Occupational Injuries for Consecutive and Cumulative Shifts Among Hospital Registered Nurses and Patient Care Associates

A Case-Control Study

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RESEARCH ABSTRACT

Nontraditional work shifts for hospital registered nurses and patient care associates and associated injuries were examined through a case-control study. Inpatient care requires that many staff work nontraditional shifts, including nights and 12-hour shifts, but some characteristics remain unexplored, especially consecutive shifts. A total of 502 cases (injured workers) were matched to single controls based on their hospital, unit type, job type, gender, and age (± 5 years). Conditional logistic regression was used for the analysis, controlling for weekly hours scheduled. For both, consecutive shifts of 2 or more days and some various cumulative shifts over a week and month period, especially night shifts, were associated with increased odds of injury. More investigations on the phenomenon of consecutive shifts are recommended. Additionally, the assessment of shift policy and subsequent injury outcomes is necessary before implementing intervention strategies.

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This work was supported by a grant from the National Institute for Occupational Safety and Health (U19 OH008861) and in part by a grant from the National Cancer Institute (K05 CA108663) to Dr. Sorensen.

This study would not have been accomplished without the participation of Partners HealthCare System and leadership from Dennis Colling and Kurt Westerman. The authors thank Partners Occupational Health Services, including Marlene Freeley for her guidance; individuals at each of the hospitals, including Jeanette Ives Erickson, Mairead Hickey, Trish Gibbons, and Chris Graf in Patient Care Services leadership; and Jeff Davis and Lisa Pontin in Human Resources. They also thank Charlene Feilteau, Kate Myers, Mimi O'Connor, Margaret Shaw, Eddie Tan, and Shari Weingarten for assistance with supporting databases, and Christopher Kenwood from the New England Research Institute for statistical support.

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Received: May 14, 2012; Accepted: August 9, 2012; Posted: September 24, 2012.

doi:10.3928/21650799-20120917-39

Employees in the health care industry consistently experience a high number of workplace injuries. This fact is especially true for direct patient care support staff (i.e., certified nursing assistants [CNAs] or patient care associates [PCAs]); their incident rate ranks third for major job groups, behind laborers/freight workers and truck drivers (Bureau of Labor Statistics, 2012a). Using private industry data from 2010, the most recent year for which national data are available, the incidence of injuries was 125.1 per 10,000 full-time workers among registered nurses (RNs) and 459.6 per 10,000 full-time workers among PCAs (Bureau of Labor Statistics, 2012b). RNs and PCAs also suffer a disproportionately high percentage of musculoskeletal injuries, with more than half the injuries reported as sprains and strains (Ando et al., 2000; Bureau of Labor Statistics, 2012b). Moreover, RNs and PCAs report significant lost workdays, with 7 and 6 median days lost from work, respectively (Bureau of Labor Statistics, 2012b).

A variety of workplace practices and policies may affect occupational injury rates for direct patient care staff. These practices and policies include changing staffing ra-

Applying Research to Practice

In general, a trend was found toward increased odds of injury as the number of cumulative work shifts and hours in the previous week or month increased, especially with 12-hour shifts. Consecutive workdays, a recent trend in health care, are also associated with increased odds of injury. Future research examining the impact of consecutive shifts on injuries is recommended.

tios by lowering RN staffing (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; Aiken et al., 2001), substituting 10- or 12-hour shifts for traditional 8-hour shifts (Bendak, 2003), long hours and the use of overtime during high patient census (Bendak, 2003; Caruso, 2006; Dembe, Delbos, & Erickson, 2009; Lipscomb, Trinkoff, Geiger-Brown, & Brady, 2002), and instituting on-call status for some units (Trinkoff, Le, Geiger-Brown, Lipscomb, & Lang, 2006). Although shift length and overtime patterns related to subsequent occupational injury rates have been a recent focus of investigation (National Institute for Occupational Safety and Health, 2004), other patterns such as consecutive shifts and cumulative work, not including overtime, have received less attention.

Consecutive shifts, working several consecutive days due to overtime or to earn increased consecutive days off, are a recent trend that may impact injury rates (Trinkoff, Geiger-Brown, Brady, Lipscomb, & Muntaner, 2006). These shifts have become more popular as health care workers try to accommodate 12-hour shifts and receive enough time off for family and other responsibilities (Alspach, 2007). Although consecutive days of work and resulting increased occupational injury risk has been explored, the ability to measure the impact of consecutive shifts accurately is limited because administrative data and detailed, accurate work schedules are difficult to access.

