Why Surveillance Informatics is an Integral Part of a Safe Patient Handling Program: Occupational Injuries Due to Patient Handling and Movement in 116 US Hospitals, Occupational Health Safety Network, 2012-2016

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ABSTRACT

Background: Workplace musculoskeletal injuries due to patient handling and movement (PHM) are a significant occupational hazard for healthcare workers in the United States.

Methods: We analyzed workplace musculoskeletal injuries surveillance data submitted by hospitals participating in the Occupational Health Safety Network (OHSN) from 2012 to 2016. The data collected examined injuries in 116 US hospitals and provided detailed analysis of patient injury data.

Results: A total of 7,675 OSHA-recordable injury events were recorded by the OHSN participating hospitals, with an annual incidence rate of 13.1 injuries per 1,000 FTEs. Nursing assistants had the highest incidence rate of PHM injuries (40.2 per 1,000 FTE, 95% CI 31.0-52.2) followed by radiology technicians (26.2, 95% CI 21.5-32.0) and nurses (18.2, 95% CI 15.1-22.0). PHM injuries were clustered in locations providing direct patient care: more in inpatient locations than outpatient. Most injuries occurred while transferring or positioning a patient. Using lifting equipment is associated with fewer injuries and reduces the severity of these injuries.

Conclusion: Improved data collection is needed to improve safe patient handling programs (SPHPs). Nursing assistants, radiology technicians, and nurses are at the highest risk for injury. Surveillance information is key for providing evidence on all aspects of SPHP.

KEYWORDS

healthcare workers, occupational injury, workplace musculoskeletal injuries due to patient handling movement

INTRODUCTION

Healthcare workers in hospitals nationwide are at high risk of being injured on the job. Musculoskeletal disorders (MSDs) caused by overexertion (which includes heavy lifting), repetitive motion, and bending or twisting are among the most common injuries experienced by hospital workers[1]. Of the 282,750 MSD cases in private industry in 2017 that resulted in days lost from work, 57,030 (20%) were in the healthcare and social assistance industry sector. The source of injury or illness in about 49% of those cases (N=27,760) was a healthcare patient or resident of a healthcare facility. This accounted for approximately 10% of all private industry MSDs in 2017.

The successful implementation of a comprehensive safe patient handling program has been shown to reduce frequency and severity of occupational injuries among hospital workers[2-7]. Important components of a safe patient handling program are policy, program development, management and staff involvement, needs assessments, equipment, education and training, and evaluation. Such programs benefit patients, employers, and staff; their use is increasingly becoming the norm for hospitals and long-term care facilities[8].

However, ongoing surveillance of patient handling injuries is a necessary first step in developing the hospital-wide, interdisciplinary core competencies that enable safe patient handling programs to create the greatest benefit for patients, healthcare workers, facilities, and communities[9]. Such surveillance is also essential for making an effective business case, which is needed to justify a comprehensive safe patient handling program.

As part of its Occupational Health Safety Network (OHSN), the National Institute for Occupational Safety and Health (NIOSH) provided participating hospitals with a surveillance tool for monitoring patient handling and movement (PHM) injuries. OHSN, which operated from 2012 – 2018, was a voluntary surveillance system created by NIOSH to enable inpatient hospitals to promptly and securely track occupational injuries by injury type, occupation, location, and other factors and to share these data with NIOSH for multihospital-level aggregate analysis. The OHSN patient handling and movement injury module collected specific standard information, including root causes of injuries, and reported this information directly back to participating hospitals in a timely manner to guide interventions. As a resource

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for prevention tools to address priority patient handling injury risks, OHSN offered an objective measure to document the impact of intervention efforts. Such information is essential since most work-related patient handling injuries are preventable. Accurate and reliable surveillance information is key for all aspects of safe patient handling programs, such as building a culture of safety, management support, staff buy-in, setting clear expectations for staff and management, adequate equipment and safety practices, initial and ongoing training, and periodic evaluations.

We examined the utility of surveillance systems to hospitals using standardized data collection methods to track the occurrence and risk factors associated with workplace injuries. We also examined how the data may be used to better understand the work environment and direct prevention and intervention efforts. Such information is also necessary for identifying risk factors associated with workplace injuries, setting safety policy priorities, and guiding prevention and intervention efforts.

METHODS

Study Design and Population

To characterize the nature and extent of PHM injuries among OHSN-participating hospitals, and to identify potential risk factors, we analyzed PHM injury surveillance data submitted to OHSN from January 1, 2012 through June 30, 2016. During this study period, OHSN enabled participating facilities to track three categories of traumatic injury to healthcare personnel (HCP): 1) slips, trips, and falls; 2) musculoskeletal injuries resulting from PHM activities; and 3) workplace violence. Hospitals uploaded existing, de-identified occupational injury data through OHSN's secure, web-based data portal.

Hospitals had the option of using OHSN-provided data collection tools to record injuries reported or to convert injury data files in their own preexisting databases to standard OHSN data elements using the OHSN data conversion tool upon upload. The OHSN data elements are designed to characterize: first, the occupation and other demographics of the injured worker; second, the type, severity, cause, and location of the injury; and finally, information on the circumstances surrounding the injury occurrence. Standardization of data across all facilities allowed comparison within and across facilities.

As of June 30, 2016, there were 120 facilities that participated in OHSN by submitting data on at least one occupational injury category for at least one year between 2012 and 2016. Participation in OHSN required that facilities submit at least three months of data in a given calendar year. For this study, we included data from facilities that provided at least three months of PHM injury data in a given year between January 1, 2012 and June 30, 2016. We included data on all workers in OHSN-participating hospitals, with or without duties involving patient care. The analysis described the distribution of PHM injury characteristics and calculated incidence rates and incidence rate ratios for occupation, year, and selected facility-level variables.

