

NOTES

Percutaneous Exposure Incidents Among Australian Hospital Staff

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We investigated all reported percutaneous exposure incidents (PEI) among staff from a large Australian hospital in the 3-year period, 2001–2003. There were a total of 373 PEI, of which 38.9% were needlestick injuries, 32.7% were cutaneous exposures and 28.4% sharps-related injuries. Nurses were the most commonly affected staff members, accounting for 63.5% of the total, followed by doctors (18.8%) and other staff (17.7%). Needlestick injuries were responsible for the majority of nurses' PEI (44.7%). Sharps injuries constituted the major category for doctors (44.3%). Most needlestick injuries (67.6%) were caused by hollow-bore needles, while the majority of cutaneous exposures involved blood or serum (55.8%). Most sharps injuries were caused by unknown devices (35.9%) or suture needles (34.9%). Overall, our investigation suggests that PEI is a considerable burden for health care workers in Australia. Further research is now required to determine the relationships, if any, between workers who suffer PEI and those who do not.

Percutaneous Exposure Incident needlestick sharps health care worker Australia
hospital universal precautions nurse doctor Hepatitis B

1. INTRODUCTION

Percutaneous exposure incidents (PEI) is a broad descriptive term that includes needlestick and sharps injuries, as well as cutaneous and mucous exposures to blood and serum. From an occupational

viewpoint, PEI represents the most efficient method for transmitting blood-borne infections between patients and health care workers. Of the transmissible diseases, Hepatitis B Virus (HBV), Hepatitis C Virus (HCV) and Human Immunodeficiency Virus (HIV) are usually the most consequential [1]. PEI

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can be very expensive occupational issues, with numerous direct and indirect costs [2]. Follow-up and ongoing costs for high-risk exposures with subsequent sero-conversion, may reach US \$1 million per case [3]. By virtue of their high frequency, high cost and inherent potential danger, the occupational implications of PEI are significant for health care workers and health care management, alike.

Nevertheless, PEI do not usually occur as random events [4]. Various risk factors have been previously demonstrated, such as staffing levels and organizational climate [5, 6]. Similarly, PEI do not affect health care workers equally. Differences in PEI rates between hospital department, job description, gender and medical specialty have all been reported in other studies [7, 8, 9, 10, 11]. Although nurses often suffer the largest proportion of all PEI [12], hospital support workers may also be burdened in this regard [13]. Differences in compliance with infection control procedures are known to exist between doctors and nurses [8, 14], suggesting unequal variations in occupationally-related PEI risk. Job-related variations in PEI reporting rates have also been found in some studies [15]. Although the exact device causing PEI varies between different hospitals and different investigations, syringe needles have been shown to be a common culprit [16, 17, 18]. Given the high incidence among health care workers around the world and their potential impact, we considered it necessary to investigate PEI among a previously understudied group from north-east Australia.

2. METHODS

For this study we accessed the PEI database from a large, modern tertiary teaching hospital in tropical northern Australia. Ethical approval was obtained from the district health service and a university human ethics committee. In order to gain a clear perception of PEI trends throughout the year, it was considered necessary to analyze a 3-year period, from the beginning of 2001 to the end of 2003. In Queensland, the use of universal precautions and the reporting of PEI is mandatory for all health care workers. As such, a large and comprehensive

PEI database was available to us. All information had been previously de-identified, meaning that recognizable demographic characteristics such as name, age and gender were not recorded. Nonetheless, our data set did contain numerous categories related to PEI events, such as PEI category, device type, exposure type, causative activity, time of injury and injury date. Certain workplace indicators such as job description and department of employment had also been recorded on the database, as well as the use of universal precautions during their PEI event. Data was converted into a common spreadsheet program before being analyzed by statistical software. PEI prevalence rates and distribution were evaluated as a group, and also evaluated with respect to job category and PEI category. For clarity, injury dates were grouped into 2-month blocks, while time of injury was analyzed in 4-hr blocks.

