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# Occupational Exposure to Blood and Bodily Fluids among Health Care Workers in a Medical Teaching Hospital

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## Abstract

The objective of this study was to evaluate blood and bodily fluids exposure through needlestick injuries (NSI) and non-percutaneous incidents among healthcare workers (HCWs). This project utilized a dataset collected from J. W. Ruby Memorial Hospital in Morgantown, West Virginia, between January 1, 2014 and August 15, 2017. Data included de-identified codes of employees, occupations, types of exposure to bloodborne pathogens, routes of exposure, infectious disease exposures, and time incidents. During this time period, 655 incident reports were documented and finalized in regards to blood or body fluid exposure. HCWs had 506 (77.25%) NSIs and 149 (22.74%) non-percutaneous incidents. The majority of the HCWs (331,50.53%) were nurses who were occupationally exposed, with 239 (47.23%) incidents reporting NSIs and 92 (61.74%) incidents reporting non-percutaneous exposures. Chi-square tests were used, and there was a statistically significant association between occupations and exposure incidents (P-value  $p < .0001$ ). Occupations and shift time were statistically associated with the routes of exposure ( $p < .0001$ ). NSIs had higher incidents than non-percutaneous exposures. Exposure to bloodborne pathogens largely occurred among nurses and physicians. Future research should assess the type and duties of nurses and physicians, as well as examine differences in the characteristics of HCWs regarding of the characteristics of shifts (such as time and length) which lead to NSIs

**Keywords:** Healthcare; Exposure; Needlestick; Hospital; Infection Control; Hcws

## Introduction

The primary role of healthcare workers (HCWs) is to care for sick and injured patients, which can expose HCWs to a variety of diseases, injuries, and conditions. A HCW is any person whose role is directly associated with healthcare, including physicians, nurses, dentists, medical technicians, medical assistants, and students in the healthcare field [1]. Unsurprisingly, HCWs can experience occupational exposure to various forms of hazards including sharps injuries, harmful exposures to chemicals and hazardous drugs, back injuries, latex allergy, violence, and stress [2]. HCWs can be exposed to blood or bodily fluids through contact with mucous membranes, non-intact skin contact, or percutaneous injuries. HCWs can face exposures to hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus, (HIV), as well as other illnesses transmitted by blood and bodily fluids HCWs are most often exposed to disease through needlestick injuries (NSIs) [3]. NSIs are defined as percutaneous injuries with sharp items contaminated with blood or other bodily fluids [4]. The high level of occupational exposure to blood and bodily fluids among HCWs is more common than in the general population [5-9]. In a 12 year CDC study of selected hospitals in the U.S., 30,945 incident of exposures were reported, with 82% of those as percutaneous exposures [10]. These exposures most often occurred in in-patient units (36%) and operating rooms (29%). Nurses (42%) were most often exposed, followed by physicians (30%). Hollow-bore needles (55%) were involved in the majority of the percutaneous incidents, followed by solid sharps (41%). Hollow-bore needles carry a higher risk of transmission of bloodborne diseases than other devices. Similar results have been observed elsewhere. One study reported 82.1% of HCWs experienced percutaneous injuries, and 48.7% experienced other types of exposure to blood and bodily fluids throughout their work in the field [6]. Another study reported 44% of HCWs experienced NSIs, 31% had other types of percutaneous injuries, and the rest of the exposures were non-percutaneous [7]. In its review of 13,847 percutaneous incidents at selected U.S. hospitals, the CDC found that 56% of the injuries were preventable (17% undetermined), most often because safer devices were available (26%) or because the needlework was unnecessary (9%). In 6%

of the cases, safer work practices would have prevented the percutaneous injury. Thus, in the healthcare setting, the high rates of occupational exposures to blood and bodily fluids can be significantly reduced by the use of universal precautions [11]. Methods of reducing exposures include using trays to pass sharp items (the neutral zone), recapping devices to prevent needlestick injuries (NSIs), utilizing blunt sutures, and eliminating unnecessary needlework. Failure to comply with universal precautions guidelines significantly increases the rates of exposure, thus endangering HCWs and their patients [6]. Other studies have found hospital environments in which more than half of HCWs did not use protective gloves and also did not wash their hands after having contact with patients [7]. In other study, the HCWs knowledge and training regarding different types of infectious diseases and universal precautions compliance were not at an acceptable level, with approximately more than two-thirds of participants reported that they had not been trained on the prevention of bloodborne pathogens and the risks of occupational exposure [12]. Interventions and safety devices may improve outcomes. Research conducted at a research hospital estimated a rate of 69.0 NSIs per 1,000 full-time HCWs prior to the introduction of safety devices, which was reduced to 52.4 per 1,000 afterwards [13]. Other research has identified the barriers to overcome with instituting NSI interventions [13,14,15]. Some types of HCW occupations may be more susceptible to exposure of bloodborne pathogens [14,16]. A lack of information exists regarding different HCW occupations that are most likely to be exposed to blood and bodily fluids through percutaneous or non-percutaneous exposure. The objective of this study was to evaluate blood and bodily fluids exposure incidents among HCWs at a university research hospital.

