

Analysis of Bloodborne Pathogen Exposure Monitoring Protocol Adherence in an Academic Medical Center: a seven-year analysis and literature review

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ABSTRACT

BACKGROUND: Health care workers (HCW) are at risk for occupational blood borne pathogen exposures (BBPE). Effective prevention and management of BBPEs relies upon reporting and post-exposure follow-up protocol adherence. As post-exposure monitoring completion is largely unexplored, seven years of a university healthcare system's BBPE exposure data was explored and compared to documented rates.

METHODS: The Marshall Health Occupational Health and Wellness division collected seven years (2012-2018) of BBPE follow-up monitoring adherence rates and demographic data. Data for HCW occupation, exposure incident, and source patient disease status were evaluated. Differences were analyzed with Chi square, Fischer Exact and logistic regression tests.

RESULTS: Of the HCWs (n =293), 31.7% completed follow-up monitoring. Completion rates of physicians and their learners (29.8%) trended lower than non-physician HCWs (43.9%; $p < 0.071$). Similar completion rates were seen for all types of exposures ($p = 0.470$). Reported incidents had higher completion rates than unreported incidents ($P = 0.001$). Reported incidents (OR 6.906; 95% CI 1.936-24.637) and source patient status independently predicted completion, regardless of type of infection. Seropositive source patient status (67.2%) was associated with the highest HCW adherence rate (OR 4.747; 2.359-9.552), while unknown source patient status (17.1%) was the lowest (OR 0.423; 0.208-0.859).

CONCLUSION: Current literature is limited regarding adherence rates to post-exposure monitoring protocols, favoring reporting rate analysis. Above results differ from some published reports potentially identifying unique demographic patterns in medical centers of differing size and governance. Understanding demographics associated with BBPEs may provide insight to institutional post-exposure monitoring adherence rates.

KEYWORDS

Blood Borne Pathogens, Post exposure adherence, Occupational medicine, Needle stick, Academic Medical center

INTRODUCTION

"First, do no harm." Although strongly emphasized, this phrase is often forgotten by health care workers (HCW) regarding their own safety from the occupational hazard of bloodborne pathogen exposures (BBPEs). An estimated 3 million HCWs

worldwide^{1,2} and 385,000 HCWs in the United States encounter some type of BBPE annually.³⁻⁶ Contact through splash exposure and puncture injuries can potentially transmit 20-30 different pathogens.^{3,4,7,8} Hepatitis B (HBV), Hepatitis C (HCV), and Human Immunodeficiency Virus (HIV) have approximate seroconversion rates of 6-30%, 1,3,9 0-7%,^{4,9,10} and

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0.3%,^{1,3,5,7,9-13} respectively. These rates depend on the source patient's viral load and the amount of fluid transferred. Potential BBPEs are a source of anxiety for HCWs as consequences of infection can be costly and threaten job security, the health of self and an intimate partner, and even life.^{11,14,15}

The Occupational Safety and Health Administration (OSHA), through the Needle Stick Safety Prevention Act of 2000, requires BBPEs to be reported by employees and logged by institutions.⁹ Despite the known risk and easily accessible reporting systems, studies have found as many as 33-70% of BBPEs are unreported.^{1,3-5,10-13,16} Reasons for underreporting are complicated and multifactorial, including desensitization to perceptions of transmission risk,^{1,3,5,10-13,17,18} time constraints,^{1,4,5,10,12,14,17} inconvenience of reporting,^{10,11,13,14,18} and an institutional "culture of silence."^{12,17} These reasons are driven by the fears of being stigmatized as negligent of basic precautions⁹ and potential breaches in confidentiality.^{11,14,18} Proper and timely account of a BBPE is important for treatment, evaluation for post-exposure prophylaxis, identification of risk-prone practices, and compensation documentation.^{1,5,11,12,14} As such, reporting rates among HCWs have been widely studied.

