Original Article

Journal of Infection Prevention

Journal of Infection Prevention
2016, Vol. 17(5) 226–232
DOI: 10.1177/1757177416645339
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Characterisation of occupational blood and body fluid exposures beyond the Needlestick Safety and Prevention Act

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Abstract

Objective: To describe the use of mandated safety engineered sharps devices (SESDs) and personal protective equipment in healthcare workers (HCWs) with occupational body fluid exposures (BFE) since the Needlestick Safety and Prevention Act.

Methods: Two questionnaires were administered, over 3 years, to HCWs who reported sharps or splash BFEs. Descriptive statistics and chi-square analysis were used.

Results: Of the 498 questionnaires completed, nurses completed 262 (53%), house staff 155 (32 %), technicians 63 (13%) and phlebotomists 11 (2%). Four (1%) completers reported 'other' and three (1%) reported unknown. Sharps injuries accounted for 349 (70%) of the BFEs. SESDs were utilised 43% (128/299) of the time with a 54% (70/130) activation rate. Phlebotomists (80%; 8/10) and nurses (59%; 79/267) used SESDs more than doctors (27%; 31/86) and technicians (26%; 10/39) (P <0.0001). Fifty-four percent (185/207) of HCWs reported having had training on SESD use; nurses (64%; 98/154) and phlebotomists (70%; 7/8) significantly more so than house staff (44%; 59/133) and technicians (44%; 21/48) (P <0.05). Most splash BFEs were to the eyes 73% (91/149). Five percent (4/79) of HCWs used protective eyewear.

Conclusions: Systematic regular training, appropriate protocols and iteratively providing the safest SESDs based on HCW experience and technological advances will further reduce the physical and emotional toll of BFEs.

Key words:

Infectious diseases, standard precautions, Needlestick Safety Prevention Act, body fluid exposures, healthcare personnel, bloodborne pathogens, safety engineered sharps devices, occupational injuries, safety devices, Occupational Safety and Health Administration (OSHA)

Date received: 7 July 2015; accepted: 27 March 2016

Background

Blood and body fluid exposures (BFEs) via percutaneous injury or splash to the mucosa or non-intact skin are important occupational injuries for healthcare workers (HCWs) as they pose a risk for acquisition of a bloodborne pathogen infection (Occupational Safety and Health Administration [OSHA], 2001). These injuries not only impact the physical and emotional health of HCWs (Gershon R et.al., 2000) but also impact hospital costs and the hospital injury rate. Hospitals bear the cost of source patient testing, exposed HCW medical evaluation and treatment for the BFE, and HCW lost time away from work due to drug toxicity, for example, that may result from the post exposure prophylaxis (PEP) medication (Centers for Disease Control [CDC],

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2011; OSHA, 2012). Based on the CDC Worksheet for estimating the Annual and Average Needlesticks and other Sharps Related Injuries (CDC, 2008), one percutaneous injury for one person at this hospital costs approximately $1000. The cost for employee lost time, source patient testing, consultants, vaccines, medications, immune globulin, post exposure prophylaxis and laboratory analysis are taken into account. In addition, BFEs are counted as injuries and tallied with other HCW injuries (Panlilio et al., 2001).

Legislation surrounding the responsibility of healthcare facilities to prevent such injuries include the Occupational Safety and Health Act (OSH) Act in the Unites States (OSHA, 1970), legislation in Canada through the Canadian Centre for Occupational Health and Safety (Canadian Center for Occupational Safety and Health [CCOHS], 2015) and the Health and Safety at Work Act of Britain (UK Legislation, 1974). The OSH Act passed with the goal to 'to assure so far as possible every working man and woman in the Nation safe and healthful working conditions…' (OSHA, 1970, section 1) places the responsibility for eliminating or minimising hazardous conditions on the employer. The CCOHS stipulates that an employer is to 'exercise due diligence to implement a plan to identify possible workplace hazards and carry out corrective action to prevent accidents or injuries arising from these hazards' (CCOHS, 2015, Due Diligence legislation). The Health and Safety at Work Act of Britain stipulates that 'employers are to ensure as far as reasonably practicable, the health, safety and welfare at work of all his employees' (UK Legislation, 2003, Part 1, Section 2). The Occupational Safety and Health Administration (OSHA) issues citations with associated fines to institutions found negligent.