3. RESULTS

We analyzed a complete data set containing all reported percutaneous exposure incidents occurring among staff in the 3-year period, 2001 to 2003. There were a total of 373 PEI, of which 38.9% were needlestick injuries, 32.7% were cutaneous exposures and 28.4% sharps-related injuries. Nurses were the most commonly affected staff members, accounting for 63.5% of the total, followed by doctors (18.8%) and other staff (17.7%). The distribution of PEI varied by staff category during this study (Table 1). Needlestick injuries accounted for the majority of PEI among nurses (44.7%) and a large proportion of all PEI (28.4%). Sharps injuries constituted the major PEI category among doctors (44.3%), although the proportion among all PEI was smaller than for nurses (8.3%). Among other staff, cutaneous exposures were the main category, with 42.4% being of this nature. By virtue of their larger numbers, however, cutaneous exposures were actually more common among nurses. One fifth (20.6%) of all PEI were cutaneous exposures among nurses, as compared to 7.5% for other staff.

The devices causing PEI varied by injury category during this study. Hollow-bore needles accounted for the majority of needlestick injuries

TABLE 1. Percutaneous Exposure Incidents (PEI) by Job Category

Staff	<i>n</i>	% ^a	% ^b
Nurse			
Needlestick	106	44.7	28.4
Cutaneous	77	32.5	20.6
Sharps	54	22.8	14.5
Any PEI	237	100	63.5
Doctor			
Sharps	31	44.3	8.3
Needlestick	22	31.4	5.9
Cutaneous	17	24.3	4.6
Any PEI	70	100	18.8
Other			
Cutaneous	28	42.4	7.5
Sharps	21	31.8	5.6
Needlestick	17	25.8	4.6
Any PEI	66	100	17.7

Notes. a—percentage of staff in each category (*n* = 237, 70 and 66, respectively), b—percentage of all PEI (*N* = 373).

(67.6%), followed by intravenous (IV) kits (15.9%) and blood collection devices (10.3%) (Table 2). The majority of cutaneous exposures involved blood/serum (55.8%), saliva/sputum (18.0%) or other substances (16.4%). Most sharps injuries were caused by unknown devices (35.9%) or suture needles (34.9%). Surgical tools and scalpel blades were also important, accounting for 16.0 and 13.2%, respectively. When analyzed as a proportion of all PEI, hollow-bore needles accounted for the majority (26.3%), followed by blood/serum cutaneous exposures (18.2%) and injuries caused by unknown sharps (10.2%). Suture needles occupied an important position, representing 9.9% of all PEI reported by staff. IV kits were also seen to be responsible for a reasonable proportion of the overall total (6.2%).

Time-series analysis indicated that the number of reported PEI events fluctuated throughout the day. In this regard, a large number of all PEI events occurred between midnight (0.00 hrs) and 3.59 a.m. (03.59 hrs). Interestingly, this number fell over the next 4-hr period, before a sustained rise between 8 a.m. (8.00 hrs) and 3.59 p.m. (15.59 hrs). The number dropped off again between 4 p.m. (16.00 hrs) and 11.59 p.m. (23.59 hrs) (Figure 1). By device category, needlestick injuries and cutaneous exposures peaked between midnight (0.00 hrs) and 3.59 a.m. (03.59 hrs). Sharps injuries peaked between 12 p.m. (12.00 hrs) and 3.59 p.m.

TABLE 2. Percutaneous Exposure Incidents (PEI) by Device Category

Device	<i>n</i>	% ^a	% ^b
Needlestick			
Hollow needle	98	67.6	26.3
IV kit/device	23	15.9	6.2
Blood collection	15	10.3	4.0
Other device	9	6.2	2.4
Cutaneous			
Blood/serum	68	55.8	18.2
Saliva/sputum	22	18.0	5.9
Other substance	20	16.4	5.4
Urine/feces	12	9.8	3.2
Sharps			
Unknown device	38	35.9	10.2
Suture needle	37	34.9	9.9
Surgical device	17	16.0	4.6
Scalpel blade	14	13.2	3.7

Notes. a—percentage of events in each category (*n* = 145, 122 and 106), respectively, b—percentage of all PEI events (*N* = 373).

