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Blood or Body Fluid Exposures and HIV Postexposure Prophylaxis Utilization among First Responders

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Abstract

Objectives—To estimate the incidence of first-responder visits to emergency departments (EDs) for blood or body fluid exposures, elucidate any temporal patterns of these visits, and quantify human immunodeficiency virus (HIV) postexposure prophylaxis (PEP) utilization for these exposures.

Methods—This was a retrospective study of first responders presenting to Rhode Island EDs for blood or body fluid exposures from 1995 to 2001. Incidence rates for exposures with 95% confidence intervals (CIs) were estimated. Temporal trends for visits were modeled. Factors associated with HIV PEP utilization were identified using logistic regression. Odds ratios (ORs) with 95% CIs were estimated.

Results—The average incidence rate of ED visits for blood or body fluid exposures was 23.29 (20.07–26.52) ED visits per 100,000 ambulance runs. The incidence rose between 1995 and 1999 and then decreased. First-responder ED visits were lowest in October and highest in April and were lowest at 7 AM and highest at 7 PM. First responders presenting with a percutaneous or blood-to-mucous membrane exposure had a 4.13 (1.82–8.89) greater odds and those exposed to a known HIV-infected source had a 9.03 (1.59–51.26) greater odds of being offered HIV PEP. First responders presenting to a teaching hospital had a 2.21 (1.02–4.77) greater odds of being offered prophylaxis and a 4.20 (1.08–16.32) greater odds of accepting prophylaxis when it was offered.

Conclusions—First responders face a risk of blood or body fluid exposure that varies over the course of the day and the year. HIV PEP is more likely to be used if the exposures are percutaneous, or blood-to-mucous membrane, or if the source is known to be HIV-infected. Standardization of protocols across EDs for administering HIV prophylaxis appears to be needed.

Keywords

emergency medical technicians; needlestick injuries; occupational exposures; blood; blood-borne pathogens; disease transmission

Introduction

Medical first responders—emergency medical technicians, firefighters, and paramedics—encounter unique occupational hazards while delivering emergency care in the prehospital setting. First responders are at risk for percutaneous injuries and blood splashes that carry the possibility of infection with the human immunodeficiency virus (HIV) and other blood-

borne pathogens. Previous studies have attempted to quantify the frequency with which first responders sustain blood or body fluid exposures as a part of their jobs.¹⁻⁻⁷ Many of these studies contain limitations that narrow their scope and utility, such as focusing on only one type of blood or body fluid exposure,³ reviewing only short study periods with relatively small sample sizes,^{2,5--7} and including a limited geographic area or a single emergency medical system.^{2,3,6,7} In addition, prior studies do not address the utilization of HIV postexposure prophylaxis (PEP) by first responders following an exposure.

The present study was designed to estimate the incidence rates for emergency department (ED) visits following blood or body fluid exposures among first re-ponders in an entire state. The study included ED visits from one year prior to the release of Centers for Disease Control and Prevention (CDC) guidelines on occupational HIV PEP (January 1995) until the second revision of these guidelines (June 2001).⁸⁻⁻¹⁰ The study also aimed to elucidate any temporal patterns of ED visits by first responders to determine the peak times of these visits by month of the year, day of the month, day of the week, and hour of the day. If temporal patterns were shown to exist, EDs could optimize their readiness to prepare for visits by first responders, and emergency medical services (EMS) systems could institute targeted educational programs to reduce the occurrence of these exposures. Finally, this study quantified how often EDs offered HIV PEP to first responders for their exposures, how often first responders accepted HIV PEP when it was offered, and what clinical and nonclinical factors were related to the use of HIV PEP.

Methods

Study Design and Setting

This was a retrospective study comprising data collected from medical records of first responders presenting to the EDs of the ten acute care general medical hospitals in Rhode Island between January 1, 1995, and June 30, 2001. Of the ten EDs, four are part of general medical teaching hospitals (affiliated with a medical school that sponsors undergraduate and graduate medical education programs) and six are nonteaching (community) general medical hospitals. Specialty, psychiatric, governmental, and military hospitals were not included in the study because first responders are not evaluated for their exposures at these facilities. The ten hospitals comply with the occupational HIV PEP guidelines that were initially issued by the CDC in 1996 and were revised in 1998 and again in June 2001.⁸⁻⁻¹⁰ Visits by first responders to other types of health facilities for blood or body fluid exposures were not the focus of the study and therefore were not included. The study was approved by the institutional review boards of all hospitals in the study.