In the USA, the National Institute for Occupational Safety and Health (NIOSH), the research arm of OSHA, formed the National Occupational Research Agenda (NORA). NORA is a partnership effort of stakeholders from academia, industry, labour and government. It serves as a research framework for NIOSH and the nation. One element of NORA is the Healthcare and Social Assistance (HCSA) sector. The 2013 NORA HCSA sector's Strategic Goal 4 is to reduce sharps injuries and their impacts among all healthcare personnel. The performance measure for this goal is to have surveillance systems in place by 2016 and to identify the number and types of healthcare personnel employed in all healthcare settings who sustain sharps injuries including the circumstances, mechanisms, procedures and devices involved in those injuries (NORA, 2013).

Although specific formal efforts towards preventing BFEs started in 1985 in the USA with the institution of Standard Precautions and later OSHA's enactment of the Occupational Exposure to Bloodborne Pathogens Standard, codified as 29 CFR §1910.1030 (OSHA, 2001), sharps and splash injuries continued to occur. As research indicated that certain safety engineered sharps devices (SESDs) helped reduce sharps injuries (Azar-Cavanagh et al., 2007), the Needlestick Safety and Prevention Act (NSPA) was enacted in the USA in 2000. The NSPA mandates that employers select safer needle devices and train employees on the proper use of all engineering and work practice controls. Engineering controls were more clearly defined for the employer specifying the use of SESDs and needleless systems (One Hundred and Sixth Congress of USA, 2000). Similarly in 2010, the European Union (EU) adopted a new Directive to protect HCWs at risk for occupational exposure to infection by legislating risk assessment, eliminating risk by prevention and protection, and minimising risk when elimination and prevention are not possible (Health and Safety Authority, 2014). The importance of a comprehensive implementation of a systematic sharps injury prevention program has become more urgent given the recent Ebola epidemic (CDC, 2015). Preventive measures and safe work practices continue to be essential for HCWs to be adequately prepared for both known and emerging infectious agents. However, it has been shown that SESDs have not always used by HCWs and some SESDs may actually cause injury (Black, 2013).

There are two main objectives of this study. First, to characterise details of BFEs including types of sharps responsible for most injuries, and HCW self-report of safety training; and second, to determine the extent to which mandated SESDs and personal protective equipment (PPE) are used by these HCWs.

Methods

Study design, setting and participants: HCWs who sustained a BFE between 1 July 2006 and 30 July 2009 were asked to complete one of two pilot tested questionnaires at the time of the incident. The questions are based on the Exposure Prevention Information Network (EPINet) questionnaire (Perry et al., 2009) modified for this HCW population through pilot testing, conducted using house-staff groups from various departments, for clarity of questions and relevance to this HCW population. Questions reflect the latest CDC Guidelines including Standard Precautions (requiring use and availability of PPE and engineering controls (Panlilio et al., 2001)) and the requirements of the Needlestick Prevention and Safety Act (to include the date and time of the incident, the type and brand of the sharp involved and whether or not a safe needle device was used (One Hundred and Sixth Congress of USA, 2000)). The *Needlestick and Sharp Object Injury Report* was completed if a percutaneous exposure injury was incurred and the *Splash, Blood and Body Fluid Report* if a splash exposure injury was incurred (Perry et al., 2009). The study population consisted of HCWs at risk for a BFE in a tertiary-care urban university medical centre. HCWs were grouped into four categories: house staff (medical interns, residents and fellows); nursing (nurse practitioners, registered nurses, licensed practical nurses, and medical, nursing

and physician assistants); phlebotomists; and technicians (respiratory therapists, clinical laboratory workers, non-lab technologists). Medical students and attending physicians were excluded as they most often receive treatment for BFE elsewhere. Individuals who were employed at another institution who presented with a BFE were also excluded. The data were anonymised and the university's Institutional Review Board approved the study. Patient consent was not required for this study.