## Methods

### Study Design

This study utilized a secondary dataset with data that was collected from J. W. Ruby Memorial Hospital in Morgantown, West Virginia, between January 1, 2014 and August 15, 2017. The design was a retrospective HCW record study on the occurrence of blood and bodily fluids exposure incidents amongst HCWs. Employees reported exposures to the Employee Health Clinic of Ruby Memorial Hospital, and all reports were electronically recorded for purposes of employee exposure laws, unrelated to this research. The Employee Health Clinic serves to fulfill the recordkeeping requirements under the Needlestick Safety and Prevention Act and the Bloodborne Pathogens standard for the exposures log. The Act requires healthcare employers to report all sharps injuries and other bloodborne pathogen exposures to the Occupational Safety and Health Administration (OSHA). WVU Healthcare's legally-required log is maintained in an electronic database, which was provided for this research. No personally identifiable information is available from this database. As part of this research, the Employee Health Clinic provided the dataset in the form of an Excel document, which was de-identified and anonymous. Data included de-identified codes, occupations, types of exposure to bloodborne pathogens, routes of exposure, infectious diseases exposures, and time and date of incidents. Occupations were categorized into major categories, including dental worker, health aide/attendant, laboratory technician, nurse, physician (surgical), technician (surgical) and technician/therapist. Non-healthcare workers were excluded from the analysis. Types of exposures to bloodborne pathogens were categorized into percutaneous injuries and non-percutaneous exposures. Percutaneous injuries include any exposure through needles, surgical sharp instruments, or glass, and non-percutaneous exposures include any physical exposure to blood and bodily fluids like splashing or touching blood or body fluids. Routes of percutaneous injuries were analyzed, whether transmitted through needles, sharp instruments, or glass, as well as how deep injuries were (superficial, moderate, or deep). Incident data were categorized by year (2014, 2015, 2016, 2017), and incident time was categorized into to three shifts: Shift 1 (8:01 AM–16:00 PM), Shift 2 (16:01 PM–0:00 AM), and Shift 3 (0:01 AM–8:00AM). Infectious disease exposure was analyzed based on the type of disease, including HBV, HCV, and HIV.

### Study Sample

J. W. Ruby Memorial Hospital is a private medical teaching facility and the largest facility in the West Virginia University Medicine family and has over 1,700 employees. [18]. It consists of a 645-bed academic medical center and was the only facility included in this study. The hospital is located in the city of Morgantown, which is in the northern part of West Virginia. As of the 2016 census, the population of the city was 30,855 [19]. The Employee Health Clinic in the hospital is open to all employees, covering annual tuberculosis skin testing, immunizations, eye exams, bloodborne pathogen exposure, flu shots, and lipid panels. The data identified 926 incidents received between January 1, 2014, and August 15, 2017. The occupations were not documented for 263 of the incidents and were excluded from analyses. Non-HCW occupations were identified in 8 of the incidents and were excluded from analyses.

### Data Analysis

Data analysis was performed using Statistical Analysis System (SAS) software, Version 9.4. Descriptive statistics were performed to summarize the characteristics of HCWs regarding the types of exposure and routes of percutaneous injuries. Chi-square tests were used to compare categorical variables. Differences at the  $\alpha=0.05$  level were considered statistically significant.

## Results

The data identified 926 incidents received between January 1, 2014, and August 15, 2017, with 913 incidents documented as