(15.59 hrs). Date-series analysis revealed that PEI rates also fluctuated throughout the year. The lowest number of cases were reported between January and February. PEI reports then peaked between March and June, before tapering off between July and August. A slight and sustained increase was seen in the 4-month period between September and December (Figure 2).

Routine patient care was responsible for the largest proportion of all PEI during this study, accounting for 27.9%. This was followed by surgical procedures (17.4%), nursing procedures (13.9%) and pathology specimen collection (12.9%). The causative activity varied when analyzed by PEI category (Table 3). In this regard, pathology specimen collection accounted for the majority of needlestick injuries (28.4%), followed by routine patient care (26.2%) and nursing procedures (19.3%). Interestingly, routine patient care was responsible for the majority of cutaneous incidents (44.3%), followed by surgical, nursing and other procedures, which represented 12.3, 12.3 and 10.7% of them, respectively. Surgical procedures were responsible for 45.3% of all sharps injuries, followed by other procedures (13.2%) and cleaning activities (12.3%). Regarding universal precautions, 92.8% of all staff reporting a PEI had been fully vaccinated against Hepatitis B. This rate was highest among doctors (97.2%) and lowest among other staff (86.4%).

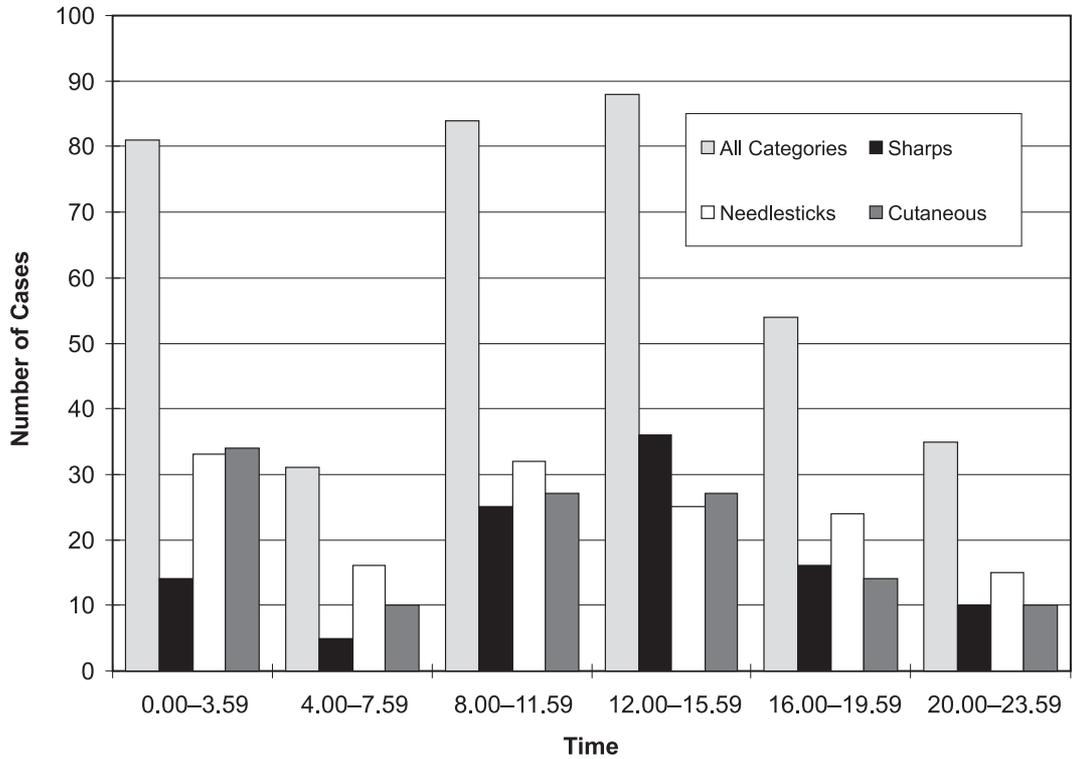


Figure 1. Percutaneous exposure incidents stratified by category and time (24 hrs).

