claim) Cost benefit analysis (24.4 M from Dec 98-Jan 03, net savings 14.3M) Compare hospitals with different level of success successful hospital had higher organizational commitment, and willingness to empower staff. They were open minded and attempted to encourage staff enthusiasm. Hospital with little change focus on equipment and policy. With floor space constraints for equipment Competency tool assess staff knowledge of no lifting philosophy, principles, and techniques. (appendix 3-4) Other survey data barriers (compliance, program funding, physical workplace constraints), facilitator (ongoing training),
(Cloutier et al., 2012) experimental pre-post design comparing emergency units (3) with safe client handling	Ergo Coach (23) safe client handling champion (rehab assistant with ergonomics training), role to review safe work procedures, training (in the moment) on equipment, and	Staff Competence Staff Use of Equipment	Self reported compliance Staff evaluation of use of equipment frequency	Baseline review, units had gaps in equipment, training, staff knowledge, and

champion added to those without (3).	record keeping Equipment Provision (2) Purchased by safe client handling champion with aid of ergonomics team Education and Training (5) in the moment training Patient risk assessment system (13) single mobility assessment tool developed by Fraser Health with a algorithm (Appendix B)	Staff Knowledge Skill Staff Injuries Financial Equipment Staff Competence (Org) Staff Perception Staff Knowledge Skill	Staff Knowledge Staff Injury Numbers Compensation Cost Accessibility of equipment storage areas, equipment and slings Safety culture measure (staff safety important as patient) Staff managers attitudes survey necessary resources, education and training Perception of Learning sufficient training	frequency of using equipment Comparing last quarter reduction in patient handling claim cost (100-97% reduction in intervention units 6 month follow up) Cost benefit status quo. Changes in survey data suggest that there was a change in safety and behaviour and safety culture (using more equipment, improved accessibility to and maintenance of equipment, improved safety priority, felt organizational support through training, equipment, and education) Focus Group Results safe client handling champion had positive effect, on training, education, staff safety and awareness of staff behaviours towards safety practice
(Duke et al., 2007) compare a best performer hospital from previous intervention (control) vs a new intervention unit (to incorporate control changes) matched for size, and equipment. Interviews to compare differences, develop survey tool to assess different (including validated safety attitudes, and safety climate Appendix A) 103 questions, pre comparison allowed to create intervention to address gaps.	Education and Training (5) 30 mins by physiotherapy once every two weeks, with a topic Patient risk assessment system (13) patient ADL posted on bed, how to work safely with resident. Management system (24) management update with staff via email on update.	Staff Competence (Org) Staff Competence (Org) Staff injuries Staff perception Staff perception Psychological well-being Patient perception Training numbers Equipment Financial Staff absence	Safety culture measure Organizational support Staff injury numbers Staff Managers attitude survey work organization Staff assessment of programme Staff job satisfaction Staff perception of patient effects Efficiency of training Accessibility of equipment Compensation Cost per claim Lost Time	Initial differences (safe control vs intervention): safe work practice (patient assessment, on unit training (interactive and problem solving) new staff trained right away), staff teamwork (schedule ADL with other care aids to assist), communication (many channels for communication), and respect (all team members have an opinion). Accessible team leader. Survey difference 76 of 90 questions. In general control had more training, high use of aids, and effective communication Pre-Post: No difference in injury rates, cost per claim, and days lost Intervention hospital had a difference in 7 survey questions (improved confidence and

				use of equipment, higher morale, better communication with workers and management) Control hospital and intervention only differed with 36 of 90 questions. Suggesting improved safety culture.
(Restrepo et al., 2013) compare long term care facilities (of same size |100 patients) with a 3+ year lifting intervention (119) protocol, with those with no or a 1-3 year period (137). Survey filled out by director of nursing of each facility. Survey data combined to safe lifting index		Staff Injury Staff competence org Staff knowledge Skill Staff perception Staff use of equipment Patient perception Financial Incident Accident Risk Assessment Training Number Equipment	Staff injury number wc number of claims Staff safety culture Director of nursing perspective Staff knowledge Staff use of hoist equipment Staff evaluation of use of equipment Staff perception of patient effect Compensation cost Staff incidents accidents Risk assessment process does one exist Training attendance number new staff trained, emphasis of equipment with evaluation Accessibility of equipment Barriers maintenance and supplies of equipment Equipment to patients requiring assistance ratio	Regardless of policy in place all facilities had similar ratios of equipment to patients. Suggest equipment itself has little effect but must be packaged with policy and other factors. Facilities with a 3 year + program had a higher safety index rating than other facilities. A 1 standard deviation level increase in safety index rating associated with a 49% reduction in claim frequency, and a 33% reduction in compensation cost. Safety index was correlated with: Organizational policies and procedures require use of equipment, and training Director of nursing preferences (preference on 2 person manual lifts, lifting patients 150 or 90 lbs). Interesting there attitudes related to injury rate suggesting direct of nursing influence on culture of safety Barriers to using equipment (using equipment in bathroom, and maintenance of equipment) Enforcement of policy repercussions to not using lift equipment
(D'Arcy et al., 2012) survey with nursing assistants	Equipment Evaluation (3) Education and Training (5)	Staff Injuries	Self reported injuries (body part, how injury occurred, severity (time	Receiving training had a 40% reduction in injury odds. Self