The widespread lack of adherence to the Centers for Disease Control post-exposure protocol after initial exposure is less frequently studied in the medical literature.¹⁹ Monitoring protocols for HCWs include immediate evaluation of disease markers followed by monitoring at four to six weeks, 12 weeks, and four to six months, depending on the pathogen.^{14,17} This is essential as antibody seroconversion in HCWs will not be detected with the initial measurement directly following the incident.²⁰ Studies have shown examples of non-immune HCWs taking nearly six months to develop detectable antibodies to HBV, although the average time is four weeks.^{8,21} Seroconversion of HIV can take up to six to 12 months²⁰ and between four and 11 weeks for HCV. This is delayed further with immunosuppression.²¹ Not only does low follow-up adherence result in systematic underestimation of seroconversion rates,^{14,20} but HCWs could unwittingly increase the risk of spreading the pathogens to personal contacts, patients, and the community.¹⁶ Current

medical literature (Table 1) is divided regarding post-exposure monitoring protocol adherence, with a majority of articles favoring a low rate between 14%-33.2%,^{13,18,22-24} while other sources demonstrate a more optimistic range of 54%-87.5%.^{3,20,25,26}

Even less attention is given to how the demographics of the HCWs (physician, fellow/resident, student, nurse, physician extender, and other), the exposure type (needle stick, other puncture, and both disclosed and non-disclosed exposures), and the source patient disease state (positive, negative, and unknown) are associated with adherence to post-exposure monitoring protocols, again with conflicting results (Table 1).^{3,20,22-26} To improve this understanding, a wider array of demographics associated with adherence rates in different clinical settings should be explored. This paper compared data from a public, academic medical center (AMC) located in an HCV endemic and emerging HIV endemic region to documented compliance rates from the literature.

MATERIALS AND METHODS

De-identified data from 2012-2018 was retrospectively collected from the occupational health and wellness (OHW) division's database and was populated with information from exposures within the AMC. Notifications of exposures were obtained through exposed employee or medical student reports, workers comp carriers, and the facility's occupational health and billing systems. The monitoring protocol for conversion was offered to affected individuals and conducted through the OHW division. Inclined individuals were followed for six months. Data collection points included employing department, job duty, date of exposure, facility in which exposure occurred, type of exposure, procedure performed when exposure occurred, if the exposure was directly reported to OHW, if follow-up was completed, and the disease status of the source patient. Because this project dealt solely with de-identified data, it was considered exempt by Marshall University's Institutional Review Board (#1088726).

Chi-square and Fischer Exact tests analyzed exposure



Table 1: Current Literature on Post-Exposure Monitoring Protocol Adherence Patterns				
Year	Author	Country	Results	
2005	Miceli, et al.	Argentina	Overall	14% adherence to post-exposure monitoring
			HCW	Not reported
			Exposure	Not reported
			Source Patient	Higher if seropositive.
2005	Gutierrez, et al	Brazil	Overall	67% adherence to post-exposure monitoring
			HCW	Lower if cleaning personnel
			Exposure	No differences reported
			Source Patient	Lower if seropositive for HIV and HCV
2008	Au, et al.	England	Overall	23.9% adherence to monitoring (surgeon survey)
			HCW	Not reported
			Exposure	Not reported
			Source Patient	Not reported
2009	Ko, et al.	Taiwan	Overall	33.2% adherence to post-exposure monitoring
			HCW	Not reported
			Exposure	Higher if percutaneous injury
			Source Patient	Higher if seropositive
2012	Winchester, et al.	England	Overall	22% adherence to post-HCV exposure monitoring for dentists
			HCW	Not reported
			Exposure	Not reported
			Source Patient	Not reported
2013	de Almedia, et al.	Brazil	Overall	66% adherence to post-exposure monitoring
			HCW	No change with profession
			Exposure	No difference in mechanism or type of exposure
			Source Patient	Higher if seronegative (29x)
2015	Escudero, et al.	Brazil	Overall	54% adherence to monitoring with notifications (33.2% baseline)
			HCW	No change with profession; Higher if female; Higher if 1st exposure
			Exposure	No difference in mechanism or type of exposure
			Source Patient	Higher if seropositive
2016	Diaz, et al.	United States	Overall	87.5% adherence rate for all providers in a military medical center
			HCW	Lower if technicians, other, offsite, Fire and Police dept.
			Exposure	Lower if splash exposure; Lower if leg involved
			Source Patient	Higher seropositive HIV & HCV; Lower if referred to ID
2017	Papavarnavas, et al.	South Africa	Overall	28% adherence to post-exposure monitoring at 6 months
			HCW	Lower for physicians and younger HCW
			Exposure	No difference in mechanism; Lower if starting PEP in < 24 hours
			Source Patient	No difference identified

