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Identifying Trends of Percutaneous Injuries at an Australian Dental School

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ABSTRACT

Objectives: The aim of this study was to retrospectively examine trends in percutaneous exposure incidences (PEIs) at the School of Dentistry (SoD) from 2009 to 2019 and to report on the underreporting rate of PEIs, current attitudes, and awareness of PEI safety protocols from clinical staff and students at the SoD in 2019.

Methods: Retrospective data were collected from deidentified archival incident reports from 2009 to 2019 from the SoD's incident reporting system (UQSafe and Legacy Database). Additionally, cross-sectional data were collected via the validated Percutaneous Exposure Incident Questionnaires (PEIQ) completed by clinical staff and students of the SoD in 2019.

Results: From the archival data, the majority (79.9%) of the 618 reported PEIs involved students. Local anaesthetic-related procedures were the most common cause in the archival (31.5%) and survey data (23.7%), whereas the needle-prick was the most common causative instrument in both data sets. Additionally, the finger was the most common site of injury found in the archival (53.0%) and survey data (52.8%). From 345 responses to the survey, 42.1% of PEIs sustained were not reported.

Conclusions: Students were at a higher risk of sustaining a PEI than staff members between 2009 and 2019. The reported knowledge on PEI classification and preventative measures is inadequate, suggesting that further PEI education is necessary. The study provides evidence of the trends in PEIs as well as data on the attitudes and awareness of student and staff at a dental teaching faculty to support the development of PEI safety management protocols.

Introduction

A percutaneous exposure incident (PEI) involves an exposure of cutaneous or mucous membranes to blood and bodily serum, often as a result of a needlestick or sharps injury.[1] This exposure may then lead to the transmission of a bloodborne virus (BBV).[1-3] The dental setting poses a constant risk of sustaining a PEI due to the common use of sharp instruments, a small operating field coupled with frequent patient movement, and the presence of blood and saliva.[4,5]

Australian dental personnel with a recordable viral load from a BBV are unable to perform exposure-prone procedures, which may greatly impact on the personnel's scope of practice.[6] Additionally, contraction of a BBV can have adverse health effects on the health care worker, including death, even in an age of antiretrovirals.[7-9] The financial burdens on the individual, workplace, and public health services derived from direct costs (eg, testing, treatment) and indirect costs (eg, loss of productivity, emotional, compensatory) total a median of US$747 for immediate postexposure management and lifetime medical costs of up to US$441,342 for a single health care worker contracting a BBV.[10-12]

Despite the consequences of contracting a BBV from a PEI, a 2018 systematic review found that the lifetime prevalence of sustaining a PEI was 57.6% in the surveyed dentists.[2] The most common instruments causing injury were needlesticks and dental burs,[2,13-15] whereas the most affected sites sustaining injury included the fingers and hands.[16-18] The risk of a PEI is compounded in the case of dental students, who lack professional skill, experience, and training.[19]

There has been a limited number of longitudinal studies investigating the incidence of PEIs in the dental setting, with the most recent report from 2 decades ago finding a gradual decline for dentists from an average of one injury every

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month to one injury every 4 months across a 10-year period.[20] The gap in the literature and subsequent effective management of PEIs may be exacerbated by the underreporting of PEIs.[17,19,21] Underreporting rates ranged from 3% to 39% amongst dental staff sustaining a PEI.[17,21-23] Underreporting has been demonstrated to be linked to a lack of knowledge about postexposure prophylaxis (PEP) and not reporting due to the injury being minor, the instrument being clean, and the patient being low-risk, which would impede appropriate postexposure management.[4,19,24]

The management of PEIs has focused mostly on adhering to infection control standards[1,25] and prevention via devices, such as safety syringes.[26] Despite infection control protocols being more widely adopted,[27,28] needlestick injuries remain commonplace within the dental environment, especially amongst less experienced dentists and dental students.[14,29] In addition, both the evidence on the efficacy of safety devices, such as retractable needles and sharps containers, as well as the financial viability of these devices offsetting the consequent cost of sustaining a PEI are inconclusive.[11,26,30,31] In the dental teaching environment, education resonates as a constantly favoured PEI management strategy.[17,32]

The body of literature focusing on PEIs and associated BBVs at dental teaching institutions can be broadly classified into 3 main areas. One group of studies has focused on the students' knowledge, such as risk of transmission,[33,34] specific infection control practices,[35] and awareness of postexposure management protocol.[36,37] Another group assessed the dental students' attitudes, such as whether students would treat HIV-positive patients,[34] and the fear of exposure.[33] Finally, the literature has investigated trends of PEIs at various dental teaching institutions within the scope of a few years.[32] Notably, this indicates that previous literature investigating PEIs and associated BBVs at dental teaching institutions has both a narrow temporal window of investigation and narrow scope confined to students.

