Caring for our Caregivers: an Evaluation of the Minnesota Safe Patient Handling Act

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Dedication

Thank you to my advisors, Dr. McGovern and Dr. Schofield, who provided tireless support throughout 4 years of patient handling research. To Adrienne, Brian, Breca, and the entire MN Department of Labor Research & Statistics team, thank you for bringing this important research topic to our attention and for your involvement in the process. I look forward to our ongoing collaboration to ensure this work is used to meaningfully protect Minnesota workers. Finally, thank you to my ever-supportive partner and parents.

This research is dedicated to Minnesota's direct care workers, who give their days and nights to ensure our loved ones are cared for with compassion.

Abstract

Background

Minnesota is one of 12 states to pass safe patient handling legislation aimed at reducing high rates of musculoskeletal disorders (MSDs) in health care workers.[1] MSD rates are 2- and 3- times higher in U.S. hospitals and nursing homes, respectively, compared to the private sector average.[2] Further, MSDs comprise almost half of all reportable injuries in these settings.[2] State safe patient handling (SPH) laws generally require health care facilities to implement multicomponent safe patient handling programs. Studies of multicomponent programs in large health care systems show substantial reductions in reportable injuries and workers' compensation claims, but few evaluations of statewide mandates have been conducted.

The 2007 Minnesota Safe Patient Handling (MN SPH) Act requires each health care facility to obtain adequate assistive lifting equipment and create a written safe patient handling plan and committee. The effectiveness of the law in nursing homes is of particular interest due to the frequency of patient handling tasks, challenging physical environment, and unique workforce comprised largely of certified nursing assistants (CNAs). To evaluate the MN SPH Act and better protect Minnesota nursing home workers, studies are needed to characterize patient handling injuries by occupation, assess temporal trends in injuries following enactment of the MN SPH Act, and compare Minnesota's experience to states without SPH legislation.

Objective

The overall objectives of this research are to provide a profile of patient handling injuries in Minnesota nursing home workers and to evaluate the effectiveness of the MN

SPH Act in reducing workers' compensation claims. Results will be used to inform future safe patient handling policymaking and to identify groups of Minnesota workers and types of facilities in need of additional state outreach and support.

Manuscript 1: *Aim:* Compare workers' compensation indemnity claim rates and severity among occupational groups in Minnesota nursing homes. *Methods:* Negative binomial and linear regression models with generalized estimating equations were used with 2005-2016 data from the statewide workers' compensation database to model the effect of occupation on type of workers' compensation indemnity claim. Minnesota Nursing Home Report Card data were used to calculate claim rates by occupation. *Results:* Claim rates were 3.68, 1.38, and 0.69 per 100 full-time equivalent workers in CNAs, licensed practical nurses (LPNs), and registered nurses (RNs), respectively. CNAs were more likely to experience musculoskeletal and patient handling injuries than RNs. However, their claims were less likely to result in temporary total disability or permanent partial disability benefits and more likely to result in stipulation settlements.

Manuscript 2: *Aim:* Compare pre- and post-MN SPH Act trends in patient handling injury claim rates among Minnesota nursing homes and assess whether temporal trends are modified by facility-level staffing and retention. *Methods:* Negative binomial regression models with generalized estimating equations were used with 2005-2016 statewide workers' compensation data matched to Centers for Medicare and Medicaid Services data to evaluate the impacts of time, staffing, and retention on patient handling injuries. *Results:* Compared to 3 pre-law years, the patient handling indemnity claim rate declined by 38% in years 7-9 following enactment of the MN SPH Act. Claims for all other injuries and illnesses declined by 20%. The association between time and patient handling claims was

not modified by staffing or retention. However, across time, nursing homes with annual staff retention ≥75% (vs. <65%) had a 17% lower patient handling injury claim rate.

Manuscript 3: *Aim:* Compare injury trends in Minnesota nursing homes, hospitals, and outpatient facilities to Wisconsin, a state without safe patient handling legislation. *Methods:* Mixed effects negative binomial regression models were used with 2005-2017 workers' compensation data from a single large insurer. The effects of the MN SPH Act were evaluated by assessing the interaction between state and time period on workers' compensation claim outcomes. *Results:* In both Minnesota and Wisconsin, patient handling injuries comprised the largest proportion of claims in nursing homes (54% and 45%, respectively) and smallest proportion in outpatient facilities (6% for both states). The change in mean annual facility-level patient handling claims from pre-law (2005-2007) to second post-implementation (2014-2017) did not differ between states. Further, changes in patient handling claims over time did not differ by healthcare setting.

Conclusion

Temporal trends in workers' compensation indemnity claims suggest that the MN SPH Act may have successfully reduced patient handling injuries in Minnesota nursing homes. However, among health care facilities enrolled with a single large insurer, the change in indemnity and medical only workers' compensation claims from pre-law to post-implementation did not differ between Minnesota and Wisconsin, a state without SPH legislation. Due to data limitations, including a small Wisconsin sample size, more research comparing Minnesota to states without legislation is needed. In Minnesota, state support of the law should target nursing homes with elevated claim rates, including those that have low staff retention, are non-profit, not affiliated with a hospital, or outside the

Twin Cities metropolitan area. Further, additional support is needed to prevent and accommodate patient handling injuries among nursing home CNAs, an occupation with high patient handling and MSD injury rates and adverse workers' compensation claim outcomes.

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Organization

The organization of this dissertation provides an initial introductory chapter, 3 individual manuscripts, and a concluding chapter. Because the 3 individual manuscripts are in preparation for peer-review, there may be some redundancy in material.

Chapter 1: Introduction

Background

Defining the problem

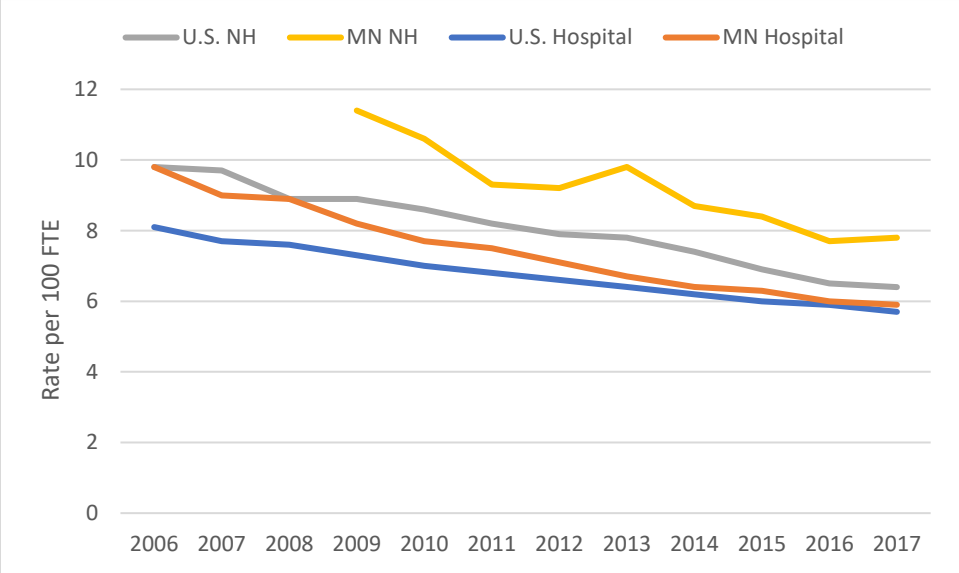
Direct care workers, including nurses and nursing assistants, are at heightened risk for musculoskeletal injuries due to repetitive lifting and transferring of patients. In nursing homes, patient handling is a fundamental component of direct care work. Nursing home residents often require assistance to perform basic activities of daily living such as bathing, toileting, getting out of bed, and moving from one location to another.[3] The level of manual handling needed to help residents with these tasks is not consistent with the 35-pound weight limit developed by the National Institute of Occupational Safety and Health (NIOSH) for patient handling in an ideal lifting scenario.[4]

Through the 1990s and early 2000s, use of lift teams, gait belts, and correct body mechanics were the predominant controls promoted to address patient handling hazards.[5,6] In 2003, the American Nurses Association (ANA) launched the Handle with Care campaign calling for a technology-oriented approach to safe patient handling. Additionally, the NIOSH Musculoskeletal Health Program, U.S. Occupational Safety and Health Administration (OSHA), and ANA have developed comprehensive guidance for establishing and maintaining safe patient handling programs.[8-10] To date, 12 states have passed legislation requiring or financially supporting multicomponent safe patient handling programs and use of assistive equipment, though only 6, including Minnesota, require program implementation in nursing homes.[1,7]

Despite these efforts, injury rates are still high across health care settings and are particularly high in nursing homes. In Minnesota, though reportable injury and illness

rates have declined over time in hospitals and nursing homes **(Figure 1)**, the rate of MSDs in nursing home workers remains elevated compared to the national average (14.4/100 full-time equivalent workers [FTE] vs. 8.4/ 100 FTE in 2017).[2] Nursing assistants are especially vulnerable. Across industries, they have one of the highest reportable injury and illness rates of any occupation (16.2/100 FTE across U.S. industries in 2017).[2] Between 2016 and 2026, the Minnesota population 65 years and older is expected to grow by 31%.[11] Retaining a consistent and healthy direct care workforce is imperative as Minnesota's baby boomer cohort ages into skilled nursing care.

Figure 1 Rates of total recordable injury and illness cases in private sector hospitals and nursing homes, 2006-2017



MN=Minnesota; U.S.=United States; NH= Nursing Home
Rates are expressed as cases per 100 full-time equivalent workers (FTE)

Peer-reviewed literature

The peer-reviewed literature lacks studies that: 1) assess patient handling injury rates by nursing home occupation and 2) evaluate the statewide effectiveness of safe patient handling laws in nursing homes.

Few population-based studies provide a profile of injuries in nursing home workers.[12-14] A 2004-2005 study of 3 health regions in British Columbia, Canada reported a workers' compensation claim rate of 31.6 per 100 FTE in nursing home workers (vs. 24.3/100 FTE in acute care workers).[12] In nursing homes, care aides had the highest reportable claim rate (37.0/100 FTE), followed by LPNs (26.8/100 FTE), and RNs (17.2/100 FTE). The relative risk for MSDs in CNAs vs. RNs was 2.16 (95% CI 1.54-3.03). A Washington study of lost time workers' compensation claims from 2002-2010 reported a higher claim rate in nursing homes (1.98/100 FTE) than community care facilities (1.81/100 FTE) and hospitals (1.65/100 FTE).[13,14] However, the analysis did not include occupation-specific injury rates or differentiate patient handling injuries from other types of injuries (e.g., falls). Importantly, national and state injury rates by occupation in individual health care industries are often not available from the Bureau of Labor Statistics (BLS) Survey of Occupational and Illnesses (SOII) due to sample size limitations.

Two states have evaluated the effectiveness of safe patient handling laws, though both studies focus on hospitals.[15-18] Washington reported a 10.1% (95% CI 8.0-12.3) decrease in lost time workers' compensation claims in in hospitals over the 5 years surrounding implementation of a safe patient handling law. Nursing homes, which are not subject to the law, experienced a decline of only 5.8% (95% CI 1.7-9.7) across the same time period.[17] Serial cross-sectional surveys of California hospital nurses over the 3 years a safe patient handling law was implemented demonstrated a decline in prevalence of self-reported major musculoskeletal symptoms (Prevalence Ratio=0.78; 95% CI=0.66-

0.91) but no changes in musculoskeletal injuries.[16] These studies had limited post-law follow-up and did not include external comparators.

The largest studies to evaluate mandatory multicomponent safe patient handling programs in nursing homes rely on samples of single employers or health care systems. One study assessed a multicomponent safe patient handling program that required equipment acquisition and staff training in a single nursing home corporation in the eastern U.S. (n=136 facilities).[19-21] Following implementation of the program, patient handling workers' compensation indemnity and medical claims declined by 32% in years 1-3 and 38% in years 4-6. Overall, 82% of facilities experienced a decline in injury rate. An economic evaluation of the same corporation found that workers' compensation costs declined by 40% and 43% for medical only and indemnity claims, respectively, in the first 3 years following the intervention.[22] A smaller study of 15 nursing homes in British Columbia, Canada found that over 6 years the rate of patient handling injury claims dropped by 34% during and 56% after a multicomponent program intervention.[23] These studies used quasi-experimental designs with no external comparator. While results are promising for employers and policy developers, they measure the impacts of individual employer or system policies. Evidence of program effectiveness does not necessarily apply to a statewide safe patient handling mandate.

Few studies have considered the impacts of chronic understaffing and low worker retention on the effectiveness of safe patient handling laws in reducing injuries in nursing homes. Staffing levels may impact the time workers have to follow patient handling policies, including locating and properly using lifting equipment.[25,26] Additionally, low staff retention may result in more employees who are unfamiliar with their work, safe

patient handling policies, and available assistive equipment.[25,27] Maintaining adequate staffing levels and retaining experienced workers could facilitate more successful implementation of safe patient handling programs. Conversely, low staffing and retention levels may act as barriers to successful program implementation.

One study of 279 Ohio nursing homes eligible for safe patient handling grants and consultation services found the rate of back injuries increased by 32% for each additional resident per staff member, with a larger effect seen in facilities with high resident acuity.[28] A second study of 445 nursing homes in 3 states found lower staffing levels were associated with higher occupational injury rates controlling for facility characteristics such as size and resident acuity. Each additional hour of direct care was associated with a predicted decrease in 2.4 injuries per 100 FTE.[6]

A large single-center study without an intervention found recent nursing assistant turnover was associated with higher back and shoulder injury rates.[5] Another study found higher turnover of Licensed Practical Nurses (LPNs) in the 2 years prior to implementation of a safe patient handling program in nursing homes was associated with small increases in relative risk of patient handling injury (post-/pre-implementation).[21] No study has evaluated whether staffing or retention modify the effectiveness of a multicomponent safe patient handling program or state safe patient handling law.

Objective

The overall objectives of this research are to provide a profile of patient handling injuries in Minnesota nursing home workers and to evaluate the effectiveness of the MN SPH Act in reducing patient handling injury workers' compensation claims. Results will be used to inform future safe patient handling policymaking and to identify groups of

workers and types of facilities that are still in need of additional state outreach and support to reduce their patient handling injury burden under the Minnesota law.

Specific Aims

The overall objectives of this research will be accomplished in 3 manuscripts that have the following specific aims:

Manuscript 1

Characterize and compare the injury experience of 3 occupational groups (specifically, RNs, LPNs and CNAs) in Minnesota nursing homes under the MN Safe Patient Handling Act using statewide workers' compensation indemnity claims data for 2005-2016.

Manuscript 2

Evaluate trends in patient handling and non-patient handling injuries among Minnesota nursing home workers pre- and post-MN SPH Act and assess whether trends are modified by facility-level staffing and retention using statewide workers' compensation indemnity claims data for 2005-2016.

Manuscript 3

Evaluate the impacts of the law by comparing pre- and post-MN SPH Act trends in patient handling injury workers' compensation claim rates among nursing homes, hospitals, and outpatient facilities in Minnesota to Wisconsin, a state without a safe patient handling law, using workers' compensation claims data for 2005-2017 from a single large insurer.

Chapter 2: Manuscript 1

Occupational differences in workers' compensation indemnity claims among direct care workers in Minnesota nursing homes, 2005-2016

ABSTRACT

Background Nursing assistants have one of the highest injury rates in the U.S., but few population-based studies assess differential injury risk by occupation in nursing homes. This statewide study assessed differences in musculoskeletal disorders (MSDs) and patient handling injuries among direct care workers in Minnesota nursing homes.

Methods Indemnity claims from the Minnesota workers' compensation database were matched to time at-risk from the Minnesota Nursing Home Report Card to estimate 2005-2016 injury and illness claim rates for certified nursing assistants (CNAs), licensed practical nurses (LPNs), and registered nurses (RNs). Associations between occupation and claim characteristics were assessed using multivariable regression modeling.

Results Indemnity claim rates were 3.68, 1.38, and 0.69 per 100 full-time equivalent workers for CNAs, LPNs, and RNs, respectively. Patient handling injuries comprised 62% of claims. Compared to RNs, CNAs had higher odds of an indemnity claim resulting from an MSD (OR=1.67, 95% CI 1.31-2.14) or patient handling injury (OR=1.89, 95% CI 1.47-2.45) as opposed to another type of injury or illness. CNAs had lower odds of receiving temporary and permanent partial disability benefits and higher odds of receiving a stipulation settlement.

Conclusions CNAs in Minnesota nursing homes are at heightened risk for lost time musculoskeletal disorders and patient handling injuries. Claims filed by CNAs are more frequently settled outside the regular workers' compensation benefit structure, an indication that the workers' compensation system is not providing adequate and timely benefits to these workers.