TABLE 1: Compilation of the discovered literature pertaining to adherence to post-exposure monitoring protocols. (HCW = health care worker, HIV = Human Immunodeficiency Virus; HCV = Hepatitis C Virus; ID = infectious disease; PEP = post-exposure prophylaxis)



incident, source patient, and HCW demographic data. A p-value < 0.05 indicated statistical significance. Logistic regression analyses, performed using SAS9.4 software, were utilized to identify the factors associated with completion of the monitoring protocol. Effects significantly associated with monitoring completion were identified, and the odds ratio and Wald confidence intervals were reported.

RESULTS

From 2012 to 2018, 293 HCWs were entered into the OHW database (Table 2). Exposures were directly reported on 253 (86.4%) of the entries. Residents/fellows accounted for 141 (48.1%) exposures, while physicians, medical students, and nurses accounted for 67 (22.9%), 44 (15.0%), and 30 (10.2%) of the exposures, respectively. Needle sticks occurred 157 (53.6%) times, while other punctures (wires, tools, scalpels, fractured bones) added 63 (21.5%) more.

There were 70 (23.9%) disclosed contacts (splashes, torn gloves, existing cuts exposed), and three (1.0%) were undisclosed.

Ninety-three (31.7%) exposed subjects completed the recommended six-month monitoring program (Table 2). Of these, 39 were fellows/residents, 22 were attending physicians, 14 were medical students, 13 were nurses, two were physician extenders, and three were classified as other. This correlates to completion rates of 27.7%, 32.8%, 31.8%, 43.3%, 40.0%, and 50.0% for each group, respectively. Forty-five (28.7%) with needle sticks demonstrated full monitoring adherence. Twenty-five (39.7%) other punctures, 22 (31.4%) disclosed contacts, and one (33.3%) undisclosed contact also completed the monitoring program. Incidents directly reported were more likely to adhere to monitoring protocols than unreported incidents (10.0%; p = 0.001). Logistic regression analysis reveals this to be an independent predictor of adherence (OR 6.906, 95% CI 1.936-24.637).

	Completed	Not Completed	Total	% Completed	Chi Square	P Value
Overall Totals	93	200	293	31.7%		
Job Description						
Physician	22	45	67	32.8%		
Fellow/Resident	39	102	141	27.7%		
Medical Student	14	30	44	31.8%	0.690	0.708
Nursing	13	17	30	43.3%		
Physician Extender	2	3	5	40.0%		
Other	3	3	6	50.0%	0.125	0.939
Physician/Trainees	75	177	252	29.8%		
Non-Physician	18	23	41	43.9%	3.254	0.071
Type of Exposure						
Disclosed Contact	22	48	70	31.4%		
Needle Stick	45	112	157	28.7%		
Other Puncture	25	38	63	39.7%		
Undisclosed	1	2	3	33.3%	2.527	0.470
Reported						
Yes	89	164	253	35.2%		
No	4	36	40	10.0%	10.634	0.001

TABLE 2: Demonstrates the impact of demographics on likelihood of completing the monitoring process. Odds ratio for adherence to a monitoring program for a reported incident was 6.906 (95% CI = 1.936 – 24.637).



Of the source patients involved, 180 were tested for HBV, 183 for HCV, and 182 for HIV (Table 3). One, 59, and four patients tested positive, respectively. Completion of monitoring for HBV occurred 100% of the time for positive exposures, 40.2% for negative exposures, and 17.70% for unknown exposures. HCV (64.4%, 30.7%, 15.5%) and HIV (100.0%, 38.8%, 18.0%) were associated with similar rates of completion. Intrinsic comparisons within each virus's data demonstrated significant differences in adherence based on source patient status ($p < 0.001$). Seropositive source patient status independently predicted monitoring protocol adherence (OR 4.747; 2.359-9.552), and sero-unknown source patient

status decreased adherence (OR 0.423; 0.208-0.859).