blood or bodily fluid exposures and 13 documented as other incidents. In 655 incidents occupations were documented as various types of HCWs. Percutaneous injuries occurred in 487 of the 662 incidents. In the final analysis, exposure incidents were primary outcomes, and HCWs occupations were the primary independent variable, so non-HCWs occupations (8 out of 662) and 263 incidents with non-identified occupations were deleted from the analyses. Blood or body fluid exposures were documented and finalized in 655 incident reports (Table 1). Percutaneous incidents occurred in 506 (77.25%) incidents and 149 (22.74%) incidents were non-percutaneous. The majority of the HCWs (331,50.53%) were occupationally exposed nurses, with 239 (47.23%) of the total occupational percutaneous incidents and 92 (61.74%) of the total non-percutaneous incidents. In this timeframe, nursing incidents were overwhelmingly percutaneous. Of the nurses, 239 (72.20%) of the 331 nurse-related incidents were percutaneous and 92 (27.79%). The majority of exposure incidents occurred in 2016 (224, 34.20%) with 171 (33.79%) incidents of percutaneous injuries and 53 (35.57%) incidents of non-percutaneous injuries. In addition, the majority of exposure incidents occurred during morning shifts of 8:01 AM–16:00 PM (348, 53.13%), with 278 (54.94%) incidents of percutaneous injuries and 70 (46.97%) incidents of non-percutaneous injuries. A chi-square test was used to evaluate the relationship between exposure incidents of HCWs and events. There was a statistically significant association only between occupations and exposure incidents (P-value [P] = <.0001) (Table 1).

Occupation	Exposure Incidents			p-value*
	Non-Percutaneous (%)	Percutaneous Injuries (%)	na(%)	
Dental worker	0(0.00)	10(1.98)	10(1.52)	
Health aide/attendant	9(6.04)	22(4.35)	31(4.73)	
Laboratory technician	4(2.68)	24(4.74)	28(4.27)	
Nurse	92(61.74)	239(47.23)	331(50.53)	
Other healthcare occupations	4(2.68)	5(0.99)	9(1.37)	
Physician, surgical	21(14.09)	147(29.05)	168(25.64)	
Technician, surgical	4(2.68)	46(9.09)	50(7.63)	
Technician/therapist, other	15(10.07)	13(2.57)	28(4.27)	<.0001
Year exposure occurred				
2014	24(16.11)	55(10.87)	79(12.06)	
2015	39(26.17)	142(28.06)	181(27.63)	
2016	53(35.57)	171(33.79)	224(34.20)	
2017 (mid-Aug)	33(22.15)	138(27.27)	171(26.10)	0.25
Shift exposure occurred (time)				
Shift 1 (8:01–16:00)	70(46.97)	278(54.94)	348(53.13)	
Shift 2 (16:01–0:00)	45(30.20)	140(27.66)	185(28.24)	
Shift 3 (0:01–8:00)	34(20.13)	88(17.39)	122(18.62)	0.17
	149(22.74)	506(77.25)	655	

<sup>a</sup>n=271 of 926 reported were deleted due to missing values of occupations and as well as the exclusion of non-HCWs

**Table 1:** Demographic characteristics of HealthCare Workers and relationship with occupational exposure (n=655)

HCWs identified the routes of percutaneous injuries in 487 incidents, with the causes identified as hollow-bore needles, surgical instruments or other sharp items, or glass (Table 2). In 168 incidents, no routes of incident were identified. The majority of incidents were caused by hollow-bore needles (278, 57.08%), followed by surgical instruments or other sharp items (199, 40.86%), and only 10 (2.05%) incidents were caused by glass. The incidents caused by glass had the lowest rate of incidents among all variables. The routes of incidents caused of percutaneous injuries were occupationally driven. Nurses had the highest number of incidents by hollow-bore needles (197, 70.86%), most likely driven by higher rates of exposures to occupational activities using hollow-bore needles. Surgical physicians were the most likely of the occupations to have percutaneous injuries from surgical instruments or other sharp objects (108,54.27%). In fact, surgical instruments or other sharp objects caused the most percutaneous injuries of the total 139 injuries of surgical physicians (108,77.70%). The clinic determined the severity of percutaneous injuries and classified them as deep<sup>1</sup>, moderate<sup>2</sup>, or superficial<sup>3</sup>. None of the injuries reported involved a deep injury. The majority of the percutaneous exposures were superficial injuries (422,86.67%), and the majority of those superficial injuries were caused by hollow-bore needles (234,84.17%). However, the majority of the moderate injuries were also by hollow-bore needles (44,15.63%). Percutaneous injuries during the morning shifts morning shifts (8:01 AM–16:00 PM) were almost evenly split between hollow-bore needles (131,

<sup>1</sup>A deep injury is classified as one with more than “some bleeding”.  
<sup>2</sup>A moderate injury is one with punctured skin and “some bleeding”.  
<sup>3</sup>A superficial injury is one with “little or no bleeding”.

49.06%) and surgical instrument or other sharp items (132,49.44%). Hollow-bore needle incidents were the most common routes of incidents for the afternoon and evening shifts (147,52.88%). Chi-square tests were used to evaluate the relationship between the routes of incidents caused and characteristics of the incidents. There was a statistically significant association between occupations and the routes of incidents caused ( $p < .0001$ ), where hollow-bore needle incidents had the dramatically highest proportion (75.08%) among other routes, specifically among nurses. In addition, there was a statistically significant association between shift time and the routes of incidents caused, where injuries most likely occurred during morning shifts.