Cumulative shifts are the number of shifts worked and cumulative hours are the corresponding hours worked in a given time period. Both cumulative shifts and cumulative hours are noteworthy when evaluating occupational injury because shifts vary in length and indicate duration of exposure to workplace hazards and cumulative hours indicate total hours exposed to the workplace. Although many studies have examined excessive work hours and overtime as described above, an incremental evaluation of the impact of increasing shifts and hours in a given time period on occupational injury rates has not been adequately conducted.

The purpose of this study was twofold. First, consecutive shifts worked by direct patient care providers were examined in relation to occupational injury rates. A case-control design was employed using hospital administrative injury and work history data and matching participants on hospital, unit type, gender, and age. Second, this study evaluated the contribution of cumulative shifts and cumulative hours to occupational injury rates for two durations, 7 days and 28 days. The researchers hypothesized that the odds of an injury increased as the number of consecutive days worked, cumulative shifts, and cumulative hours increased. Finally, other shift factors, such as 12-hour shifts and both day and night, were evaluated for their respective contribution to the impact of consecutive days and cumulative hours on occupational injury rates.

METHODS

Study Design

This study was a cross-sectional, nested, case-control analysis of administrative data consisting of integrated injury and staffing data for workers on patient care units of two large hospitals collected from January 1 to December 31, 2008. This study was part of the inaugural project for the Harvard School of Public Health, Center for Work, Heath, and Wellbeing, and was conducted in the metropolitan Boston area. The goal of the overall project was to explore how policies, programs, and practices on hospital units impact the work and health of individuals employed on those units. All research protocols were approved by the applicable institutional review board for protection of human subjects.

Integrated Injury and Staffing Data

For this study, the researchers used three employee-related administrative data sources from these hospitals: (1) a Human Resources database (information on the number and types of jobs, job role, worker overtime, absences, paycheck, and demographics); (2) the staffing database, which included all scheduled and worked shifts for all workers; and (3) the Occupational Health Services database, consisting of all incident reports and workers' compensation claims. A full-time research information systems specialist combined these databases into a single database for administrative and research purposes.

Human Resources data were used to identify participating Patient Care Services units using the unit cost center code. Eligible employees were found if they were either assigned to that unit as their primary work unit or could be found working on the unit from their paycheck data. Paycheck data were also used to filter the cohort for eligible employees. The staffing database for Patient Care Services provided detailed shift and acuity data. Shift codes are employed by the units and customized based on unit needs. An algorithm was created for each code to describe hours worked and shift. For the purposes of this study, only shifts greater than 4 hours were included in the analyses. The data generated from paychecks and shifts were routinely updated and corrected for accurate reporting of shifts worked.

The Occupational Health Services injury database included all reports of injury and information on workers' compensation claims. For the Occupational Health Services database, all injured workers report work-related incidents by completing either a hard copy form or an intranet-based form. All incidents were collected by Occupational Health Services and entered into the Occupa-

tional Health Worker's Compensation database. Worker incidents resulting in injury were recorded regardless of whether they were mandated as recordable for Occupational Safety and Health Administration (OSHA) purposes (i.e., requiring medical treatment, lost days, or restricted work). Injuries were matched to individual workers using unique identifiers. All data were de-identified from the integrated database before analysis.

Sample of Patient Care Workers

The integrated database included data on nurses and PCAs who worked more than 20 hours per week from a total of 66 units in the Patient Care Services departments at two hospitals (37 at one hospital and 29 at the other). Two direct patient care job role groups were identified using department expenditure codes, RNs and unit support staff for patient care known as PCAs. The greater than 20 hours per week requirement minimized the possibility of work exposure from other jobs or hospitals. Additionally, the few temporary and agency staff found on the units were excluded due to the temporary nature of their work on any given unit. Agency staff may work more than 20 hours but typically did not work more than 3 months on any unit, and temporary workers generally did not meet the 20-hour requirement on a single unit. A total of 5,080 workers were part of the study. The final cohort was coded with study identification numbers and all identifying information was removed to protect workers' identities.

For matching purposes, units were next grouped by type based on several characteristics, including adult, pediatric, or mixed population and acuity level (i.e., intensive care, cardiac step-down, and medical/surgical units). Acuity of the patient population was confirmed by examining acuity data for each unit. Prior to analysis, unit names were replaced with identification numbers. Four unit categories were created for the purpose of reporting results.

Case and Control Selection

From the cohort of workers, cases were selected from those who had reported an injury incident during 2008. Excluded incidents were those lacking a direct link to a workplace event such as exposures to infectious substances such as aerosolized agents or to noise, skin complaints, and systemic complaints. Blood-borne pathogen exposures due to sharps injuries were also excluded. If a cohort employee worked in more than one unit, the unit where the worker was assigned on the day of the incident was used as the unit for the study. Additionally, if the injured worker had more than one incident, one of those incidents was randomly selected from the list for inclusion.