First-Responder System in Rhode Island

The State of Rhode Island does not have a centralized first-responder system. First responders are dispatched from municipal and volunteer EMS systems and firefighter systems. There are 54 fire departments and 36 EMS systems, which are independent from fire departments.¹¹ Of the first-responder systems, 27 operate advanced life support (ALS) response systems, 15 operate basic life support (BLS) response systems, and 48 conduct both. There are approximately 1,800 firefighters and 880 emergency medical technicians and paramedics in the state.¹²

Data Collection

Emergency department visits by first responders were identified using *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes. Hospital and ED provider billing databases for each of the ten hospitals were searched using the ICD-9-CM codes. The following codes were chosen to identify ED patients who had

sustained a blood or body fluid exposure: E920.5 (needlestick), V01.7 (exposure to other viral diseases), V01.8 (exposure to other communicable disease), V07.8 (other specific prophylactic measure), V07.9 (unspecified prophylactic measure), and V15.85 (exposure to potentially hazardous body fluids). The billing records for the EDs were searched using these ICD-9-CM codes.

Trained researchers retrieved and reviewed the medical records of patients identified through an ICD-9-CM code search and extracted the age, gender, and occupation of the patient from the medical records as well as the hospital where the patient presented, the type and the time of exposure, the HIV status of the source, and whether the patient had received HIV PEP. The researchers entered the data onto a standardized reporting form.

Data Analysis

Data were loaded into Epi Info 2002 (CDC, Atlanta, GA) using a database created by one of the study authors (RCM). The data were analyzed using STATA 9.2 (StataCorp LP, College Station, TX) and R 2.5.1 (www.r-project.org). The study authors calculated summary statistics for the demographic characteristics of the first responders, the characteristics of their exposures, and the type of hospital where the first responders made their ED visits. Pearson's χ^2 test was used to assess the relationship between first-responder age and gender with significance of the exposure. Percutaneous injuries and blood-to-mucous membrane splashes were considered to be significant exposures. The incidence rates for ED visits for blood and body fluid exposures by first responders were calculated using the total number of ambulance runs in Rhode Island annually from 1995 to 2001. Because the study period covered only half of 2001, all data from that year were doubled before being analyzed. Incidence rates were generated using a Poisson regression model. Plots of actual and Poisson regression fitted estimates of ED visits were created for exposures by month of the year, day of the month, day of the week, and hour of the day. The Walter and Elwood test of seasonality as well as χ^2 goodness-of-fit tests were conducted to analyze the temporal patterns of ED visits. The proportions of first responders who were offered and who accepted HIV PEP were stratified by the demographic characteristics of the first responders, the characteristics of their exposures, and the types of hospital where they made their ED visits. Logistic regression analysis was used to analyze the data on HIV PEP utilization. Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated. Differences at the $\alpha = 0.05$ level were considered significant.

Results

First-Responder Demography and Exposure Characteristics

Between 1995 and 2001, there were 200 ED visits by first responders to Rhode Island EDs for blood or body fluid exposures (Table 1). The vast majority of first responders with a blood or body fluid exposure were men, half were age 30 years and younger, and the majority presented to a nonteaching hospital ED for evaluation of their exposure. The vast majority were exposed to a patient whose HIV status was unknown at the time of ED evaluation, and 45% sustained either a percutaneous or blood-to-mucous membrane exposure. Almost all (98.8%) presented within 48 hours after their exposure. Neither age ($p < 0.6$) nor gender ($p < 0.08$) of the first responder was associated with having had a significant (percutaneous or blood-to-mucous membrane) exposure.

Blood or Body Fluid Exposure Incidence

Table 2 provides the annual incidence of ED visits by first responders for blood or body fluid exposures over the course of the study period. The incidence peaked in 1999 and declined slightly for the next two years. The incidence rate of ED visits for percutaneous and

blood-to-mucous membranes exposures exhibited a similar trend; however, the incidence of ED visits for all other exposures generally increased over the study period.