Variables

The case definition used by OHSN facilities for reporting PHM injury events was any traumatic musculoskeletal injury sustained by an employee, contractor, or volunteer of a participating hospital while engaged in lifting, positioning, transferring, moving, or transporting a patient. While hospitals could report PHM injuries that do not meet OSHA recordability criteria to OHSN, we included only OSHA-recordable injury data.

We used variables to describe the demographic distribution of PHM injuries, which included the age group, sex, and occupation of the person who sustained the injury. Variables describing injury characteristics included severity (e.g., injuries resulting in days away from work, job transfer or restriction, or other OSHA-recordable injuries), nature (e.g., fracture, dislocation, sprain, and strain), and affected body part(s). Variables used to describe the circumstances surrounding the injury included the functional (e.g., inpatient, outpatient, and radiology) and physical locations (e.g., patient room, corridor, lavatory) where the injury occurred, the specific activity the injured HCP was engaged in at the time of the injury, the presence of any contributing patient (e.g., size or weight, uncooperative) or equipment (e.g., not accessible, not suitable for use) factors, and whether or not lifting equipment was used. Lifting equipment includes all transfer and lifting equipment; information on specific types was not collected.

We used predictor variables in the analysis of PHM injury rates, which included occupation, event year, and five categorical, facility-level variables: hospital type (such as general medical and surgical and children's hospitals); hospital size (in terms of number of beds); hospital location (in terms of urbanicity); hospital ownership; and affiliation with a medical school. We also included the ratio of nurse full-time equivalent workers (FTEs) to average monthly admissions as a continuous facility-level variable intended to serve as a proxy measure for staffing levels.

We used data on facility-level characteristics, including the annually updated number of overall and occupation-specific FTEs, which were obtained from annual American Hospital Association member surveys and confirmed or updated by participating hospitals[9].

Statistical Analysis

We described the frequency and proportional distribution of PHM injury characteristics. Denominator data were unavailable by age, sex, or event location; thus, we could not calculate rates for or evaluate the association of these factors with the occurrence of PHM injury. While it is possible, in principle, to calculate PHM injury rates by variables such as severity, nature, affected body part, etc., these variables were "unknown" or "unspecified" for a large proportion of events, which would undermine the validity of calculated rates and make interpretation difficult. Therefore, these variables are also described only in terms of frequency and proportional distribution.

To evaluate the association of selected characteristics of PHM injuries with the use or disuse of lifting equipment when the injury occurred, we cross-tabulated occupation, sex, age group, nature, se-

verity, injured body part, functional location, hospital type, hospital size, and hospital medical school affiliation by lifting equipment use for all cases where the use of lifting equipment was specified and exposure variables data were available (not missing). We calculated odds ratios and their Wald 95% confidence intervals to determine the statistical significance of the association of each category of the selected exposure variables with the odds that lifting equipment was being used when the PHM injury occurred.

PHM injury incidence rates were calculated as the number of injuries occurring per 1,000 FTE. For OHSN purposes, a hospital's annual number of FTEs is defined as the ratio of total employee-hours worked in a year to the number of hours normally worked by a full-time employee—2,000 hours, based on working 40 hours per week and 50 weeks per year. Annual denominators for rates were calculated at a hospital based on the number of months of observation; i.e., the number of months that the hospital reported data to OHSN divided by 12. Pooled mean incidence rates for groups of facilities were calculated as the total number of events occurring at all the facilities of interest divided by the sum of the FTE denominators for the same facilities. Because OHSN facilities report occupation-specific as well as total numbers of FTEs each year, occupation-specific incidence rates were calculated as well. Poisson-based 95% confidence intervals were calculated for all rates.

Bivariate incidence rate ratios (IRR) and their 95% confidence intervals were calculated using Poisson regression to assess the association of occupation as well as event year and selected facility characteristics. For categorical variables, the largest categories in terms of FTE or number of facilities were selected as reference groups except for event year. In bivariate analyses, event year was analyzed as a categorical variable with 2012 as the reference.

Because study data consisted of events clustered within hospitals, all standard errors for incidence rates and bivariate IRRs were adjusted to account for correlated data by specifying hospital as a repeated measure in the Poisson regression models.

To evaluate the relationship between occupation and the rate of PHM events while controlling for the effect of event year and selected hospital characteristics, we modeled IRR using negative binomial regression. We used negative binomial rather than Poisson regression for our multivariable analyses because preliminary analyses suggested that the data were over-dispersed (i.e., the assumption that the data variance is equal to the mean was violated). Additionally, because study data consisted of events clustered within hospitals, with some covariates measured at the hospital level, the study model was partially ecologic. Therefore, to account for the hierarchical structure of the data, a generalized multilevel, multivariable model using the SAS GLIMMIX procedure was constructed to estimate adjusted IRR for all independent variables (fixed effects), while specifying hospital as a random effect. In the multivariable analysis, event year was analyzed as a continuous variable, with IRR representing the average annual rate change over the study period.

All analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC).

Human Subjects Review

The NIOSH Human Subjects Review Board determined that the activities in this study were conducted to provide information on how to tailor a proven-effective intervention, service, or program in a specific setting or context and did not meet the criteria of research according to 45 CFR 46.1101(b)(2).

RESULTS

Between January 1, 2012 and June 30, 2016, a total of 116 hospitals reported PHM injury surveillance data to OHSN in at least one calendar year of the study period. A total of 7,675 OSHA-recordable PHM injury events were reported by these hospitals.

The distribution of PHM injury characteristics is presented in Table 1. By occupation, nurses sustained the most PHM injuries (n=3,449, 44.9%), followed by nursing assistants (n=1,997, 26.0%). Combined, these two occupation categories account for more than two-thirds of all PHM injuries. By sex, females were most often injured, accounting for 78.4% (n=6,014) of all PHM injuries.