Controls were identified by matching the injured workers to workers with similar demographic characteristics in their hospital (i.e., unit type, job type, gender, and age [± 5 years]) at a ratio of one case to one control. All controls worked the same day that the injury occurred to the cases. Because controls were matched to case workers by examining whether they worked the day of injury, a case could act as a control for another injury at a different time if demographic characteristics matched the latter case. The researchers did not match employees on hours worked each week (i.e., full-time equivalents [FTEs]) because hours can fluctuate during the year based on an individual staff member's preference; also, the FTE listed in the database may not accurately reflect the hours worked at the time of injury for both cases and controls.

Characterizing the Work Shifts

Several categories of shift worked prior to the injury incident were constructed, including consecutive workdays and cumulative hours worked in the previous 7 days and 28 days and cumulative shifts worked in the previous 7 days and 28 days. For each of these categories, several measures were created and calculated for both cases and controls. For the consecutive workdays category, the first measure was the number of consecutive days for which a staff member worked a shift greater than 4 hours prior to the date of the occupational injury. The second measure was the number of consecutive days for which a staff member worked a shift greater than 12 hours. The final measure was the number of consecutive days an employee worked a night shift greater than 12 hours. For the previous 7 days and 28 days categories, two types of measures were used—cumulative counts of shifts and cumulative hours worked. Cumulative counts included four measures: number of shifts greater than 4 hours, number of shifts greater than 12 hours, number of night shifts greater than 4 hours, and number of night shifts greater than 12 hours. Cumulative hours included two measures: total number of hours worked and total number of hours worked in a night shift. A shift was categorized as a night shift if it included 1:00 a.m. to 2:00 a.m. as part of the shift.

Analysis

After comparing the characteristics of cases and controls, conditional logistic regression was employed to calculate incidence odds ratios (ORs) with 95% confidence intervals (CIs) for cumulative hours and days. Prior to calculating the ORs, consecutive days, cumulative days for 7 days and 28 days, and cumulative hours for 7 days and 28 days were categorized into groups by increasing exposure, with normal shift lengths used as a guide to forming the categories. A referent group of no or low exposure was used to compare all exposure groups for consecutive days and cumulative days and hours in this data set. FTEs were compared to shifts worked and added to all models. All analyses were performed using the personal computer version of STATA 11.1 SE (Stata Corporation, College Station, TX).

RESULTS

A total of 502 of the 533 injuries reported for calendar year 2008 were eligible for the study and successfully matched to a control staff member in the cohort (Table 1). Approximately half of the injuries were OSHA recordable with either medical treatment, lost days, or restricted days recorded. Cases and controls were matched on all characteristics in Table 1 except scheduled hours per week and OSHA-recordable injuries, which did not exist for the controls. The cases and controls were similar in

Table 1

Select Characteristics of Units and Direct Care Provider Cases and Controls

	Cases (n = 502)	*Controls (n = 502)*
Hospital 1	235	235
Hospital 2	267	267
Mean age in years (range)	40 (38–42)	39 (37–41)
Gender		
Female 5.8% (4.3%–7.2%)	473 (92.4%)	473
Male 94.2% (92.7%–95.7%)	29 (5.8%)	29
Median scheduled hours per week (range)	36 (36–36)	32 (28–36)
Job type		
RN 84.1% (81.8%–86.3%)	422 (84.1%)	422
PCA 15.9% (13.7%–18.2%)	80 (15.9%)	80
OSHA-recordable injuries	223	
Unit type		
Adult medical/surgical units	257	257
Adult ICU	92	92
Step-down	65	65
Pediatric units	21	21
OB-postpartum	67	67

Note. *RN = registered nurse; PCA = patient care associate; OSHA = Occupational Safety and Health Administration; ICU = intensive care unit; OB = obstetrics.*

mean age. However, cases and controls did not have similar FTEs, with median hours worked being 36 for cases and 32 for controls. The 31 injured workers not matched were compared to those matched in the analyses and found to be similar overall. As expected, the majority of injuries were found among employees on adult medical/surgical floors, where the greatest number of health care workers are found in the hospital setting.

Consecutive shifts were categorized as any type of consecutive shift worked, followed by 12-hour or more consecutive work shifts and finally 12-hour or more consecutive night shifts. Injury incident ORs were higher for consecutive work shifts, with the exception of working one to two shifts of any length prior to injury for which the OR was 0.81 (95% CI = 0.60–1.08), when compared to working no previous shifts (Table 2). For consecutive days, only working 1 to 2 days of 12-hour shifts prior to injury was significant, with an injury incident OR of 1.77 (95% CI = 1.30–2.44), when compared to no shifts worked prior to injury.