Temporal Patterns of First-Responder Emergency Department Visits

Figure 1 displays the plots of ED visits by first responders, showing actual and fitted regression equation values over different time periods. By the plots, a peak in visits was observed during April, on Fridays, and around 7 PM. Nadirs for these types of visits were seen in October, on Tuesdays, and around 7 AM. By the Walter and Elwood test for seasonality, visits by month of the year demonstrated a definite seasonality trend ($p < 0.03$). The χ^2 goodness-of-fit test demonstrated adequate fitness of the model ($p < 0.07$). The test for seasonality was also positive for hour of the day ($p < 0.01$), but the goodness of fit for the model was poor ($p < 0.01$). The plot for day of the month appeared to show a peak in ED visits in the middle of the month, but the seasonality test was negative ($p < 0.09$). The seasonality test for day of the week was also negative ($p < 0.09$).

HIV Postexposure Prophylaxis Utilization

HIV PEP was offered to 19.5% of first responders presenting to EDs for their exposure. Of these 39 first responders who were offered prophylaxis, 17 (43.6%) accepted it. Table 3 shows the percentage of first responders who were offered HIV PEP and who accepted HIV PEP when it was offered, as stratified by the demographic characteristics of the first responders, the characteristics of their exposures, and their ED visits. The percentage of first responders offered HIV PEP was significantly greater for those exposed to a known HIV-infected source, those who presented to a teaching hospital, and those who sustained a significant exposure. Over the course of the study period, the offering of HIV PEP increased until 1998, and decreased thereafter. When HIV PEP was offered, it was accepted by a greater percentage of those first responders who had presented to a teaching hospital.

Table 4 shows the results of the logistic regression analyses attempting to identify factors associated with HIV PEP utilization. As expected, the type of exposure and HIV status of the source were strong determinants as to whether PEP was offered. The other expected determinant—time elapsed between exposure and arrival at the ED—was not found to be significant whether time elapsed was modeled as a continuous or a categorical variable. However, very few first responders presented more than 72 hours after their exposure, so the lack of time trends was not definitive. First responders presenting to a teaching hospital ED had a greater odds of being offered HIV PEP than those presenting to nonteaching hospital EDs, after adjustment for HIV source status and type of exposure. First responders presenting to a teaching hospital ED were more likely to accept HIV PEP when it was offered.

Discussion

The results of this study should assist leaders of EDs and EMS systems in improving the management of exposures to blood or body fluid sustained by first responders. This study details the frequency of ED visits by first responders for these exposures, when these visits were most likely to occur, and the types of exposures they sustained. These findings should assist in planning educational and preventive initiatives for first responders on how to avoid these injuries and help hospitals be more prepared for first-responder visits for these exposures. These observations regarding HIV PEP utilization pinpoint shortcomings that might be overcome with better adherence to CDC protocols and standardization of practice.

Fewer than half of the exposures would be considered significant—that is, most of these exposures would not have carried the potential for HIV or hepatitis transmission. Thus, HIV

PEP prescription would be a consideration for fewer than half of the presenting first responders. Moreover, few first responders were exposed to a known HIV-infected source, whereas most were exposed to a source of unknown HIV status. HIV PEP would therefore definitely be recommended under CDC guidelines for a minority of cases in this study.⁸⁻¹⁰ Moreover, since rapid HIV testing can now be employed to clarify the HIV status of these sources, unnecessary prescription of PEP could be avoided.

The rising number of visits to the ED seen at the start of the study may reflect the growing knowledge and awareness of first responders of the need for the evaluation of their exposures and the potential receipt of prophylaxis during this period. The U.S. government has published recommendations for the management of blood-borne pathogen exposures to HIV and hepatitis since 1987 and has established a standard of care for management of these exposures in the workplace through 1991's Occupational Safety and Health Administration (OSHA) guidelines.^{13,14} However, the increase in ED visits seen over the course of this study's observation period could be due to the release in 1996 and revision in 1998 of the CDC's occupational HIV PEP guidelines, as well as increases in first-responder education and safety protocols.⁸⁻¹⁰ The subsequent drop in visits after 1999 may reflect a rise in the use of universal precautions and safety devices or an increasing awareness of the relatively low infection risk of HIV transmission from an exposure. The drop could also be explained by a decrease in alarm about these exposures and interest in using HIV PEP after an initial attention to the guidelines subsided. The data suggest that toward the end of the study period, a larger percentage of first-responder ED visits were for exposures other than percutaneous injuries and blood-to-mucous membrane splashes, which are the two higher-risk exposures. This may reflect increased safety practices or an increase in a "better safe than sorry" viewpoint about exposure evaluations among first responders.