The seroconversion rate of contracting a BBV, even without a readily available vaccine is low,[38] with an average of up to 0.3% for HIV and 0.1% to 1.2% for hepatitis C virus.[39-42] Regardless, the likelihood of sustaining a PEI in a dental setting and consequences of contracting a BBV support further investigations into the incidence of PEI to inform PEI management protocols. The limited longitudinal literature exploring the incidence of PEIs in a dental institution, which are especially prone to PEIs, tends to focus primarily on dental students and fails to focus on the other dental staff who are also exposed to the risk of sustaining a PEI.

This study had two aims. The first aim was to retrospectively examine the trends in PEIs from archival incident reports at The University of Queensland School of Dentistry (UQ SoD) from the period of 2009 to 2019. The second aim was to analyse the current attitudes towards PEI safety protocols, causes of PEIs, and rate of underreporting of PEIs from the clinical staff and students at UQ SoD in 2019. Additionally, this longitudinal study simultaneously compared the trends in PEIs with various interventions that have been introduced in the past to reduce the incidence of PEIs at the UQ SoD. The literature had previously primarily explored PEIs at dental teaching institutions across a shorter time frame. To the authors' knowledge, this is the first study recording the trend of PEIs at a dental school over an extensive 11-year period.

Methodology

Ethics approval and participant selection

This study adheres to the Guidelines of the ethical review process of The University of Queensland. Ethics approval was granted from The University of Queensland Human Research Ethics Committee (approval no. 2019001306). UQ SoD's clinical staff (clinical supervisors and dental assistants) and dental students enrolled in the Bachelor of Dental Science (BDScHons) and Doctor of Clinical Dentistry (DClinDent) program were invited to voluntarily and anonymously submit hard copies of the survey.

Data collection: Archival data were requested from The University of Queensland's incident and hazard reporting system, Legacy Database (2008-2016) and UQ Safe Database (2016-2019), in the form of deidentified incident reports submitted in the period of 2009 to 2019 from the UQ SoD's student clinics and preclinics. All reports unrelated to PEIs were excluded.

The definition used to categorise a PEI included any injury exposing skin or mucosa to blood or bodily serum that could potentially lead to the transmission of a BBV. Although preclinical activities were performed with noncontaminated instruments and should not have a potential for a BBV transmission, the activity simulated the clinical environment and was included as a PEI. This definition of PEI excluded near-miss injuries; all injuries from instruments or apparatus that would not be reasonably exposed to patient contact, including cuts from paper towel dispensers and paper cuts; and all trips, falls, and collisions with apparatus that did not expose skin or mucous membranes (such as bumping the overhead light) or were not in a clinical, preclinical, or laboratory setting (such as falling down stairs or bumping into signage).

For each category, variables were coded by date and location of incident, demographic of those involved in the incident, bodily site of injury, and causative injury. Open responses on the archival reports underwent thematic analysis via deductive coding using a preliminary code book with expected variables. Frequency tables were created for each variable, and those categories with a lower count were combined into broader categories. Using descriptive statistics, PEI trends for the period of 2009 to 2019 at the UQ SoD were created.

Survey data were captured by the Percutaneous Exposure Incident Questionnaire (PEIQ) validated from a previous study (Supplemental data)[23] providing non-identifying demographic data of the respondent, vaccination status of involved parties, and knowledge or attitude towards safety protocols such as recapping of needles and PEP. Additionally, if a PEI occurred, the questionnaire provided information about the year, bodily location, and cause of injury as well as what protective personal equipment was used. Finally, the survey provided data on whether the injury was reported and, if not, the reason for not reporting.

At least 211 responses were required for a 95% confidence interval. This minimal sample size was calculated using the Epi Info statistical software and was based off a total population of 487 and an average underreporting rate of 41.5%.