Injury incident ORs increased with more cumulative shifts and cumulative hours worked in the previous 7 days (Table 3). Shifts were again categorized: total shifts worked, total night shifts, total shifts 12 or more hours, and total night shifts of 12 or more hours. Total hours worked the previous 7 days included both total hours worked and total night hours worked. Cumulative shifts were significant for three or more night shifts (OR = 2.90; 95% CI = 1.47–5.74) and three or more 12-hour night shifts (OR = 2.09; 95% CI = 1.10–4.98) compared to no night shifts in the previous 7 days. Cumulative hours worked for 7 days prior to injury were significant for 29 to 36 hours (OR = 1.68; 95% CI = 1.20–2.36) and working greater than 36 hours (OR = 1.26; 95% CI = 1.02–1.54) compared to working less than 20 hours. Additionally, injury rates among staff working greater than 36 night hours (OR = 1.34; 95% CI = 1.07–1.66) were statistically significant when compared to working less than 20 night hours in the previous 7 days.

For the previous 28 days (4 weeks), the injury incident ORs increased with more cumulative shifts and cumulative hours worked (Table 4). To characterize the cumulative hours worked during the 28-day period, the hours were similar to those worked during 7 days but multiplied by 4 for comparison. For example, a work period of less than 80 hours for 4 weeks was equivalent to 4 weeks of less than 20 hours worked per week. For a 28-day period, the injury incident ORs were 2.09 (95% CI = 1.12–3.89) for 12 or more shifts of any length when compared to 6 shifts of any length. The ORs for night shift were 2.18 (95% CI = 1.26–3.78) for 6 to 12 total night shifts of any length and 2.24 (95% CI = 1.05–4.76) for 12 or more 12-hour night shifts compared to less than 6 night shifts in a month. Cumulative hours for a 28-day period were significant for 116 to 144 hours (OR = 1.76; 95% CI = 1.13–2.74) and working greater than 144 hours (OR = 1.53; 95% CI = 1.07–2.17) compared to working less than 80 hours in 28 days. Additionally, injury rates among staff working greater than 144 night hours (OR = 1.50; 95% CI = 1.06–2.14) were statistically significant when compared to working less than 80 night hours in 28 days.

DISCUSSION

The purpose of this study was to examine staff work patterns preceding an injury and compare these to gender- and age-matched controls using hospital administrative injury and work history data. For almost all of the measures of consecutive and cumulative work metrics, the researchers observed a trend of increasing ORs with increasing number of consecutive workdays and cumulative work shifts and hours. A few of the ORs in all categories of consecutive shifts, cumulative shifts, and cumulative hours either were statistically significant or indicated strong associations.

The researchers found that consecutive days or working more shifts in a row, with the exception of one to two shifts of any type prior to injury, showed moderate in-

Table 2

Odds Ratios for Consecutive Shifts (Number of Shifts Worked in a Row) Prior to Injury

Exposure—Consecutive Shifts	*Number of Shifts*	*Cases (N = 502)*	*Controls (N = 502)*	*OR (95% CI)*	p
Any shifts ⩾ 4 hours (days, evenings, nights, or rotating)	0	299 (59.6%)	306 (61.0%)	1*	
	1 to 2	190 (37.8%)	190 (37.8%)	0.81 (0.60–1.08)	.16
	3 to 11	13 (2.6%)	6 (1.2%)	1.19 (0.39–3.65)	.75
12-hour (or longer) shifts (days, evenings, nights, or rotating)	0	297 (59.2%)	373 (74.3%)	1*	
	1 to 2	189 (37.6%)	124 (24.7%)	1.77 (1.30–2.44)	.000
	3 to 6	16 (3.2%)	5 (1.0%)	1.30 (0.70–2.43)	.402
12-hour (or longer) night shifts	0	336 (72.1%)	362 (77.7%)	1*	
	1 to 2	115 (24.7%)	91 (19.5%)	1.09 (0.76–1.57)	.64
	3 to 6	15 (3.2%)	13 (2.8%)	1.19 (0.71–2.01)	.50

Note. *OR = odds ratio; CI = confidence interval. *Referent category.*

creases in ORs for occupational injury. Whereas many of these consecutive shift findings were not statistically significant, with the exception of one to two 12-hour shifts prior to injury, they may be due to inadequate power, low number of staff working three or more shifts, or the addition of 4- to 8-hour shifts in the study limiting worker exposure (i.e., the use of short, 4-hour shifts may have impacted the results). In general, prior to this study, the impact of consecutive shifts on injury rates had not been adequately explored in the literature, most likely due to the specificity of administrative data needed to explore the phenomenon of consecutive days.