The most injured body part was the back, accounting for 44.2% of all PHM injuries (n=3,390). One quarter of the injuries (n=1,943, 25.3%), however, occurred to HCW upper extremities, with shoulder injuries representing the largest proportion (n=887, 45.7% of upper extremity injuries, data not shown). The most reported type of injury was soreness/pain/hurt (n=3,217, 41.9%) followed by sprains, strains, or tears (n=2,273, 29.6%). Ten percent (n=780, 10.2%) of PHM injuries involved job transfer or restriction, and 5.3% (n=405) involved lost workdays.

Inpatient care locations were the most common functional location of PHM injuries (n=5,019, 65.4%), followed by outpatient care locations (n=1,045, 13.6%). Analysis of more detailed functional location data (data not shown) reveal that, within inpatient care locations, adult wards were the most common detailed functional locations for PHM injuries (n=2,795, 55.7% of inpatient cases), followed by adult critical care units (n=732, 14.6% of total). Within outpatient care locations, the most common detailed functional location of PHM injuries was the emergency department (n=684, 65.5% of outpatient cases). The most common physical locations where PHM injuries occurred were patient rooms (n=4,074, 53.1%) and exam rooms (n=585, 7.6%). One fifth (n=1,627, 21.1%) of the functional locations were unknown or not specified.

For a majority of PHM injury cases, activity (n=4,808, 62.6%) and contributing factor (n=5,254, 68.5%) were reported as "unknown or not specified" (Table 1). Most of the 2,867 cases where an activity was reported fell into the catch-all category "other activity". However, among the 1,958 cases where a specific activity was reported, most occurred while

Table 1. Characteristics of Patient Handling and Movement Injuries (n=7,675)

Characteristic		Number of injuries (%)
Occupation		
	Physicians, dentists and interns	11 (0.1)
	Nurses	3,449 (44.9)
	Pharmacists and pharmacy technicians	3 (0.0)
	Nursing assistants	1,997 (26.0)
	Radiology technicians	442 (5.8)
	Laboratory professionals	36 (0.5)
	Respiratory therapists	49 (0.6)
	Other trainees	21 (0.3)
	All others, including	1,490 (19.4)
	Unknown or not specified	177 (2.3)
Sex		
	Female	6,014 (78.4)
	Male	982 (12.8)
	Not specified	679 (8.9)
Age Group		
	34 yrs or younger	2,859 (37.3)
	35 - 54 yrs	3,800 (49.5)
	55 yrs or older	1,016 (13.2)
Injured Body Part		
	Head & neck	359 (4.7)
	Back (incl. spine & spinal cord)	3,390 (44.2)
	Trunk (excl. back)	377 (4.9)
	Upper extremities (shoulder)	887 (11.6)
	Upper extremities (all others)	1,056 (13.8)
	Lower extremities	490 (6.4)
	Body systems	56 (0.7)
	Other body part	17 (0.2)
	Unknown or not specified	1,043 (13.6)
Injury Nature		
	Crushing injuries	1 (0.0)
	Dislocations	10 (0.1)
	Fractures	11 (0.1)
	Internal injuries to organs	19 (0.3)
	Intracranial injuries	7 (0.1)
	Multiple non-specified injuries	1 (0.0)
	Multiple traumatic injuries	2 (0.0)
	Non-classifiable injuries	21 (0.3)
	Open wounds	35 (0.5)
	Other traumatic injuries	251 (3.3)
	Soreness, pain, hurt	3,217 (41.9)
	Sprains, strains, tears	2,273 (29.6)
	Surface wounds and bruises	355 (4.6)
	Unknown or not specified	1,472 (19.2)

Characteristic		Number of injuries (%)
Severity		
	OSHA recordable, Days away from work	405 (5.3)
	OSHA recordable, Job transfer or restriction	780 (10.2)
	OSHA recordable, All other cases	6,488 (84.5)
	Unknown or not specified	2 (0.0)
Functional Location		
	Inpatient locations	5,019 (65.4)
	Outpatient locations	1,045 (13.6)
	Radiology locations	443 (5.8)
	Non-radiology procedure locations	3 (0.0)
	Non-patient care locations	240 (3.1)
	Unknown or not specified	925 (12.1)
Physical Location		
	Patient room	4,074 (53.1)
	Patient bathroom	185 (2.4)
	Exam room	585 (7.6)
	Operating Room	312 (4.1)
	Kitchen/dietary/cafeteria/dining/break room	6 (0.1)
	Facility entrance/exit/lobby/foyer	116 (1.5)
	Waiting room area	30 (0.4)
	Corridor/hallway/elevator/stairwell	364 (4.7)
	Nurses' station	23 (0.3)
	Office/workstation	34 (0.4)
	Public bathroom/staff bathroom/staff locker room	15 (0.2)
	Outside hospital	45 (0.6)
	Off-site home/patient residence	4 (0.1)
	Other room or location	253 (3.3)
	Unknown or not specified	1,627 (21.2)
Activity		
	Performing patient hygiene	109 (1.4)
	Positioning patient	653 (8.5)
	Transferring patient	900 (11.7)
	Transporting patient	198 (2.6)
	Responding to patient medical emergency	34 (0.4)
	Sustained lifting/holding of body parts	64 (0.8)
	Other activity	909 (11.8)
	Unknown or not specified	4,808 (62.6)
Contributing Factor		
	Patient factor (patient size or weight)	1,574 (20.5)
	Patient factor (all others)	237 (3.1)
	Equipment factor	274 (3.6)
	Other factor	336 (4.4)
	Unknown or not specified	5,254 (68.5)
Lifting equipment used		
	Yes	816 (10.6)
	No	4,159 (54.2)
	Unknown or not specified	2,700 (35.2)

transferring (n=900, 46.0%) or positioning (n=653, 33.4%) a patient. Among the 2,421 cases where a contributing factor was identified, the most common were patient factors (n=1,811, 74.8%). More specifically, the patient's size or weight was identified as a contributing factor in 1,574 (86.9%) of these cases. Data on whether lifting equipment was being used when the PHM injury occurred was missing or unspecified in 35.2% (n=4,975) of cases. Among the 4,975 injury cases where data was available, lifting equipment was not being used 83.6% (n=4,159) of the time.