Data collection

HCWs who sustain a BFE are required to report the exposure to the Occupational Medicine (OM) Clinic immediately during business hours, and to the Emergency Department (ED) after hours. Those employees who report to the ED are expected to be followed up by the OM Clinic within 2 business days (Green-McKenzie and Shofer, 2007). A report of their exposure is sent to the OM Clinic and a detailed record of the exposure is also available through the ED Electronic Medical Record system. Upon presentation, the employee is evaluated and offered post-exposure care in accordance with CDC guidelines (OSHA, 2012; Panlilio et al., 2001). During the evaluation process, the HCW is asked to complete the relevant questionnaire depending on whether they sustained a percutaneous or splash injury.

Data extracted included the job category of the HCW, the activity at the time of the incident and the location where the incident occurred. In the event of a sharps injury, data collected included the type of device causing the injury, whether a safety device was used and if so whether it was activated. If a safety device was not used, the reason was queried. In the event of a splash exposure, questions included the area contact with the body the BFE, the type of body fluid, whether PPE was available, whether it was utilised and if not, why not. In addition, the HCWs were asked whether they had received training on safety devices. Some HCWs who reported to the ED initially but did not return for follow-up with the OM clinic may not have received a questionnaire. Clinical records were examined in an effort to determine the total number of HCWs who sustained a BFE during the study period. A chart review was conducted to compare demographics and injury type of those that did not complete the questionnaire to those who did.

Statistical analysis

Standard descriptive statistics were used to characterize the HCWs. Means and standard deviations were used for continuous data, and frequencies and percentages for categorical data. The chi-square or Fisher's exact test was used to compare HCW groups (house staff, nursing, phlebotomist and medical technicians) with regard to SESD use and training on SESDs. All analyses performed used SAS statistical software (SAS Institute Inc., 2004). A *P* value of less than 0.05 was considered significant.

Results

Injury distribution: Over the 3-year period, 886 HCWs reported a BFE to the OM clinic. Of these, 18 (2%) were attending physicians and 19 (2%) were medical students. They were excluded from the study. Of the remaining 849 HCWs, 498 (59%) completed the injury appropriate questionnaire. Non-completers (n = 351) did not differ by injury type (sharp or splash), job category or age (Table 1). Of the completed questionnaires, 262 (53%) were nurses, 155 (32%) were house staff, 63 (13%) were technicians and 11 (2%) were phlebotomists. Four (<1%) reported 'other' and three (<1%) reported unknown. Seventy percent (349/498) of the body fluid exposures resulted from sharps injury. House staff were significantly more likely to sustain a sharps injury in the operating room (49% vs. 22%) whereas nurses

Table 1. Comparison of questionnaire completers to non-completers.

Demographic		Non-completers		Completers		
		n	(%)	n	(%)	*P* value
BPE type	Sharps	243	(69.2)	349	(70.1)	0.82
	Splash	108	(30.8)	149	(29.9)	
Job category*	House staff	103	(34.1)	155	(31.1)	0.26
	Nursing	167	(55.3)	262	(53.4)	
	Phlebotomist	7	(2.3)	11	(2.2)	
	Technicians	25	(8.3)	63	(12.8)	
Age (years)	Mean ± standard deviation	31.8 ± 8.1		31.8 ± 8.4		0.91

*There were 14 other job categories (10 non-completers, 4 completers) and 49 unknowns (46 non-completers, 3 completers). Other job categories included security and pastoral care.

were more likely to have been injured in patient rooms (18% vs. 57%), respectively (P <0.0001, $\chi 2$ statistic; Table 2).