This study also revealed that increasing the number of shifts and hours worked during a 1- or 4-week period is associated with increasing ORs when compared to workers who work part-time or shifts. The researchers found that increasing the total number of cumulative days and hours worked in a week or month is associated with an increased odds of injuries among hospital direct care providers (i.e., the more workers work, the more likely they are to be injured). This is not a surprising finding, but has only been explored regarding overtime or extended shifts in the literature citing occupational injury related to these longer time periods (Bendak, 2003; Caruso, 2006; Dembe et al., 2009; Grosch, Caruso, Rosa, & Sauter, 2006; Ilhan, Durukan, Aras, Turkcuoglu, & Aygun, 2006; Johnson & Lipscomb, 2006; Trinkoff et al., 2006). One reason for the lack of correlation between shift types and injury rates may also be related to the definition of shift, with many studies reporting a variety of definitions for shifts, in addition to specificity in some databases regarding shift length (Caruso et al., 2006; Caruso & Waters, 2008; Driscoll, Grunstein, & Rogers, 2007).

The relationship of cumulative shifts to injury was stronger when combined with 12-hour shifts. The 12-hour shifts may be an attractive shift choice because they allow workers to request stretches of workdays followed by several days off to accommodate schedules outside of work, but may be a concern for occupational injury. Although the extended shifts, followed by extended rests, may be desirable, the overall impact may be increased occupational injuries associated with these longer shifts (Bendak, 2003; Dwyer, Jamieson, Moxham, Austen, & Smith, 2007).

An increase in OR for occupational injuries was found with consecutive shifts and cumulative shifts when they were combined with night shifts. Working night shifts and rotating to night shifts have also been associated with increased injury rates (Caruso & Condon, 2006; Dembe et al., 2009; Muecke, 2005).

Many studies have explored shifts and work characteristics such as job satisfaction, errors, or health. Several investigators have explored the relationship between 12-hour shifts and job performance (Fitzpatrick, While, & Roberts, 1999), job satisfaction, and turnover (Bame, 1993; Coffey, Skipper, & Jung, 1988; Ruggiero & Pezzino, 2006). Night shifts were associated with loss of sleep (Burch et al., 2009; Novak & Auvil-Novak, 1996) and patient errors (Ohayon, Lemoine, Arnaud-Briant, & Dreyfus, 2002). Additionally, overall health and well-being were examined regarding various shifts (Barnes-Farrell et al., 2008; Conway, Campanini, Sartori, Dotti, & Costa, 2008; DeMoss, McGrail, Haus, Crain, & Asche, 2004; Poissonnet & Veron, 2000). Although many of these studies do not implicate various shifts as a cause of occupational injury, the range of studies illustrates the complexity of evaluating shift work among health care workers.

The main strength of this study was the large number of participants in the cohort, allowing for detection of differences in staffing patterns and injuries. This study is generalizable to large academic hospitals in the northeast. Another strength of this study was the use of de-

Table 3

Odds Ratios for Number of Shifts or Hours Worked 7 Days Prior to the Day of Injury

Exposure—All Shifts and Hours Worked in Previous 7 Days	*Number of Shifts*	*Cases (N = 502)*	*Controls (N = 502)*	*OR (95% CI)*	p
Total shifts (any shift ⩾ 4 hours) in previous 7 days	0	17 (3.4%)	40 (8.0%)	1*	
	1 to 2	304 (60.5%)	354 (70.5%)	175 (0.82–3.71)	.15
	3 to 6	181 (36.1%)	108 (21.5%)	1.68 (0.94–2.99)	.08
Total 12-hour (or longer) shifts in previous 7 days	0	114 (22.7%)	137 (27.3%)	1*	
	1 to 2	341 (67.9%)	338 (67.3%)	1.09 (0.77–1.54)	.062
	3 to 6	47 (9.4%)	27 (5.4%)	1.00 (0.57–1.76)	.99
	Hours Worked				
Total hours worked in previous 7 days	< 20	97 (19.3%)	189 (37.7%)	1*	
	20 to 28	124 (24.7%)	125 (24.9%)	1.44 (0.81–2.55)	.21
	29 to 36	127 (25.3%)	98 (19.5%)	1.68 (1.20–2.36)	.002
	> 36	154 (30.7%)	90 (17.9%)	1.26 (1.02–1.54)	.028
Exposure—Night Shifts and Hours Worked in Previous 7 Days	***Number of Shifts***	***Cases (N = 466)***	***Controls (N = 466)***	***OR (95% CI)***	**p**
Total night shifts (⩾ 4 hours) in previous 7 days	0	29 (6.2%)	59 (12.7%)	1*	
	1 to 2	271 (58.2%)	315 (67.6%)	1.26 (0.69–2.30)	.45
	3 to 6	166 (35.6%)	92 (19.7%)	2.90 (1.47–5.74)	.002
Total 12-hour (or longer) night shifts in previous 7 days	0	111 (23.8%)	151 (32.4%)	1*	
	1 to 2	312 (67.0%)	291 (62.4%)	1.31 (0.75–1.48)	.76
	3 to 6	43 (9.2%)	24 (5.2%)	2.09 (1.10–4.98)	.028
	Hours Worked				
Total night hours worked in previous 7 days	< 20	100 (21.5%)	175 (37.6%)	1*	
	20 to 28	97 (20.8%)	108 (23.2%)	0.89 (0.50–1.60)	.705
	29 to 36	126 (27.0%)	104 (22.3%)	1.33 (0.98–1.81)	.070
	> 36	143 (30.7%)	79 (16.9%)	1.34 (1.07–1.66)	.009