The cross-tabulation of selected variables by lifting equipment use is shown in Table 2. Nature of injury, injured body part, functional location, and hospital size were all significantly associated with the use of lifting equipment when the injury occurred. Compared with those that resulted in sprains, strains, or tears, PHM injuries that resulted in surface wounds and bruises were half as likely to have occurred in conjunction with lifting equipment use (OR 0.5, 95% CI 0.3-0.8). Compared with injuries to the back, lower extremity injuries were 70% more likely to have occurred when lifting equipment was being used (OR 1.7, 95% CI 1.2-2.3). Compared with inpatient locations, injuries that occurred in outpatient locations were 30% less likely to involve lifting equipment use (OR 0.7, 95% CI 0.5-0.9). Injuries that occurred in radiology settings compared to inpatient were 40% more

likely to have involved the use of such equipment (OR 1.4, 95% CI 1.1-1.9). Compared with medium-sized hospitals, injuries occurring in large hospitals were 30% more likely to involve the use of lifting equipment (OR 1.3, 95% CI 1.1-1.5). Additionally, severity was also found to be associated with the use of lifting equipment, but the significance of the association was marginal. Compared to other OSHA-recordable injuries, those that did result in days away from work were 30% less likely to have occurred in conjunction with the use of lifting equipment (OR 0.7, 95% CI 0.5-1.0).

For the analysis of PHM incidence rates, we excluded data from one hospital due to unreliable denominator data; thus, incidence rates are based on a sample of 115 hospitals. Collectively, the 115 hospitals contributed 577,388 FTEs of observation during the study period, during which 7,562 PHM injuries occurred, corresponding to an overall PHM injury incidence rate of 13.1 events per 1,000 FTE (95% CI: 12.8-13.4). However, analyses of PHM injury incidence rates by event and facility characteristics were based on a total numerator of 7,262 cases because we excluded 300 events that could not be classified due to missing occupation or other covariate data.

Crude PHM injury incidence rates and IRRs by occupation, event year, and hospital type, hospital size, urbanicity, and medical school affiliation are shown in Table 3. We also present the IRR for the nurse FTEs to average monthly admissions ratio, the continuous staffing level proxy variable.

Nursing assistants had the highest incidence rate of PHM injuries (40.2 per 1,000 FTE, 95% CI 31.0-52.2) followed by radiology technicians (26.2, 95% CI 21.5-32.0) and nurses (18.2, 95% CI 15.1-22.0). Pharmacists (and pharmacy technicians) (0.2, 95% CI 0.1-0.9) and physicians (0.4, 95% CI 0.2-0.7) had the lowest rates of PHM injuries. Compared with all other HCW, including non-patient care personnel, nursing assistants (IRR 7.3, 95% CI 5.7-9.4), radiology technicians (IRR 4.8, 95% CI 3.7-6.2), and nurses (IRR 3.3, 95% CI 2.8-3.9) all