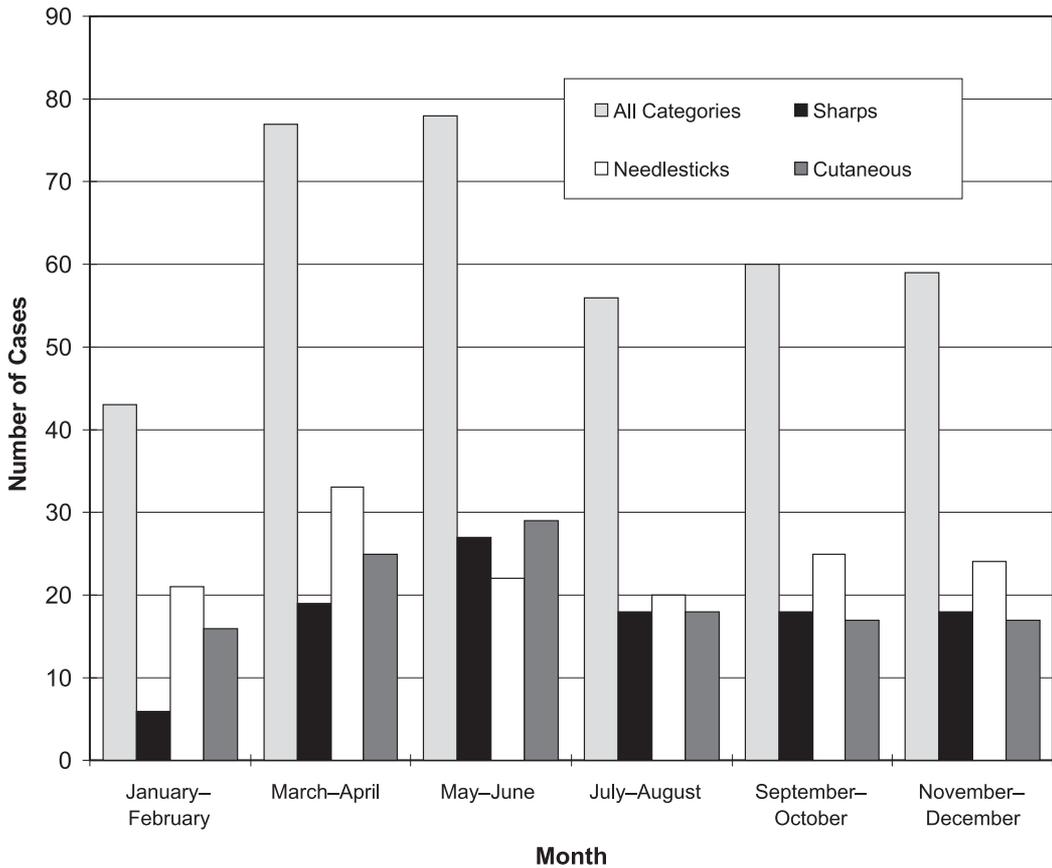


Figure 2. Percutaneous exposure incidents stratified by category and month.

TABLE 3. Percutaneous Exposure Incidents (PEI) by Category and Causative Activity

Causative Activity	All		Needlestick		Cutaneous		Sharps	
	<i>n</i>	% ^a	<i>n</i>	% ^b	<i>n</i>	% ^b	<i>n</i>	% ^b
Routine patient care	104	27.9	38	26.2	54	44.3	12	11.3
Surgical procedure	65	17.4	2	1.4	15	12.3	48	45.3
Nursing procedure	52	13.9	28	19.3	15	12.3	9	8.5
Pathology collection	48	12.9	41	28.4	7	5.7	0	0.0
Other procedure	33	8.9	6	4.1	13	10.7	14	13.2
Cleaning activities	24	6.4	6	4.1	5	4.1	13	12.3
Unspecified activity	24	6.4	8	5.5	11	9.0	5	4.7
Waste disposal	13	3.5	8	5.5	1	0.8	4	3.8
Anesthetic procedure	10	2.7	8	5.5	1	0.8	1	0.9

Notes. a—percentage of all PEI events ($N = 373$), b—percentage of events in each category ($n = 145, 122$ and 106 , respectively).