Sharps responsible for injuries: Of the 349 sharps injuries, 251(73%) were the result of a needlestick, 87 (25%) the result of a sharp object, six (2%) a result of glass and five were reported as unknown. Of the needlestick injuries, 60 (24%) were from suture needles, 134 (53%) from hollow bore needles (including insulin and tuberculin needles) and the remainder from catheters, spinal needles and central lines (Table 3). Scalpels inflicted 33 (38%) of the non-needle sharps injuries and a wire, lancet, clamp or forcep inflicted 20 (23%) (Table 3).

Use of engineered safety prevention devices: Forty-four percent (110/251) of HCWs who sustained a needlestick injury indicated that the sharp was a SESD, 117 (47 %) indicated it was not a SESD and 24 (10%) did not know. Of the 110 who indicated it was a SESD, 42 (38%) indicated it was not activated, 28 (25%) that it was fully activated, 20 (18%) that it was partially activated and 20 (18%) unknown. Of the 117 HCWs who reported injury from a non-SESD, 69 (59%) indicated that a safety design does not exist, 12 (10%) indicated that a SESD was not available to them and 36 (30%) either did not respond or reported the 'other' reason category. Phlebotomists and nurses were significantly more likely to use SESDs than house staff and technicians. Phlebotomists were significantly more likely to know if a safety device was being used (P <0.0001, $\chi 2$ statistic; Table 4).

Training on SESD use: Fifty-four percent (185) of HCWs recalled training on the use of safety devices, 40% (140) did not respond or noted that they did not know while 6% (22) indicated they had not had training. Ninety-eight nurses (64%) and seven phlebotomists (70%) were significantly more likely to report training than 51 house staff

Table 2. Healthcare worker job category and location sharps injury occurred.

Location where sharps injury occurred	Nursing		House staff		Phlebotomist		Technicians	
	n	(%)	n	(%)	n	(%)	n	(%)
Operating room/Recovery	38	(22.2)	64	(48.9)	1	(10.0)	8	(25.0)
Patient room (on floor)	97	(56.7)	23	(17.6)	4	(40.0)	3	(9.4)
Emergency Department	11	(6.4)	14	(10.7)	1	(10.0)	0	(0.0)
Intensive/Critical Care Unit	5	(2.9)	11	(8.4)	0	(0.0)	0	(0.0)
Other locations	20	(11.7)	19	(14.5)	4	(40.0)	21	(65.6)

Table 3. Frequency of injury by device type.

Device	Type	Frequency	Percent*
Needle (n = 251)	Suture needle	60	23.9%
	Butterfly	19	7.6%
	Insulin needle	20	8.0%
	Tuberculin needle	13	5.2%
	Other hollow bore needle	101	40.2%
	Catheter needle	18	7.2%
	Spinal/epidural needle	4	1.6%
	Central line	8	3.2%
	Unknown	8	3.2%
Sharps (n = 87)	Lancet	4	4.6%
	Scalpel	33	37.9%
	Wire/Forceps/Clamps	16	18.4%
	Other sharp (e.g. razor, trocar, scissors)	20	23.0%
	Unknown	14	16.1%
Glass (n = 6)		6	100.0%

*Type percent uses device total as denominator.

Table 4. Healthcare worker job category by use of and training in SESD.*

	Use of SESD				Training in SESD					
	Yes		No		Yes		No		Unknown	
Job category	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
House staff	31	(26.5)	86	(73.5)	59	(44.4)	10	(7.5)	64	(48.1)
Nursing	79	(59.4)	54	(40.6)	98	(63.6)	5	(3.3)	51	(33.1)
Technicians	10	(25.6)	29	(74.4)	21	(43.8)	6	(23.5)	21	(43.8)
Phlebotomists	8	(80.0)	2	(20.0)	7	(70.0)	1	(10.0)	2	(20.0)
P value	<0.0001				0.01					

*Safety engineered sharps device.