Table 2. Use of Lifting Equipment by Selected Characteristics of PHM Injuries

	Lifting Equipment Used				
	No	Yes			
Characteristic	Number of injuries (%)	Number of injuries (%)	Total	OR*	95% CI†
Occupation					
Physicians, dentists and residents	6 (0.2)	1 (0.1)	7	0.8	(0.1-6.7)
Nurses	1,879 (46.3)	351 (43.9)	2,230	0.9	(0.7-1.1)
Pharmacists and pharma	1 (0.0)	0 (0.0)	1	Undef.	Undef.
Nursing assistants	1,119 (27.6)	208 (26.0)	1,327	0.9	(0.7-1.1)
Radiology technicians	211 (5.2)	58 (7.3)	269	1.3	(0.9-1.8)
Laboratory professionals	8 (0.2)	2 (0.3)	10	1.2	(0.3-5.7)
Respiratory therapists	21 (0.5)	6 (0.8)	27	1.4	(0.5-3.4)
Other trainees	7 (0.2)	4 (0.5)	11	2.7	(0.8-9.5)
All others, including	810 (19.9)	169 (21.2)	979	Ref	
Total	4,062 (100.0)	799 (100.0)	4,861		
Sex					
Female	3,310 (85.6)	610 (83.9)	3,920	Ref	
Male	558 (14.4)	117 (16.1)	675	1.1	(0.9-1.4)
Total	3,868 (100.0)	727 (100.0)	4,595		
Age group					
34 yrs or younger	1,578 (37.9)	286 (35.1)	1,864	0.9	(0.7-1.0)
35 - 54 yrs	2,022 (48.6)	424 (52.0)	2,446	Ref	
55 yrs or older	559 (13.4)	106 (13.0)	665	0.9	(0.7-1.1)
Total	4,159 (100.0)	816 (100.0)	4,975		
Nature of injury					
Crushing injuries	1 (0.0)	0 (0.0)	1	Undef.	Undef.
Dislocation	5 (0.2)	2 (0.3)	7	2.0	(0.4-10.4)
Fractures	8 (0.2)	1 (0.2)	9	0.6	(0.1-5.0)
Internal injuries to organ	9 (0.3)	5 (0.8)	14	2.8	(0.9-8.4)
Intracranial injury	6 (0.2)	1 (0.2)	7	0.8	(0.1-7.0)
Multiple traumatic injuries	2 (0.1)	0 (0.0)	2	Undef.	Undef.
Non-classifiable injuries	8 (0.2)	1 (0.2)	9	0.6	(0.1-5.0)
Open wounds	19 (0.6)	6 (1.0)	25	1.6	(0.6-4.0)
Other traumatic injuries	118 (3.6)	15 (2.5)	133	0.6	(0.4-1.1)
Soreness, pain, hurt	1,636 (49.7)	308 (50.2)	1,944	0.9	(0.8-1.1)
Sprains, strains, tears	1,265 (38.5)	252 (41.1)	1,517	Ref	
Surface wounds and bruises	212 (6.5)	22 (3.6)	234	**0.5**	**(0.3-0.8)**
Total	3,289 (100.0)	613 (100.0)	3,902		
Severity					
OSHA recordable, Days away from work	319 (7.7)	47 (5.8)	366	0.7	(0.5-1.0)
OSHA recordable, Job transfer or restriction	432 (10.4)	92 (11.3)	524	1.1	(0.8-1.4)
OSHA recordable, All other cases	3,408 (81.9)	677 (83.0)	4,085	Ref	
Total	4,159 (100.0)	816 (100.0)	4,975		
Injured body part					
Back (incl. spine & spinal cord)	1,804 (52.3)	306 (49.2)	2,110	Ref	
Body systems	27 (0.8)	7 (1.1)	34	1.5	(0.7-3.5)
Head & neck	179 (5.2)	34 (5.5)	213	1.1	(0.8-1.6)
Lower extremities	231 (6.7)	66 (10.6)	297	**1.7**	**(1.2-2.3)**
Other body part	10 (0.3)	1 (0.2)	11	0.6	(0.1-4.6)
Trunk (excl. back)	200 (5.8)	36 (5.8)	236	1.1	(0.7-1.5)
Upper extremities (incl. shoulder)	999 (29.0)	172 (27.7)	1,171	1.0	(0.8-1.2)
Total	3,450 (100.0)	622 (100.0)	4,072		
Functional location					
Inpatient locations	2,732 (74.5)	577 (77.8)	3,309	Ref	
Outpatient locations	594 (16.2)	86 (11.6)	680	**0.7**	**(0.5-0.9)**
Radiology locations	206 (5.6)	63 (8.5)	269	**1.4**	**(1.1-1.9)**
Non-radiology procedure locations	3 (0.1)	0 (0.0)	3	Undef.	Undef.
Non-patient care locations	133 (3.6)	16 (2.2)	149	0.6	(0.3-1.0)
Total	3,668 (100.0)	742 (100.0)	4,410		
Hospital type					
Children	22 (0.5)	5 (0.6)	27	1.2	(0.4-3.1)
Med/Surg	4,099 (98.6)	801 (98.2)	4,900	Ref	
Other	38 (0.9)	10 (1.2)	48	1.3	(0.7-2.7)
Total	4,159 (100.0)	816 (100.0)	4,975		
Hospital size					
Large	977 (23.5)	219 (26.8)	1,196	**1.3**	**(1.1-1.5)**
Medium	2,549 (61.3)	455 (55.8)	3,004	Ref	
Small	633 (15.2)	142 (17.4)	775	1.3	(1.0-1.5)
Total	4,159 (100.0)	816 (100.0)	4,975		
Affiliated with a medical school					
No	1,071 (25.8)	226 (27.7)	1,297	Ref	
Yes	3,088 (74.3)	590 (72.3)	3,678	0.9	(0.8-1.1)
Total	4,159 (100.0)	816 (100.0)	4,975		

*OR=Odds Ratio

†CI=Confidence Interval

Odds Ratios in **bold** are statistically significant

Table 3. PHM Injury Incidence Rates and Rate Ratios by Occupation, Year, and Selected Facility Characteristics

Characteristic	Number of Hospitals (n=115)	FTE* (n=577,388)	Injuries (n=7,262)	Rate per 1,000 FTE	95% CI†	IRR‡	95% CI†
Occupation							
Physicians, Dentists, Interns, Residents	115	26,301	11	0.4	(0.2-0.7)	**0.1**	**(0.0-0.1)**
Nurses	115	184,577	3,356	18.2	(15.1-22.0)	**3.3**	**(2.8-3.9)**
Pharmacists and Pharm Technicians	115	13,873	3	0.2	(0.1-0.9)	**0.0**	**(0.0-0.2)**
Nursing Assistants	115	48,274	1,942	40.2	(31.0-52.2)	**7.3**	**(5.7-9.4)**
Radiology Technicians	115	16,037	421	26.2	(21.5-32.0)	**4.8**	**(3.7-6.2)**
Laboratory Professionals/Technicians	115	13,853	36	2.6	(0.9-7.0)	0.5	(0.2-1.4)
Respiratory Therapists	115	8,961	47	5.2	(3.6-7.7)	1.0	(0.6-1.4)
Other Trainees	115	3,283	8	2.2	(0.4-11.2)	0.4	(0.1-2.0)
Other	115	262,229	1,438	5.5	(4.5-6.8)		Ref
Year							
2012	79	112,448	1,418	12.6	(9.4-16.9)		Ref
2013	95	139,371	1,758	12.6	(9.8-16.1)	1.0	(0.9-1.2)
2014	100	130,566	1,747	13.4	(10.8-16.6)	1.1	(0.8-1.4)
2015	103	130,876	1,616	12.3	(10.0-15.2)	1.0	(0.7-1.3)
2016	95	64,127	723	11.3	(8.8-14.3)	0.9	(0.7-1.2)
Hospital Type							
Children	2	20,120	50	2.5	(2.1-2.9)	**0.2**	**(0.2-0.2)**
Other	5	3,270	84	25.1	(11.0-57.2)	2.0	(0.8-4.6)
Med/Surg	108	553,999	7,128	12.9	(10.6-15.7)		Ref
Facility Size							
Large (≥ 500 beds)	14	225,413	1,792	7.9	(5.4-11.7)	**0.6**	**(0.4-0.9)**
Medium (200-499 beds)	41	267,980	4,305	16.1	(13.2-19.5)	1.2	(0.9-1.5)
Small (< 200 beds)	60	83,995	1,165	13.8	(11.7-16.3)		Ref
Facility Location§							
Division	1	9,722	196	20.2	(20.2-20.2)	**1.6**	**(1.3-2.0)**
Metro	101	552,216	6,826	12.4	(10.1-15.1)		Ref
Micro	6	10,240	167	16.2	(11.6-22.8)	1.3	(0.9-2.0)
Rural	7	5,209	73	13.9	(9.8-19.9)	1.1	(0.7-1.7)
Medical School Affiliation							
No	61	131,416	1,819	13.8	(11.7-16.3)	1.1	(0.8-1.5)
Yes	54	445,971	5,443	12.2	(9.5-15.6)		Ref
Hospital Ownership							
Public	3	11,539	63	5.5	(4.5-6.7)	**0.4**	**(0.3-0.6)**
Private	112	565,849	7,199	12.7	(10.4-15.5)		Ref
Avg ratio of nurse FTE to admissions	--	--	--	--	--	**0.1**	**(0.0-0.4)¶**