TABLE 4. Universal Precautions Usage by Staff Category in an Australian Hospital

Precautions	All		Nurse		Doctor		Other	
	<i>n</i>	% ^a	<i>n</i>	% ^b	<i>n</i>	% ^b	<i>n</i>	% ^b
Hepatitis B status								
Fully vaccinated	346	92.8	221	93.2	68	97.2	57	86.4
Unknown status	13	3.5	7	3.0	1	1.4	5	6.0
Partial immunity	8	2.1	4	1.7	0	0.0	4	7.6
Unvaccinated	6	1.6	5	2.1	1	1.4	0	0.0
Other methods								
Glove usage	221	59.2	123	51.9	57	81.4	41	62.1
Eye protection	105	28.2	57	24.1	33	47.1	15	22.7
Surgical mask	80	21.4	38	16.0	34	48.6	8	12.1
Protective gown	125	33.5	64	27.0	36	51.4	25	37.9

Notes. a—percentage of all percutaneous exposure incidents ($N = 373$), b—percentage of staff in each category ($n = 237, 70$ and 66 , respectively).

Glove usage and eye protection appeared to be a little less common, however, being worn by 59.2 and 28.2% of staff, respectively, who reported a PEI (Table 4).

4. DISCUSSION

Nurses suffered the majority of PEI occurring within this study, accounting for almost two thirds (63.5%) of all reported events. This finding is similar to previous PEI investigations among health care workers. For example, a study of 18 Italian hospitals conducted by Puro et al. [7] showed that nurses experienced more PEI than physicians, in a variety of wards. In the USA, Perry et al. [12] revealed that nurses sustained the largest proportion of sharps injuries within the health care profession (44%). Nurses also accounted for 42% of all occupationally-derived HIV infections, more than any other occupational group. HIV exposure among the American cohort

followed a similar pattern in Puro et al.'s study [7], which revealed a higher HIV exposure level occurring among Italian nurses when compared to Italian doctors. Canadian research also demonstrated that nurses (and nursing students) were often the most frequently affected subgroup, accounting for 78.8% of all PEI described by Yassi and McGill [9]. Interestingly, de Vries and Cossart [10] showed that Australian nurses were less likely to have experienced a PEI of some sort, when compared to doctors. Indeed the prevalence of PEI among physicians in surgical units was reported to be 100%, whereas for nurses it was 42% [10]. However, another Australian study conducted by Whitby and McLaws [18] showed that most injuries from "dirty" hollow-bore needles (66.2%) were sustained by nurses. These conflicting results suggest that although nurses may suffer the highest proportion of PEI among health care workers, the trend is not uniform in all investigations. Similarly, greater numbers

of PEI events does not necessarily mean higher risk. Further research will be needed to elucidate potential risk factors and test the hypothesis of increased risk among nurses.

By category, most PEI reported during our study (38.9%) were caused by needlesticks. This result is similar to a previous Canadian study, where 82% of all accidental exposures were caused by needlesticks [9]. When analyzed as a group, hollow-bore needles accounted for roughly one quarter (26.3%) of all PEI reported during our investigation. The proportion was highest among nurses, where needles accounted for more than two thirds (67.6%) of their PEI. Again, our result reflects previous research conducted in other countries. For example, Perry et al. [12] demonstrated that disposable syringes were responsible for most PEI among American nurses. Similarly, Guo et al. [16] reported that syringe needles were responsible for the highest proportion (52.0%) of needlestick and sharps injuries among Taiwanese health care workers. Shiao et al. [13] also found that 42.2% of all sharps injuries among Taiwanese hospital support personnel were caused by hollow-bore needles.