Statistical analysis: All responses were counted, coded, and represented in descriptive statistic form. Underreporting rates were calculated from the total number of PEIs captured by the PEIQ and how many were captured in the archival data for the corresponding year. PEI frequencies from the archival data and survey data were then compared using demographics and type of injury. Using the archival data, the year of study/occupation, age and sex were compared with the type of the injury and site of injury using Chi-square tests of independence.

All data were managed using Microsoft Excel (version 16.32) and JASP (version 0.10.2). These two programs analysed the data to present descriptive statistics and Chi-square tests of independence. Data were then imported into the GraphPad Prism Software (version 8, GraphPad Prism) for collation and creation of appropriate graphs.

Results

Demographics: From the archival data, there were a total of 1156 injuries reported from the 11-year period of January 2009 to December 2019, of which there were 618 PEIs. Of the 618 PEIs, 507 (82.0%) occurred in clinics, 77 (12.5%) occurred in the preclinical or lab setting, and 34 (5.5%) were sterilisation-related injuries. For the survey, the response rate was 70.8%, with 345 respondents completing the questionnaire out of the invited 487 dental staff and students. Table 1 shows the demographic data of the total PEIs.

From the archival data, there were 182 (37.8%) male injuries and 299 (62.2%) female injuries. There were 137 entries without sex specified. Regarding occupation, there were 494 (79.9%) student injuries, 24 (6.8%) supervisor/clinical staff injuries, 42 (3.9%) dental assistant injuries, and 58 (9.4%) employees otherwise unspecified injuries.

From the survey, there were 143 (42.2%) male and 196 (57.8%) female respondents, with 6 not indicating the sex. Regarding occupation, there were 285 (82.6%) student respondents, 28 (8.1%) supervisor/clinical staff respondents, and 32 (9.3%) dental assistant respondents (Table 1).

Underreporting rate: Of the 345 survey responses, there were 38 (11.0%) PEI exposures in the period of 2018 to 2019. According to the responses, only 22 of these incidences were reported. Therefore, there was an underreporting rate of 42.1%. The most common reason for not reporting was due to the injury being minor (38.9%), with next most common reasons being that the item was unused (16.7%) and the dissatisfaction with waiting times and follow-up procedures (16.7%).

PEI summary of distributions: From the archival data, the procedure with the highest number of injuries was local anaesthetic (LA)–related injuries with 156 (31.8%) occurrences, followed by 75 (15.3%) restorative-related injuries and 43 (8.8%) scaling-related. Table 2 shows the distribution of causative instrument causing PEIs and bodily site of injury. Table 3 shows the bivariate distribution of occupation with the causative instrument and bodily site of injury. Based on a Chi-square test of independence, there was a significant relationship found between occupation and causative instrument in the archival data (Table 3, χ^2 (10, N = 598) = 35.21, $P < .05$). Table 4 shows the comparison of sex with causative instrument causing PEIs and bodily site of injury. Based on a Chi-square test of independence, there was a significant relationship found between sex and causative instrument (Table 4, χ^2 (9, N = 467) = 23.16, $P < .05$). Most instruments causing the PEIs were contaminated (65.9%).

The archival data showed a similar trend to the survey data with LA-related injuries being the highest (23.7%), followed by restorative procedures (18.4%). Most instruments were contaminated (70.6%). From the archival data, 570 (97.6%) patients were not exposed to an instrument that caused a PEI, but 14 injuries (2.4%) were reported to have exposed the patient to the same instrument that had caused a PEI to the clinical staff or student. In all, 547 (94.5%) PEIs

Table 1 – Univariate distribution of demographic characteristics of respondents.

		Archival data [No. (%)]	Survey data [No. (%)]
Total		618 (100.0)	345 (100.0)
Sex			
	Male	182 (37.8)	143 (42.2)
	Female	299 (62.2)	196 (57.8)
Age			
	<20*	-	63 (18.3)
	20-29	206 (47.4)	216 (62.6)
	30-39	172 (39.5)	25 (7.2)
	40-49	31 (7.1)	21 (6.1)
	50-59	10 (2.3)	17 (4.9)
	>60	16 (3.7)	3 (0.9)
Occupation			
	Undergraduate 1st year	-	74 (21.4)
	Undergraduate 2nd year		71 (20.6)
	Undergraduate 3rd year	-	49 (14.2)
	Undergraduate 4th year	-	53 (15.4)
	Undergraduate 5th year	-	25 (7.2)
	Postgraduate		13 (3.8)
	Student –unspecified**	494 (79.9)	
	Supervisor/clinical staff	24 (6.8)	28 (8.1)
	Dental assistant	42 (3.9)	32 (9.3)
	Employee –unspecified	58 (9.4)	
HBV status			
	Not vaccinated		-
	Incomplete vaccination		5 (1.4)
	Full vaccination		337 (97.7)
	Unknown		3 (0.9)

* Although there were 63 respondents younger than 20 in the survey data, there were no incident reports submitted by a respondent younger than 20 years old captured by the archival data.