In an earlier study on first-responder blood and body fluid exposures, Reed et al. observed an incidence rate of 440 blood or body fluid exposures and 130 significant (percutaneous and blood-to-mucous membrane and nonintact skin) exposures per 100,000 EMS calls among fire rescue and EMS personnel in Portland from 1988 to 1989.² Leiss et al. used a sample of over 3,000 paramedics across the United States from 2002 to 2003 to calculate an overall incidence rate of 60 total blood or body fluid exposures and 24 percutaneous and blood-to-mucous membrane exposures per 100,000 EMS calls.¹ The present study calculated an average annual incidence of approximately 25 total exposure ED visits and 11 percutaneous and blood-to-mucous membrane exposure ED visits per 100,000 ambulance runs. Taking into consideration the data from earlier studies, it appears that the incidence rate is falling over time. This trend may be explained by the reasons mentioned above.

Other researchers have examined blood or body fluid exposure occurrence among health care workers, but have not estimated the incidence rates for first responders.¹⁵⁻¹⁸ Unfortunately, these estimates are not directly comparable with the results of this study because different methods of estimating these occurrences were used. Merchant et al. used the average number of people employed in the State of Rhode Island to calculate incidence rates of visit to EDs for blood or body fluid exposures by health care worker occupation. They found that the yearly incidence of ED visits for blood or body fluid exposures was 127 ED visits per 10,000 first responders, 56 per 10,000 medical staff, and 51 per 10,000 nursing staff.¹⁹

The variation of first-responder ED visits across the months of the year, with a maximum of visits around April and a minimum around October, is not unexpected. The winter peak may be due to an increase in ambulance runs during the winter months, when inclement weather and reduced number of daylight hours increase the potential for blood or body fluid exposures. Over the course of the day, the lowest number of visits were at 7 AM and the

highest number of visits were at 7 PM. This variation may reflect ambulance run activity, although the peaks do not coincide with estimates of all ambulance runs in the state. According to the Rhode Island Department of Health, ambulance runs are slightly higher at 11 AM, on Fridays, and in September (unpublished data, Rhode Island Department of Health, 2008). This study's findings on the temporal nature of ambulance runs for blood or body fluid exposures can be used to educate first responders regarding when they face increased risk, as well as to improve ED readiness for handling exposure cases. Because this is a study of ED visits for these exposures, we do not know how frequently first responders visit other types of health care facilities for evaluation and treatment of their blood or body fluid exposures. It seems likely that the patterns of ED visits, particularly being more frequent during evening hours, could reflect the availability of treatment facilities during these hours. It should be noted, however, that these temporal pattern analyses are partially dependent on the number of data points in the analysis. Given the relatively small number of ED visits ($n = 200$), these analyses should be considered indicative of general trends.

In compliance with CDC occupational HIV PEP guidelines,⁸⁻⁻¹⁰ first responders who sustained a higher-risk exposure—a percutaneous or blood-to-mucous membrane exposure and/or an exposure to a known HIV-infected source—had a greater odds of being offered prophylaxis. It is reassuring to note that age and gender were not found to be determinants of whether first responders were offered prophylaxis. However, a first responder had a twofold greater odds of being offered PEP if he or she presented to a teaching hospital as opposed to a nonteaching hospital, after adjusting for the significance of the exposure and the HIV status of the source. Once HIV PEP was offered, a first responder had a fourfold greater odds of accepting it if he or she presented to a teaching instead of a nonteaching hospital. This observation may be explained by a difference in the way the HIV PEP guidelines are implemented in these two kinds of hospitals. Standardization of HIV PEP utilization protocols across institutions may help to ensure that the appropriate treatment is being provided to minimize the risk of HIV seroconversion following blood or body fluid exposures. First-responder education regarding treatment options after an exposure might also help ensure compliance with CDC occupational exposure guidelines. Of course, there may be other factors, such as personal beliefs of the ED clinician and patient, that could not be accounted for in this type of study that influence the offering and acceptance of HIV PEP.