DISCUSSION

Regardless of the HCW's role within the health care system, BBPEs are a significant risk.¹⁴ Protection of these workers can be accomplished through a system of education, preventative practices, reporting events, and post-event monitoring. The medical literature primarily revolves around reporting of BBPEs, both for rates and decision rationale to initiate or forgo reporting. The decision conflict for HCWs is the triad of relative importance

Table 3: Impact of Source Patient's Seroconversion Status on Monitoring Adherence					
	Completed	Not Completed	Total participants	Percent Comp	P Value
Surveyed	93	200	293	31.7%	
Source Patient Status by disease					
Hepatitis B - yes	1	0	1	100.0%	
Hepatitis B - no	72	107	179	40.2%	
Hepatitis B - unknown	20	93	113	17.7%	< 0.001
Hepatitis C - yes	38	21	59	64.4%	
Hepatitis C - no	38	86	124	30.7%	
Hepatitis C - unknown	17	93	110	15.5%	< 0.001
HIV - yes	4	0	4	100.0%	
HIV - no	69	109	178	38.8%	
HIV - unknown	20	91	111	18.0%	< 0.001
Source Patient Status by Seroconversion					
Hepatitis B - yes	1	0	1	100.0%	
Hepatitis C - yes	38	21	59	64.4%	
HIV - yes	4	0	4	100.0%	0.388
Total	43	21	64	67.2%	
Hepatitis B - no	72	107	179	40.2%	
Hepatitis C - no	38	86	124	30.7%	
HIV - no	69	109	178	38.8%	0.205
Total	179	302	481	37.2%	
Hepatitis B - unknown	20	93	113	17.7%	
Hepatitis C - unknown	17	93	110	15.5%	
HIV - unknown	20	91	111	18.1%	0.859
Total	57	277	334	17.1%	

TABLE 3: Depicts the source patient's disease state on the likelihood of the health care worker completing the monitoring protocol sorted by disease-specific grouping (top) and result-specific grouping (bottom). Analysis by Chi-square or Fischer Exact tests. Linear regression odds ratio for adherence of an exposure incident with a seropositive patient was 4.747 (95% CI = 2.359 – 9.552) and sero-unknown patient was 0.423 (95% CI = 0.208 – 0.854) both relative to a seronegative patient. (HIV = Human Immunodeficiency Virus)



placed on their own health, the risk of the exposure to their health, and the disadvantages they perceive for reporting.¹⁰ While this complex interplay of variables driving the decision to report BBPEs is well-documented, factors affecting adherence to monitoring protocols are much less studied. These factors are likely similar to those for post-exposure monitoring. Local rates of post-exposure adherence (31.7%) mirror some published rates (14% to 40%),^{13,18,22-24} yet there is nearly as much literature with higher adherence rates (54% to 87.5%).^{3,19,25,26} The highest of these results was reported in a military medical center, which likely has a different culture among its physicians, students, and staff.³ This difference illustrates that characteristics in structure and governance of medical centers may impact adherence rates to post-exposure monitoring protocols and requires further investigation.

Demographic information of HCWs (Table 2) demonstrated a predominance of physicians and their learners (fellows, residents, and medical students) encountering BBPEs; this is likely due to an increased risk of exposure from engaging in a larger variety and complexity of procedures.^{13,27} When HCWs' occupations are analyzed, adherence rates are homogeneous between the grouping of attending physicians and their learners ($p = 0.708$). A similar correlation was seen when grouping nurses, physician extenders, and other providers (p -value = 0.939). While not significant, these two groups trended towards a difference in adherence to monitoring protocols ($p = 0.071$). These results may represent differences in collective concerns regarding the risks of exposure. The medical literature contains some studies unable to determine a correlation by profession,^{13,18,20,22,23,25} while others identify specific sub-characteristics impacting adherence rates. These include females and those without a previous exposure having higher rates²⁵ and younger HCWs having lower rates.²⁴ Profession-specific differences were seen in reduced adherence rates for cleaning personnel,²⁶ technicians,³ and physicians.²⁴ A decrease in adherence to monitoring protocol was seen for individuals considered outside of their military system.³ Physicians and their trainees tend to report less frequently,^{12,27} focusing more on the disadvantages of reporting,¹⁰ which are primarily based on time and stigmatization issues.^{9,10,12,13,18} Nurses and auxiliary staff tend to

report more frequently, as they perceive themselves as having less control over the exposure and, therefore, the victim of the incident.¹ Furthermore, they routinely report having adequate time for the process.¹ Identified as core beliefs, these can be applied to rationales dictating adherence to monitoring protocols.