Note. *OR = odds ratio; CI = confidence interval.*Referent category.*

tailed and accurate payroll data for analysis. Individual staffing schedules were amended at these two institutions because hours from the scheduling system were directly exported to the payroll system. The accuracy of these data allowed detailed analyses of cumulative days and cumulative shifts and hours.

Limitations were also found in working with large data sets. Misclassification of data is always a concern due to inaccurate or missing data entry. However, missing data did not appear to be a problem with individual variables as less than 3% of the variables had any missing data. Additionally, misclassification of unit or incorrect ledgers of staff schedules can bias data toward the null hypothesis and no difference in injury rate would be seen. The researchers were also not able to account for shifts that might have been worked at another area of the hospital outside Patient Care Services or at another institution. The detailed staffing data available at each institution minimized misclassification of the data and minimized missing data from other departments or institutions by setting inclusion criteria to include workers who worked substantial hours at their respective institutions. Several concerns were identified when working with reported injury data. It is unclear if incident reporting is accurate and if the data reflect true injury rates because many incentives and disincentives exist for employees to report injuries.

Table 4

Odds Ratios for Number of Shifts or Hours Worked 28 Days (4 Weeks) Prior to the Day of Injury

Exposure—Count of Days Worked in Previous 28 Days (4 Weeks)	*Number of Shifts*	*Cases (N = 448)*	*Controls (N = 448)*	*OR (95% CI)*	p
Total shifts (any shift ⩾ 4 hours) in previous 28 days	< 6	27 (6.0%)	89 (19.9%)	1*	
	6 to 12	252 (56.3%)	258 (57.6%)	215 (1.23–3.75)	.007
	> 12	169 (37.7%)	101 (22.5%)	2.09 (1.12–3.89)	.02
Total 12-hour (or longer) shifts in previous 28 days	< 6	174 (38.8%)	248 (55.3%)	1*	
	6 to 12	246 (54.9%)	192 (42.9%)	1.31 (0.94–1.83)	.11
	> 12	28 (6.3%)	8 (1.8%)	2.09 (0.98–4.47)	.06
Total night shifts (⩾ 4 hours) in previous 28 days	< 6	31 (6.9%)	93 (20.8%)	1*	
	6 to 12	254 (56.7%)	256 (57.1%)	2.18 (1.26–3.78)	.006
	> 12	163 (36.4%)	99 (22.1%)	1.62 (0.94–2.79)	.085
Total 12-hour (or longer) night shifts in previous 28 days	< 6	253 (56.5%)	180 (40.2%)	1*	
	6 to 12	187 (41.7%)	244 (54.5%)	1.25 (0.89–1.75)	.20
	> 12	8 (1.8%)	24 (5.3%)	2.24 (1.05–4.76)	.036
Exposure—Hours Worked in Previous 28 Days (4 Weeks)	***Hours Worked***	***Cases (N = 448)***	***Controls (N = 448)***	***OR (95% CI)***	**p**
Total hours worked in previous 28 days	< 80	61 (13.6%)	146 (32.6%)	1*	
	80 to 115	126 (28.1%)	149 (33.3%)	1.41 (0.82–2.44)	.22
	116 to 144	114 (25.4%)	71 (15.8%)	1.76 (1.13–2.74)	.013
	> 144	147 (32.8%)	82 (18.3%)	1.53 (1.07–2.17)	.019
Total night hours worked in previous 28 days	< 80	68 (15.2%)	150 (33.5%)	1*	
	80 to 115	127 (28.4%)	153 (34.1%)	1.46 (0.86–2.48)	.17
	116 to 144	109 (24.3%)	72 (16.1%)	1.45 (0.96–2.19)	.08
	> 144	144 (32.1%)	73 (16.3%)	1.50 (1.06–2.14)	.023

Note. *OR = odds ratio; CI = confidence interval. *Referent category.*

Therefore, care should be taken when interpreting incident report data. However, variability in reporting injuries appears random, and it does not appear that underreporting or overreporting of injuries significantly impacted the overall number of work-related injuries on these units.