INTRODUCTION

Nursing home workers are at heightened risk for serious occupational injuries due to the very nature of their work caring for sick and elderly residents, many who have limited mobility. According to the U.S. Bureau of Labor Statistics (BLS), the 2017 rate of injuries and illnesses resulting in days away from work was 1.92 per 100 full-time equivalent (FTE) workers in nursing homes compared to 1.30/100 in hospitals and 0.89/100 across the private sector industries.[2]

The rate of lost time injuries and illnesses in Minnesota nursing homes was even higher at 2.53/100.[2] Reducing health care worker injuries resulting from ergonomic, violence-related, and safe patient handling hazards is an ongoing priority of the Minnesota Occupational Safety and Health Administration.[29]

Musculoskeletal disorders (MSDs) are the leading lost time injury in nursing homes, comprising 44% of cases nationally.[2] Nursing assistants are particularly vulnerable. Across U.S. industries, lost time MSD rates were 1.62/100 in nursing assistants, 0.36/100 in licensed practical and vocational nurses, and 0.45/100 in registered nurses (RNs) in 2017.[2]

Occupational injury disparities by nursing occupations may be attributable, at least in part, to differing work patterns. Certified nursing assistants (CNAs) primarily provide resident care, including transferring, mobilizing, and repositioning residents (i.e., patient handling). RNs and licensed practical nurses (LPNs) often balance resident care, medical, and administrative duties.[12] However, recent research asserts that personal, organizational, and structural forces also play important roles in CNAs' work and injury experiences.[25,30] CNAs are especially vulnerable because they are less educated, receive

lower compensation, and are disempowered to influence workplace safety and staffing practices.[25,30]

Few population-based studies compare injury and illness rates among occupational groups in nursing homes because denominator data are insufficient or difficult to obtain.[12,14] Further, state-specific rates for these subgroups are often not available from the BLS Survey of Occupational Injuries and Illnesses due to sample size limitations.

This study describes workers' compensation indemnity claims filed by direct care workers (i.e., RNs, LPNs, and CNAs) in Minnesota nursing home injured between 2005 and 2016. We assess whether occupation is associated with injury type by comparing MSD and patient handling injury claims to claims filed for all other injuries and illnesses. Additionally, we compare workers' compensation benefits paid to RNs, LPNs, and CNAs.

Abbreviations frequently used in the text:
BLS = U.S. Bureau of Labor Statistics
CNA = certified nursing assistant
FTE = full-time equivalent
LPN = licensed practical nurse
MN DLI = Minnesota Department of Labor and Industry
MSD = musculoskeletal disorder
OIICS = Occupational Injury and Illness Classification System
PPD = permanent partial disability, payments for permanent loss of a percent of body function
RN = registered nurse
TPD = temporary partial disability, payments for partial days away from work (light duty at a lower wage, reduced hours)
TTD = temporary total disability, payments for full days away from work

METHODS

Study design and data sources

This is a descriptive analysis of injuries and illnesses resulting in workers' compensation claims with indemnity (lost time) benefits in all Medicaid-certified Minnesota nursing homes between 2005 and 2016. Data are limited to direct care workers: RNs, LPNs, and CNAs. Each year is defined as October 1 of the previous year through September 30 of the reporting year due to data collection methods for time at-risk.

We selected indemnity claims from the Minnesota Department of Labor and Industry (MN DLI) statewide workers' compensation database for employers with North American Injury Classification System code 623110 (skilled nursing facilities). Using employer name, address, and year, claims were matched to time at-risk from the Minnesota Nursing Home Report Card.[31] The Report Card provides quality measures intended to help inform nursing home choice for Minnesota residents. From the Report Card, we used occupation-specific hours of direct care summed across all facilities over the study to calculate workers' compensation claim rates. The study was determined to be exempt from review by the University of Minnesota Institutional Review Board as research involving the study of existing data recorded in a manner that subjects cannot be identified.

Workers' compensation claims

Claims data include claimant occupation, age, gender, job tenure, employment status, and pre-injury wage; date of injury or illness; date of claim closure; benefit payments and duration; and Occupational Injury and Illness Classification System (OIICS) codes for source, event, nature, and body part. OIICS is maintained by U.S. BLS

for national injury and illness data and used by MN DLI to code the statewide workers' compensation database. MN DLI staff manually apply OIICS codes based on the first report of injury at the time each claim is submitted to the state.

For each claim, we determined whether the following benefits were paid: temporary partial disability (TPD), temporary total disability (TTD), permanent partial disability (PPD), and/or a stipulation settlement **(Supplemental Table 1)**. A single claim can result in any combination of benefits. Minnesota has a three-day waiting period for indemnity benefits, which includes date of injury or illness, and a ten-day retroactive period. A worker who remains disabled on day 10 or beyond is eligible for compensation of benefits for days 1-3.[32]

Injury categories

We classified patient handling injuries two ways: 1) all claims with resident as injury source [broad] and 2) MSDs with resident as injury source [narrow]. We applied the BLS definition of MSD which uses combinations of OIICS codes for nature and event such as back pain due to repetitive motion and sprain due to overexertion **(Supplemental Table 2)**.

MN DLI transitioned from OIICS version 1 to 2 in January 2012, which included changes to all coding categories and the definition of MSD. Coding changes affected the narrow definition of patient handling injury, as new nature codes specific to MSDs were created (e.g., pinched nerve and herniated disc) and violence was prioritized over all other events. Beginning in 2012, claims for which the event description included violence were coded as violence regardless of other events involved.[33]

Within the broad patient handling injury definition, we identified the subset of claims for which the injury event was violence. We also identified claims for which the injury source was patient handling equipment. Though related to patient handling, equipment claims were not included in the broad or narrow patient handling injury definitions because the source was not resident. Finally, we created additional injury categories based on the most commonly reported event codes: slips, trips, and falls; bodily reaction; and exposure to harmful substances **(Supplemental Table 3)**.

Claim benefits

We selected the following claim benefit measures: payment of TTD benefits (yes/no), duration of TTD benefits (weeks), duration of TTD and TPD benefits combined (weeks), payment of PPD benefits (yes/no), PPD impairment rating, claim duration (weeks), and total paid ($). We also considered payment of a stipulation settlement (yes/no), which can prevent or cut short receipt of other benefits. Weekly benefits were paid at two-thirds of the worker's pre-injury wage, with a minimum weekly benefit of $130, or the worker's actual wage if less than $130, and a maximum benefit that increased from $750 in 2005 to $1,009 in 2016.[34] Total paid includes payments made for TTD, TPD, and PPD benefits; stipulation settlements; and reimbursements for select attorney fees. Costs for medical services were not available in the Minnesota workers' compensation database.

Time at-risk

Time at-risk was based on occupation-specific estimates of productive hours submitted annually by all Medicaid-certified nursing homes in the state to the Minnesota Department of Human Services. Nursing homes may base their estimates on actual time

reports or periodic time studies.[11] Productive hours include all paid time on care-related duties, which is generally all paid time for RNs, LPNs, and CNAs.[35] Exceptions are employees who work multiple roles (e.g., CNA and housekeeping). For these employees, productive hours only include time worked in their patient care role. For each occupation, we converted productive hours to FTEs using a conversion factor of 2000 productive hours per FTE-year (e.g., 25,000 productive hours=12.5 FTE for a given year).[36]

Statistical analyses

Workers' compensation claims were valued as of October 2018. We did not apply a development factor to adjust for claim growth as all claims had two or more years to develop. Pre-injury wage and payment variables were adjusted to 2016 dollars using the statewide average weekly wage.

We calculated summary statistics for worker and claim characteristics separately for CNAs, LPNs, and RNs. Occupations were compared using chi-squared tests for categorical variables and Kruskal-Wallis rank tests for continuous variables. We determined crude annualized indemnity claim rates for each occupational group using statewide injury counts and time at-risk (FTE-years) for the entire study period.

Multivariable models were developed to assess whether occupation is associated with injury type and benefits paid. We used RNs as the referent occupation in all analyses; we hypothesized RNs would have the best claim outcomes. We selected the following covariates a priori: age, gender, region, injury year, and pre-injury wage. Time at-risk was not included because estimates were not available at the individual worker level.

We used logistic regression to estimate odds ratios (ORs) and 95% CIs for associations between occupation and binary outcomes: MSD claim, patient handling claim, payment of TTD benefits, payment of PPD benefits, and payment of a stipulation settlement. We used linear regression to analyze associations between occupation and continuous outcomes: duration of TTD benefits, duration of TTD and TPD benefits combined, PPD impairment rating, claim duration, and total paid. We log-transformed continuous outcomes using the natural log because they were highly right skewed as is common in workers' compensation data. To calculate ratios of the means, we estimated exponentiated adjusted means of continuous outcomes for each occupational group and divided comparator occupation means (LPN and CNA) by the referent occupation mean (RN). General estimating equations with an exchangeable matrix were used to account for correlation within facilities for all models. Statistical analyses were conducted using Stata 15.1.

RESULTS

Worker characteristics

From 2005 to 2016, there were 5940 claims filed by 5276 direct care workers in 402 Minnesota nursing homes. Compared to RNs and LPNs, CNAs were more likely to be male, younger, a part-time employee, have shorter job tenure, work in a non-metro county, and have lower pre-injury wage **(Table 1)**. Multiple claims were filed by 545 employees: 448 (8.2%) filed 2 claims, 81 (1.5%) filed 3 claims, and 16 (0.3%) filed 4 or more claims. CNAs and LPNs filed more repeat claims than RNs.

Table 1 Worker characteristics by occupation for workers' compensation indemnity claims, direct care workers in Minnesota nursing homes, 2005-2016

Worker characteristic	CNA (n=5016)	LPN (n=632)	RN (n=292)	Chi-square statistic (p-value)
Gender, n (%)				
Female	4607 (92%)	605 (96%)	275 (94%)	14.2 (p=.001)
Male	395 (8%)	25 (4%)	16 (5%)	
Missing	14 (<1%)	2 (<1%)	1 (<1%)	
Age, n (%)				
16-24 years	1135 (24%)	26 (4%)	6 (2%)	327.7 (p<.001)
25-34 years	1175 (23%)	96 (15%)	49 (17%)	
35-44 years	1054 (21%)	131 (21%)	62 (21%)	
45-54 years	988 (20%)	216 (34%)	94 (32%)	
≥55 years	601 (12%)	154 (24%)	74 (25%)	
Missing	63 (1%)	9 (1%)	7 (2%)	
Employment status, n (%)				
Full-time	2993 (60%)	421(67%)	220 (75%)	30.3 (p<.001)
Part-time or seasonal	1696 (34%)	178 (28%)	63 (22%)	
Missing	327 (7%)	33 (5%)	9 (3%)	
Pre-injury wage [weekly], n (%)*				
<$250	462 (9%)	19 (3%)	6 (2%)	1885.4 (p<.001)
$250-<$500	2568 (51%)	75 (12%)	19 (7%)	
$500-<$750	1593 (32%)	227 (36%)	45 (15%)	
≥$750	306 (6%)	305 (38%)	219 (75%)	
Missing	87 (2%)	6 (1%)	3 (1%)	
Tenure, n (%)				
<3 months	671 (13%)	37 (6%)	23 (8%)	128.5 (p<.001)
3-11 months	1289 (25%)	103 (16%)	57 (20%)	
1-5 years	1655 (33%)	210 (33%)	102 (35%)	
>5 years	1127 (22%)	248 (39%)	100 (34%)	
Missing	274 (5%)	34 (5%)	10 (3%)	
Region, n (%)				
Twin Cities metroł	1478 (29%)	220 (35%)	115 (39%)	18.9 (p<.001)
Non-metro	3538 (71%)	412 (65%)	177 (61%)	
Multiple claims, n (%)				
Yes	1025 (20%)	154 (24%)	30 (10%)	13.2 (p<.001)
No	3991 (80%)	478 (76%)	262 (90%)	

CNA=certified nursing assistant; LPN=licensed practical nurse; RN=registered nurse
*Adjusted to 2016 dollars using Minnesota statewide average weekly wage
ł 7-county Twin Cities metropolitan area: Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington counties

Claim rates by injury category

From 2005 to 2016, 61% of FTE-years were contributed by CNAs, 20% by LPNs, and 19% by RNs **(Table 2)**. Annualized indemnity claim rates per 100 FTE were as follows: 3.68/100 in CNAs, 1.38/100 in LPNs, and 0.69/100 in RNs. MSD claim rates

were 2.47/100 in CNAs, 0.71/100 in LPNs, and 0.34/100 in RNs. CNAs had the highest indemnity claim rates in all injury and illness subcategories analyzed.

Using the broad patient handling injury definition, claim rates were 2.39/100, 0.65/100, and 0.30/100 in CNAs, LPNs, and RNs, respectively. Patient handling injuries comprised 62% of all indemnity claims for these occupations. Rates were only slightly lower using the narrow patient handling injury definition. Approximately 5% of all injuries were attributable to resident violence, and an additional 5% were attributable to patient handling equipment. Across injury and illness categories, the most common injuries were to the back, shoulder, and multiple body parts.

Table 2 Workers' compensation indemnity claim rates by occupation, direct care workers in Minnesota nursing homes, 2005-2016

	CNA (n=5016)		LPN (n=632)		RN (n=292)	
	Count (%)	**Rate per 100 FTE (95% CI)**	**Count (%)**	**Rate per 100 FTE (95% CI)**	**Count (%)**	**Rate per 100 FTE (95% CI)**
FTE-years	*136127.0*		*45884.6*		*42199.6*	
All claims	5016 (100%)	3.68 (3.58-3.79)	632 (100%)	1.38 (1.27-1.49)	292 (100%)	0.69 (0.61-0.78)
MSDs	3358 (67%)	2.47 (2.28-2.55)	326 (52%)	0.71 (0.64-0.79)	143 (49%)	0.34 (0.29-0.40)
Patient handling injuries						
Patient handling [broad]*	3258 (65%)	2.39 (2.31-2.48)	298 (47%)	0.65 (0.58-0.73)	125 (43%)	0.30 (0.25-0.35)
Patient handling [narrow]*ǂ	2854 (57%)	2.10 (2.02-2.17)	238 (38%)	0.52 (0.45-0.59)	98 (34%)	0.23 (0.19-0.28)
Resident violenceǂ	251 (5%)	0.18 (0.16-0.21)	37 (6%)	0.08 (0.06-0.11)	19 (7%)	0.05 (0.03-0.07)
Equipment	260 (5%)	0.19 (0.17-0.22)	17 (3%)	0.04 (0.02-0.06)	13 (4%)	0.03 (0.02-0.05)
Other injuries and illnesses						
Slips, trips, and falls	680 (14%)	0.50 (0.46-0.54)	178 (28%)	0.39 (0.33-0.45)	94 (32%)	0.22 (0.18-0.27)
Bodily reaction	235 (5%)	0.17 (0.15-0.20)	46 (7%)	0.10 (0.07-0.13)	19 (7%)	0.05 (0.03-0.07)
Exposure to harmful substances	36 (0.7%)	0.03 (.02-.04)	6 (1%)	0.01 (0.005-0.03)	3 (1%)	0.007 (0.001-0.02)
Other	547 (11%)	0.40 (0.37-0.44)	87 (14%)	0.19 (0.15-0.23)	38 (13%)	0.09 (0.06-0.12)
Body part injured						
Back	2338 (47%)	1.72 (1.65-1.79)	214 (34%)	0.47 (0.41-0.53)	107 (37%)	0.25 (0.21-0.31)
Multiple parts	638 (13%)	0.47 (0.43-0.51)	104 (16%)	0.23 (0.19-0.27)	52 (18%)	0.12 (0.09-0.16)
Shoulder	462 (9%)	0.34 (0.31-0.37)	50 (8%)	0.11 (0.08-0.14)	27 (9%)	0.06 (0.04-0.09)
Leg	393 (7%)	0.29 (0.26-0.32)	80 (13%)	0.17 (0.14-0.22)	27 (9%)	0.06 (0.04-0.09)
Wrist	175 (3%)	0.13 (0.11-0.15)	21 (3%)	0.05 (0.03-0.07)	13 (4%)	0.03 (0.02-0.05)
Arm	141 (3%)	0.10 (0.09-0.12)	27 (4%)	0.06 (0.04-0.09)	10 (3%)	0.02 (0.01-0.04)
Other	869 (17%)	0.64 (0.60-0.68)	136 (22%)	0.30 (0.25-0.35)	56 (19%)	0.13 (0.10-0.17)

CI=confidence interval; CNA=certified nursing assistant; FTE=full-time equivalent; LPN=licensed practical nurse; MSD= musculoskeletal disorder; RN=registered nurse

*Patient handling [broad] includes all claims with resident as injury source. Patient handling [narrow] includes MSD claims with resident as injury source.

ǂ Injury category is a subset of patient handling [broad]

Claim benefits

Across occupations, 83% of injured workers were paid TTD benefits, meaning they were completely unable to work and lost wages for a period of time more than 3 days after the day of injury. Thirty-three percent were paid TPD benefits, meaning they were back to work but earning less than their pre-injury wage. Twenty-five percent were paid both TTD and TPD benefits **(Table 3)**.

CNAs had the lowest proportion of claims paid TTD benefits, the lowest proportion of claims paid both TTD and TPD benefits, and the shortest duration of TTD and TPD benefits combined. TTD and TPD benefits paid ($) were highest for RNs and lowest for CNAs, reflecting both benefit duration and pre-injury wage.