from 582 facilities, compare answers with injury rates, American national nursing survey	Review Staffing Levels (16)	Staff Knowledge Skill Staff Perception Equipment Staff Perception	off)) Perception of Learning (receive training/ perceived quality) Effect on staff/ workload Accessibility to Equipment Informal/Formal Interview	report high quality training had no effect) Nurse assistant who felt they had time to complete task had a 33% reduction in injury odds Access to lifting equipment had a 40% reduction in injury odds Working at one place for less than 1 year had a 80% increase in injury odds

Table 8: Findings and conclusions of patient handling interventions from current literature reviews

Paper (Author, Date)	Outcome Measures Assessed	Findings/Conclusion
Garg, 2012	Assessed discussion points on barriers to implementing a patient-handling intervention. Barriers addressed with some solutions in brackets Safety Culture Equipment Patient Perception Staff competency Staff Knowledge and Skill Risk Assessment	employee motivation (employee engagement in equipment selection), convenience and accessibility to equipment, equipment maintenance (assign duty of maintenance and supply order to nursing staff) supportive management, patient related factor (mobility assessment listed on patient bed), lack of no-manual-lift policy (flexibility to manually lift), devices in only selective unites, inadequate training on devices, concern for patient safety and comfort, longer transfer time, and ability to select appropriate device for patient (addressed by chart on patient bed)
Kay, 2012 (K Kay, Glass, & Evans, 2012b)	Epidemiological data is most common outcome measure (MSD prevalence, incidence, cost, workload measures (perceived)) Technique has been compared Most lit. Reviews synthesize information about pain and injury rate. Safety Culture (belief, attitudes, and behaviour) recent applied to healthcare Measure nurses attitudes, beliefs, behaviours, and experience. (Few Studies)	Patient handling activity should be typed (intervention may only target lifting) Training and technique reduction injury may be partially related to inconsistency in program Workers belief of management commitment to safety is a key structure. No Consensus on how to evaluate patient handling programs. Cannot pin point what elements of a multidisciplinary intervention is effective.

		Measuring from nurses may assist with addressing barriers, and compliance issues with patient handling policy.
Koppelar, 2009	Measure factors that can be barriers or facilitators to an intervention program. Compliance with taught methods Safety Culture Measure Organizational Support Staff Injury Numbers Staff Knowledge Staff/ Managers attitude Survey Staff evaluation of use of equipment Psycho-social Stressors (supportive management) Patient comfort Patient Attitude to Equipment Financial Evaluation Speed of Transfer Accessibility of Equipment Equipment Provided	Interventions have mixed results despite proof or minimizing workload, suggesting that some underlying factors are barriers or facilitators to successful implementation. Studies often cite addressing barriers but do not measure the effect of them. In general Major Barriers and Facilitators (Environmental: convenience and easy accessibility, supportive management climate, and patient related factors, Individual: staff motivation). Engineering Type Studies (time to transfer patient, time to implement intervention, availability of equipment, and patient were important environmental factors. Individual motivation and ability were discussed). Personal Interventions: had little effect more environmental barriers than individual barriers common barrier (convenience and accessibility, patients, and motivation) Multidisciplinary: convenience and accessibility, supportive management climate, and patient. Most studies identify barriers/ facilitators retrospectively or identify them in study design but do not measure/ evaluate their effect. One study measured access to equipment.
MacKenzie, 2012 past 5 years (MacKenzie, 2012)	Staff Injury Numbers Compensation Cost Staff incidents/Accidents Lost time/ sickness absence Staff assessment of program Staff perception of patient effect Patient perception Staff reported compliance Staff self reported knowledge skill Staff evaluation of use of equipment	Majority of the literature finds multifactoral interventions reduce MsK injury rate. One exception of a study with no "no-lift-policy" included. Safe patient handling has positive effect on work place quality (perception of equipment), barriers adequate # of trained staff (peer leaders may assist), and staff age/ room layout. Patient perception influences nurses decisions Staff feel that repeated lift use and follow-up

		training is more effective for lift use compliance than policy change. Important to address barriers to equipment use environmental, and individual as outlined by Koppelaar.
Tullar, 2010	Staff Injury Numbers Staff Pain reporting Lost time/ sickness absence	Moderate evidence that multi-component patient handling intervention reduces MSK risk. Moderate evidence that exercise training has a positive effect on MSK health (most of those studies secondary intervention (once injured)). Moderate evidence that patient handling training has no effect. Moderate evidence that cognitive behavioural therapy has no effect.