ORIGINAL ARTICLE

Duration of Time on Shift Before Accidental Blood or Body Fluid Exposure for Housestaff, Nurses, and Technicians

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BACKGROUND. Shift work has been found to be associated with an increased rate of errors and accidents among healthcare workers (HCWs), but the effect of shift work on accidental blood and body fluid exposure sustained by HCWs has not been well characterized.

OBJECTIVES. To determine the duration of time on shift before accidental blood and body fluid exposure in housestaff, nurses, and technicians and the proportion of housestaff who sustain a blood and body fluid exposure after 12 hours on duty.

METHODS. This retrospective, descriptive study was conducted during a 24-month period at a large urban teaching hospital. Participants were HCWs who sustained an accidental blood and body fluid exposure.

RESULTS. Housestaff were on duty significantly longer than both nursing staff ($P = .02$) and technicians ($P < .0001$) before accidental blood and body fluid exposure. Half of the blood and body fluid exposures sustained by housestaff occurred after being on duty 8 hours or more, and 24% were sustained after being on duty 12 hours or more. Of all HCWs, 3% reported an accidental blood and body fluid exposure, with specific rates of 7.9% among nurses, 9.4% among housestaff, and 3% among phlebotomists.

CONCLUSIONS. Housestaff were significantly more likely to have longer duration of time on shift before blood and body fluid exposure than were the other groups. Almost one-quarter of accidental blood and body fluid exposures to housestaff were incurred after they had been on duty for 12 hours or more. Housestaff sustained a higher rate of accidental blood and body fluid exposures than did nursing staff and technicians.

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Millions of American workers are engaged in shift work,[1,2] including approximately 25%[3,4] of the 6 million healthcare workers (HCWs) in the United States.[5] Shift work is defined as work performed primarily outside typical daytime hours and includes evening shifts, rotating shifts, irregular shifts, extended-duty shifts, and flextime.[6-9] Housestaff and nurses routinely work extended hours and perform work outside of typical daytime hours.[10] Shift work, an occupational stressor, has been linked to social, psychological, and medical problems.[11,12] It has also been shown to lead to fatigue[13] and to disruption of the circadian clock.[14,15]

Fatigue resulting from shift work has also been associated with increased rates of errors and accidents while at work among several occupational groups,[16-21] including HCWs.[22-32] The catastrophic accidents at Three Mile Island, Bhopal, and Chernobyl and the Exxon-Valdez oil spill each occurred between midnight and 4 AM; deaths associated with truck driver fatigue are estimated at approximately 440 per year; and truck driver crashes fatal to the driver have been found to increase with an increase in the number of consecutive driving hours.[33] Evidence suggests that HCWs are at increased risk of motor vehicle accidents due to fatigue. An increased accident rate has been reported for interns, residents, and nurses (involved in shift work) traveling to and from work,[28-31] and some of those accidents have resulted in significant injury to others.[32] Excessive daytime sleepiness has been found to be significantly associated with occupational accidents in nurses,[34] and attentional failures have been documented in interns who work extended shifts.[26] Moreover, interns were found to make significantly more medical errors when they worked frequent shifts of 24 hours or more than when they worked shorter shifts,[26] and housestaff have attributed errors to fatigue.[27]

Although many medical and psychological effects of shift work, and shift work–related errors and accidents have been documented, much less work has been done to examine the extent to which shift work modulates 1 of the major occupational risks to HCWs—namely, exposure to potentially infectious blood and body fluid.[35] Blood and body fluid exposure poses a risk for acquisition of infection with human immunodeficiency virus, hepatitis B virus, and hepatitis C virus[36-41] and may result in emotional distress for those exposed.[34] Measures to help prevent blood and body fluid ex-

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posures include training on standard precautions, provision of personal protective equipment, and provision of devices engineered to prevent injury from needles (safe needle devices).[41-45] However, human error still poses a risk of exposure, and carelessness while fatigued has frequently been listed as one of the main causes of needlestick injury to HCWs.[46] We studied the duration of time on shift before accidental blood and body fluid exposure for housestaff, nurses, and technicians and measured the proportion of housestaff who sustain blood and body fluid exposure after 12 hours on duty.

METHODS

Study Design, Setting, and Participants

This retrospective, descriptive study consisted of a data review of all accidental blood and body fluid exposures reported to the Occupational Medicine Clinic or to the Emergency Department over the 24-month period, January 2001 to December 2002, at a large urban teaching hospital with approximately 6,000 employees. All HCWs at the hospital who sustain a work-related injury or illness are required to present to the Occupational Medicine Clinic, the sole provider of care to injured and ill workers, for evaluation and treatment during business hours, or to the Emergency Department during nights and weekends. The study participants were HCWs who reported occupational accidental blood and body fluid exposures to the Occupational Medicine Clinic or Emergency Department during the study period. The study was approved by the institutional review board.