Table 3 Workers' compensation indemnity claim benefits by occupation, direct care workers in Minnesota nursing homes, 2005-2016

	All direct care workers (n=5940)	CNA (n=5016)	LPN (n=632)	RN (n=292)	Chi-square statistic (p-value)
TTD benefits, n (%)	4955 (83%)	4144 (83%)	557 (88%)	254 (87%)	15.2 (p=.001)
TTD duration, n (%)					
<1 month	3498 (71%)	2950 (71%)	377 (68%)	171 (67%)	
1-<3 months	840 (17%)	701 (17%)	95 (17%)	44 (17%)	8.6 (p=.197)
3-<6 months	290 (6%)	235 (6%)	36 (6%)	19 (7%)	
≥6 months	327 (7%)	258 (6%)	49 (9%)	20 (8%)	
TTD paid ($), median (IQR)*	593 (202-1892)	519 (185-1646)	1642 (559-4490)	1643 (559-4490)	169.9 (p<.001)
TPD benefits, n (%)	1940 (33%)	1616 (32%)	214 (34%)	110 (38%)	4.2 (p=.123)
TPD duration, n (%)					
<1 month	876 (45%)	741 (46%)	89 (41%)	46 (42%)	
1-<3 months	461 (24%)	384 (24%)	52 (24%)	25 (23%)	
3-<6 months	207 (11%)	178 (11%)	20 (9%)	9 (8%)	7.8 (p=.252)
≥6 months	252 (13%)	196 (12%)	38 (18%)	18 (16%)	
Missing	144 (7%)	117 (7%)	15 (7%)	12 (11%)	
TPD paid ($), median (IQR)*	678 (217-2179)	589 (194-1855)	1188 (388-3779)	1535 (556-4565)	52.1 (p<.001)
TTD + TPD benefits [both], n (%)	1479 (25%)	1203 (24%)	183 (29%)	93 (32%)	15.4 (<.001)
TTD + TPD benefits [either], n (%)	5416 (91%)	4557 (91%)	588 (93%)	271 (93%)	4.4 (p=.113)
TTD + TPD duration, n (%)					
1 month	3375 (62%)	2870 (63%)	350 (60%)	155 (57%)	
1-<3 months	1032 (19%)	871 (19%)	104 (18%)	57 (21%)	
3-<6 months	410 (8%)	340 (7%)	47 (8%)	23 (8%)	13.1 (p=.041)
≥6 months	574 (11%)	457 (10%)	83 (14%)	34 (13%)	
Missing	25 (0.5%)	19 (0.5%)	4 (0.7%)	2 (0.7%)	
TTD + TPD paid ($), median (IQR)*	677 (219-2276)	595 (200-1926)	1164 (412-4202)	1987 (636-4850)	165.6 (p<.001)
PPD benefits, n (%)	695 (12%)	525 (10%)	108 (17%)	62 (21%)	50.8 (p<.001)
PPD impairment rating					
<5%	324 (47%)	245 (47%)	52 (48%)	27 (44%)	3.0 (p=.803)
5-<10%	183 (26%)	140 (27%)	29 (27%)	14 (23%)	

10-<15% ≥15%	133 (19%) 55 (8%)	102 (19%) 38 (7%)	17 (16%) 10 (9%)	14 (23%) 7 (11%)	
PPD paid ($), median (IQR)*	4831 (2283-9115)	4538 (2296-9090)	5127 (2275-8955)	5327 (2557-11214)	.796 (p=.672)
Stipulation settlement, n (%)	1240 (21%)	1056 (21%)	132 (21%)	52 (18%)	1.8 (p=.415)
Stipulation paid ($), median (IQR)*	19325 (8124-49664)	17758 (7863-37348)	35206 (14082-63155)	29176 (12348-63080)	36.0 (p<.001)
Claim duration (weeks), median (IQR)	7.3 (2.0-58.3)	7.0 (2.0-55.3)	8.9 (2.1-69.3)	11.0 (2.4-74.6)	15.3 (p<.001)
Total paid ($), median (IQR)*	796 (212-5527)	807 (227-5628)	1542 (480-10800)	2931 (709-12831)	111.0 (p<.001)

CNA=certified nursing assistant; IQR=interquartile range; LPN=licensed practical nurse; PPD=permanent partial disability; RN=registered nurse; TPD=temporary partial disability; TTD=temporary total disability

*Adjusted to 2016 dollars using Minnesota statewide average weekly wage

Multivariable models

The odds of an MSD claim (vs. non-MSD claim) were 1.67 (95% CI 1.31-2.14) times higher in CNAs compared to RNs after controlling for age, gender, region, and injury year **(Table 4)**. The odds of a patient handling injury claim (vs. non-patient handling injury claim) were 1.89 (95% CI 1.47-2.45) times higher in CNAs compared to RNs using the broad definition of patient handling injury and 2.09 (95% CI 1.60-2.71) times higher using the narrow definition. LPNs did not have elevated odds of an MSD or a patient handling injury claim compared to RNs.

For claim benefit outcomes, results are displayed for all claims and patient handling injury claims separately **(Table 4)**. Compared to RNs, CNAs had lower odds of being paid TTD benefits for all claims (OR=0.63; 95% CI 0.43-0.91) and for patient handling injury claims specifically (OR=0.49; 95% CI 0.28-0.87). CNAs also had lower odds of being paid PPD benefits for all claims (OR=0.60; 95% CI 0.44-0.82), but differences were not statistically significant for patient handling injury claims.

Comparing CNAs to RNs, the odds of receiving a stipulation settlement were 1.51 (95% CI 1.08-2.10) times higher for all claims and 1.72 (95% CI 1.01-2.90) times higher for patient handling injury claims. Occupation was not associated with duration of TTD benefits, duration of TTD and TPD benefits combined, claim duration, or total paid.

Table 4 Associations between occupation and workers' compensation indemnity claim outcomes, direct care workers in Minnesota nursing homes, 2005-2016

	All claims			Patient handling claims [broad]*		
	CNA (n=5016)	**LPN (n=632)**	**RN (n=292)**	**CNA (n=3258)**	**LPN (n=298)**	**RN (n=125)**
Binary outcomes	**Adjusted Odds Ratio (95% CI)**					
MSD vs. non-MSD	1.67 (1.31-2.14)	1.11 (0.82-1.51)	1.0	N/A		
Patient handling [broad]* vs. non-patient handling injury	1.89 (1.47-2.45)	1.17 (0.86-1.58)	1.0	N/A		
Patient handling [narrow]* vs. non-patient handling injury	2.09 (1.60-2.71)	1.20 (0.87-1.65)	1.0	N/A		
TTD vs. no TTD	0.63 (0.43-0.91)	1.02 (0.67-1.55)	1.0	0.49 (0.28-0.87)	0.75 (0.38-1.50)	1.0
PPD vs. no PPD	0.60 (0.44-0.82)	0.74 (0.52-1.07)	1.0	0.79 (0.49-1.27)	0.65 (0.36-1.16)	1.0
Stipulation settlement vs. no stipulation settlement	1.51 (1.08-2.10)	1.28 (0.89-1.84)	1.0	1.72 (1.01-2.90)	1.55 (0.88-2.73)	1.0
Continuous outcomes	**Adjusted Ratio of the Means (95% CI)**					
TTD duration (weeks)	0.96 (0.80-1.16)	0.97 (0.78-1.22)	1.0	1.19 (0.90-1.57)	1.06 (0.75-1.50)	1.0
TTD + TPD duration (weeks)	0.96 (0.78-1.19)	1.01 (0.79-1.29)	1.0	1.33 (0.97-1.83)	1.19 (0.83-1.70)	1.0
PPD rating (% of body)	0.91 (0.72-1.15)	0.96 (0.73-1.26)	1.0	0.71 (0.50-1.00)	0.91 (0.61-1.37)	1.0
Claim duration (weeks)	0.93 (0.74-1.17)	0.91 (0.70-1.18)	1.0	1.34 (0.96-1.88)	1.17 (0.81-1.71)	1.0
Total paid ($)	1.00 (0.73-1.36)	1.06 (0.79-1.44)	1.0	1.37 (0.88-2.14)	1.26 (0.81-1.96)	1.0

CI=confidence interval; CNA=certified nursing assistant; LPN=licensed practical nurse; MSD=musculoskeletal disorder; N/A=not applicable; RN=registered nurse
All models adjusted for age, gender, region, and injury year. Model for total paid also adjusted for wage.
*Patient handling [broad] includes all claims with resident as the injury source. Patient handling [narrow] includes MSD claims with resident as the injury source

DISCUSSION

Injuries and illnesses by occupation

In this descriptive study of direct care workers in Minnesota nursing homes, we found that CNAs had the highest rates of total, MSD, and patient handling-related workers' compensation indemnity claims. CNA claimants were approximately twice as likely as RN claimants to have experienced a patient handling injury as opposed another type of injury or illness. However, CNAs were less likely than RNs to receive traditional workers' compensation benefits, including temporary total and permanent partial disability, for their injury or illness. Instead, their claims were more likely to end in a stipulation settlement.

These findings support the literature on occupational injury disparities in long-term and acute care settings. The relative risk (RR) of musculoskeletal injury in nursing aides compared to RNs was 2.06 (95% CI 1.69-2.51) in nursing homes in 3 health regions of British Columbia, Canada.[3] In a large university hospital system in the eastern U.S., RRs comparing aides to nurses were 2.8 (95% CI 2.1-3.8) for all indemnity workers' compensation claims and 2.1 (95% CI 2.0-2.3) for patient handling claims.[37,38]

A second hospital system study in the northeastern U.S. found a more modest risk for musculoskeletal workers' compensation claims (RR=1.2; 95% CI 1.1.-1.4 for aides vs nurses).[39] Importantly, the study found that patient handling was the leading risk factor for musculoskeletal injury and accounted for occupational differences in claim risk. The lower RR in this study may be attributable to the inclusion of additional covariates, including FTEs, in adjusted models. Alternatively, it could be attributable to real differences in injury risks between direct care workers in hospitals and nursing homes. For example, we would expect to see a lower RR (aides vs. RNs) in hospitals if hospital

aides have better access to assistive equipment or perform fewer lifts than nursing home aides (e.g., due to differences in patient acuity) while RNs have similar patient handling workloads in both settings.

Indemnity claim rates

We estimated a workers' compensation MSD indemnity claim rate of 1.71 per 100 FTE in Minnesota nursing home workers. This is comparable to rates of compensable MSD claims reported for all workers in Washington state nursing homes: 1.98 per 100 FTE (years 2002-2010) [13] and 2.05 per 100 FTE (years 1999-2013).[40] In Washington, compensable claims require a three-day waiting period which excludes the date of injury or illness. Small differences in Minnesota and Washington claim rates may be attributable to differences in MSD definitions. While our study relied on OIICS codes alone, Washington uses a combination of coding systems, including the American National Standards Institute (ANSI), OIICS, and the International Classification of Diseases (ICD-9).[40] Additionally, MSDs are declining in U.S. nursing homes over time,[2] and our study looked at a later time period.

Our overall indemnity claim rates were 3.68, 1.38, and 0.69 per 100 FTE for CNAs, LPNs, and RNs, respectively. Rates of reported injuries resulting in lost time or medical compensation in British Columbia, Canada nursing homes from 2004-2005 were significantly higher: 37.0, 26.8, and 17.2 per 100 FTE for CNAs, LPNs, and RNs, respectively.[12] However, trends were consistent in that CNAs had the highest rates of all direct care workers. Inclusion of cases requiring only medical compensation may be responsible, at least in part, for the higher rates. A U.S. hospital study that included both indemnity and medical only claims reported claim rates among nurses (15.3/100 FTE)

and aides (21.4/100 FTE) that were closer to rates presented for acute care settings in British Columbia (21.9/100 FTE and 30.7/100 FTE, respectively).[12,39] Additionally, British Columbia does not have an indemnity benefit waiting period; injured workers are eligible for wage loss benefits the first day after injury.[41] More studies of occupation-specific injury rates in U.S. nursing homes are needed.

Workers' compensation benefits

Compared to RNs, CNAs in our study were less likely to receive TTD and PPD benefits and more likely to receive a stipulation settlement. There are several plausible explanations for these findings, though results should be interpreted with caution as individual claims can result in payment of multiple benefit types.

Stipulation settlements generally result from a disagreement about the circumstances or severity of an injury or a desire by one or more of the parties for a lump sum payment instead of weekly benefits. In a survey of Minnesota workers who accepted settlements, workers gave as reasons that the claim dispute was too lengthy, a settlement was the best way to get benefits paid, and that they needed money quickly.[42] In our study, 60% of CNAs were paid less than $500 weekly (compared to 15% of LPNs and 9% of RNs), meaning even a timely payment of TTD benefits would result in less than $333 weekly. CNAs' low wages, lack of job security, and frequent role as family breadwinner[30] may make receiving compensation and returning to work quickly after an injury financially necessary.

Further, work-relatedness of chronic injuries, such as repetitive musculoskeletal trauma or back pain, and subsequent disability can be difficult to prove.[43] CNAs' low socioeconomic and workplace status put them at an inherent disadvantage to navigate

procedural hurdles to receiving benefits (e.g., accessing medical care and establishing a specific, work-related cause of back pain with the medical provider).[43] Regardless of the cause, a stipulation settlement can be a costly outcome for the worker, employer, and workers' compensation provider because of prolonged litigation, and it may not result in a payment that fairly values the worker's injury.[43]

Study strengths and weaknesses

Our study is one of the first to provide a statewide profile of workers' compensation claims among nursing home workers. The large population and 12-year follow-up allowed us to compare occupations that are infrequently compared due to sample size constraints or targeted sampling of a single occupational group.[44-47]

The study has several limitations. Despite the large population, the number of RNs with patient handling claims was small (n=125), limiting our power to detect differences in patient handling claim outcomes such as specific injury nature (e.g., sprains, strains, tears) or body part injured. Due to limited granularity of time at-risk data, we were unable to include FTEs in multivariable models or calculate adjusted claim rates. Additionally, use of OIICS codes to define MSDs and patient handling injuries may have resulted in outcome misclassification. As misclassification would not differ by occupation, any bias would likely be toward the null.

Our broad and narrow definitions of patient handling injury were limited by the OIICS coding structure. The broad definition likely overestimates patient handling injuries as it includes injuries with resident as source that may have been unrelated to patient handling (e.g., resident violence that did not occur during patient handling).

Conversely, the narrow definition may exclude some patient handling injuries (e.g., resident violence related to patient handling).

Workers' compensation data underestimate the occupational injury experience.[48-51] A capture-recapture study estimated that only 52-65% of lost time injuries in Minnesota result in a workers' compensation claim.[49] This figure is likely lower for repeated back, neck, spine, and upper extremity musculoskeletal injuries.[50,51] Further, only 23-24% of Minnesota workers' compensation claims result in indemnity benefits.[52] The majority are medical care only claims not captured in the statewide database and not included in this study.

CONCLUSION AND RECOMMENDATIONS

Among Minnesota nursing home workers, CNAs bear a disproportionate burden of MSDs and patient handling injuries. Workplace injury can result in job dissatisfaction, turnover, and poor quality of resident care.[9,53-55] The nursing assistant workforce is projected to increase by 11% in the U.S. between 2016 and 2026.[56] In the same period, the Minnesota population 65 years and older is expected to grow by 31%.[11] Retaining a consistent, healthy direct care workforce is imperative as Minnesota baby boomers age into long-term care.

Despite the vulnerability of CNAs to workplace injuries, a nationally representative survey of nursing assistants has not been conducted since 2004.[57] Existing data sources, including state workers' compensation data and employers' Occupational Safety and Health Administration injury and illness logs, should be leveraged to establish occupation-specific reference rates for injuries and illnesses in nursing home workers.

Population-based safety initiatives, such as safe patient handing programs and laws, seek to protect nursing home workers from MSDs by modifying hazards across the entire worker population (e.g., through mandated use of assistive equipment).[58,59] However, they could unintentionally increase health disparities if certain workers are better able to take advantage of the programs than others.[59] Studies of such initiatives should seek to evaluate their acceptability and effectiveness by occupational group.

The present study adds to the body of evidence on the magnitude of MSDs and patient handling injuries in nursing home workers. Results suggest that special attention is needed to research, prevent, and accommodate injuries in nursing assistants. As a complement to population-based safety initiatives, interventions targeting CNAs could serve to reduce workers' compensation costs, improve employee health, and help retain a consistent direct care workforce for the benefit of current and future nursing home residents.

Chapter 3: Manuscript 2

An evaluation of the Minnesota Safe Patient Handling Act: trends in workers' compensation indemnity claims in nursing home workers before and after enactment of the law

ABSTRACT

Background The 2007 Minnesota Safe Patient Handling Act aims to protect health care workers from injuries caused by lifting and transferring patients. The effectiveness of the law in nursing homes is unknown and may be impacted by facility levels of staffing and retention. This statewide study measured changes in patient handling injuries in Minnesota nursing homes before and after the law was enacted. In addition, the study assessed if the effect of the law was impacted by facility and staffing characteristics.