	Routes of Incident Caused				
	HOLLOW-BORE NEEDLE (%)	SURGICAL INSTRUMENT OR OTHER SHARP ITEM (%)	GLASS (%)*	n <sup>a</sup>	P- value
<b>Occupation</b>					
Dental worker	3(1.08)	7(3.25)	0 (0.00)	10	
Health aide/attendant	11(3.96)	8(4.02)	0(0.00)	19	
Laboratory technician	23(8.27)	0(0.00)	0(0.00)	23	
Nurse	197(70.86)	33(16.58)	4(40.0)	234	
Other healthcare occupations	2(0.72)	3(1.51)	0(0.00)	5	
Physician, surgical	30(10.79)	108(54.27)	1(10.0)	139	
Technician, surgical	8(2.88)	36(18.09)	2(20.0)	46	
Technician/therapist, other	4(1.44)	4(2.01)	3(30.0)	11	<.0001
<b>Year exposure occurred</b>					
2014	32(11.51)	20(10.05)	1(10.0)	53	
2015	83(29.86)	47(23.62)	4(40.0)	134	
2016	97(34.89)	66(33.17)	4(40.0)	167	
2017 (mid-Aug)	66(23.74)	66(33.17)	1(10.0)	133	0.27
<b>Shift exposure occurred</b>					
Shift 1 (8:01–16:00)	131(47.12)	132(66.33)	4(40.00)	267	
Shift 2 (16:01–0:00)	84(30.22)	49(24.62)	1(10.00)	134	
Shift 3 (0:01–8:00)	63(22.66)	18(9.05)	5(50.00)	86	<.0001
<b>Injury Depth</b>					
Superficial	234(84.17)	179(89.95)	9(90.0)	422	
Moderate <sup>b</sup>	44(15.63)	20(10.05)	1(10.0)	65	0.17
	278(57.08)	199(40.86)	10(2.05)	487	

a. There were only 487 entries due to incomplete data.  
 b. No one reported deep injuries, so it was excluded from analysis.

TABLE 2: Demographic information of HealthCare Workers and relationships with types of percutaneous injuries. (n=487)

524 incidents involved exposure to infectious diseases such as HBV and HCVs (Table 3). 591 (94.65%) incidents were exposed to HBV, and 5.44% were not exposed to HBV (Table 3). The exposure to HBV was relatively similar between non-percutaneous and percutaneous incidents, with 90.03% and 95.72%, respectively. 517(82.72%) incidents were exposed to HCV, and 17.28% were not exposed to HCV (Table 3). However, the exposure to HCV had a quite similar proportion between non-percutaneous and percutaneous incidents, with 23.13% and 15.68%, respectively. Accordingly, there was a statistically significant association between HCV exposure and exposure incidents ( $p=0.04$ ).

Exposure*	Non-Percutaneous (%)	Percutaneous (%)	n(%)
<b>Hepatitis B Exposure</b>			
Yes	121(90.03)	470(95.72)	591(94.65)
No	13(9.30)	21(4.25)	34(5.44)
<b>Hepatitis C Exposure</b>			
Yes	31(23.13)	77(15.68)	108(17.28)
No	103(78.87)	414(84.32)	517(82.72)
	134	491	625

\*HIV test indication was not included due to low sample size (36) and was therefore deleted from analysis

TABLE 3: Healthcare Workers Reporting Occupational Exposure to Infectious Diseases (n=625)