Limitations and Future Studies

One of the primary limitations of this study was that it was retrospective; thus, missing or incomplete information might have affected the number of cases identified and the data available for the analyses. For the analyses conducted, we believe that the necessary information was available in a large enough sample to perform the primary calculations of interest. Also, “missingness” of data was likely not associated with the outcomes of the study. Underreporting of cases by first responders and utilization of other medical facilities for exposures would lead to underestimates of the frequency of these exposures. However, this study concerned only ED visits by first responders, so first-responder visits to other facilities were not relevant. It should also be noted that since the advent of rapid HIV testing, HIV PEP utilization has likely changed. Future studies can examine the impact of rapid HIV testing on first responders' offering and acceptance of HIV PEP. In this study, we used the number of ambulance runs in the state in the calculation of incidence rates. Ideally, we would have used the number of ambulance runs in which potential contact with blood or body fluids might have occurred. Unfortunately, no existing database contains this information. However, our estimates use methods comparable with other studies and allow for ease of comparisons across first-responder systems. It should also be noted that the incidence rates are dependent on clinician recording of the diagnoses in the medical record,

billing database personnel noting of the diagnosis in the billing database, and other administrative factors that could not be controlled for in this study.

Conclusions

This study shows that there is variation in the risk of blood or body fluid exposures faced by first responders over the course of the day and the year. These findings can help pinpoint when first responders face increased risk and can be incorporated into exposure prevention and educational efforts. As the findings also show a variance in the results in HIV PEP prescription and utilization between teaching and nonteaching hospitals, it is clear that a standardization of EDS' policies is needed to properly address blood and body fluid exposures among first responders.

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Figure 1.

Time courses of first-responder emergency department (ED) visits. Open circles: observed data; dashed line: fitted curve.

Table 1

Demographics of the First Responders (N = 200)

Age, median (range)	30 years(15--58)
Gender	
Male	92.5%
Female	7.5%
Type of hospital	
Teaching	30.5%
Nonteaching	69.5%
HIV status of source	
Negative	0.5%
HIV-infected	3.0%
Unknown	96.5%
Type of exposure	
Percutaneous	34.5%
Blood splash to mucous membrane	10.5%
Blood splash to skin	29.0%
Body fluid splash to mucous membrane	14.5%
Body fluid splash to skin	11.5%
Total significant exposures	45.0%
Time elapsed since exposure (N = 180) *	
<24 hours	89.4%
24--48 hours	9.4%
49--72 hours	0.0%
>72 hours	1.2%

* Time elapsed was not available for all patients.

HIV = human immunodeficiency virus.

Table 2

Incidence Rates of First-Responder Emergency Department Visits Following Exposure

Year	First-Responder ED Visits, 1995 to Mid-2001 n	Total Ambulance Runs n	Average Yearly Incidence of First-Responder ED Visits, per 100,000 Ambulance Runs		
			All Exposures IR (95% CI)	Percutaneous and Blood-to-Mucous Membrane Exposures IR (95% CI)	All Other Exposures IR (95% CI)
1995	8	97,386	8.21 (2.52--13.91)	2.05 (0.00--4.90)	6.16 (1.23--11.09)
1996	20	104,441	19.15 (10.76--27.54)	9.57 (3.64--15.51)	9.57 (3.64--15.51)
1997	32	104,636	30.58 (19.99--41.18)	15.29 (7.80--22.78)	15.29 (7.80--22.78)
1998	31	113,990	27.20 (17.62--36.77)	14.91 (7.82--22.00)	12.28 (5.85--18.72)
1999	47	123,063	38.19 (27.27--49.11)	17.06 (9.77--24.36)	21.13 (13.01--29.25)
2000	42	128,988	32.56 (22.71--42.41)	13.95 (7.51--20.40)	18.61 (11.16--26.05)
2001 *	40	125,449	31.89 (22.00--41.77)	9.57 (4.15--14.98)	22.32 (14.05--30.59)
1995--2001	31	113,993	27.19 (17.62--36.77)	12.28 (5.85--18.71)	15.79 (8.50--23.09)
1996--2001	35	116,761	29.98 (20.04--39.91)	13.70 (6.99--20.42)	17.13 (9.62--24.6)

* One-half year, original data doubled.