Methods Indemnity claims from the state workers' compensation database for years 2005-2016 were matched to time at-risk and facility characteristics from the Nursing Home Report Card and Brown Long-term Care Focus. Trends in patient handling injury claims were analyzed using multivariable regression modelling. The primary predictors were time period, staff hours per resident day, and staff retention.

Results The patient handling claim rate declined by 25% in years 4-6 and 38% in years 7-9 following enactment of the law. Claims for all other injuries and illnesses declined by 20% in years 7-9 only. Associations between pre- and post-law time periods and patient handling claims did not vary by levels of staffing or retention. However, across time, facilities with annual retention ≥75% had a 17% lower patient handling claim rate than facilities with retention <65%.

Conclusions Results suggest the law reduced lost time patient handling claims in nursing homes. However, independent of the law, claim rates were elevated in facilities with low worker retention as well as those that were non-profit, not affiliated with a hospital, or outside the Minneapolis-Saint Paul metropolitan area. Continued state grant and consultation support is needed to support facilities with these characteristics.

INTRODUCTION

State safe patient handling (SPH) laws are designed to protect health care workers from disabling and potentially career-ending musculoskeletal injuries, but the effectiveness of such laws in nursing homes has not been systematically evaluated. Minnesota is one of 12 states to pass a safe patient handling law or ordinance and one of only 6 to require the participation of nursing homes.[1,10] The 2007 Minnesota Safe Patient Handling (MN SPH) Act requires each health care facility to adopt an SPH program that establishes a plan to minimize manual lifting of patients by direct care workers through use of assistive equipment.[60]

Safe patient handling in nursing homes poses a particular challenge due to the frequency of resident lifts and transfers; high resident acuity, frailty and combativeness; and small cluttered spaces.[61,62] In 2018, the national rate for recordable injury and illness cases was more than 2-times higher in nursing homes compared to the private sector average (6.2/100 full-time equivalent workers [FTEs] vs. 2.8/100). Further, 42% percent of nursing home worker injuries resulting in one or more days away from work were musculoskeletal disorders (MSDs).[2]

The success of safe patient handling programs in nursing homes may be undermined by systemic understaffing and low staff retention. Minnesota law requires a minimum of 2 nursing personnel hours per resident day,[63] well below expert recommendations of 4.1-4.9 hours per resident day.[64] When staffing levels are low, less time is available to follow safe patient handling program requirements, particularly locating equipment and coworkers to assist in use of equipment.[26,65]

Worker retention estimates vary: a national nursing home survey estimated 1-year median direct care staff retention was 69%, though individual facilities have reported annual turnover of certified nursing assistants (CNAs) exceeding 100%.[66-68] Low staff retention can result in influxes of inexperienced workers, high workloads for remaining employees, and changing managerial directives regarding safe patient handling.[65,68] Studies suggest that low staffing and high turnover are associated with elevated worker injury rates, though few have focused on patient handling injuries specifically.[5,6,21,28]

Pre-post studies of SPH programs in nursing homes show declines in workers' compensation claim frequency and costs.[20-23,47,69-72] These studies focus on single facilities or health care systems that have electively implemented and evaluated SPH programs in states without SPH legislation. Program elements generally include some combination of the following evidence-based standards: an explicit no-lift or reduced-risk lift policy, equipment acquisition and training, ergonomic hazard assessment, patient care planning, and/or use of an SPH coordinator or resource staff.[9,73,74] Evaluations of SPH laws focus on their effectiveness in hospitals.[15-18] To our knowledge, no study has evaluated the impacts of a state safe patient handling law in nursing homes or assessed whether its effectiveness is modified by facility staffing and retention levels.

This quasi-experimental study of Minnesota nursing homes uses statewide workers' compensation indemnity claims data to evaluate: 1) changes in patient handling injury rates following enactment of the MN SPH Act, and 2) whether changes in patient handling injury rates over time vary by staff hours per resident day or staff retention. We hypothesize that, across Minnesota, patient handling injury rates will decline from pre-law to post-implementation and that facilities with high staffing and retention will

experience greater reductions in injury rates than facilities with low staffing and retention.

Methods

Study design

We used a quasi-experimental design, examining trends over 3 time periods defined as: pre-law (2005-2007), implementation (2008-2010), first post-implementation (2011-2013), and second post-implementation (2014-2016). Each year is defined as October 1 of the previous year through September 30 of the reporting year to match reporting of time at-risk estimates.

The MN SPH Act required each facility to establish a written program and committee by July 1, 2008. The written SPH program must include: 1) hazard assessment, 2) equipment acquisition, 3) equipment training, 4) procedures to ensure building modifications are consistent with program goals, and 5) an evaluation plan. Beginning January 1, 2011, the MN Occupational Safety and Health Administration (MN OSHA) can cite facilities for not effectively meeting program and committee requirements. To support the law, the Minnesota Department of Labor and Industry (MN DLI), through the Workplace Safety Consultation division of MN OSHA, provides facilities ergonomic consultation and grant support of up to $40,000 annually.[60]

Study population and data sources

Minnesota nursing homes were eligible for inclusion if they reported data to the Minnesota Nursing Home Report Card between 2005 and 2016, including all 3 pre-law years and at least 6 total years. The dataset was matched to the Brown Long-Term Care Focus database (LTCFocus) using a U.S. Centers for Medicare & Medicaid Services (CMS) identifier. The combined dataset was then linked to the Minnesota workers'

compensation database using facility name and address. The final dataset was limited to direct care workers: certified nursing assistants (CNAs), licensed practical nurses (LPNs), and registered nurses (RNs) **(Supplemental Figure 1)**.

The Minnesota Nursing Home Report Card, maintained by the Minnesota Departments of Health and Human Services, provides quality measures intended to help inform nursing home choice for state residents and families.[31] Staffing and time at-risk measures used for this study are from mandatory statistical and cost reports that facilities participating in the Minnesota Medical Assistance Program (i.e., Medicaid) submit annually to the state.

The Long-Term Care Focus Database (LTCFocus), created and maintained by the Brown University Center for Healthcare Research, compiles several national data sources.[75] Facility and aggregate resident characteristics used for this study are from the Online Survey Certification and Reporting (OSCAR) and Certification and Survey Provider Enhanced Reporting (CASPER) systems, administrative datasets collected by state agencies and maintained by CMS for annual certification.

The Minnesota workers' compensation database, maintained by MN DLI, includes all indemnity claims filed by Minnesota employees. Indemnity claims are those that are qualified to receive a payment for wage loss and/or permanent disability benefits. Typically, injured workers qualify for indemnity benefits after more than 3 days of work disability, including the day of injury. Some injured workers may qualify for permanent disability benefits without the 3-day waiting period.

Variables

Staffing and organizational characteristics

We extracted average staff hours per resident day from LTCFocus and dichotomized the measure consistent with previous research (<4 vs. ≥4 hours).[76,77] We also extracted number of beds (<100 vs. ≥100), average resident acuity index (i.e., level of care needed), region (7-county Twin Cities metropolitan area [metro] vs. non-metro), profit status (for-profit vs. non-profit), chain status (multifacility vs. single site), and hospital affiliation (yes vs. no). Variables were selected to capture differences in facility resources, management, and resident case-mix that could influence both staffing and resident care practices.[25,28,67,77,78]

We used staff retention from the MN Nursing Home Report Card. For a given year, retention was calculated by dividing the number of direct care staff employed October 1 through September 30 by the number of direct care staff employed on October 1. We created staff retention tertiles because studies have shown nonlinear associations between staff turnover and care outcomes,[27,67] but no benchmarks exist for low or high retention. Finally, we extracted annual productive hours, which includes all paid time on care-related duties. We converted productive hours to FTEs using a conversion factor of 2000 productive hours per FTE. Annual FTEs were used to measure time at-risk.

Injury characteristics

From the MN workers' compensation database, we captured data on injury or illness source, nature of injury or illness, event or exposure, and body part for each indemnity claim. Injury characteristics are coded by MN DLI staff based on first report of injury description using the Occupational Injury and Illness Classification System (OIICS).

We defined patient handling claims as claims for which the injury or illness source was resident, patient, or client. Non-patient handling claims were defined as claims with any other sources of injury. Non-patient handling claims were intended to serve as an internal comparator for temporal trends in patient handling injuries as we did not have access to external comparator data (e.g., claims from a state without SPH legislation).

OIICS codes were used to create subcategories of patient handling and non-patient handling claims. Musculoskeletal disorders (MSDs) were identified using the U.S. Bureau of Labor Statistics (BLS) definition, which relies on OIICS codes for nature of injury or illness and event or exposure. Other subcategories were determined using the most common nature of injury or illness codes (i.e., violence for patient handling claims and slips, trips, and falls for non-patient handling claims).

Injury severity

We selected several workers' compensation benefit measures to approximate injury severity. These included payment of Temporary Total Disability (TTD) benefits (yes/no) and duration of TTD benefits (TTD benefits <3 months, 3-<6 months, ≥6 months). TTD benefits are partial wage replacement awarded for the period of time an injured worker is totally unable to work. The TTD benefit category includes claims awarded Permanent Total Disability (PTD) benefits, meaning the injured worker is never able to return to gainful employment. These claim types are collapsed in the Minnesota workers' compensation database because PTD claims are extremely rare. Payment of TTD benefits for ≥6 months was selected as the maximum duration category because return to work becomes much less likely after 6 months of disability.[19,79]

We also selected payment of permanent partial disability (PPD) benefits (yes/no) and PPD impairment rating (<5%, 5-<10%, ≥10%). PPD is awarded for permanent functional loss of use of the body. Claims resulting in PPD benefits are generally more severe than those resulting in only TTD benefits. An impairment rating that reflects the percentage of disability to the body as a whole is assigned based on a disability schedule defined by Minnesota law.

Workers' compensation claims were valued as of October 2018. We did not apply a development factor to adjust for claim growth as all claims had two or more years to develop. However, in later years a higher proportion of claims were still developing (i.e., accruing benefits) compared to early years (3.6% of claims in 2016 vs. 0.32% in 2005). This could bias results for benefit duration if claims in later years only appear to be of shorter duration because they are not fully mature. Further, using claim benefits to approximate injury severity requires caution as an individual claim can result in multiple benefit types.

Analysis

Staffing and organizational characteristics

We characterized distributions and calculated means for staffing and organizational characteristics by time period (pre-law, implementation first post-law, second post-law). Crude associations between all characteristics and time period were assessed using analysis of variance for continuous variables and chi-square tests for categorical variables.

Multivariable analysis

Calculation of Injury Rates

For each facility, we summed total, patient handling, and non-patient handling workers' compensation indemnity claims per year. We estimated indemnity claim rates by time period for total claims, patient handling claims, non-patient handling claims, and all claim subcategories using negative binomial regression with FTEs as the offset. The unit of analysis was facility-year. Generalized estimating equations (GEEs) with an autoregressive correlation structure were used to account for dependence of observations within facility. We used Wald chi-square tests to assess overall significance of time period as a predictor of claim rate. Finally, we calculated annual claim rates for individual facilities and determined the proportion of facilities for which claim rates declined over time.

Measures of Association

We regressed annual indemnity claim counts on predictors also using negative binomial regression with GEEs. The primary predictors were time period, staff retention (<65%, 65-<75%, ≥75%), and average staff hours per resident day (<4 vs. ≥4 hours). The primary outcomes were patient handling claims and non-patient handling claims. To assess whether the effects of time period on claim rates were modified by levels of staffing or retention, we tested interactions for time period*staff hours per resident day and time period*staff retention. We used interaction terms rather than stratified models to test both main effects and joint effects of the primary predictors. We selected the following covariates a priori to control for potential confounding: number of beds, average acuity index, region, profit status, chain status, and hospital affiliation.

RESULTS

Staffing and organizational characteristics

Of the 406 nursing homes that reported data to the MN Nursing Home Report Card between 2005 and 2016, 377 were eligible for inclusion. Twenty-seven facilities were excluded because they did not have ≥6 years of data including 3 pre-law years. Data for an additional 2 facilities were collapsed because individual locations for a single employer could not be distinguished in the workers' compensation database. Of eligible facilities, 15 were missing a single year of productive hours and retention data (15 facility-years) and 2 were missing multiple years of data for all other covariates (7 facility-years). These observations were treated as missing in analysis.

Characteristics of eligible nursing homes are presented in **Table 5**. Across time periods, the proportion of facilities with annual retention ≥75% declined while the proportion of facilities with ≥4 staff hours per resident day <100 beds, and the mean average acuity index increased. Distributions of annual FTEs, region, profit status, chain status, and hospital affiliation were consistent over time.

Table 5 Staffing and organizational characteristics of eligible nursing homes (n=377) over time, 2005-2016

Variable	Time period				p-value*
	Pre-law, 2005-2007 (n=377)	**Implementation, 2008-2010 (n=377)**	**First post, 2011-2013 (n=374)**	**Second post, 2014-2016 (n=363)**	
Staffing characteristics					
Annual staff retention, n (%)					
Tertile 1 (0-<65%)	104 (28%)	73 (19%)	134 (36%)	157 (43%)	**<.001**
Tertile 2 (65-<75%)	157 (42%)	160 (42%)	131 (35%)	135 (37%)	
Tertile 3 (≥ 75%)	116 (31%)	144 (38%)	107 (29%)	70 (19%)	
Missing	0	0	2 (0.05%)	1 (0.03%)	
Average staff hours per resident day, n (%)					
≤4	359 (95%)	327 (87%)	329 (88%)	298 (82%)	**<.001**
>4	18 (5%)	50 (13%)	45 (12%)	65 (18%)	
Annual FTEs, mean (sd)	51.6 (34.5)	50.6 (33.0)	49.5 (32.6)	47.3 (32.0)	.344

Organizational characteristics					
Total beds					
<100	255 (68%)	265 (70%)	280 (75%)	281 (77%)	**.017**
≥100	120 (32%)	112 (30%)	94 (25%)	82 (23%)	
Missing	2 (0.5%)	0	0	0	
Average acuity index, mean (sd)	10.01 (1.2)	10.10 (1.2)	10.8 (1.4)	11.1 (1.2)	**<.001**
Region, n (%)					
Twin Cities metroł	106 (28%)	106 (28%)	105 (29%)	103 (28%)	1.0
Non-metro	271 (72%)	271 (72%)	269 (72%)	260 (72%)	
Profit status, n (%)					
For-profit	99 (26%)	103 (27%)	108 (29%)	112 (31%)	.558
Non-profit	276 (73%)	274 (73%)	266 (71%)	251 (69%)	
Missing	2 (0.53%)	0	0	0	
Chain status, n (%)					
Multifacility	188 (50%)	195 (52%)	196 (52%)	197 (54%)	.729
Single site	187 (50%)	182 (48%)	178 (48%)	166 (46%)	
Missing	2 (0.53%)	0	0	0	
Hospital-affiliated, n (%)					
Yes	59 (16%)	53 (14%)	46 (12%)	46 (13%)	.513
No	316 (84%)	324 (86%)	328 (88%)	317 (87%)	
Missing	2 (0.5%)	0	0	0	

FTE=full time equivalent workers
*p-value based on chi-square statistic for categorical variables and F-test for continuous variables
ł 7-county Twin Cities metropolitan area: Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington counties.

Injury characteristics

Between 2005 and 2016, direct care workers filed 5891 indemnity claims. Of these, 3654 (62%) were patient handling claims and 2237 (38%) were non-patient handling claims **(Table 6)**. Rates of total claims, MSDs, and patient handling claims declined over time. When claims were stratified by patient handling relatedness, declines in MSD rates were observed for patient handling claims but not for non-patient handling claims. Similarly, improvements in injuries to the back, shoulder, and multiple body parts were observed for patient handling claims only.

From pre-law to second post-implementation, 209 individual facilities (55%) experienced a decline in patient handling claim rate and 166 (44%) experienced a decline in non-patient handling claim rate. Among facilities that reported one or more claims during the pre-law period (i.e., facilities that had 'room to improve,' n=328), 209 (64%)

experienced a decline in patient handling claim rate and 166 (51%) experienced a decline in non-patient handling claim rate.

Injury severity

Across follow-up, 83% of patient handling claims resulted in payment of TTD benefits and 10% resulted in payment of PPD benefits **(Table 7)**. Similarly, 84% of non-patient handling claims resulted in TTD benefits and 14% in PPD benefits. For patient handling claims, payment of TTD benefits (yes/no) and TTD claims lasting less than 3 months declined over time. This was expected given the overall decrease in patient handling claims because TTD claims lasting less than 3 months was the most common benefit outcome. The rates of TTD claims with longer durations did not decline over time. This included TTD claims for which return to work was unlikely (i.e., ≥6 months). For non-patient handling claims, payment of TTD benefits did not change significantly after the law was enacted nor did rates of TTD claims of any duration.

Payment of PPD benefits (yes/no) declined for both patient handling and non-patient handling claims. After the law, fewer injuries and illnesses resulted in permanent functional loss of use of the body. Among patient handling claims resulting in payment of PPD benefits, improvements were seen in PPD awards with impairment rating ≥5%, representing relatively more severe injuries. Among non-patient handling claims resulting in payment of PPD benefits, improvements were seen only in PPD awards with impairment rating <5%, representing relatively less severe injuries.