## Discussion

HCWs treat a plethora of medical conditions, and therefore, face occupational exposure to a variety of infectious diseases. Because of the risks of disease, the Centers for Disease Control and Prevention (CDC) and the United States Occupational Safety and Health Administration (OSHA) created universal precautions and guidelines for bloodborne pathogen exposure and needlestick safety guidelines [20]. However, exposures still occur, and it is critical for the health of HCWs, patients, and the general public to understand what exposure issues still continue to exist. This study evaluated the occupational exposure incidents among HCWs through blood and bodily fluids in a university research hospital setting. This study identified the occurrences of exposure to blood pathogens and bodily fluids through percutaneous and non-percutaneous exposure among HCWs in order to assess possible approaches to prevent such incidents. Research has shown that occupational exposure to blood and bodily fluids continues to exist among HCWs [10-14]. Our research finds similar incidents in a research university hospital reported to that hospital's employee clinic. In the time period of January 1, 2014 and August 15, 2017, different occupations of HCWs reported 655 incidents regarding blood and bodily fluids exposure from in a university research hospital. Of those exposures, HCWs reported, the majority were percutaneous injuries (n=506, 77.25%), and 22.74% (n=149) reported non-percutaneous exposure to blood and bodily fluids (Table 1). Previous studies support our findings that exposures occur due to percutaneous injuries more than non-percutaneous exposures [21-23]. Occupations were associated with the occurrence of percutaneous injuries, which is consistent with past studies [24,25]. As various studies have identified, exposure to bloodborne pathogens predominantly occur among nurses, physicians, and lab workers [24,25]. However, our study found that nurses (50.53%) were exposed to blood and bodily fluids more than other HCW occupations, followed by surgical physicians (25.64%). This is likely due to higher rates and durations of exposure. Nurses make contact with patients for longer periods of time compared to other occupations, which consequently exposes to blood and bodily fluids. It is estimated that 70.4% of registered nurses (RNs) experience at least one needle stick injury per year, while the less experienced nurses received more needlestick injuries [26]. Published studies reveal most nurses inadequately comply with universal precautions worldwide, where nurses are selective regarding the implementation of universal precautions recommendations, which is strong evidence of the low level of compliance of universal precautions [27,28]. In our study, we included all types of nurses in one category. Future studies should assess the extent of the exposure among different types of nurses in order to find out the better preventive measures. The majority of percutaneous injuries incidents were caused by hollow-bore needles (75.08%), followed by surgical or other sharp items (40.86%). Previous studies are consistent with our study, as NSIs, particularly with hollow-bore needles, are the most frequent items resulting in exposure to blood and bodily fluids [29,30]. Percutaneous injuries caused by hollow-bore needles were the most frequent incidents among nurses (70.86%), whereas surgical instruments or other sharp items were the most frequent incidents among physicians (surgical) (54.27%). In addition, shift times when injuries occurred were positively associated with percutaneous injuries, where morning shifts comprised a greater percentage of injuries among HCWs. Previous research showed the majority of exposures occurred during the morning shift [31]. This may be attributed to busy schedules and greater demands of patients during morning shifts. However, there are previous studies inconsistent with our results, which found that fatigue and sleep deprivation affect extended shifts more than regular working hours, so the night shift is associated with high percentages of percutaneous injuries among HCWs [32,33]. Future research should examine differences between the characteristics of HCWs regarding types of shifts resulting in percutaneous injuries. HCWs encounter all type of infectious diseases during performance their duties, resulting in concerns regarding transmission of blood borne pathogens. In United States, cases of acute hepatitis B increased by 20.7% to 3,370 cases in 2015 in general population, and cases of acute HCV infection increased by increased 11% to 2,436 cases in 2015 [34]. In our study, most reported incidents are associated with patients who have hepatitis B, C or both. More protective procedures should be applied through attending Bloodborne pathogen education and implementing standard precautions compliance. Future study should assess the extent of HCWs' knowledge about infectious diseases, its routes of transmission and its effects and explore the extent of HCWs concern to consistently attend continuing medical education programs. This study has some limitations, underreporting of blood and bodily fluids exposure is missed in our data, resulting in an underestimate of the true magnitude of the problem. For example, some HCWs who were exposed tended to report, and others did not report the incidents because they might believe the exposure was not significant. Therefore, these results cannot necessarily be generalized, as the results underestimate the problem. Moreover, the dataset lacks information, including gender, years of experience, shift schedule, and blood pathogen training attendance. These information can help to assess different characteristics of HCWs and also estimate the true burden of the exposure among HCWs.

## Conclusion

Exposure to blood and body fluids is a concern among HCWs. The majority of incidents reported here were percutaneous injuries. Exposure to bloodborne pathogens largely occur among nurses and physicians. Future studies should assess all types and duties of nurses and physicians in order to estimate the magnitude of the exposure to help establish better preventive measures based on the workplace environment. The majority of percutaneous injuries incidents were caused by hollow-bore needles, followed by other sharp items. Additionally, morning shifts comprised a greater percentage of percutaneous injuries among HCWs. Future research should examine differences based on characteristics of HCWs regarding types of shifts resulting in percutaneous injuries. The exposure to hepatitis B and C had more reporting among HCWs. Future study should assess the extent of HCWs' knowledge about infectious diseases, its routes of transmission and its effects and explore the extent of HCWs concern to consistently attend continuing medical education programs

## Declaration of Interest

The authors report no conflicts of interest. The author alone is responsible for the content and writing of the paper.

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