** The incident reporting forms captured by the archival data did not differentiate between student year group or undergraduate/postgraduate status. HBV, hepatitis B virus.

Table 2 – Univariate distribution of percutaneous exposure incidences by causative instrument and bodily site.

		Archival data [No. (%)]	Survey data [No. (%)]
Instrument	Other^	175 (29.3)	10 (25.0)
	Needle prick	98 (16.4)	11 (27.5)
	Bur	91 (15.2)	4 (10.0)
	Probe/explorer	53 (8.9)	3 (7.5)
	Scaler tip	41 (6.9)	6 (15.0)
	Ultrasonic scalar	37 (6.2)	-
	Matrix band	30 (5.0)	3 (7.5)
	File	26 (4.3)	1 (2.5)
	Wire	20 (3.3)	1 (2.5)
	Elevator/luxator	16 (2.7)	1 (2.5)
	Suture needle	11 (1.8)	-
	Total	**598 (100.0)**	**40 (100.0)**
Bodily site	Fingers	319 (53.0)	19 (52.8)
	Thumb	116 (19.3)	5 (13.9)
	Hands	69 (11.5)	5 (13.9)
	Arms	68 (11.3)	4 (11.1)
	Eye	16 (2.7)	3 (8.3)
	Others	14 (2.3)	-
	Total	**602 (100.0)**	**36 (100.0)**

^ "Other" included procedures such as eye splash, hatchet, scalpel blade, and Hollenback carver. Each causative instrument grouped in "Other" has an $n \leq 10$.

were not noticed retrospectively, but 32 (5.5%) PEIs were noticed after the conclusion of the dental appointment. The fourth-year (32.4%) students had the most PEIs, followed by clinical supervisors (17.6%) and first years students (14.7%).

The yearly trend of the PEIs comparing different occupations are shown (Figure). These archival incident reports indicate that students consistently report more than twice the number of incidents compared to staff members in each year from 2009 to 2019. In this 11-year period, the number of student reports rose to a peak in 2013 before declining until 2017, when a rise was observed again. Meanwhile, staff members have observed a sustained reduction in incident reports since 2015.

PEI awareness and knowledge: From the survey, most respondents (51.9%) reported not having an awareness of PEP. Most respondents (68.1%) also did not have knowledge of the PEP 72-hour window. When asked to classify sharps injuries, 250 (74.9%) respondents did not classify splashes onto mucous membranes as a PEI, 4 (1.2%) respondents did not classify a needlestick injury via skin as a PEI, and 33 (9.6%) did not classify a puncture from a clean needle as a PEI. There were 188 (55.3%) respondents who believed needles should be recapped. The one-handed technique for recapping was favoured by 152 (44.1%) respondents, the two-handed technique by 14 (4.1%) respondents, and needle block or another device by 52 (15.1%) respondents.

Discussion

In this 11-year longitudinal study, percutaneous injury reports at an Australian dental school have been analysed to identify the trends of percutaneous injuries. Between 2009 and 2019, the number of PEIs reported by students rose to a peak in 2013 before declining until 2017, when a rise was observed again. Meanwhile, staff members have observed a sustained reduction in incident reports since 2015. These findings coincide with the relocation of the dental school to a newly constructed clinic which had a different clinic design, including larger angled sharps containers, utilisation of instrument cassettes, and mechanised cleaning processes to reduce handling of loose instruments. However, given the comprehensive overhaul in clinical layout and sharps-handling processes, it is not possible to attribute the trend in PEIs sustained by staff and students to specific interventions.

Table 3 – Bivariate distribution of percutaneous exposure incidences by occupation vs causative instrument and bodily site.