Table 6 Workers' compensation indemnity claim count and rate by time period, direct care workers in Minnesota nursing homes, 2005-2016

	Pre-law		Implementation		First post-implementation		Second post-implementation		p-value‡
	Count, n	Rate*	Count, n	Rate*	Count, n	Rate*	Count, n	Rate*	
All claims	1716	3.1	1678	3.0	1389	2.6	1108	2.2	**<.001**
MSDs	1133	2.0	1081	1.9	878	1.6	708	1.4	**<.001**
Patient handling claims									
Resident source	1121	2.0	1060	1.88	826	1.5	647	1.3	**<.001**
MSD	981	1.8	923	1.64	711	1.3	553	1.1	**<.001**
Violence	81	0.14	68	0.118	83	0.15	72	0.14	.527
Other	59	0.10	69	0.12	32	0.06	22	0.04	**<.001**
Body part									
Back	664	1.2	614	1.1	439	0.81	349	0.69	**<.001**
Shoulder	109	0.19	130	0.23	98	0.18	72	0.14	**.010**
Neck	21	0.04	16	0.03	13	0.02	9	0.02	.330
Upper extremity	85	0.15	75	0.13	78	0.14	65	0.13	.800
Lower extremity	48	0.08	51	0.09	35	0.06	33	0.07	.338
Multiple	116	0.20	117	0.21	73	0.13	60	0.12	**.001**
Other	78	0.13	57	0.10	90	0.17	59	0.12	**.030**
Non-patient handling claims									
Not resident source	595	1.1	618	1.1	563	1.0	461	0.93	.132
MSD	152	0.27	158	0.28	167	0.31	155	0.31	.564
Slips, trips, and falls	230	0.40	290	0.51	247	0.45	176	0.35	**.001**
Other	213	0.38	170	0.30	149	0.27	130	0.26	**.010**

Body part									
Back	164	0.29	153	0.27	137	0.25	121	0.24	.531
Shoulder	29	0.05	31	0.05	33	0.06	35	0.07	.539
Neck	8	0.01	10	0.02	8	0.02	5	0.01	.634
Upper extremity	75	0.13	72	0.13	60	0.11	58	0.12	.708
Lower extremity	147	0.26	165	0.29	148	0.27	107	0.21	.082
Multiple	123	0.21	121	0.21	96	0.18	79	0.16	.124
Other	49	0.09	66	0.12	81	0.15	56	0.11	.052

*Rate per 100 FTE adjusted for within-facility correlation

ŧ Wald chi-squared test for main effect of time period

Table 7 Workers' compensation indemnity claim benefit count and rate by time period, direct care workers in Minnesota nursing homes, 2005-2016

	Pre-law		Implementation		First post-implementation		Second post-implementation		p-value *t*
	Count, n	**Rate***	**Count, n**	**Rate***	**Count, n**	**Rate***	**Count, n**	**Rate***	
Patient handling claims									
TTD benefits	948	1.7	868	1.6	690	1.3	535	1.1	**<.001**
TTD duration									
<3 months	836	1.5	770	1.4	592	1.1	469	0.93	**<.001**
3-<6 months	49	0.09	47	0.08	48	0.09	34	0.07	.676
≥6 months	63	0.11	51	0.09	50	0.09	32	0.06	.078
PPD benefits	125	0.22	115	0.20	84	0.15	56	0.11	**<.001**
PPD award									
<5%	42	0.07	46	0.08	38	0.07	29	0.06	.509
5-<10%	36	0.06	34	0.06	15	0.03	16	0.03	**.005**
≥10%	47	0.08	35	0.06	31	0.06	11	0.02	**.002**
Non-patient handling claims									
TTD benefits	512	0.91	500	0.89	464	0.86	396	0.80	.397
TTD duration									
<3 months	440	0.79	450	0.80	401	0.75	343	0.70	.341
3-<6 months	34	0.06	19	0.03	34	0.06	23	0.05	.116
≥6 months	38	0.07	31	0.06	29	0.05	30	0.06	.832
PPD benefits	95	0.16	89	0.16	80	0.15	48	0.10	**.014**
PPD award‡									
<5%	47	0.08	52	0.09	46	0.08	22	0.04	**.028**
5-<10%	25	0.04	24	0.04	18	0.03	14	0.03	.453
≥10%	23	0.04	13	0.02	16	0.03	12	0.03	.419

*Rate per 100 FTE adjusted for within-facility correlation
t Wald chi-squared test for main effect of time period
‡Impairment rating reflects percentage of disability to the body

Multivariable models

In unadjusted models, we found the claim rate declined significantly over time for patient handling injuries but not for non-patient handling injuries **(Table 8)**. Compared to the pre-law period, the patient handling claim rate was 24% lower in the first post-implementation period and 36% lower in the second post-implementation period.

In adjusted models, declines were observed in rates of both patient handling and non-patient handling claims **(Table 8).** Compared to the pre-law period, the patient handling claim rate declined by 25% in the first post-implementation period and 38% in the second post-implementation period. The non-patient handling claim rate declined by 20% in the second post-implementation period only.

Associations between time and claim outcomes were not modified by staffing or retention. Interaction terms were therefore excluded from models to allow interpretation of main effects. Controlling for time (i.e., the effects of the law) and other covariates, facilities with annual staff retention ≥75% had a 17% lower patient handling claim rate compared to facilities with <65% retention. Staff retention was not associated with non-patient handling claims. Further, staff hours per resident day was not associated with patient or non-patient handling claims.

The patient handling claim rate was 34% lower among metro facilities (vs. non-metro), 37% lower among hospital-affiliated facilities (vs. not hospital-affiliated), and 15% lower among for-profit facilities (vs. non-profit). The non-patient handling claim rate was 30% lower among metro facilities (vs. non-metro), 39% lower among hospital-affiliated facilities (vs. not hospital-affiliated), and 8% higher with each 1-point increase

in average acuity index. Associations with total beds were not examined due to collinearity with FTEs.

Table 8 Multivariable modeling of predictors of annual workers' compensation indemnity claim rate, direct care workers in Minnesota nursing homes, 2005-2016

Predictor	Unadjusted IRR (95% CI)	Adjusted IRR (95% CI)	Unadjusted IRR (95% CI)	Adjusted IRR (95% CI)
	Patient handling claims		**Non-patient handling claims**	
Time period				
Pre-law	1.0	1.0	1.0	1.0
Implementation	0.934 (0.842-1.04)	0.944 (0.851-1.05)	1.03 (0.913-1.16)	1.04 (0.919-1.17)
First post	**0.763 (0.680-0.856)**	**0.750 (0.669-0.840)**	0.975 (0.853-1.11)	0.917 (0.796-1.06)
Second post	**0.635 (0.563-0.715)**	**0.622 (0.548-0.706)**	0.879 (0.757-1.02)	**0.800 (0.683-0.936)**
Average staff hours per resident day				
≤4		1.0		1.0
>4		0.968 (0.876-1.07)		0.886 (0.758-1.04)
Retention (%)				
Tertile 1 (0-<65%)		1.0		1.0
Tertile 2 (65-<75%)		0.968 (0.876-1.07)		0.928 (0.823-1.04)
Tertile 3 (≥ 75%)		**0.832 (0.735-0.941)**		0.911 (0.791-1.05)
Average acuity index		1.01 (0.967-1.05)		**1.08 (1.03-1.13)**
Metro		**0.660 (0.572-0.763)**		**0.698 (0.606-0.805)**
For-profit		**0.863 (0.753-0.989)**		0.928 (0.812-1.06)
Hospital-affiliated		**0.634 (0.501-0.803)**		**0.614 (0.338-0.841)**
Chain		1.05 (0.929-1.20)		1.06 (0.943-1.20)

IRR=incident rate ratio; CI=confidence interval

DISCUSSION

In this study of changes in workers' compensation indemnity claims following enactment of the MN Safe Patient Handling Act, we found earlier and greater declines in claims for patient handling injuries compared to claims for non-patient handling injuries. Compared to 3 pre-law years, patient handling claims declined by 25% in years 4-6 and 38% in years 7-9 following enactment of the law. In contrast, non-patient handling claims declined by 20% in years 7-9 only. Further, temporal changes in TTD and PPD benefits suggest that injury severity may have improved more for patient handling injuries compared to non-patient handling injuries. Staffing and retention levels did not modify associations between time period and claim outcomes. However, independent of the law,

high staff retention (≥75% vs. <65%) was associated with a lower patient handling injury claim rate.

Few studies have evaluated safe patient handling program effectiveness in large samples of nursing homes, and none have focused on a state law. One study evaluated the impact of a state-sponsored grant, training, and consultation program on changes in Ohio nursing home workers' compensation back injury claims over 10 years (n=887).[28] Compared to 5 pre-program years, indemnity and medical only claims declined slightly in years 3-4 following promotion of the program to nursing homes (RR=0.94; p=0.002). In a subset of facilities linked to staffing data (n=379), each additional resident per staff member was associated with a 32% increase in back injury rate. Our results show a larger decline in claims over time and no impact of staffing on patient handling injury rate, though nursing homes in the Ohio study were not required to participate in the state program.

A second study evaluated a corporate safe patient handling initiative in a large nursing home chain in the eastern U.S. (n=136).[21] Indemnity and medical only claims for patient handling injuries declined by 32% in years 1-3 and 38% in years 3-6 following initiation of a corporate-wide safe patient handling program that was implemented and monitored by an external risk management company. Corresponding relative risks (RR) for the first and second follow-up periods (vs. pre-program) were 0.681 (95% CI 0.643-0.721) and 0.617 (95% CI 0.580-0.655). Average pre-program turnover of LPNs was associated with a slightly higher rate of workers' compensation claims. Staffing and turnover for other occupations and time periods were not analyzed. The earlier decline in patient handling claims compared to our study may be due to inclusion of medical only

claims (representing less severe injuries) or the program implementation and monitoring strategies.

To date, evaluations of safe patient handling legislation have focused on hospitals. In Washington hospitals, the incidence rate of workers' compensation claims (indemnity and medical only) declined by 10.1% (95% CI 8.0-12.3) in the 5 years surrounding implementation of a safe patient handling law. In Washington nursing homes, which were not subject to the law, claims declined by only 5.8% (95% CI 1.7-9.7).[17] Over the 3 years a California safe patient handling law was implemented, serial cross-sectional surveys of hospital nurses demonstrated a decline in the prevalence of major musculoskeletal symptoms (Prevalence Ratio=0.78; 95% CI 0.66-0.91) but no changes in incidence of self-reported musculoskeletal injuries.[16] Our results suggest that follow-up longer than 3 years may be necessary to measure the impacts of a patient handling law on injury incidence.

The relationship between staffing and occupational injury is complex, and our largely null findings for staff hours per resident day are not definitive. We hypothesized that facilities with higher staffing would experience greater declines in patient handling injury rate over time. It's possible that staffing did not affect patient handling practices and subsequent injuries in Minnesota nursing home workers during the years studied. The impact of staffing on injury may also depend on level of safe patient handling program implementation (e.g., higher staffing only prevents injuries if adequate equipment and training are available). Our study did not measure or control for level of program implementation. Finally, the lack of association between staffing and injury may be due to measurement error. Studies demonstrate that, compared to state cost report data,

nursing homes overreport staffing levels to the OSCAR/CASPER systems and certain types of facilities (e.g., larger and for-profit) are more likely to overeport.[80,81]

More research is needed to explore the mechanisms by which retention and patient handling injury are related. We hypothesized that higher staff retention would result in greater declines in patient handling injury rate over time. While we did not find that staff retention modified the association between time and patient handling injuries, facilities with higher retention did experience lower patient handling claim rates overall. Retention may impact patient handling practices directly via staff consistency and experience. Alternatively, it is possible that staff retention and patient handling practices are both affected by work environment (e.g., unit culture, pace, and receptiveness to change),[26] which was unmeasured in this study. If unmeasured confounding accounted for the observed differences in claim rates, efforts to improve retention alone would not effectively reduce patient handling injuries. Further, the retention of some staff roles (e.g., the director of nursing) may be more influential on safety than others. As we used an aggregate measure of RN, LPN, and CNA retention, we were unable to determine if this was the case.

LIMITATIONS

In this statewide study, we used 3-year time periods to evaluate the effectiveness of the MN SPH Act on workers' compensation indemnity claims in nursing homes. Factors other than the law, such as injury reporting trends or other industry-wide safety initiatives, may have influenced changes in workers' compensation claim rates over time.[50] In order to assess whether temporal trends were responsible for apparent effectiveness of the law, we compared trends in patient handling claims to non-patient

handling claims. We found declines in patient handling claims were larger and occurred earlier following enactment of the law. However, we did not have access to a true control (e.g., claims data from Minnesota nursing homes not subject to the MN SPH Act) or external comparator (e.g., claims data from a state without safe patient handling legislation).

Data on level of safe patient handling program implementation in individual facilities were not available for our secondary data analysis. Change in patient handling injury rates likely depends on level of program implementation, with better-developed programs resulting in earlier and greater injury declines. As previously discussed, the effects of staffing and organizational characteristics on injuries may differ by level of program implementation. Our study did not assess level of program implementation, but rather serves as an evaluation of the real-world effectiveness of passing a state safe patient handling law on workers' compensation claims for patient handling injuries.

The study was limited to measures available in the Minnesota workers' compensation database, LTCFocus, and Nursing Home Report Card. We categorized injuries and illnesses using OIICS codes. The OIICS was significantly revised by the U.S. BLS in 2010, and changes were adopted by Minnesota in January 2012.[33] Relevant to our study, for each claim, coding of violence was prioritized over all other injury events. Additionally, new nature codes were added to the definition of MSD. These changes may have impacted our injury categories, including a likely increase in claims meeting the definition of patient handling injury after January 2012. However, the changes would not have resulted in a systematic reduction in patient handling injury claims over time.

The Minnesota workers' compensation system only captures indemnity claims which comprise approximately 23% of total claims in the state.[52] The remainder are medical only claims. These could be trending in the opposite direction if injuries are becoming less severe over time but are not being prevented entirely. Benefit payments only approximate injury severity, and trends observed in our study were likely influenced by larger trends in the workers' compensation system. For example, across Minnesota industries, the percent of PPD claims has decreased over time (from 23.9% in 2005 to 18.9% in 2015) likely due to an increase in stipulation settlements.[52] In assessing counts of claims receiving each benefit type by time period, we did not account for these trends nor did we account for claims receiving payments for multiple benefit types.

Average staff hours per resident day and annual retention do not capture potentially important staffing attributes such as average staff tenure and staffing cohesiveness.[45,46] Further, our models may be missing important predictors of patient handling injury rate, including receipt of state safety grants, union participation, changes in nursing home ownership, and additional resident characteristics (e.g., body mass index).[21,28]

CONCLUSIONS AND RECOMMENDATIONS

In Minnesota, a state safe patient handling law was associated with a substantial (38%) reduction in patient handling indemnity claims in nursing homes over 12 years, with 55% of individual facilities experiencing improvement. As all Medicaid-certified nursing homes in the state were included in the study regardless of level of safe patient handling program implementation, reductions in injury claims may be even greater in nursing homes with well-developed programs.

Our study also found higher patient handling claim rates in nursing homes that had low worker retention, non-metro location, non-profit status, and those that were not affiliated with a hospital. Safety grants and consultation services, already offered by Minnesota state agencies, should target groups of nursing homes at increased risk for patient handling injury claims. Future evaluations of state safe patient handling laws should aim to assess differential impacts of these laws by level of program implementation and elucidate the mechanisms by which retention and other staffing characteristics influence patient handling injuries.

Chapter 4: Manuscript 3

The Minnesota Safe Patient Handling Act: a comparison of Minnesota's experience to a state without safe patient handling legislation in a single-insurer sample

ABSTRACT

Background The Minnesota Safe Patient Handling Act was designed to protect health care workers from musculoskeletal injuries caused by frequent lifting, transferring, and repositioning of patients. Few studies compare the injury experiences of states with and without safe patient handling (SPH) legislation or assess the differential effectiveness of SPH laws by health care setting.

Methods Data from a single workers' compensation provider were used to describe claim characteristics in hospitals, nursing homes, and outpatient facilities in Minnesota (SPH law) and Wisconsin (no SPH law). Multivariable models were used to compare patient handling claim rates and estimate adjusted claim counts by state and health care setting between 2005 and 2017.

Results Across health care settings, the change in mean annual facility-level patient handling claims from pre-law (2005-2007) to second post-implementation (2014-2017) did not differ between states ($\chi^2 = 1.6$, p=.207). Mean annual claims declined from 1.4 (95% CI 0.98-1.7) to 0.85 (95% CI 0.62-1.1) in Minnesota facilities and from 1.5 (95% CI 0.84-2.2) to 0.58 (95% CI 0.37-0.78) in Wisconsin facilities. Further, change in patient handling claims over time did not differ by healthcare setting.