The second component of BBPE, the exposure incident, failed to demonstrate a difference in monitoring protocol completion. Non-needle stick punctures (39.7%), needle sticks (28.7%), disclosed exposures (31.4%), and undisclosed exposures (33.3%) carried a similar chance of monitoring completion ($p = 0.470$). The bulk of reported exposures, needle sticks, correlated least with monitoring protocol adherence. This corresponds to previous literature correlating the number of events with adherence to monitoring protocols.²⁵ A majority of the literature cannot identify a correlation with adherence to the specific exposure event.^{13,18,20,22,24-26} Contrary to these findings, some studies found increased adherence to percutaneous exposure²³ and decreased adherence with splash exposures.³ Here again, we see the potential effect of specific institutional characteristics on post-exposure adherence.

Correlations emerge when adherence is analyzed by the infection status of the source patient (Table 3). Significant discordance was seen intrinsically between positive, negative, and unknown status within HBV, HCV, and HIV (all $p < 0.001$). When the infections were grouped extrinsically, by the patient's seroconversion status regardless of specific infection, consistent agreement is seen for positive (p -value = 0.388), negative (p -value = 0.205), and unknown (p -value = 0.857) statuses. While the intrinsic analysis of one virus proves that the patient status did significantly impact adherence to monitoring protocols, the extrinsic analysis between pathogens demonstrates a relative lack of perceived differences between the three infections. This illustrates the greater importance of source patient status than the virus type.

Lower source patient post-exposure adherence for an unknown status than for one who is seronegative (17.9% vs. 39.0%) seems counterintuitive. Despite some of the literature providing expected results



of higher adherence rates with seropositive source patients,^{3,22,23,25} counterintuitive anomalies in monitoring adherence have been reported, including a decreased adherence after exposure to HIV and HCV seropositive patients,²⁶ as well as a 29-fold decrease after exposure to a seropositive source patient.²⁰ A likely explanation for these lower-adherence rates might occur if HCWs were referred to infectious disease specialists, thereby removing the monitoring protocol's relative importance.³ It is important to note that while some guidelines allow for the cessation of monitoring protocols if the source patient is negative, our OHW division continues to provide testing as source patient seroconversion may not be apparent at the time of exposure.

The main limitation of this article is the potential completeness of the data collected. It is possible that the numbers might not be inclusive of the total exposures, as both source patients and HCWs could have chosen to use a provider outside of the AMC for monitoring completion. Fortunately, the AMC is large enough for the area served to assume that a vast majority of the exposed subjects' information would fall in the database. Another limitation is that this analysis occurred in only one medical system. It is possible, and extremely likely based upon our conclusions, that when these results are compared to other medical systems, a unique "fingerprint" of HCW values occurs in different medical centers. Future research should focus on discovering the value patterns of HCWs within AMCs of differing sizes and governances that drive these different adherence "fingerprints." Furthermore, it is important to confirm and better understand this low-monitoring completion rate following exposure to a sero-unknown source patient. Ultimately, discovering ways to improve the low completion rates is paramount. Our findings are the first step in understanding these questions.

CONCLUSION

The adherence to the monitoring protocol following BBPEs in our OHW division was low, correlating with some of the previously published literature. These low rates were driven by categories of physicians' and their learners' demographics, undisclosed and unreported exposures, and

unknown patient infectious status. As there are reports of conflicting results in different types of AMCs, different institutions likely carry their own specific "demographic fingerprint." Understanding these institutional patterns will allow improvement in targeting post-exposure resources and therefore improved care of HCWs following a BBPE.

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