		Archival data			Survey data		
		Student [No. (%)]	Staff [No. (%)]	Chi-square (χ^2) (*P* value)	Student [No. (%)]	Staff [No. (%)]	Chi-square (χ^2) (*P* value)
Causative instrument	Needle prick	93 (94.9)	5 (5.1)	35.21 (< .001*)	7 (63.6)	4 (36.4)	8.62 (.375)
	Elevator/luxator	12 (75.0)	4 (25.0)		1 (100.0)	-	
	Suture needle	10 (90.9)	1 (9.1)		-	-	
	Wire	13 (65.0)	7 (35.0)		-	1 (100.0)	
	Probe/explorer	37 (69.8)	16 (30.2)		3 (100.0)	-	
	Scaler tip	31 (75.6)	10 (24.4)		6 (85.7)	1 (14.3)	
	Bur	77 (84.6)	14 (15.4)		2 (40.0)	3 (60.0)	
	File	23 (88.5)	3 (11.5)		1 (100.0)	-	
	Matrix band	23 (76.7)	7 (23.3)		1 (50.0)	1 (50.0)	
	Ultrasonic scaler	34 (91.9)	3 (8.1)		-	-	
	Other	125 (71.4)	50 (28.6)		8 (100.0)	2 (0.0)	
Bodily site	Fingers	243 (76.2)	76 (23.8)	10.02 (.075)	12 (63.2)	7 (36.8)	4.66 (.324)
	Thumb	96 (82.8)	20 (17.2)		5 (100.0)	-	
	Hands	56 (81.2)	13 (18.8)		3 (60.0)	2 (40.0)	
	Arms	61 (89.7)	7 (10.3)		4 (100.0)	-	
	Eye	15 (93.8)	1 (6.3)		2 (66.7)	1 (33.3)	
	Other	10 (71.4)	4 (28.6)		-	-	

* Significant at $P \leq .05$.

Table 4 – Bivariate distribution of percutaneous exposure incidences by sex vs causative instrument and bodily site.

		Archival data			Survey data		
		Male [No. (%)]	Female [No. (%)]	Chi-square (χ^2) (*P* value)	Male [No. (%)]	Female [No. (%)]	Chi-square (χ^2) (*P* value)
Causative instrument	Needle prick	34 (41.5)	48 (58.5)	23.16 (< .006*)	2 (20.0)	8 (80.0)	14.96 (.528)
	Elevator/luxator	12 (75.0)	4 (25.0)		-	1 (100.0)	
	Wire	6 (30.0)	14 (70.0)		-	1 (100.0)	
	Probe/explorer	8 (20.5)	31 (79.5)		3 (100.0)	-	
	Scaler tip	7 (20.0)	28 (80.0)		2 (28.6)	5 (71.4)	
	Bur	30 (42.3)	41 (57.7)		2 (40.0)	3 (60.0)	
	File	5 (27.8)	13 (72.2)		-	1 (100.0)	
	Matrix band	13 (50.0)	13 (50.0)		1 (50.0)	1 (50.0)	
	Ultrasonic scalar	7 (36.8)	12 (63.2)		-	-	
	Other	53 (37.6)	88 (62.4)		7 (70.0)	3 (30.0)	
Bodily site	Fingers	85 (34.1)	164 (65.9)	8.51 (.130)	6 (33.3)	12 (66.7)	5.08 (.749)
	Thumb	43 (44.3)	54 (55.7)		2 (40.0)	3 (60.0)	
	Hands	21 (42.0)	29 (58.0)		4 (80.0)	1 (20.0)	
	Arms	21 (41.2)	30 (58.8)		2 (50.0)	2 (50.0)	
	Eye	7 (53.8)	6 (46.2)		2 (66.7)	1 (33.3)	
	Other	1 (10.0)	9 (90.0)		-	-	

* Significant at $P \leq .05$.

The archival data indicate a significant correlation amongst the causative instrument, sex, and occupation. Similar to other studies,[14,17,29] this suggests that students were more likely to sustain a PEI compared to staff members, potentially due to differences in professional skill, experience, and training. It was also observed that females were more likely to sustain a PEI when compared to male counterparts, with females more likely to sustain an injury from a needle, scaler tip and probe. The literature suggests that this finding may potentially be due to female students having greater compliance with safe sharps management,[32] a greater disposition to reporting,[4] or a greater fear of injury.[33] However, it must be taken into consideration that out of the 618 archival percutaneous exposure incidents, 137 entries had not specified sex. A recent study from Croatia found that males had increased chances of underestimating such injuries.[43] Similarly, an Ethiopian study into health care workers also found that males were 10 times more likely to experience a PEI than females.[44] Furthermore, the findings of the survey data are consistent with the literature, where the most common PEI sustained was found to be via a needle prick and the finger was the most common site of injury.[2,14,17] Out of the different occupations and year of study, fourth-year dental students had the highest number of injuries, possibly due to the introduction of new dental procedures such as prosthodontics and periodontics, as well as the increased patient load.