Conclusions In this single-insurer sample, Minnesota facilities did not experience a greater decline in patient handling injuries compared to Wisconsin facilities following enactment of the MN SPH Act. The study is the first to compare objective injury

measures among states with and without SPH legislation, though it is limited by a small, self-selected sample. Results highlight an urgent need for population-based research that utilizes external comparators to inform patient handling policymaking.

INTRODUCTION

The health care sector employs 12% of the U.S. workforce, totaling 16.9 million workers in 2018.[82] While health care workers are exposed to diverse hazards, those in direct patient care roles are particularly vulnerable to musculoskeletal injuries due to frequent lifting, transferring, and repositioning of patients. Manual patient handling techniques are also linked to adverse outcomes for patients, including falls and skin tears.[83] In response, several states have passed legislation aimed at reducing patient handling hazards and subsequent injuries to workers and patients.[10,84]

The 2007 Minnesota Safe Patient Handling Act requires each health care facility to adopt an SPH program that establishes a plan to minimize manual lifting of patients by direct care workers through use of assistive equipment.[60] To date, 12 states have enacted an SPH law or ordinance, most requiring SPH program implementation in hospitals.[1] Minnesota is one of only 6 states to require SPH program implementation in nursing homes and one of only 3 to require implementation outpatient facilities.[1,10]

Historically, rates of recordable injuries and illnesses in Minnesota health care facilities have exceeded national averages. Between 2007 and 2018, injury and illness rates in Minnesota hospitals declined from 9.0/100 full-time equivalent workers (FTE) [vs. 7.7/100 U.S. average] to 6.0/100 (vs. 5.6/100 U.S. average).[2] However, the 2018 injury and illness rate remained elevated in Minnesota nursing homes (7.8/100 vs. 6.2/100 U.S. average). Injury and illness rates in outpatient facilities are notably lower (3.6/100 in Minnesota vs. 3.3/100 U.S. average in 2018). This could be due, in part, to lower exposures to patient handling hazards.[72]

Published evaluations assess the effectiveness of SPH laws in hospitals. Researchers in Washington state compared patient handling in Washington hospitals

(subject to SPH legislation) to Washington nursing homes and Idaho hospitals (not subject to SPH legislation). Over 3 years following enactment of the 2006 Washington Safe Patient Handling law, Washington hospitals experienced favorable declines in workers' compensation claims (vs. Washington nursing homes) and several measures of worker-reported SPH program implementation (vs. Idaho hospitals).[17,18] In a pre-post California study, hospital RNs experienced declines in self-reported musculoskeletal symptoms but no change in injury incidence in 4 years following enactment of the 2012 Hospital Patient and Health Care Worker Injury Protection Act.[15,16]

No evaluation has compared objective occupational injury measures (e.g., workers' compensation claims) among states with and without SPH legislation. Further, the duration of existing evaluations may be inadequate to capture the full impacts of SPH laws because requirements of such laws (e.g., acquisition of equipment, assembly of SPH committees) are often rolled out over several years.[18,60] Finally, the evidence base lacks studies that evaluate differential effectiveness of SPH laws by health care setting. Longitudinal evaluations with external comparators are needed to inform outreach efforts in states with SPH laws as well as future SPH policymaking.

In this exploratory study using data from a single workers' compensation provider, we seek to compare temporal trends in patient handling injury claims among nursing homes, hospitals, and outpatient facilities in Minnesota (a state with an SPH law) and Wisconsin (a state without an SPH law). We hypothesize that patient handling claims will decline more over time in Minnesota compared to Wisconsin. Further, we hypothesize that declines in patient handling claims will be greater in hospitals and outpatient facilities compared to nursing homes.

METHODS

Study population

We used workers' compensation claims data from a large private workers' compensation provider based in the Midwest. All Minnesota and Wisconsin claims from January 1, 2005 through December 31, 2017 were extracted for Minnesota Classification Index (MCI) codes 8833 and 9040 (hospitals), 8829 and 8830 (nursing homes), and 8832 (outpatient facilities). Facility was defined as each unique combination of employer and MCI code. This definition does not necessarily reflect individual physical locations; employers may have multiple sites and each site may employ workers classified under multiple MCI codes.

Time periods were categorized based on implementation of the MN SPH law: pre-law (2005-2007), implementation (2008-2010), first post-implementation (2011-2013), and second post-implementation (2014-2017). Facilities were included in the sample for all years they were enrolled with the workers' compensation insurer. The study was determined to be exempt from review by the Institutional Review Board as research involving the study of existing data recorded in a manner that subjects cannot be identified.

Workers' compensation data

Workers' compensation claim data included worker occupation, injury date, claim type (lost time or medical only), text description of injury, and Workers' Compensation Insurance Organization (WCIO) codes for body part injured, injury nature, and cause. WCIO codes were assigned by the insurer based on the first report of injury.

Patient handling injuries were identified using a list of activities developed by the Minnesota Department of Labor and Industry **(Supplemental Table 4)**. Aided by WCIO

codes and keyword search, two authors manually reviewed text descriptions to determine patient handling relatedness. Common patient handling tasks included transferring patient to bed, wheelchair, or commode; repositioning or moving patient in bed; bathing, diapering, or dressing patient; fall prevention or recovery; and positioning patient for treatment (e.g., x-ray or catheter). Cumulative musculoskeletal injuries (e.g., lifting patients all day) were also included. Injuries resulting from general patient contact (e.g., patient walked worker into door); patient violence unrelated to lifting, transferring, or repositioning; and contact with patient handling equipment when no patient was present were excluded. For claims that were unclear, patient handling relatedness was discussed and determined by consensus.

Data analysis

We calculated claim counts and rates for total claims and patient handling claims separately by state and health care setting. Crude claim rates were calculated using claim count as the numerator and payroll as the denominator. To account for inflation, we adjusted payroll to 2017 dollars using an estimate of 2% growth per year. Claim counts and rates were then stratified by claim type (lost time vs. medical only). Facilities that reported crude claim rates of ≥100 claims per $1 million payroll for a given year were excluded from analysis due to likely reporting or data collection errors.

We described claimant and injury characteristics for total and patient handling claims separately by health care setting. Claimant characteristics included age, gender, and occupation. Claim characteristics included body part injured, cause (i.e., mechanism of injury), and nature (i.e., injury type).

We regressed claim counts on predictors using mixed effects negative binomial regression with annual payroll as the offset and employer and facility as random intercepts. We modeled total claims and patient handling claims separately. The unit of analysis was facility-year. The primary predictors were time period, health care setting, and state. Time period and state were included to assess the impacts of the MN SPH Act. Health care setting was included to account for differences in average patient acuity and frequency of patient handling tasks.

We did not have access to additional covariates because data were de-identified by the workers' compensation insurer. This may have resulted in residual confounding. As data collection is standardized across facilities enrolled with the insurer, we did not anticipate influential reporting or information bias. A follow-up study, including additional facility-level covariates, is planned.

We assessed 2- and 3-way interactions to determine whether the impact of time period on claim rate differed by state and health care setting. Wald χ^2 tests were used to determine significance of interaction effects (time period*state, time period*health care setting, and time period*state*health care setting). We included significant interactions in final models and calculated mean facility-level annual claim counts using post-estimation commands. We used adjusted counts instead of rates due to limitations of the statistical software package. Stata 15.1 was used for all analyses.

RESULTS

Descriptive results

Between 2005 and 2017, 1,980 Minnesota facilities and 176 Wisconsin facilities were enrolled with the insurer **(Table 9)**. On average, facilities were enrolled for 4.6 years (sd 3.5; range 1-13). Thirty-five percent of Minnesota facilities (n=695) and 49% of

Wisconsin facilities (n=87) reported at least one claim during the study period. The low proportion of facilities with claims was expected as many are small employers. Having fewer workers may result in lower injury counts. Further, many workers in the health care sector experience precarious employment (e.g., temporary, on-demand work) and may not be represented in the data due to lack of access to workers' compensation coverage.[85]

Claim characteristics by state and health care setting

Over the study period, Minnesota workers filed 19,501 claims, and Wisconsin workers filed 1,584 claims **(Table 9)**. In Minnesota and Wisconsin, respectively, total claim rates per $1 million payroll were 0.92 (95% CI 0.91-0.94) and 1.4 (95% CI 1.3-1.4) and patient handling claim rates were 0.26 (95% CI 0.26-0.27) and 0.43 (95% CI 0.39-0.47). Nursing homes had the highest proportion of patient handling claims in both states (45% in Minnesota and 54% in Wisconsin) and outpatient facilities had the lowest (6% in Minnesota and Wisconsin). Patient handling claim type (lost time vs. medical only claim) did not differ between states overall (χ^2=.997; p=.318) or for any individual health care setting.

Table 9 Workers' compensation claims by state and health care setting, 2005-2017

	Fac-ili-ties, n	Payroll (million $)	Total claims		PH claims		PH lost time claims		PH medical only claims	
			Count, n	Rate (95% CI) ŧ	Count, n (% of total)	Rate (95% CI) ŧ	Count, n (% of PH)	Rate (95% CI) ŧ	Count, n (% of PH)	Rate (95% CI) ŧ
Minnesota										
All settings	1980	21128.1	19501	0.93 (0.91-0.94)	5547 (28%)	0.26 (0.25-0.27)	1097 (20%)	0.05 (0.05-0.06)	4450 (80%)	0.21 (0.20-0.22)
Outpatient	1299	13128.4	4658	0.35 (0.34-0.37)	261 (6%)	0.02 (0.01-0.02)	42 (16%)	0.003 (0.002-0.004)	219 (84%)	0.02 (0.01-0.02)
Hospital	425	6133.1	7795	1.3 (1.2-1.3)	2142 (27%)	0.35 (0.33-0.36)	506 (24%)	0.08 (0.08-0.09)	1636 (76%)	0.27 (0.25-0.28)
Nursing home	256	1866.6	7048	3.8 (3.7-3.9)	3144 (45%)	1.7 (1.6-1.7)	549 (18%)	0.29 (0.27-0.32)	2595 (82%)	1.4 (1.3-1.4)
Wisconsin										
All settings	176	1169.5	1584	1.4 (1.3-1.4)	502 (32%)	0.27 (0.25-0.29)	90 (18%)	0.05 (0.04-0.06)	412 (82%)	0.22 (0.20-0.24)
Outpatient	114	578.0	460	0.80 (0.72-0.87)	26 (6%)	0.04 (0.03-0.07)	1 (4%)	-	25 (96%)	0.04 (0.03-0.06)
Hospital	32	354.8	380	1.1 (0.97-1.2)	74 (19%)	0.21 (0.16-0.26)	22 (30%)	0.06 (0.04-0.09)	52 (70%)	0.15 (0.11-0.19)
Nursing home	30	236.7	744	3.1 (2.9-3.4)	402 (54%)	1.7 (1.5-1.9)	67 (17%)	0.28 (0.22-0.36)	335 (83%)	1.4 (1.3-1.6)

PH=patient handling

*Adjusted for 2% annual inflation

ŧ Crude claim rate per million $ payroll

Claimant and injury characteristics by health care setting

Table 10 displays claimant characteristics for total and patient handling workers' compensation claims. Across health care settings, the majority of claimants were female. Nursing home claimants were younger than claimants working in other settings. Forty-seven percent of nursing home claimants were less than 35 years of age (vs. 36% of both hospital and outpatient claimants). For patient handling claims, 57% of nursing home claimants were less than 35 years of age (vs. 47% of hospital and 36% of outpatient claimants).

Aides comprised 60% of total nursing home claimants (vs. 22% of hospital and 9% of outpatient claimants) and 85% of patient handling injury claimants (vs. 48% of hospital and 15% of outpatient claimants). In hospitals, most claimants were direct patient care workers, including nurses, aides, and other care workers (e.g., paramedics, surgical assistants, and phlebotomists). Outpatient facilities reported more claimants in professional provider (17%) and administrative (19%) roles than other settings.

We observed differences in claimant characteristics by state *(data not shown).* Compared to Wisconsin, Minnesota claimants in nursing homes and hospitals were younger and less likely to be female for total and patient handling claims. In hospitals, Minnesota claimants with patient handling injuries were more likely to be aides (49% vs. 30% of Wisconsin claimants) and less likely to be nurses (36% vs. 49% of Wisconsin claimants). In outpatient facilities, Minnesota claimants with any injury or illness were much less likely to work in dental positions (7% vs. 43% of Wisconsin claimants). Also in outpatient facilities, Minnesota claimants with patient handling injuries were more likely to work in professional positions (e.g., physician or nurse practitioner) [20% vs.

4% of Wisconsin claimants]. These results likely reflect differences in health care setting subtype (e.g., dental office vs. family practice clinic) not otherwise captured in the study data.

Table 10 Worker characteristics by health care setting for total and patient handling workers' compensation claims, 2005-2017

	Hospital, n (%)	**Nursing home, n (%)**	**Outpatient, n (%)**
Total claims			
Claimants	**N=8175**	**N=7792**	**N=5118**
Age (years)			
<25	968 (12%)	1804 (23%)	440 (9%)
25-<35	1949 (24%)	1848 (24%)	1369 (27%)
35-<45	1674 (20%)	1439 (18%)	1184 (23%)
45-<55	2029 (25%)	1573 (20%)	1185 (23%)
≥55	1540 (19%)	1095 (14%)	914 (18%)
Missing	15 (<1%)	33 (<1%)	26 (<1%)
Gender			
Female	6884 (84%)	6881 (88%)	4372 (85%)
Male	1276 (16%)	900 (12%)	741 (15%)
Missing	15 (<1%)	11 (<1%)	5 (<1%)
Occupation			
Nursing/medical/care aide	1806 (22%)	4652 (60%)	462 (9%)
Nurse (RN, LPN)	2202 (27%)	1054 (14%)	681 (13%)
Professional provider	308 (4%)	37 (<1%)	856 (17%)
Dental	0	0	540 (11%)
Housekeeping	804 (10%)	520 (7%)	53 (1%)
Food services	544 (7%)	639 (8%)	13 (<1%)
Administrative	376 (5%)	88 (1%)	993 (19%)
Other care	1077 (13%)	225 (3%)	797 (16%)
Other non-care	766 (9%)	262 (4%)	325 (6%)
Missing or unclear	292 (4%)	315 (4%)	398 (8%)
Patient handling claims			
Claimants	**N=2216**	**N=3546**	**N=287**
Age (years)			
<25	431 (19%)	1053 (30%)	26 (9%)
25-<35	623 (28%)	970 (27%)	82 (29%)
35-<45	440 (20%)	662 (19%)	73 (25%)
45-<55	464 (21%)	559 (16%)	62 (22%)
≥55	253 (11%)	290 (8%)	43 (15%)
Missing	5 (<1%)	12 (<1%)	1 (<1%)
Gender			
Female	2001 (90%)	3259 (92%)	242 (84%)
Male	212 (10%)	282 (8%)	45 (16%)
Missing	3 (<1%)	5 (<1%)	0
Occupation			
Nursing/medical/care aide	1062 (48%)	2998 (85%)	44 (15%)
Nurse (RN, LPN)	801 (36%)	310 (8%)	81 (28%)
Professional provider	48 (2%)	12 (<1%)	53 (18%)
Dental	0	0	1 (<1%)
Housekeeping	5 (<1%)	8 (<1%)	1 (<1%)

Food services	4 (<1%)	4 (<1%)	0
Administrative	19 (<1%)	5 (<1%)	3 (1%)
Other care	174 (8%)	67 (2%)	64 (22%)
Other non-care	50 (2%)	5 (<1%)	9 (3%)
Missing or unclear	53 (2%)	137 (4%)	31 (11%)

Table 11 displays injury characteristics by health care setting for total and patient handling claims. For total claims, the most common injury mechanisms were lifting, handling, or carrying (23%) and slip, trip, or fall (15%). For patient handling claims, the most common mechanisms were lifting, handling, or carrying (48%), patient or coworker (18%), and strain (16%). Compared to hospitals and nursing homes, outpatient facilities reported more claims attributable to exposure (e.g. ingestion and inhalation) [11%], machine or tool (e.g., needles and lancets) [13%], and repetitive/cumulative motion (e.g., computer tasks) [11%].

The most common types of injuries were sprain or strain (52% of total claims and 90% of patient handling claims) and contusion or inflammation (16% of total claims and 7% of patient handling claims). Punctures (e.g., needlesticks) were also common in outpatient facilities, comprising 23% of total claims. Back injuries were most common in nursing homes (29% of total claims) and least common in outpatient facilities (7% of total claims). Conversely, upper extremity injuries, particularly injuries to the hands and fingers, were most common in outpatient facilities (50% of total claims) and least common in nursing homes (26% of total claims). For patient handling claims, back injuries comprised over 40% of injuries in all health care settings.

We observed few notable differences in claim characteristics between states *(data not shown).* Patient handling claims in Minnesota outpatient facilities were more likely to be back injuries (41% vs. 27% of Wisconsin claims) and less likely to be upper extremity

injuries (21% vs. 46% of Wisconsin claims). However, the number of Wisconsin patient handling claims in outpatient facilities was very low (n=26).