Data Collection and Analysis

HCWs with a work-related injury or illness are required to fill out the Employee Report of Injury or Disease (EROID) at the time of presentation, which is a self-report of the injury or illness that contains information on the date, time, and type of injury. It also gathers information on demographic characteristics, such as name and date of birth of the injured HCW, the number of dependents, marital status, occupation, and whether the HCW works full-time or part-time. All records were stripped of identifying information as per Health Insurance Portability and Accountability Act requirements.

Percutaneous blood and body fluid exposures (ie, by needlestick injury reportedly sustained due to intravenous catheter, suture needle, awl, or drill or by a laceration reportedly caused by a scalpel, blade, or broken specimen tube) and permucosal blood and body fluid exposures (ie, by splash of blood or other infectious body fluid to nonintact skin, or mucosal surface [ie, eyes or mouth]) were used in the analysis. Time to injury was defined as the time between the start of the shift and the reported time of injury. Data regarding time of shift end were unavailable. A day shift was defined as a shift that started at 7 AM and ended at 3 PM, an evening shift as one that started at 3 PM and ended at 11 PM, and a night shift as one that started at 11 PM and ended at 7 AM.

Housestaff included interns, residents, and fellows; nursing staff included registered nurses, licensed practical nurses, and nursing assistants; and technicians included phlebotomists, apheresis specialists, medical and surgical technologists, blood bank technologists, central-processing technologists, radiology technicians, respiratory therapists, and physical therapists. Medical students and attending physicians were not included in this analysis, because alternate modes of reporting blood and body fluid exposures were available for these groups.

Statistical Analysis

Standard descriptive statistics were used to characterize the 3 groups. Mean values and standard deviations were used for continuous data, and frequencies and percentages for categorical data. Analysis of variance was used to test for differences between groups with regard to time to blood and body fluid exposure. The χ^2 test was used to compare groups with regard to seasonality, shift, and number of hours on duty. All analyses were performed using SAS statistical software (SAS Institute).[47] A P value of less than .05 was considered statistically significant.

RESULTS

Demographic Characteristic Information

During the study period, there were 407 EROIDs that documented an accidental blood and body fluid exposure, 16 of which were filled out by persons who did not meet the inclusion criteria (12 attending physicians, 1 medical student, and 3 others). The remaining 391 EROIDs included 29 from HCWs reporting 2 exposures and 2 from HCWs reporting 3 exposures. Of the 360 HCWs who reported an accidental blood and body fluid exposure, 243 (68%) were women, 180 (50%) were married, 139 (40%) had 1 or more dependents, 158 (44%) were housestaff, 141 (39%) were nurses, and 61 (17%) were technicians; 3 of the technicians were phlebotomists. The mean age of all 360 HCWs was 33 years (range, 21-75 years).

Blood and Body Fluid Exposures

The majority (292 [75%]) of accidental exposures were percutaneous; 85 (22%) were permucosal, and 1 was a scratch. The specific mode of exposure was not reported for 13 (3%). There was no statistically significant difference in the reported blood and body fluid exposures by month or quarter for housestaff. The average yearly rate of reported accidental blood and body fluid exposures (average across the 2-year period) was 9.4% for housestaff, 7.9% for nursing staff, 3% for phlebotomists, and 3% for all HCWs.

Housestaff were on duty for a significantly greater mean number of hours before accidental blood and body fluid exposures (7.9 $\pm$ 4.9 hours) than were nursing staff (6.3 $\pm$ 3.7 hours; $P = .02$) and technicians (4.8 $\pm$ 2.6 hours; $P < .0001$). Of blood and body fluid exposures incurred by house-

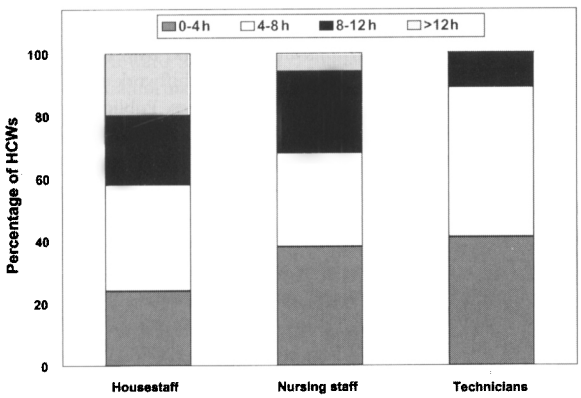

FIGURE. Percentage of each group of healthcare workers in the study that was on duty for a given number of hours before accidental blood or body fluid exposure.

staff, 30 (24%) occurred during the first 4 hours of duty, 42 (34%) during hours 4-8, 27 (22%) during hours 8-12, and 24 (20%) after 12 hours (Figure). Eight (6%) of the nurses and no technicians sustained an accidental blood and body fluid exposure after more than 12 hours of duty.

The accidental blood and body fluid exposures reported by nursing staff were almost equally distributed among the 3 shifts (Table). Approximately half of the accidental blood and body fluid exposures reported by both the housestaff and technicians occurred during the day shift.