(44%) and 21 technicians (44%) ($P = 0.05$, $\chi 2$ statistic; Table 4). There was no significant difference among job categories regarding knowledge of safety device brand, as all job categories (doctors 2 (5%), nursing 3 (10%), phlebotomists 3 (10%) and technicians 6 (19%)) were equally unaware ($P = 0.2$, $\chi 2$ statistic). Only 33 (9%) of the HCWs reported knowing the brand of the safety device, 175 (50%) reported not knowing and 141 (40%) did not respond. In response to the open-ended question asking what procedure HCW perceived as placing them at greatest risk, central line placement was reported most frequently; second was 'giving injections'. Performing angiograms, arterial blood gas, emergent thoracotomy, any surgery, 'any time we cut', starting an intravenous line and passing a suture needle to another HCW were also reported by the HCWs. Other comments were: 'I don't prefer blunt needles' and 'need to find more safe butterfly needles'.

Splash injuries: Over the 3-year study period, splash injuries comprised 149 (29%) of BFEs. Of the splash injuries, 73% (n = 105) were reported by nursing and 73% (n = 91) of the splash exposures were to the eyes; only 4% (n = 5) wore eye protection. Other mucosal areas splashed were the mouth 21% (n = 31) and nose 7% (n = 10). Appropriate PPE was reportedly worn only 5% (4/79) of the time. Of the 57 HCWs responding to why PPE was not worn, 42 (74%) reported that PPE was not required for the activity, two (3%) reported it was not available and five (7%) reported that they did not have sufficient time to don. Ninety-eight percent (119/122) reported that they washed, flushed or irrigated the affected area.

Discussion

Despite safety legislation (NSPA), more than half of the sharps injuries incurred were with non-safe devices. Injuries were also seen to occur even with the use of safe needle devices, mostly before activation, but also during and after activation. These injuries may be preventable with aggressive training (Black, 2013). The data show that training was not universally reported and some HCW groups were more likely to report training than others. House staff work in various areas of the hospital during a shift, rotate in different departments frequently and may consequently miss schedule safety training session. Nurses and phlebotomists are more likely to remain in the same geographic area enabling them to attend training sessions offered. With mandatory, annual, electronic training now in place this issue should be reduced or resolved (Mehrdad et al., 2013).

Another strategy is substituting SESDs, noted by electronic surveillance system to be associated with a higher injury rate, for SESDs with a lower injury rate (U.S. Food and Drug Administration [FDA], 2015). For instance, SESDs with a passive activation mechanism have been found to be associated with fewer SESD injuries than those requiring activation by the end-user (Black, 2013). Anecdotal evidence suggests that some providers may preferentially use non-SESDs and some administrators may inadvertently order non-SESDs. Thus, SESDs may not have always been available for HCWs (Green-McKenzie et al., 2001). This has been remedied as options to order non-SESDs have been restricted.

Few HCWs knew the brand of the SESD leading to their injury. This lack of reporting can negatively affect elucidation of the more effective and safe brands, information that can be used to inform future purchasing of SESDs. Anecdotally, however, HCWs discuss among themselves, and with their supervisor, which brands are more problematic. Hence, information is disseminated informally, albeit not reported on the standard questionnaire, still allowing iterative improvement in the ordering safer SESDs, as mandated by the NSPA. One-quarter of the needlestick injuries were the result of a suture needle (usually utilised by surgeons) and 13% of the needlestick injuries were from insulin and tuberculin needles (usually administered by nurses). This may explain why house staff were reportedly significantly more likely to be injured in the OR and nurses in patient rooms.

Just as training on the use of SESDs was not evidenced to be universal in this population, neither was the use of

PPE. Protective eyewear and face shields were used infrequently even though most reported splash exposure injuries were to the eyes, a potential portal for HIV infectivity. The main reason given for not using PPE was that there was no protocol requiring its use for that activity. These results are consistent with EPINet® data (Perry et al., 2009). Anecdotal evidence suggests that some HCWs may be unaware of what constitutes appropriate eye protection, for example, they may be unaware that eyeglasses without side shields are inadequate. Some HCWs may also not be aware as to which procedures present splash risk and should be performed with eye protection. Again annual, mandatory electronic training regarding when to use protective eyewear and what constitutes protective eyewear, based on CDC guidance (CDC, 2014), should reduce HCW splash BFE rates.