Finally, one major disadvantage of case-control studies is that they do not indicate absolute risk; rather, the risk of the category worked is related to another lower or referent category. However, understanding the relative risks of various categories of work can provide valuable information.

IMPLICATIONS FOR OCCUPATIONAL HEALTH NURSES

Occupational health nurses must be aware of the type and length of shifts employees work at the various work sites they oversee. Shift characteristics (e.g., length, consecutive days worked, total hours worked, night shifts, and overtime) are an important component of working conditions, and some shift characteristics may contribute to employee injuries. When little information on employee shifts exists, routine detailed assessment of shift information for individual workers can be valuable, with emphasis on how shift characteristics may contribute to workplace illness and injury.

Workplace policy development related to shifts can also make an important contribution to the health and safety of workers. The assessment of existing work site policies and the level of specificity may be crucial to occupational health nurses' understanding characteristics of work shift scheduling of employees. Occupational health nurses should assess, when possible, whether policies ad-

dress details such as minimum number of days or weeks on a specific shift, how shifts rotate, number of days that can be worked consecutively without a day off, the maximum length of a shift, or the amount of overtime in a given shift or week. Such information is valuable for understanding how much latitude is given in the scheduling process and the potential variance that might be seen in shift schedules. Some managers and schedulers may follow the policies as written, whereas others may adjust the policies for their particular area. Understanding how shifts are assigned may offer valuable insight into the scheduling culture of the work site and allow the occupational health nurse to advocate for detailed work shift policies and adherence to those policies.

CONCLUSION

Understanding organizational scheduling patterns and their impact on occupational injuries is essential when exploring how work shift patterns can be altered to decrease injuries to direct patient care providers. The researchers have observed increased risk of injury with consecutive workdays and longer cumulative working hours. Future research should be conducted in this area to overcome limitations and more reliably examine the impact of consecutive working shifts.

REFERENCES

Aiken, L. H., Clarke, S. P., Sloane, D. M., Sochalski, J., & Silber, J. H. (2002). Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. *Journal of the American Medical Association, 288*(16), 1987-1993.

Aiken, L. H., Clarke, S. P., Sloane, D. M., Sochalski, J. A., Busse, R., Clarke, H., et al. (2001). Nurses' reports on hospital care in five countries. *Health Affairs, 20*(3), 43-53.

Alspach, G. (2007). Facilitating the retention of experienced critical care nurses: A survey report on what matters most. *Critical Care Nurse, 27*(5), 12-19.

Ando, S., Ono, Y., Shimaoka, M., Hiruta, S., Hattori, Y., Hori, F., et al. (2000). Associations of self estimated workloads with musculoskeletal symptoms among hospital nurses. *Occupational and Environmental Medicine, 57*(3), 211-216.

Bame, S. I. (1993). Organizational characteristics and administrative strategies associated with staff turnover. *Health Care Management Review, 18*(4), 70-86.

Barnes-Farrell, J. L., Davies-Schrils, K., McGonagle, A., Walsh, B., Milia, L. D., Fischer, F. M., et al. (2008). What aspects of shiftwork influence off-shift well-being of healthcare workers? *Applied Ergonomics, 39*(5), 589-596.

Bendak, S. (2003). 12-hour workdays: Current knowledge and future directions. *Work & Stress, 17*(4), 321-336.

Burch, J. B., Tom, J., Zhai, Y., Criswell, L., Leo, E., & Ogoussan, K. (2009). Shiftwork impacts and adaptation among health care workers. *Occupational Medicine (Oxford), 59*(3), 159-166.

Bureau of Labor Statistics. (2012a). *Incidence rates per 10,000 full-time workers of nonfatal injuries and illnesses—2010.* Retrieved from www.bls.gov/iif/oshcdnew2010.htm#10b

Bureau of Labor Statistics. (2012b). *Workplace injuries and illnesses—2010.* Retrieved from www.bls.gov/news.release/archives/osh2_11092011.pdf

Caruso, C. C. (2006). Possible broad impacts of long work hours. *Industrial Health, 44*(4), 531-536.

Caruso, C. C., Bushnell, T., Eggerth, D., Heitmann, A., Kojola, B., Newman, K., et al. (2006). Long working hours, safety, and health: Toward a National Research Agenda. *American Journal of Industrial Medicine, 49*(11), 930-942.