This study found an underreporting rate of 42.1% amongst dental staff and students, which is slightly higher than the underreporting rate found by other studies that range from 3% to 39%.[17,21-23] The most common reason for not reporting a PEI was that the injury was perceived as being minor

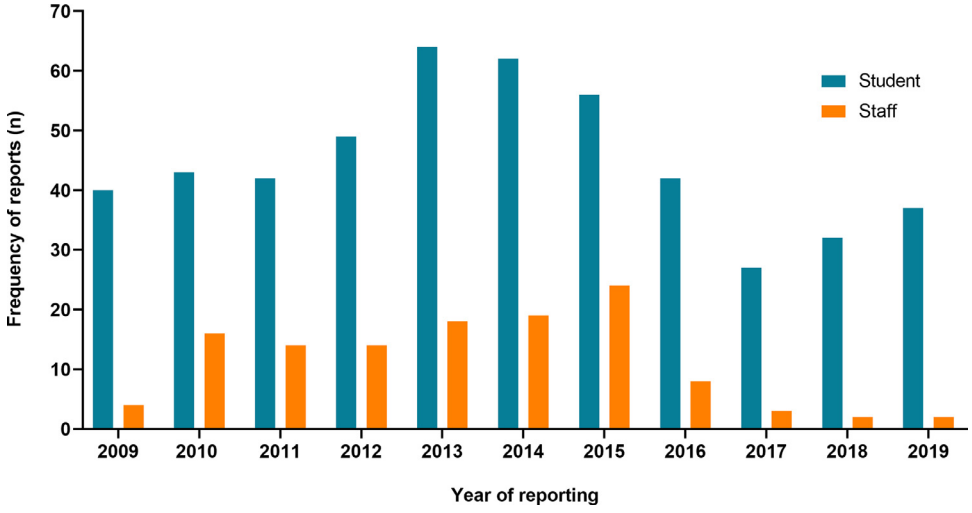

Figure – Frequency of reported percutaneous exposure incidences from archival incident reporting data from 2009 to 2019 by occupation.

(38.9%) and the causative instrument was not used on a patient (16.7%), indicating that smaller injuries or injuries from uncontaminated instruments were erroneously perceived to have a lower risk of BBV transmission.

Furthermore, the dissatisfaction with follow-up procedures and waiting times (16.7%) were also shown to be a disincentive to reporting percutaneous injuries amongst survey respondents. This lack of reporting from respondents could also be attributed to a lack of knowledge towards PEP (51.9%), which was greater than the Pavithran study (38%) but less than the Jaber study (52.2%).[45,46] Evidently a lack of knowledge regarding PEI and its safety management protocols represents a barrier to reporting. However, respondents appear to be cognizant of this knowledge gap, and 80.3% are receptive to further education, presenting an opportunity for dental schools to provide greater training such as annual safety reviews.

The archival data captured by the incident reporting system was limited by the discretionary responses provided to the open-ended questions. Consequently, samples failed to specify requisite information, such as the student's year of study or causative instrument involved. In these cases, information had to be extrapolated from the open-ended responses or excluded from analysis. A revision of the incident reporting forms involving the inclusion of more closed-ended questions is recommended to ensure the capturing of pertinent information. This can include the casualty's specific occupation or student year level as well as whether the PEI occurred in a clinical, preclinical, or laboratory setting. The PEIQ was distributed as a paper hard copy and therefore introduced nonresponse bias because questions could not mandate a response, unlike a digital survey. Nonresponses were excluded for analysis or reporting of that specific question, but any responses from the same sample were included where possible.

Conclusions

The study showed that the number of PEIs reported by students peaked in 2013 before declining until 2017, whereas staff injuries have observed a persistent decrease since 2015. Furthermore, the underreporting rate was found to be 42.1%. It is recommended that dental schools provide further PEI education, especially regarding the severity of a BBV transmission, even in minor injuries, and postexposure management including PEP. Incident reporting forms can also mandate more closed-ended questions to capture pertinent information that may inform the development of safety protocols.

Conflict of interest

None disclosed.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.identj.2021.05.001.

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