* FTE=Full Time Equivalent Workers

† CI=Confidence Interval

‡ IRR=Incidence Rate Ratio

¶ IRR reflects change in incidence rate per 1-point increase in the nurse FTE : monthly admissions ratio

§ Based on U.S. Office of Management and Budget Core-Based Statistical Area (CBSA) designation: Metropolitan Division (large urban), Metropolitan (urban), Micropolitan (small urban) or non-CBSA (rural).

IRRs in **bold** are statistically significant.

experienced significantly higher rates of PHM injuries. By comparison, pharmacists (IRR 0.0, 95% CI 0.0-0.2) and physicians (IRR 0.1, 95% CI 0.0-0.1) had significantly lower rates.

Overall, PHM injury incidence rates did not vary significantly from the 2012 baseline during the first five years of the study period (data not shown).

Each of the facility characteristics we examined was significantly associated with the PHM injury incidence rate in the bivariate analyses, except for medical school affiliation. Children's hospitals had significantly lower rates compared to general medical and surgical hospitals (IRR 0.2, 95% CI 0.2-0.2). Compared with small hospitals, large hospitals had significantly lower rates (IRR 0.6, 95% CI 0.4-0.9). Compared with those in metropolitan areas, hospitals in large urban (division) areas (IRR 1.6, 95% CI 1.3-2.0) had significantly higher rates. Publicly-owned hospitals had significantly lower rates than private hospitals (IRR 0.4, 95% CI 0.3-0.6). Increasing ratios of nurse FTEs to average monthly admissions were significantly associated with lower PHM injury rates (IRR 0.1, 95% CI 0.0-0.4).

In the multilevel, multivariable model that adjusted for the effects of all covariates simultaneously—as well as the random effect of hospital characteristics—only occupation and hospital type remained significantly associated with PHM injury incidence rates (Table 4).

Nursing assistants had PHM injury incidence rates that were nearly seven times that of all other HCW, including non-patient care personnel (IRR 6.7, 95% CI 5.8-7.6). The rate for radiology technicians was nearly five times that of all other HCW, including non-patient care personnel (IRR 4.8, 95% CI 4.1-

5.6), and the rate for nurses was over three times as high (IRR 3.1, 95% CI 2.8-3.6). By comparison, pharmacists (IRR 0.0, 95% CI 0.0-0.1), physicians (IRR 0.1, 95% CI 0.0-0.1), and lab techs (IRR 0.4, 95% CI 0.3-0.5) had rates that were significantly lower than that for all other HCW, including non-patient care personnel. Children's hospitals had PHM injury incidence rates that were 80% lower than general medical/surgical hospitals (IRR 0.2, 95% CI 0.0-0.5).

DISCUSSION

We examined PHM injuries in 116 US hospitals and evaluated how OHSN tools can help participating hospitals implement a safe patient handling program.

OHSN helped participating hospitals to better understand the magnitude of the problem in terms of injury number, rates, and distribution by job category, department, and risk factors. A total of 7,675 OSHA-recordable PHM injury events were recorded by the OHSN participating hospitals, with an annual incidence rate of 13.1 injuries per 1,000 FTEs. These injuries included 405 (5.3%) days away from work and 780 (10.2%) job transfers or restrictions. According to one large national survey drawn from 53 healthcare systems with roughly 1,000 hospitals in all 50 states, patient handling injuries accounted for 25% of all workers' compensation claims for the healthcare industry in 2011[10]. On average, workers' compensation claims related to patient handling and movement injuries cost $15,600. Wage replacement accounted for nearly 80% ($12,000) of this cost. In terms of wage replacement, patient handling and movement injuries are among the most expensive types of hospital worker injuries.

Table 4. Multivariable-adjusted PHM Injury Incidence Rate Ratios by Occupation and Selected Facility Characteristics

Characteristic	IRR*†	95% CI‡
Occupation		
Physicians	**0.1**	**(0.0-0.1)**
Nurses	**3.1**	**(2.8-3.6)**
Pharmacists	**0.0**	**(0.0-0.1)**
Nursing Assistants	**6.7**	**(5.8-7.6)**
Radiology Techs	**4.8**	**(4.1-5.6)**
Lab Techs	**0.4**	**(0.3-0.5)**
Respiratory Therapists	0.8	(0.6-1.1)
Other Trainees	1.0	(0.5-2.0)
Others, including non-patient care personnel	Ref	
Hospital Type		
Children's	**0.2**	**(0.0-0.5)**
Other	1.5	(0.6-3.6)
General Medical and Surgical	Ref	
Facility Size		
Large (≥ 500 beds)	0.6	(0.3-1.1)
Medium (200-499 beds)	1.3	(0.8-2.0)
Small (< 200 beds)	Ref	
Facility Location**		
Division	1.5	(0.3-8.0)
Metro	Ref	
Micro	1.0	(0.5-2.1)
Rural	1.1	(0.5-2.3)
Medical School		
Not affiliated with a medical school	1.1	(0.7-1.7)
Affiliated with a medical school	Ref	
Hospital Ownership		
Public	0.6	(0.2-1.7)
Private	Ref	
IRR Year	1.0	(0.9-1.0)¶
IRR Nurse FTEs to Admissions	2.0	(0.8-4.7) §

* IRR=Incidence Rate Ratio

† IRRs adjusted for the effect of all other variables in table

‡ CI=Confidence Interval

¶ IRR reflects average annual change in incidence rate

§ IRR reflects change in incidence rate per 1-point increase in the nurse FTE : monthly admissions ratio

** Based on U.S. Office of Management and Budget Core-Based Statistical Area (CBSA) designation: Metropolitan Division (large urban), Metropolitan (urban), Micropolitan (small urban) or non-CBSA (rural).