The most important activities causing PEI during this study were routine patient care, surgical procedures and nursing procedures, accounting for 27.9, 17.4 and 13.9% of all PEI, respectively. Interestingly, other international investigations have shown that various tasks can be responsible for PEI within health care settings. With respect to needlestick and sharps injuries, Leggat [17] found that giving injections was a common cause among Australian nurses. Alternatively, Guo et al. [16] demonstrated recapping and penetration of the needle cap were the most important activities in Taiwan. Recapping was also mentioned as a risky activity among Canadian nurses, in an earlier study by Yassi and McGill [9]. PEI seem to occur more often "during use" rather than "after use", as demonstrated by our investigation and also by other research from Australia [18]. Interestingly, Perry et al. [12] found that the highest number of PEI seemed to occur after use and before disposal, among American nurses. When considered together, these results suggest that various procedures may be responsible for PEI among

Australian health care workers, as elsewhere throughout the world. More detailed studies of daily work activities will be useful in elucidating exactly what these high-risk tasks may be.

The high-degree compliance with universal precautions among staff within our study was very encouraging. More than 9 out of every 10 staff reporting a PEI of some description (92.8%) had been fully vaccinated against HBV prior to their injury. The use of barrier protection, such as gloves, eye protection, surgical masks and protective gowns was less common, however, occurring among 59.2, 28.2, 21.4 and 33.5%, respectively. A previous study of Australian nurses by Knight and Bodsworth [11] showed that the use of universal precautions may vary within hospitals. In the United Kingdom, Stein et al. [14] also demonstrated that the rate of compliance with infection control guidelines varies between doctors and nurses. In our study, the proportion of those using universal precautions varied by job category, with physicians having the highest HBV vaccination rate of all, almost 100% (97.2%). Physicians also had the highest rate of glove usage among the group (81.4%). Despite the discrepancy in these results, it is difficult to determine exactly what activity each staff member was doing when they experienced their PEI, suggesting that an analysis of eye protection, surgical mask and protective gown usage during PEI may be limited. Nonetheless, HBV vaccination and glove usage are widely known to be effective in preventing disease transfer and as such, compliance with these measures should have been 100%. Unfortunately, 1.6% of staff reporting a PEI during this study were unprotected against HBV, suggesting the need for more aggressive coverage of the vaccination program. However, as our facility already has a comprehensive HBV vaccination policy for all employees, it is possible that this unvaccinated group comprised new employees who sustained a PEI in their first few days of work, before they were able to undergo protective vaccinations.

Although our current study investigated a reasonably large and comprehensive dataset, one of the main limitations was a dependency on reported data. As such, this information depends heavily on what health care workers actually

report, both in terms of PEI as well as factors associated with PEI. Non-reporting of PEI has been previously highlighted in Australia [10, 11] and other countries [14, 15]. As such, it is possible that some types of PEI may be underreported by hospital staff, including within our study. Future research targeting all health care workers, regardless of whether they experienced a PEI or not, will be needed to clarify this situation.

5. CONCLUSION

Overall, this study showed that the majority of PEI occurring within an Australian hospital were caused by needlestick injuries. Nurses were the most commonly affected staff members, accounting for almost two thirds of the total. Needlestick injuries were responsible for the majority of nurses' PEI, whereas sharps injuries constituted the major category for doctors. More than two thirds of needlestick injuries were caused by hollow-bore needles, while the majority of cutaneous exposures involved blood or serum. Most sharps injuries were caused by unknown devices or suture needles. Routine patient care was responsible for the largest proportion of all PEI. Regarding universal precautions, almost all staff had been fully vaccinated against Hepatitis B. Overall, our investigation suggests that PEI is a considerable burden for Australian health care workers. Although the nature and distribution of injuries clearly varies between job categories, precise risk factors were difficult to establish as our data was derived from reported incidents. Further research among Australian health care workers is now required to elucidate the significance of these preliminary findings and to determine the relationships, if any, between workers who suffer PEI and those who do not.

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