Table 11 Injury characteristics by health care setting for total and patient handling workers' compensation claims, 2005-2017

	Hospital, n (%)	**Nursing home, n (%)**	**Outpatient, n (%)**
Total claims			
Claimants	**N=8175**	**N=7792**	**N=5118**
Cause- mechanism of injury			
Lifting/handling/carrying	1882 (23%)	2212 (28%)	726 (14%)
Slip/trip/fall	1352 (17%)	1025 (13%)	831 (16%)
Strain	883 (11%)	1024 (13%)	342 (7%)
Patient/coworker	703 (9%)	850 (11%)	226 (4%)
Push/pull/reach/twist	624 (8%)	792 (10%)	185 (4%)
Exposure	693 (8%)	368 (5%)	541 (11%)
Machine/tool	395 (5%)	316 (4%)	670 (13%)
Repetitive/cumulative	411 (5%)	174 (2%)	573 (11%)
Contact with object	444 (5%)	352 (5%)	237 (5%)
Cut/puncture/scrape	311 (4%)	268 (3%)	444 (9%)
Other	476 (6%)	411 (5%)	343 (7%)
Nature- injury type			
Sprain/strain	4459 (55%)	4893 (63%)	1708 (33%)
Contusion/inflammation	1313 (16%)	1192 (15%)	774 (15%)
Puncture	519 (6%)	514 (7%)	1174 (23%)
Laceration	506 (6%)	373 (5%)	323 (6%)
Contagious disease	303 (4%)	158 (2%)	353 (7%)
Foreign body	158 (2%)	84 (1%)	138 (3%)
Fracture/dislocation	168 (2%)	99 (1%)	100 (2%)
Burn	168 (2%)	126 (2%)	47 (<1%)
No physical injury	86 (1%)	38 (<1%)	79 (2%)
Other	495 (6%)	315 (4%)	422 (8%)
Part- body location			
Back	1683 (21%)	2289 (29%)	382 (7%)
Upper extremity	2410 (29%)	2036 (26%)	2583 (50%)
Lower extremity	1166 (14%)	1000 (13%)	511 (10%)
Shoulder	544 (7%)	588 (8%)	175 (3%)
Trunk	429 (5%)	421 (5%)	160 (3%)
Head	675 (8%)	404 (5%)	455 (9%)
Neck	141 (2%)	106 (1%)	54 (1%)
Multiple	1127 (14%)	948 (12%)	798 (16%)
Patient handling claims			
Claimants	**N=2216**	**N=3546**	**N=287**
Cause- mechanism of injury			
Lifting/handling/carrying	1116 (50%)	1677 (47%)	115 (40%)
Slip/trip/fall	12 (<1%)	20 (<1%)	0
Strain	347 (16%)	610 (17%)	38 (13%)
Patient/coworker	401 (18%)	599 (17%)	81 (28%)
Push/pull/reach/twist	272 (12%)	524 (15%)	37 (13%)
Exposure	3 (<1%)	0	0
Machine/tool	6 (<1%)	12 (<1%)	0

Repetitive/cumulative	25 (1%)	30 (<1%)	15 (5%)
Contact with object	11 (<1%)	38 (1%)	0
Cut/puncture/scrape	2 (<1%)	5 (<1%)	0
Other	21 (<1%)	27 (<1%)	1 (<1%)
Nature- injury type			
Sprain/strain	1996 (90%)	3190 (90%)	238 (83%)
Contusion/inflammation	145 (7%)	257 (7%)	29 (10%)
Puncture	8 (<1%)	29 (<1%)	8 (3%)
Laceration	15 (<1%)	22 (<1%)	4 (1%)
Contagious disease	7 (<1%)	5 (<1%)	1 (<1%)
Foreign body	1 (<1%)	0	0
Fracture/dislocation	15 (<1%)	12 (<1%)	0
Burn	0	0	0
No physical injury	2 (<1%)	5 (<1%)	0
Other	27 (1%)	27 (<1%)	7 (2%)
Part- body location			
Back	1056 (48%)	1678 (47%)	115 (40%)
Upper extremity	275 (12%)	513 (14%)	66 (23%)
Lower extremity	152 (7%)	244 (7%)	21 (7%)
Shoulder	247 (11%)	412 (12%)	20 (7%)
Trunk	166 (7%)	252 (7%)	19 (7%)
Head	48 (2%)	62 (2%)	8 (3%)
Neck	53 (2%)	62 (2%)	5 (2%)
Multiple	219 (10%)	323 (9%)	33 (12%)

Multivariable models

Claims over time by state

Final multivariable models included state, health care setting, time period, and interactions for state*time period and state*health care setting. The association between time period and claim rate differed by state for patient handling claims (χ^2 for state*time period=8.4; p=.039) but not for total claims (χ^2 for state*time period=3.3; p=.353) **(Supplemental Table 5)**. Both states experienced declines in patient handling claims from 2005 to 2017 **(Table 12)**. From pre-law to second post-implementation, the mean annual facility-level patient handling claim count declined from 1.4 (95% CI 0.98-1.7) to 0.85 (95% CI 0.62-1.1) in Minnesota (χ^2 = 9.4; p=.002). In Wisconsin, the mean count declined from 1.5 (95% CI 0.84-2.2) to 0.58 (95% CI 0.37-0.78) [χ^2 = 7.2; p=.007]. In Minnesota, the decline in claims leveled off between the first and second post-implementation periods (χ^2 = 0.06, p=.810) **[Figure 2]**. The *change* in mean claim count

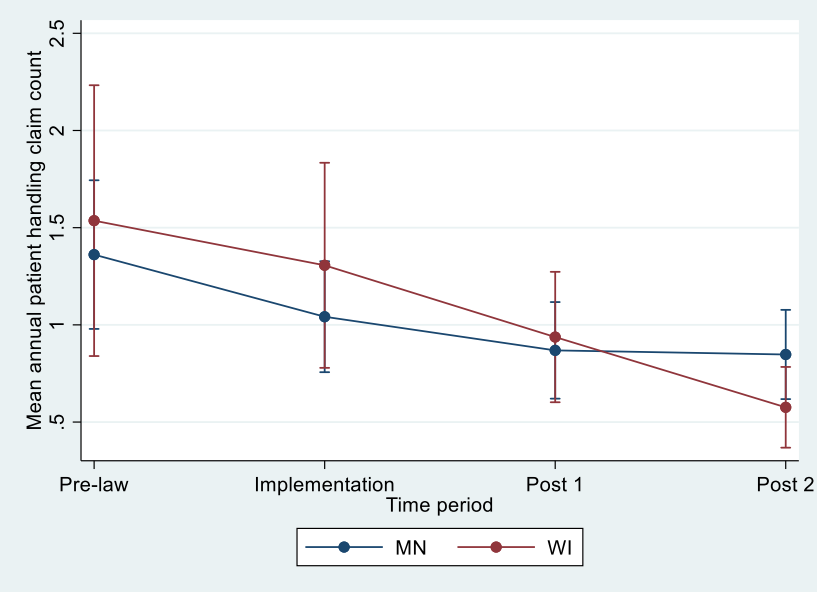
from pre-law to second post-implementation did not differ between states ($\chi^2 = 1.6$, p=.207). Further, for each time period analyzed, the mean claim count did not differ between states. Contrary to our hypothesis, the decline in patient handling claim rate was not greater in Minnesota than Wisconsin.

Table 12 Mean adjusted facility-level annual count of total and patient handling claims by state, time period, and setting, 2005-2017

	Total claims, n	**Patient handling claims, n**	**Payroll (million $)**	**Mean adjusted facility-level annual claim count (95% CI)**	
				Total claims	**Patient handling claims**
Minnesota					
Pre-law	4795	1509	3727.3	4.1 (3.3-4.9)	1.4 (0.98-1.7)
Implementation	4763	1405	4481.5	3.4 (2.8-4.1)	1.0 (0.76-1.3)
First post	4584	1181	5264.0	3.2 (2.6-3.8)	0.87 (0.62-1.1)
Second post	5359	1452	7655.3	2.9 (2.4-3.4)	0.85 (0.62-1.1)
Wisconsin					
Pre-law	381	119	169.9	4.4 (3.0-5.8)	1.5 (0.84-2.2)
Implementation	486	132	299.4	3.4 (2.1-4.7)	1.3 (0.78-1.8)
First post	278	104	227.7	2.9 (2.0-3.8)	0.94 (0.78-1.8)
Second post	439	147	472.4	2.4 (1.7-3.0)	0.58 (0.37-0.78)
Minnesota					
Outpatient	4663	261	13128.4	1.0 (0.85-1.2)	0.06 (0.04-0.09)
Hospital	7813	2142	6133.1	5.7 (4.4-6.9)	1.7 (1.1-2.2)
Nursing Home	7126	3144	1866.6	10.9 (8.6-13.1)	5.3 (3.7-6.9)
Wisconsin					
Outpatient	460	26	578.0	1.6 (1.1-2.1)	0.15 (0.04-0.26)
Hospital	380	74	354.8	3.7 (2.0-5.4)	0.61 (0.26-0.96)
Nursing Home	744	402	236.7	11.0 (7.8-14.3)	8.8 (5.2-12.4)

Final models include time period, state, setting, time period*state, and state*health care setting interactions, and annual payroll.
Pre-law=2005-2007; Implementation=2008-2010; First post=2011-2013, Second post=2014-2017

Figure 2 Mean adjusted facility-level annual count of patient handling claims: Minnesota vs. Wisconsin



MN=Minnesota; WI=Wisconsin
Pre-law=2005-2007; Implementation=2008-2010; Post 1=2011-2013, Post 2=2014-2017

Claims over setting by state

The association between health care setting and claim rate differed by state for patient handling (χ^2 for state*health care setting=19.3; p<.001) and total claims (χ^2 for state*health care setting=10.5; p=.005) **[Supplemental Table 5]**. In both states, mean annual facility-level patient handling claim counts were highest in nursing homes, followed by hospitals, and outpatient facilities **(Table 12)**. Mean annual patient handling claims differed between states for nursing homes and hospitals. For nursing homes, the mean claim count was 5.3 (95% CI 3.7-6.9) in Minnesota compared to 8.8 (95% CI 5.2-12.4) in Wisconsin (χ^2 = 4.1, p=.043). For hospitals, the mean claim count was 3.7 (95% CI 2.0-5.4) in Minnesota compared to 0.61 (0.26-0.96) in Wisconsin (χ^2 = 13.0, p=<.001).

Claims over time by setting

The interaction for health care setting*time period was not significant for patient handling (χ^2=416.1; p=.757) or total claims (χ^2=392.4; p=.698) and therefore was excluded from final models. The association between time period and claim rate did not differ by health care setting. In models that only included Minnesota facilities (n=1980), the interaction for health care setting*time period was also not significant *(data not shown)*. Contrary to our hypothesis, the decline in patient handling claim rate was not greater in hospitals and outpatient facilities compared to nursing homes.

DISCUSSION

In this longitudinal study of workers' compensation claims from a single insurer, we found the patient handling injury claim rate declined in Minnesota health care facilities following enactment of the Minnesota SPH Act. However, the decline in claims from pre-law (2005-2007) to second post-implementation (2014-2017) was not greater than the decline observed in Wisconsin, a neighboring state without SPH legislation. Further, across time, the patient handling claim rate was greater in Minnesota hospitals compared to Wisconsin hospitals.

The crude patient handling injury claim rate differed by health care setting, with the lowest rates reported in outpatient facilities (0.02 and 0.04 claims/$1 million payroll in Minnesota and Wisconsin, respectively) and highest rates reported in nursing homes (1.7 claims/$1 million payroll in both states). Despite high claim rates in nursing homes, the change in patient handling claims over time did not differ among nursing homes, hospitals, and outpatient facilities. There are several plausible explanations for these findings.

Over the past 20 years, several national organizations have launched SPH initiatives that aim to make research, toolkits, web-based trainings, and other resources widely available. Leaders include the American Nurses Association (ANA),[9,86] the Tampa VA Research and Education Foundation,[87] the National Institute for Occupational Safety and Health,[88] and the U.S. Occupational Safety and Health Administration.[89] Given the availability of resources, implementation of evidence-based SPH programs may have been widespread in both states during the years of study despite Wisconsin not requiring program implementation under a legislative mandate. Further, health care facilities may be motivated to implement SPH programs by factors other than a law, including reducing occupational injury costs and improving patient care outcomes.

It's also possible that the MN SPH Act, and subsequent development of local safe patient handling resources, impacted both Minnesota and Wisconsin health care facilities included in our study. Employers in both states may have had access to resources based in the Minneapolis-St. Paul metropolitan area, including ergonomic consultation services, patient handling equipment vendors, and educational opportunities (e.g., safe patient handling conferences). Finally, several health care employers in our study operate facilities in both states. For these employers, it's possible that new SPH initiatives under the MN SPH Act were implemented across all facilities regardless of location.

We've previously demonstrated declines in workers' compensation patient handling indemnity claim rates in Medicaid-certified Minnesota nursing homes following implementation of the Minnesota SPH Act. Compared to 2005-2007 (pre-law), claims declined by 25% in 2011-2013 and by 38% in 2015-2016.[90] Claims for all other injuries and illnesses declined by 20% in 2015-2016 only. However, the study did not have an

external comparator and excluded medical only claims which comprise approximately 77% of total claims.[52] In this study, compared to 2005-2007 (pre-law), patient handling claims declined by 63% in 2014-2017 across Minnesota and Wisconsin. This greater reduction in claims may be the result of inclusion of medical only claims, inclusion of hospitals and outpatient facilities in the study sample, or a longer study duration. Alternatively, enrollees with the insurer may have experienced greater success in reducing patient handling injuries compared to all nursing homes in Minnesota.

Washington and California have both published evaluations of state safe patient handling laws.[15-18] The 2006 Washington law requires each hospital to implement an SPH program and committee and acquire adequate assistive equipment. Between 2001 and 2009, a 10.1% (95% CI 8.0-12.3) decrease was observed in compensable claims for work-related MSDs in hospitals.[17] Nursing homes, used as a comparator, experienced a 5.8% (95% CI 1.7-9.7) decline in MSDs. The rate of MSD claims in nursing homes was 1.6 times higher than hospitals. In our 2005-2017 study, the rate of patient handling injury claims was 1.3 times higher in Minnesota nursing homes than hospitals, though both were subject to the MN SPH Act. The longitudinal Washington study was comprised largely of pre-law years while our study focused on post-law years. Further, Washington cases were categorized as MSDs based on American National Standards Institute (ANSI), Occupational Injury and Illness Classification System (OIICS), and International Classification of Diseases (ICD-9) codes,[18] while our study reviewed text descriptions of injury to determine patient handling relatedness.

A second Washington study used 2007 and 2009 cross-sectional surveys of direct care hospital workers in Washington and Idaho, a state without safe patient handling

legislation, to assess changes in perceptions and behaviors related to SPH program implementation.[18] Compared to Idaho workers, Washington workers reported beneficial changes in knowledge of workplace SPH policies, availability and use of assistive equipment, and equipment quality and training. In both states, declines were observed in belief that taking risks was part of the job and belief that a member of the team would be injured within a year. Washington workers reported more back pain than Idaho workers. No differences were seen between states in perceived physical exertion, satisfaction with staff input on assistive equipment, or whether a committee existed to identify equipment needs.

A study of the 2012 California Hospital and Health Care Worker Injury Protection also focused on hospitals, using pre-post cross-sectional surveys to elicit changes in nurses' perspectives of safe patient handling policies, practices, and injury outcomes in the 4 years following enactment of the law.[16] While the authors found improvements in knowledge of the law, SPH training, presence of assistive equipment, and prevalence of musculoskeletal symptoms between 2013 and 2016, prevalence of work-related injury in the last 12 months did not significantly decline. Our previous research on the MN SPH Act suggests that more than 3 years of follow-up may be necessary to detect changes in injuries following enactment of a law.[90] The California study did not have an external comparator or include objective measures of worker injuries. However, worker perspectives on the effectiveness of SPH legislation are an important component of evaluation. The Washington and California studies suggest that SPH laws can effectively improve worker awareness of safe patient handling, training opportunities, and equipment access.

Comparing success of state SPH laws is complicated by differences in each law's requirements and implementation strategies. The MN SPH Act requires each health care facility (i.e., hospitals, nursing homes, and other clinical settings that move patients) to establish a written SPH program and committee.[60] Minnesota provides ergonomic consultation services and grant support of up to $40,000 annually for equipment purchase.[60] Similarly, the Washington law requires acute care hospitals to establish an SPH program and committee; it also defines minimum equipment requirements and establishes workers' right-to-refuse unsafe lifts.[17, 21,91] Washington offers a tax credit for equipment purchase and a special risk class with lower premiums in the state-run workers' compensation fund for hospitals that implement a safe patient handling program. California requires acute care hospitals to develop an SPH policy and plan that includes worker training, use of assistive equipment, and availability of lift teams of trained assistive staff.[92] California does not offer funding or incentives for SPH program development. Despite these differences, research from the 3 states provides pragmatic evaluation strategies and can be used to help inform future state and federal policymaking.