Caruso, C. C., & Condon, M. E. (2006). Night shifts and fatigue: Coping skills for the working nurse. *American Journal of Nursing, 106*(8), 88.

Caruso, C. C., & Waters, T. R. (2008). A review of work schedule issues and musculoskeletal disorders with an emphasis on the healthcare sector. *Industrial Health, 46*(6), 523-534.

Coffey, L. C., Skipper, J. K., Jr., & Jung, F. D. (1988). Nurses and shift work: Effects on job performance and job-related stress. *Journal of Advanced Nursing, 13*(2), 245-254.

Conway, P. M., Campanini, P., Sartori, S., Dotti, R., & Costa, G. (2008). Main and interactive effects of shiftwork, age and work stress on health in an Italian sample of healthcare workers. *Applied Ergonomics, 39*(5), 630-639.

Dembe, A. E., Delbos, R., & Erickson, J. B. (2009). Estimates of injury risks for healthcare personnel working night shifts and long hours. *Quality & Safety in Health Care, 18*(5), 336-340.

DeMoss, C., McGrail, M., Jr., Haus, E., Crain, A. L., & Asche, S. E. (2004). Health and performance factors in health care shift workers. *Journal of Occupational and Environmental Medicine, 46*(12), 1278-1281.

Driscoll, T. R., Grunstein, R. R., & Rogers, N. L. (2007). A systematic review of the neurobehavioural and physiological effects of shiftwork systems. *Sleep Medicine Reviews, 11*(3), 179-194.

Dwyer, T., Jamieson, L., Moxham, L., Austen, D., & Smith, K. (2007). Evaluation of the 12-hour shift trial in a regional intensive care unit. *Journal of Nursing Management, 15*(7), 711-720.

Fitzpatrick, J. M., While, A. E., & Roberts, J. D. (1999). Shift work and its impact upon nurse performance: Current knowledge and research issues. *Journal of Advanced Nursing, 29*(1), 18-27.

Grosch, J. W., Caruso, C. C., Rosa, R. R., & Sauter, S. L. (2006). Long hours of work in the U.S.: Associations with demographic and organizational characteristics, psychosocial working conditions, and health. *American Journal of Industrial Medicine, 49*(11), 943-952.

Ilhan, M. N., Durukan, E., Aras, E., Turkcuoglu, S., & Aygun, R. (2006). Long working hours increase the risk of sharp and needlestick injury in nurses: The need for new policy implication. *Journal of Advanced Nursing, 56*(5), 563-568.

Johnson, J. V., & Lipscomb, J. (2006). Long working hours, occupational health and the changing nature of work organization. *American Journal of Industrial Medicine, 49*(11), 921-929.

Lipscomb, J. A., Trinkoff, A. M., Geiger-Brown, J., & Brady, B. (2002). Work-schedule characteristics and reported musculoskeletal disorders of registered nurses. *Scandinavian Journal of Work, Environment and Health, 28*(6), 394-401.

Muecke, S. (2005). Effects of rotating night shifts: Literature review. *Journal of Advanced Nursing, 50*(4), 433-439.

National Institute for Occupational Safety and Health. (2004). *Overtime and extended work shifts: Recent finding on illness, injuries, and health behaviors.* Retrieved from www.cdc.gov/niosh/docs/2004-143

Novak, R. D., & Auvil-Novak, S. E. (1996). Focus group evaluation of night nurse shiftwork difficulties and coping strategies. *Chronobiology International, 13*(6), 457-463.

Ohayon, M. M., Lemoine, P., Arnaud-Briant, V., & Dreyfus, M. (2002). Prevalence and consequences of sleep disorders in a shift worker population. *Journal of Psychosomatic Research, 53*(1), 577-583.

Poissonnet, C. M., & Veron, M. (2000). Health effects of work schedules in healthcare professions. *Journal of Clinical Nursing, 9*(1), 13-23.

Ruggiero, J. S., & Pezzino, J. M. (2006). Nurses' perceptions of the advantages and disadvantages of their shift and work schedules. *Journal of Nursing Administration, 36*(10), 450-453.

Trinkoff, A., Geiger-Brown, J., Brady, B., Lipscomb, J., & Muntaner, C. (2006). How long and how much are nurses now working? Too long, too much, and without enough rest between shifts, a study finds. *American Journal of Nursing, 106*(4), 60-72.

Trinkoff, A. M., Le, R., Geiger-Brown, J., Lipscomb, J., & Lang, G. (2006). Longitudinal relationship of work hours, mandatory overtime, and on-call to musculoskeletal problems in nurses. *American Journal of Industrial Medicine, 49*(11), 964-971.