CI = confidence interval; ED = emergency department; IR = incidence rate.

Table 3
Percentage of First Responders Offered and Receiving HIV Postexposure Prophylaxis, by Factor

Age	n	Percentage Offered HIV PEP	Percentage Not Offered HIV PEP	p-Value	n	Percentage Accepting PEP When Offered	Percentage Not Accepting PEP When Offered	p-Value
30 years	114	21.0	79.0		24	50.0	50.0	
<30 years	86	17.4	82.6		15	33.3	66.7	
Gender				<0.2				<0.9
Male	185	18.4	81.6		34	44.1	55.9	
Female	15	33.3	66.7		5	40.0	60.0	
Type of hospital				<0.002				<0.03
Teaching	61	32.8	67.2		20	60.0	40.0	
Nonteaching	139	13.7	86.3		19	26.3	73.7	
HIV status of source*				<0.003				<0.8
HIV-infected	6	66.7	33.3		4	50.0	50.0	
Unknown	193	18.1	81.9		35	81.9	18.1	
Type of exposure†				<0.001				<0.2
Significant	90	31.1	68.9		28	50.0	50.0	
Nonsignificant	110	10.0	90.0		11	27.3	72.7	
Time elapsed since exposure‡				<0.3				<0.4
<3 days	178	20.2	79.8		36	44.4	55.6	
>3 days	2	50.0	50.0		1	0.0	100.0	
Year of exposure				<0.2				<0.5
1995	8	0.0	100.0		0	0.0	100.0	
1996	20	10.0	90.0		2	0.0	100.0	
1997	32	12.5	87.5		4	75.0	25.0	
1998	31	32.3	67.7		10	30.0	70.0	
1999	47	21.3	78.7		10	50.0	50.0	
2000	42	23.8	76.2		10	50.0	50.0	
2001	40	15.0	85.0		10	33.3	66.7	

* Confirmed HIV-negative sources (1) not included.

[‡]Significant exposures were percutaneous and blood-to-mucous membrane exposures.

[‡]Time elapsed was not available for all patients. HIV = human immunodeficiency virus.

Table 4

Logistic Regression Analysis of Offering and Acceptance of HIV Postexposure Prophylaxis

Factor	HIV PEP Offered		HIV PEP Accepted When Offered Univariate Analysis OR (95% CI) <i>n</i> = 39
	Univariate Analysis OR (95% CI) <i>n</i> = 199	Multivariate Analysis OR (95% CI) <i>n</i> = 199	
Age			
30 vs. <30 years	1.28 (0.62--2.61)		2.00 (0.52--7.63)
Gender			
Female vs. male	2.47 (0.78--7.83)		0.84 (0.12--5.72)
Type of hospital			
Teaching vs. nonteaching	3.06 (1.49--6.28)	2.21 (1.02--4.77)	4.20 (1.08--16.32)
HIV status of source			
Positive vs. unknown	9.03 (1.59--51.26)	7.63 (1.22--47.56)	1.33 (0.17--10.58)
Type of exposure			
Significant vs. nonsignificant *	4.13 (1.82--8.89)	3.34 (1.49--7.48)	2.67 (0.58--12.19)
Time elapsed since exposure †	<i>n</i> = 179		<i>n</i> = 37
>3 Days vs. <3 days ‡	3.92 (0.24--64.14)		N/A
Elapsed days (continuous)	1.20 (0.55--2.59)		1.42 (0.31--6.44)
Elapsed time (hours)	0.84 (0.41--1.74)		0.70 (0.16--3.18)

* Significant exposures were percutaneous and blood-to-mucous membrane exposures.

† Time elapsed was not available for all patients.

‡ All patients presented within three days.

CI = confidence interval; HIV = human immunodeficiency virus; N/A = not applicable; OR = odds ratio; PEP = postexposure prophylaxis.