Strengths and Limitations

Our sample was limited to health care facilities enrolled with a single large workers' compensation insurer. The dataset included a small number of Wisconsin facilities, particularly in the early years of study (n=32 during the pre-law period and n=64 during the implementation period). Due to the small sample, we were unable to calculate changes in facility-level claim counts over time by both state and health care setting (e.g. Minnesota nursing homes vs. Wisconsin nursing homes).

The data did not include potentially important predictors of injury rate such as level of safe patient handling program implementation or detailed information on facility (e.g., location, health care setting subtype), staffing (e.g., proportion of staff in direct care positions, staff to patient ratio), or patient population (e.g., average acuity, body mass index). This limited our ability to assess why some facilities in our sample had particularly high patient handling injury rates and may have resulted in residual confounding. For example, Minnesota hospitals may have higher claim rates than Wisconsin hospitals because they serve higher need populations, are located in regions with fewer resources, or employ more direct care staff. Despite this limitation, the study provides a broad summary of injury trends in hospitals, nursing homes, and outpatient facilities enrolled with the insurer.

The study has several important strengths. Workers' compensation studies often exclude medical only claims because many state systems only collect data on lost time claims.[17,72,90] In our study, medical only claims comprised 85% of total claims. Though we didn't observe differences in patient handling injury claim type (lost time vs. medical only) by state or health care setting, the inclusion of medical only claims provides a more complete picture of the injury experience in health care facilities across the study period.

Importantly, we reviewed text from detailed injury descriptions to identify patient handling injuries. Many studies have used a subset of injuries (e.g., back injuries) or pre-coded fields for injury nature, source, and event, such as those provided by the Occupational Injury and Illness Classification System (OIICS), to define patient handling injuries.[17,72,90] Review of individual injury circumstances likely resulted in more accurate identification of patient handling relatedness.

CONCLUSIONS AND RECOMMENDATIONS

The present study highlights the need for evaluations of SPH legislation that are population-based and include external comparators. Despite only 12 states having enacted SPH legislation, data from the BLS Survey of Occupational Injuries and Illnesses show that musculoskeletal injuries are declining in health care settings across the U.S.[2] In our study, Wisconsin experienced declines in patient handling injury claims over 15 years in the absence of a safe patient handling law. Our results suggest that pre-post studies demonstrating injury declines following implementation of a state SPH law may be capturing more than the impacts of the law. Rather, they are likely capturing the combined effects of the law and national safety and injury trends. Due to the limitations of our sample, additional studies are needed to test whether the patterns we observed are true in larger, more representative study populations. In addition to evaluating the overall effectiveness of SPH legislation, future studies should seek to assess which components of safe patient handling laws are most effective. This research could help identify evidence-based safe patient handling practices that could be easily adopted by all health care facilities, regardless of whether they are subject to a state SPH law.

Chapter 5: Conclusion

Summary

Manuscript 1 provides a statewide profile of injuries in Minnesota nursing homes workers and provides context for Minnesota's elevated injury and illness rates as reported on the BLS SOII. In 2017, the rate of reportable MSDs resulting in one or more days away from work was 1.44 per 100 FTE in Minnesota nursing homes compared to 0.84 per 100 FTE in U.S. nursing homes.[2] However, the SOII does not provide occupation-specific injury rates by industry due to sample size limitations.

In our study, the overall workers' compensation indemnity claim rate in direct care workers (i.e., RNs, LPNs, and CNAs) was 1.71 per 100 FTE for years 2005-2016. This is comparable to the MSD claim rate reported for all workers in Washington nursing homes for years 1999-2013: 2.05 per 100 FTE.[13] As MSDs are declining over time in Minnesota and nationally, it's expected that rates from the Minnesota and Washington studies are higher than 2017 SOII rates.

Our study suggests that injuries to CNAs may be driving Minnesota's elevated MSD rates. In a statewide sample, CNA injuries comprised 84% of direct care worker indemnity claims across the study period. MSD rates were 2.47, 0.71, and 0.34 per 100 FTE in CNAs, LPNs, and RNs, respectively. CNAs also had the highest claim rates for patient handling injuries, injuries attributable to patient handling equipment, and injuries attributable to resident violence.

Further, multivariable analyses demonstrated that the rate of MSD claims (vs. claims for all other injuries and illnesses) was 1.67 times higher (95% CI 1.31-2.14) among CNAs compared to RNs. The patient handling claim rate was 1.89 times higher

(95% CI 1.47-2.45) among CNAs compared to RNs. Claims filed by CNAs were more likely to result in a stipulation settlement rather than payment of traditional workers' compensation benefits, suggesting that the workers' compensation system may not be benefiting all direct care workers equitably.

In Minnesota nursing homes, CNAs bear a greater injury burden than other direct workers. Our study fills an evidence gap in occupation-specific injury rates in nursing homes workers. Further, our results suggest that population-based safety initiatives, such as state safe patient handling laws, may not be fully protecting all direct care workers. Special attention is needed to research, prevent, and accommodate occupational injuries in nursing home CNAs.

In *Manuscript 2*, we evaluated the MN SPH Act by comparing temporal trends in statewide workers' compensation indemnity claims for patient handling injuries to claims for all other injuries and illnesses ('non-patient handling claims'). Compared to 3 pre-law years, patient handling claims declined by 25% in years 4-6 and 38% in years 7-9 following enactment of the law. Claims for all other injuries and illnesses declined by 20% in years 7-9 only. Fifty-five percent of nursing homes experienced a decline in patient handling claim rate and 44% experienced a decline in non-patient handling claim rate.

We also evaluated and compared temporal trends in injury severity using measures of workers' compensation benefits often awarded for relatively severe injuries: TTD and PPD benefits. Payment of TTD benefits declined for patient handling claims but not for non-patient handling claims, suggesting that patient handling injuries resulting in 3 or more days away from work are decreasing over time. Payment of PPD benefits declined

for both patient handling and non-patient handling claims. However, PPD awards with higher impairment ratings (i.e., higher proportion of the body impairment) declined for patient handling claims only.

Contrary to our hypothesis, associations between time and patient handling injuries were not modified by staffing or worker retention levels. However, independent of the law, facilities with annual retention ≥75% had a 17% lower patient handling claim rate compared to facilities with retention <65%. Further, elevated claim rates were observed for facilities that were non-profit (vs. for-profit), not hospital-affiliated (vs. hospital affiliated), or outside of the Minneapolis-Saint Paul metropolitan area (vs. metro area).

Our study adds to a small body of literature evaluating state safe patient handling legislation and is the only study to evaluate the effectiveness of a law in nursing homes. As injury and illness rates in nursing homes are consistently higher than rates in hospitals and outpatient settings, this is an important contribution. Our results also suggest that state SPH laws that exclusively require safe patient handling program implementation in hospitals are missing an opportunity to improve injury rates and protect direct care workers in nursing homes. The largest study limitation was lack of an external comparator (i.e., a state without SPH legislation). Declines in patient handling injuries in Minnesota nursing homes could be the result of the MN SPH Act, industry-wide safety initiatives and trends, or a combination of both. We sought to address this limitation in *Manuscript 3*.

In *Manuscript 3*, we compared temporal trends in workers' compensation indemnity and medical only claims in Minnesota to trends in Wisconsin, a state without safe patient handling legislation. In Minnesota and Wisconsin, patient handling injuries

comprised the largest proportion of claims in nursing homes (45% and 54%, respectively), followed by hospitals (27% and 19%, respectively), and finally outpatient settings (6% in both states). Patient handling claim rates declined in both Minnesota and Wisconsin, and the change in mean annual facility-level claim count from pre-law (2005-2007) to second post-implementation did not differ between states (2014-2017). In Wisconsin facilities, the mean count declined from 1.5 (95% CI 0.84-2.2) during the pre-law period to 0.58 (95% CI 0.37-0.78) during the second post-implementation period. In Minnesota facilities, the mean count declined from 1.4 (95% CI 0.98-1.7) during the pre-law period to 0.85 (95% CI 0.62-1.1) during the second post-implementation period. Across states, changes in patient handling claim rate over time did not differ by healthcare setting.

The use of an external comparator and inclusion of medical only claims, which comprise 77% of total workers' compensation claims in Minnesota,[52] addressed limitations of *Manuscript 2*. Further, the study allowed us to compare trends in workers' compensation claims among nursing homes, hospitals, and outpatient facilities. Though the small Wisconsin sample precludes generalizability of results and broad conclusions about the effectiveness of the MN SPH Act, it does highlight limitations in the current body of evidence. Published evaluations that lack external comparators and use pre-post designs to evaluate SPH laws and programs may be overstating their effects. Future evaluations of SPH laws should aim to include population-based samples and external comparators.

The objectives of our research were to provide a profile of patient handling injuries in Minnesota nursing home workers and to evaluate the effectiveness of the MN SPH Act

in reducing patient handling injury workers' compensation claims. Together, the present studies demonstrate that while workers' compensation claim rates for MSDs and patient handling injuries have significantly declined following enactment of the MN SPH Act, evidence on the impacts of the law itself is mixed. In Minnesota nursing homes, declines in MSD and patient handling claims were larger and occurred earlier than declines in claims for all other injuries and illnesses. However, in a smaller sample limited to enrollees with a single workers' compensation insurer, declines in patient handling injury claims did not differ between Minnesota and Wisconsin.

Regardless of the effects of the MN SPH Act, MSDs and patient handling injuries are elevated in Minnesota nursing homes with certain characteristics (i.e., those with low worker retention and those that are non-profit, not hospital-affiliated, or not located in the Minneapolis-Saint Paul metropolitan area) and specific occupational groups (i.e., CNAs). Our findings present an opportunity for state agencies and their partners in the academic, non-profit, and for-profit sectors to provide additional outreach and support to the facilities and workers that are most adversely affected by patient handling injuries. Importantly, our studies can also be used to inform pragmatic evaluations of state safe patient handling laws and future policymaking aimed at preventing occupational injuries in health care workers.

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Supplemental Table 1 Definitions of indemnity benefits captured by the Minnesota workers' compensation database (Manuscript 1)

Benefit	Abbreviation	Definition
Temporary partial disability	TPD	Partial wage replacement for the period an employee is back to work but earning less than their pre-injury wage (light duty at lower wage, reduced hours on the job). In general, TPD benefits are limited to 225 weeks.
Temporary total disability	TTD	Partial wage replacement for the period an employee is totally unable to work due to the injury or illness (full days away from work). In general, TTD benefits are limited to 104 weeks for injuries occurring prior to October 1, 2008 and 130 weeks thereafter. Workers determined to be permanently totally disabled can qualify for extended benefit payments.
Permanent partial disability	PPD	Payment for permanent functional loss of use of the body. An impairment rating reflects the percentage of disability to the body.
Stipulation settlement	-	Payment of a specific amount of money to settle disagreements about indemnity and medical benefits or, in the absence of a dispute, to provide a lump sum payment; the employee may forfeit the right to past or future benefits.

Supplemental Table 2 U.S. Bureau of Labor Statistics musculoskeletal disorder (MSD) definition, by version of Occupational Injury and Illness Classification System (Manuscript 1)

OIICS Version 1.01*	
Nature title	**Nature code**
Sprains, strains, tears	021
Back pain, hurt back	0972
Soreness, pain, hurt, except back	0973
Carpal tunnel syndrome	1241
Hernia	153
Musculoskeletal system and connective tissues diseases and disorders	17
Event title	**Event code**
Bending, crawling, reaching, twisting	211
Overexertion	22
Repetitive motion	23
OIICS Version 2.01 **	
Nature title	**Nature code**
Pinched nerve	1131
Herniated discs	1211
Meniscus tears	1221
Sprains, strains, tears	123
Hernias due to traumatic incidents	124
Soreness, pain, hurt – nonspecified injury	1972
Numbness – nonspecified injury	1974
Carpal tunnel syndrome	2241
Tarsal tunnel syndrome	2244
Raynaud's syndrome or phenomenon	2371
Hernia – nontraumatic	253
Musculoskeletal system and connective tissue diseases and disorders	27
Event title	**Event code**
Rubbed, abraded, or jarred by vibration	67
Overexertion and bodily reaction, unspecified	70
Overexertion involving outside sources	71
Repetitive motions involving microtasks	72
Other exertions or bodily reactions	73
Multiple types of overexertions and bodily reactions	78

OIICS=Occupational Injury and Illness Classification System

* OIICS version 1.01: MSDs must have a combination of exactly one nature category and exactly one event category from this table. Two- and three-digit categories include subcategories that are not listed separately.

** OIICS version 2.01: MSDs must have a combination of at least one nature category and at least one event category from this table. Two-and three-digit categories include subcategories that are not listed separately.

Supplemental Table 3 Injury category definitions, by version of Occupational Injury and Illness Classification System (Manuscript 1)

Injury category	Source code	Event code	Nature code
Patient handling injury [broad] OIICS V1.01 OIICS V2.01	573 574-575	Any	Any
Patient handling injury [narrow] OIICS V1.01 OIICS V2.01	573 574-575	Event and Nature combinations specified in MSD definition (see Supplementary Table II)	
Resident violence OIICS V1.01 OIICS V2.01	573 574-575	60-63 10-12	Any
Patient handling equipment OIICS V1.01 OIICS V2.01	344, 372, 775, 779 372, 757, 759, 775, 799	Any	Any
Slips, trips, and falls OIICS V1.01 OIICS V2.01	Not 573 Not 574-575	10-13 40-44	Any
Bodily reaction OIICS V1.01 OIICS V2.01	562 562	21 73	Any
Exposure to harmful substances OIICS V1.01 OIICS V2.01	Not 573 Not 574-575	30-39 50-59	Any

MSD=musculoskeletal disorder; OIICS=Occupational Injury and Illness Classification System; V=version

Supplemental Table 4 Minnesota Department of Labor & Industry patient handling and mobility activities (Manuscript 3)

PATIENT/RESIDENT HANDLING and MOBILITY ACTIVITY
1. Ambulating/walking patient
2. Bathing/diapering/dressing patient in bed
3. Bathing/showering/diapering/dressing patient other than in bed
4. Fall prevention (preventing patient fall) Used patient handling equipment (e.g. lift, assistive/transfer device)
5. Fall recovery (off floor/ground, after fall)
6. Lifting/holding limb/head/stomach/other body part
7. Lifting patient up while on ambulance (hydraulic) gurney/board
8. Making occupied bed
9. Managing uncooperative/aggressive behavior
10. Personal care in bed: feeding, brushing teeth/hair, other
11. Personal care other than in bed: feeding, brushing teeth/hair, other
12. Positioning/removing sling/assistive device
13. Repositioning/moving patient side-to side/up in bed/cot/gurney
14. Repositioning patient in chair/wheelchair
15. Transferring patient to/from toilet
16. Transferring patient in/out of vehicle
17. Transferring patient to/from bed/chair/wheelchair/commode/similar seated items
18. Transferring patient to/from bed/stretcher/trolley/exam table (lateral transfer - from lying position to lying position)
19. Transporting patient in wheelchair
20. Transporting patient by stretcher, gurney, trolley
21. No defined/listed cause Lifting patients all day

Supplemental Table 5 Adjusted incident rate ratios for total and patient handling workers' compensation claims, 2005-2017 (Manuscript 3)

	Total claims, IRR (95% CI)	**Wald χ^2 statistic (p-value)**	**Patient handling claims, IRR (95% CI)**	**Wald χ^2 statistic (p-value)**
State				
WI	1.0	.04 (p=.846)	1.0	.65 (p=.420)
MN	0.56 (0.39-0.80)		0.38 (0.18-0.80)	
Time period				
Pre-law	1.0	51.4 (p<.001)	1.0	30.7 (p<.001)
Implementation	0.76 (0.60-0.97)		0.85 (0.57-1.3)	
First post	0.66 (0.49-0.89)		0.61 (0.40-0.93)	
Second post	0.53 (0.38-0.75)		0.37 (0.24-0.59)	
Setting				
Outpatient	1.0	402.5 (p<.001)	1.0	416.8 (p<.001)
Hospital	2.3 (1.4-3.9)		4.0 (1.7-9.4)	
Nursing home	6.9 (4.7-10.1)		57.9 (27.2-122.8)	
State*Time period				
MN*Pre-law	1.0	3.3 (p=.353)	1.0	8.4 (p=.039)
MN*Implementation	1.1 (0.85-1.4)		0.90 (0.59-1.4)	
MN*First post	1.2 (0.9-1.6)		1.0 (0.66-1.7)	
MN*Second post	1.3 (0.91-1.9)		1.7 (0.98-2.8)	
State*Setting				
MN*Outpatient	1.0	10.5 (p=.005)	1.0	19.3 (p<.001)
MN*Hospital	2.4 (1.4-4.1)		6.4 (2.6-15.8)	
MN*Nursing home	1.5 (0.99-2.3)		1.4 (0.64-3.2)	

CI=confidence interval; IRR=incident rate ratio; MN=Minnesota; WI=Wisconsin

Supplemental Figure 1 Flow diagram for achieving study sample (Manuscript 2)