IRRs in **bold** are statistically significant.

The NIOSH OHSN enabled participating hospitals to identify which occupations experience the highest rates and counts of patient handling injuries. Overall, for the 116 OHSN participating facilities, rates of patient handling injuries were highest among nurse assistants, radiology technicians, and nurses. In contrast, physicians, dentists, interns, and residents had low injury rates. These data indicate prioritizing prevention resources and intervention efforts on occupations with high injury prevalence (Table 1). OSHA has stated every injury counted has an indirect cost that is estimated to be three to five times the direct cost[11]. For example, the consequences of work-related musculoskeletal disorders (MSD) among nurses are substantial. Along with higher employer costs due to medical expenses, disability compensation, and litigation, nurse injuries also are costly in terms of chronic pain and functional disability, absenteeism, and turnover. Several studies have tried to estimate the cost of replacing a nurse who leaves the profession, factoring in the cost associated with separation, recruitment, hiring, productivity loss, and orientation and training. These studies estimate those costs to range between $27,000 and $103,000 per nurse[7, 10].

These results highlight the high risk of PHM to nursing assistants. Nursing assistants and orderlies, sometimes called nursing aides, help provide basic care

for patients in hospitals and residents of long-term care facilities. They transport patients and clean treatment areas[12]. Studies show that nursing assistants accounted for the greatest proportion of MSD cases involving a patient (43%), while registered nurses accounted for 20% and personal care aides for another 8%[1]. The MSD incidence rate for nursing assistants was 171.0 cases per 10,000 full-time workers in 2015 compared to 94 for heavy and tractor-trailer truck drivers and 107 for laborers and freight, stock, and material movers[13].

In addition to nurses and nursing assistants, these results highlighted the high risk of PHM injury for radiology technicians. Safe and effective patient handling techniques and operations are important in the radiology department. In a radiology department, lifting activities such as transferring patients on scanner beds and X-ray tables, and positioning patients into bed to put an X-ray plate behind them, are common. Diagnostic imaging modalities face a variety of patient handling tasks such as transferring patients from a stretcher or wheelchair to an exam table and then back again. Ultrasound, X-ray, Computed Tomography (CT), and interventional radiology also frequently require radiology technicians to manually reposition patients to obtain optimal imaging. It is important to note that most imaging procedures are performed by one technician, including transporting, transferring, and positioning the patient in order to obtain a diagnostic exam[14-16].

The NIOSH OHSN also helped participating hospitals to implement or manage their safe patient handling programs by identifying which departments had the highest rates of worker injuries associated with handling patients. Patient handling injuries reported to OHSN were clustered in locations providing direct patient care: more in inpatient locations than outpatient, patient room, radiology department, examination room, operating room, and corridor/hallway/elevator/stairwell (Table 1). Analysis of detailed, facility-level data could identify the higher-risk occupations and physical locations and assist in customizing prevention measures.

Table 5 shows the list of OHSN activities the health care worker was performing at the time the patient handling movement (PHM) injury occurred and lifting equipment use at time of injury.

Health care worker activity	Equipment use during patient handling activity
Hygiene: Bathing patient in bed	1. Yes 2. NO 3. Not Applicable, not appropriate for the activity 4. Not known
Hygiene: Bathing/Toileting patient in bathroom	
Hygiene: Dressing/Undressing or diapering patient	
Hygiene: Other	
Positioning: Positioning/Repositioning in bed or stretcher	
Positioning: Positioning/Repositioning in chair	
Positioning: Other	
Responding to patient medical emergency	
Sustained Lifting /Holding of body part(s)	
Transfer: Transferring/Lifting to/from bed or chair	
Transfer: Transferring/Lifting from floor	
Transfer: Lateral transfer of patient to/from bed.	
Transfer: Transferring/Lifting deceased patient	
Transfer: Other	
Transport: Moving patient by wheelchair	
Transport: Moving patient by stretcher, bed, litter, trolley, etc.	
Transport: Escorting patient without equipment	
Transport: Other	
Assisting patient to walk	
Other: Specify	

The NIOSH OHSN further guided participating hospitals' implementation and operation of their safe patient handling programs by identifying which activities account for the highest number or severity of injuries. Participating hospitals also use OHSN to document lifting equipment use during patient handling activities (Table 5).

Documenting activities which lead to patient handling injuries provided unique details useful in developing safety interventions targeting specific patient handling tasks. Targeting prevention strategies can protect healthcare personnel from potentially disabling injuries and help in managing resources. Our analyses of these activities indicate the need to improve and foster complete collection of all activities which led to patient handling injuries as listed in Table 5. However, our analyses also indicate that certain of these are especially important. Among cases where a specific activity was reported, most injuries occurred while transferring or positioning a patient, which is consistent with existing studies. Among cases where a contributing factor was identified, the most common by far were patient factors. More specifically, the patient's size or weight was identified as a contributing factor in 87% of these cases.