Using CDC guidelines (CDC, 2008) and lessons learned from HCW experience at this institution, efforts are currently underway to mitigate these issues. In addition to mandatory annual electronic training (Mehrdad et al., 2013), electronic safeguards to prevent the purchase of non-SESDs without a written justification and policies physically removing all unsafe devices have been implemented. Increased availability of the SESDs (U.S. FDA, 2015), coupled with lack of availability of non-safe devices may further reduce sharps injuries from these devices. Continuing the use of needle-free i.v. delivery systems and alternate routes of medication delivery are other strategies underway. In keeping with the NORA 2016 performance measure goals, the institution now has an electronic surveillance system in place (NORA, 2013) which includes standardised documentation of HCW's description of their occupational BFEs. A possible area of further study would be to characterise BFEs in HCWs after implementation of these and other relevant changes.

The NSPA plays an important role in ensuring that HSCA Sector employers provide training, as well as appropriate SESDs and PPE, to HCWs. The NSPA has had a documented impact on the increasing adoption of SESDs in American hospitals (Phillip et al., 2007) and there has been a reduction in the percutaneous injury rate nationally since its adoption (Black, 2015; Guglielmi and Ogg, 2012). Given this temporal relationship, it is hypothesised that this reduction is an independent effect of the legislation (Phillip et al., 2007). Similarly, in Canada, post the 2006 regulation regarding the substitution of SESDs, the needlestick injury rate in Ontario, captured by the number of workers' compensation claims, declined significantly (Chambers et al., 2015). Perhaps, most impressively, between 1985 and 1998 there have been 57 confirmed cases in the USA of occupationally acquired HIV and only one confirmed case since 1999 (Joyce et al., 2015).

The study is limited by the fact that it is observational; therefore, conclusions about cause and effect cannot be made. The setting is a single institution and the findings may not be generalisable to other hospitals. Another limitation is the voluntary self-report of data, which is subject to reporting bias. Although the questionnaires were confidential, they are not anonymous and this may compound the issue of reporting bias. Under-reporting of BFEs by HCWs is also an issue as studies estimate that 50% or more of HCWs do not report sharp or splash injuries (Makary et al., 2007). For this study, approximately 60% of the HCWs with a reported BFE completed the questionnaires as HCWs making their first BFE presentation to the ED (after hours) may not have had reliable access to questionnaires. Therefore, the reported data do not capture the entire HCW experience at this institution. However, chart review of the HCWs who did not complete the questionnaire revealed no significant differences from those who did.

There have been significant inroads in reducing HCW exposure to bloodborne pathogens, since global legislation and guidelines (CDC, 2008; Lavoie et al., 2014; OSHA, 2012; UK Legislation, 1997). Work still needs to be done, however, as it is increasingly clear, that with new and emerging infectious agents (CDC, 2015), a small error can have potentially huge consequences. Targeted, systematic efforts towards training, ensuring availability of PPE and iteratively providing the safest SESDs will help drive down these injuries even further. As training becomes more systematic and prevention methods become more sophisticated, the healthcare industry will be better equipped to protect HCWs from accidental BFEs. NORA Strategic Goal 4 may become not merely to reduce, but to eliminate, sharps injuries and their impact among all healthcare workers.

Acknowledgements

The authors would liked to thank Nick Pinizzotto, CIH and Roberta Carty, RN for their assistance in calculating the average cost of a needlestick injury for one employee.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This research was partially supported by the National Institute of Occupational Safety and Health (NIOSH), Occupational Safety and Health Training Grant – Occupational Medicine, T01-00H-008628; and by the National Institute for Occupational Safety and Health at the Johns Hopkins University Bloomberg School of Public Health Education and Resource Center (#T42CCT310419).

Peer review statement

Not commissioned; blind peer-reviewed.

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