DISCUSSION

The results indicate that the duration of time from shift start to accidental blood and body fluid exposure was significantly longer among housestaff than among nursing staff or technicians. In addition, almost one-quarter of the reported accidental blood and body fluid exposures to housestaff were incurred after having been on duty for 12 hours; during the same period, 6% of blood and body fluid exposures were incurred by nursing staff, and none by technicians. Furthermore, almost 10% of housestaff reported an accidental blood and body fluid exposure, which is a higher rate than that for the general HCW population. Phlebotomists reported the lowest rate (3%), similar to that for the general HCW population.

Although the duration of time on duty before blood and body fluid exposure was 12 hours or more for approximately 20% of the housestaff, only 9% of the nursing staff were injured during the night shift, probably because housestaff are exposed to extended shifts as a result of on-call schedules, beginning their shifts during the day time and extending them into the evening and the next day or, alternatively, starting at night and working into the next morning. Although 6% of nursing staff incurred blood and body fluid exposure after being on duty for 12 hours or more, there was no significant difference between when the blood and body fluid exposures were incurred (day, evening, or night). This may be because nursing staff routinely work 8-12-hour shifts throughout the 24-hour cycle, exceeding 12 hours if they work overtime or double shifts. Phlebotomists routinely work 8-hour shifts.

Phlebotomists have potential for blood and body fluid exposures during the majority of their days, yet they reported the lowest rate of blood and body fluid exposure in this study population. This may be because they work in a more controlled environment, with phlebotomy their main task. As such, they are experienced and well trained in the use of devices engineered to prevent injury from sharp instruments. They perform less risky and more-routine procedures and work fewer night and extended shifts. Housestaff are more likely to perform emergency and more-difficult procedures.

If the amount of time on duty is used as a surrogate for fatigue, of which housestaff frequently complain,[48] these data suggest that fatigue may have an important impact on the occurrence of accidental blood and body fluid exposure for housestaff as half the injuries were incurred after 8 hours, and that decreasing the length of the extended shift or duty hours for housestaff may help to decrease the incidence of accidental blood and body fluid exposures by decreasing the exposure time during which they are more likely to be fatigued. Indeed, the American College of Graduate Medical Education (ACGME) recently limited the shift duration and number of hours that residents may work.[49] In addition to limiting the hours worked, strategies to help solve the problem of fatigue in HCWs should also address organizational culture,[50-52] which has been shown to affect the incidence of needlestick injury in nurses,[52] and the observation of standard precautions by HCWs.[51]

One of the limitations of this study is that the injury rate per shift was not determined, because denominator data (ie, the number of HCWs who routinely manned each shift) were not available. As such, we were unable to ascertain whether the night shift had a greater injury rate from accidental blood

TABLE. Blood and Body Fluid Exposures for Each Group of Healthcare Workers (HCW), According to Shift During a 24-Hour Period

HCW group	No. (%) of exposures during shift			Total no. of exposures
	7 AM to 3 PM	3 PM to 11 PM	11 PM to 7 AM	
Housestaff	69 (53)	53 (40)	9 (7)	131
Nursing staff	48 (37)	46 (35)	36 (28)	130
Technician	31 (54)	21 (37)	5 (9)	57
All	148	120	50	318

and body fluid exposures than has been suggested elsewhere.[53] Incomplete ascertainment due to reporting bias—in which some HCWs may choose not to report an exposure—which is well-documented in the literature, is another limitation.[43,54,55] In any event, underreporting would reduce the injury rate. Incomplete ascertainment may also occur because not all HCWs who reported an exposure filled out an EROID. However, this number is small—fewer than 10 such exposures per year (personal communication with the workers' compensation office).

Another limitation of this study is the role played by confounding. This study showed that the 3 groups of HCWs differ significantly with respect to time to accidental blood and body fluid exposure and that the duration of time on shift before accidental blood and body fluid exposure was significantly longer for housestaff. However, housestaff are also more likely to work longer shifts than are both nurses and technicians, which allows more time for an accidental blood and body fluid exposure to occur. The EROID captures data on shift start time and the time of injury but does not capture data on shift end time; hence, it does not allow for adjustment of the data for average length of shift. It is possible that if the data allowed adjustment for the average length of shift, a significant difference might not be found among the groups. Regardless, the data show that almost one-quarter of accidental blood and body fluid exposures occurred after 12 hours on duty, suggesting that the incident rate for housestaff might have been lower if they had not worked such extended shifts. Long working hours have been found to be associated with an increase in occupational injuries.[56]

Even in the face of study limitations, these findings are important because they provide a step toward a better understanding of the effect of duration of time on shift on the incidence of accidental blood and body fluid exposures among HCWs. Future studies should be conducted to investigate whether limiting the duration of extended shifts for housestaff, subsequent to the recent ACGME requirements,[49] is associated with a reduction in the incidence of accidental blood and body fluid exposures among housestaff, as well as to further investigate the extent to which accidental blood and body fluid exposure among HCWs is modulated by shift work, circadian dysrhythmia, and organizational culture. Furthering this knowledge will allow interventions aimed at reducing the incidence of these potentially devastating exposures for HCWs.

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