It is essential for safe patient handling programs to document the impact of interventions such as reducing the number and severity of employee injuries and lost days from work. OHSN helped participating hospitals to measure that impact. Our analyses showed that independent of occupation, hospital location, age, gender, and hospital type, using lifting equipment reduced patient handling injuries. Multiple studies showed that hospitals with successful safe patient handling programs have found they can significantly reduce the number of employee injuries and lost workdays from injuries. For example, injury rates were significantly lower after safe patient handling programs were introduced in 23 high-risk units across seven South-

east Veterans Health Administration facilities. The injury rate fell from 16.9 per 100 workers per year to 14, a 30% reduction[10]. During 2012-2016, one of our participating hospital systems in OHSN showed a reduction of patient handling injuries from 25 injuries per 1,000 admissions to 18 injuries per 1,000 admissions, using their information from OHSN as a guide for intervention. Of course, lifting equipment alone is not enough; it must be part of comprehensive safe patient handling programs and properly implemented. Proactive assessment of each patient's mobility and lifting requirement is essential.

Our findings are also consistent with published studies which show that using lifting equipment is not only associated with fewer injuries, but also reduces severity of those injuries. Our study showed using lifting equipment may be associated with a reduction in OSHA recordable patient handling injuries with days away from work. Injuries associated with days away from work are an indication of injuries severity in our study. The aforementioned information is essential for any OHSN participating hospital when using their corresponding data for building a business case for safe patient handling programs. A substantial proportion (35%) of records were missing data on the use of lifting equipment. If their data were not missing at random with respect to the use or disuse of lifting equipment, this could have biased the results of the analyses involving that variable.

The OHSN and NIOSH topic pages provided links to helpful resources on safe patient handling methods to prevent patient handling injuries among healthcare personnel[17, 18]. Collaboration of hospitals with NIOSH occupational safety and health programs have fostered research to identify injury risk factors and safety interventions to prevent injuries during patient handling. Using a standard surveillance tool, OHSN enabled participating hospitals to perform long-term tracking of patient handling injuries, view trends over time, and objectively monitor intervention impact.

To date, no federal safe patient handling laws have been enacted. Safe patient handling laws have been enacted in 11 states[18]. According to the proceeding of the Fifth International Congress on Applied Human Factors and Ergonomics, only 11% of US hospitals have "successful" safe patient handling programs that will reduce patient handling injuries.

NIOSH OHSN demonstrated the ability to create both an informatics and prevention tool to reduce patient handling injuries by helping essential components of safe patient handling programs. OHSN helped hospitals to clearly see patient handling problems in order to guide them to the appropriate solutions. OHSN empowered participating hospitals to identify and prioritize the specific patient handling tasks or practices that are associated with PHM injuries in their facilities. When used to guide prevention and intervention efforts, this information may substantially reduce musculoskeletal injuries among hospital workers (anecdotal confidential report).

With its Standard Occupational Data Architecture (SODA), NIOSH OHSN provided specific, standardized definitions for data elements that could be used to record various aspects of PHM injuries (Table 5). This allowed participating hospitals to categorize and summarize PHM injury data in ways useful for identifying and implementing prevention strategies and interventions. Other commonly-used injury classification systems, such as the Bureau of Labor Statistics' Occupational Injury and Illness Classification System (OIICS), https://www.bls.gov/iif/oshoiics.htm, cannot capture the context-specific characteristics of PHM injuries necessary for implementing prevention measures. Safe patient handling programs would benefit from such a classification scheme that enables the detailed, context-specific characterization of PHM injuries and, therefore, the comparable assessment of risk factors and the impact of prevention.

OHSN created a set of standardized variables essential to creating a useful, intra- and inter-hospital surveillance system. The standardized variables define the injury type, specific denominators, occupation, hospital injury location, and risk factors and activities that lead to injury. Standardization permitted any hospital or health system to compare data from month to month and over years, and also to objectively measure impact of any intervention. Standardization allowed NIOSH OHSN to highlight lessons learned from aggregate data.

LIMITATIONS

This study is subject to at least five limitations. First, OHSN is a non-random sample of hospitals which voluntarily shared their PHM injury surveillance data with NIOSH. It is not a probability sample designed to be representative of all US hospitals. Therefore, all estimates apply to only OHSN participating hospitals and are not necessarily generalizable to other hospitals or hospital populations. Voluntary participation may have biased our sample in favor of best-practice facilities with established prevention programs or, conversely, in favor of hospitals whose participation in OHSN is part of an effort to address known, preexisting workplace injury problems. The former could have led to underestimates of workplace PHM injury rates relative to US hospitals on average, while the latter could have led to overestimates.

Second, while OHSN provided tools to facilitate hospital reporting, some facilities still may not report all injuries, especially facilities that operationalize the PHM injury case definition differently than described in the guidelines for determining a standard case definition. Furthermore, not all injuries are reported, for any number of reasons. Both factors could have resulted in underestimates of workplace PHM injury rates and possibly confounded associations with putative risk factors as well.

Third, data on several important characteristics (e.g., severity, nature, body part affected) of PHM injuries were either missing or categorized as unspecified in most cases, precluding drawing conclusions based on these variables.

Fourth, while OHSN PHM injury (numerator) data is reported by department,

denominator data is only reported for the hospital as a whole. Therefore, department-specific rates could not be calculated, only event counts. Therefore, risk comparisons across departments could not be made. Facility-level rates are of limited value because PHM injuries are known to be more likely to occur in certain departments (e.g., radiology) than in others. Comparing departments based on event counts can provide information on burden but not on risk and, as mentioned earlier, the inability to take department or unit-specific exposure into account could confound occupation-specific risk estimates.

Finally, small sample size may have limited the ability to detect some associations, especially in subgroup analyses.

CONCLUSION

Successful comprehensive safe patient handling programs ensure worker safety and patient handling occur with care and dignity. Musculoskeletal injuries due to patient handling are the most common, costly, and disabling non-fatal injuries among hospital workers but also are preventable. Surveillance information is key for providing evidence on all aspects of safe patient handling programs such as building a culture of safety, management support, staff buy-in, adequate equipment and safety practices, setting clear expectations to staff and management, initial and ongoing training, periodic evaluations of the safe patient handling programs, and others.

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention.

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