



An Analysis of Student Percutaneous Injuries at Dalhousie Dental School

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Abstract

Objective: The objective of the study was to determine circumstances under which student clinician injuries occur at the Dalhousie University Dental Clinic. Necessary policies and procedures may then be recommended and implemented to decrease the frequency of such occurrences.

Methods: This study reviewed student injury reports collected from 1999-2013. Data collated included: student gender, program of study, instrument causing injury, location of injury, year, month, day, and time. Chi-square analysis was used to examine effects of gender, program of study, month, day and time. Partial correlation was used to examine trends in injury rates over time.

Results: The mean number of injuries per academic year was 13.7 ± 1.8 (mean \pm SE), (range 1 - 25). The annual injury rate rose over the 13-year period (partial correlation $r = 0.709$, $df = 9$, $p = 0.015$). The most common instruments causing injury were needles (23.5%), burs (16%), scalers (15.5%) and lab knives (15%). The most common body part injured was the finger (45.5%), followed by the thumb (31%) and the hand (15%). Injuries were more likely to occur at the end of clinic session than at the beginning (OR 1.90, 95% CI 1.39-2.60). There were no statistically significant effects of gender, academic program, and time of day, day of the week or month of the year on injury rate.

Conclusion: The analysis of the data may be used to assess and improve the effectiveness of safety protocols, and increase the safety of student clinicians by decreasing the occurrence of percutaneous injuries.

Keywords

Percutaneous injuries, Needle stick injuries, Student clinicians, Risk factors, Finger injuries, Dental schools

Background

A percutaneous injury is considered to be the most likely opportunity for clients' microorganisms to infect a health professional [1]. Younai [1] states that these injuries are more likely to occur in the dental environment, compared to other health care settings, because of the small operating area of the mouth, the likeliness of the patient to move, and the proximity to sharp dental instruments that frequently become contaminated with blood and saliva. It is suggested that students in dental schools may be at an increased

risk of exposure to infections due to inexperience, [1,2] nervousness and anxiety in performing a procedure to the satisfaction of the supervising faculty [1,3]. It is important to study the occurrence of accidental percutaneous injuries in order to facilitate a reduction in the number of future incidences.

Percutaneous injuries are a serious concern due to the risk of contracting communicable diseases via blood or saliva [4]. The main concerns to a dental professional include hepatitis B, hepatitis C, and human immunodeficiency virus (HIV) [1,5-9]. As stated by Younai, [1] studies show that dental professionals have a relatively small risk of HIV transmission (0 to 0.8%); however, there are higher rates of hepatitis B (9%), and hepatitis C (1.4%) transmission. Hepatitis C is a leading cause of chronic hepatitis and cirrhosis of the liver. At the present time there is no protective vaccine against hepatitis C; therefore, it is extremely important to monitor and manage occupational exposures among dental professionals [7,10]. It is imperative that dental schools collect and analyze injury data to identify potential problems, improve the quality of patient care, and to educate future oral health professionals about injury prevention and risk management [11].

Variables

Gender

Several articles stated [1,12,13] that a larger percentage of females reported percutaneous student injuries. Further investigation is needed to determine if females experience more injuries than their male counterparts, or if females are simply more likely to report their injuries [1]. Stewardson [5] found only one of the four UK dental schools studied reported an increase of female injuries, compared to males; however, across all five years in all four schools, there was no statistical significance between gender and frequency of injury. Machado-Carvalho [4], and Gatto [14] also found that gender was not a significant factor in the reporting of student injuries.

Instrument causing injury

Stewardson [5] reports needle sticks as the most frequent cause of injury. A variety of other dental schools report consistent findings in terms of the high percentage of injuries that result from anesthetic needles, ranging between 31 and 45 percent [1,3,8,11,14-16]. Shah [7] specified needle sticks to be the most common cause of injury for both dentists and dental hygienists, 82 percent and 91 percent

respectively, followed by dental instruments. Smith [13] reported needle sticks as the most frequent cause of injury, but among the students, periodontal scalers caused the most injuries. This was most likely because the dental assistants were responsible for the disposal of sharps.

Dental burs appear to be another frequent cause of injury, ranging between 8 and 26 percent [1,11,15-17]. Other reported causes of percutaneous injuries include explorers, laboratory knives [3], blades, endodontic files, [11] scalpels, and suture needles [7].

Two observational studies of dental students found that the majority of percutaneous injuries occurred outside the mouth during fabrication or adjustment of removable prostheses [4,9].

Injury location

According to Callan [11], the most common body part to be injured is the finger, occurring 25 percent of the time during nonclinical incidents, and 45 percent during clinical incidents. The thumb follows the finger as the second most injured body part during nonclinical and clinical incidents, with a frequency of 16 percent and 27 percent respectively. Smith [13] reported that 82% of injuries occurred on the hand, this study did not separate digits from hands; therefore, this percentage includes fingers and thumbs. Gatto [14] also reported the fingers, followed by thumbs, as the most likely areas of the body to be injured. Other parts of the body that have been reported as injured include the arm, palm, knee, leg, ankles, eyes, legs, head, and nose [11].

Time in clinic/Time of day

Numerous studies found that 76 percent of clinical injuries occurred between 1:30 p.m. and 5:00 p.m. The authors explained these findings by noting that injuries occur more often in the afternoon because, as patients began to lose adequate anesthesia, there is limited time to complete the clinical procedure; therefore, students become tense and stressed as the appointment comes to an end. Although dental anesthesia is not always a concern, there are likely pressures of time management, patient management, and faculty evaluations. [1,5,8,9,11]. Younai [1] also acknowledged that many injuries happen during instrument cleanup at the end of the appointment.

Day of week

Callan [11] found clinical injuries occurred more often on Tuesday than any other day of the week, and in the days and weeks following a break in the academic schedule. Other authors suggested that injuries occur more frequently after a break due to the lack of experience of the students and the need for them to re-establish the mental acuity and routine necessary for clinical practice. The non-clinical injuries were also more prevalent at the beginning of the week compared to the end of the week [1,5,8,9,11]. Gatto [14] found that most injuries occurred on Monday and Tuesday, while Wednesday was the least likely day for an injury to occur.

Month of the year

According to Callan [11], injuries occur more frequently between January and March, and July and September. Gatto [14] reported that the most injuries occurred in June and November, and July and December were the months with the least number of injuries. This study did not include August as clinic activity ceased during this month.

Program (DH or DDS)

Gatto [14] found no statistical significance between the injury and the professional profile. Shah [7] acknowledged the inability to calculate rate of percutaneous injuries of dental professionals by occupation because of the lack of access to denominator data.

Rate of exposure

Cleveland [9] acknowledged the inability to calculate the rate of percutaneous injuries because of the lack of access to denominator

data. Many studies combine the rate of percutaneous and mucous membrane injuries. Of the published reports that measured the frequency of percutaneous injuries, incidence rates ranged from 9/10,000 [4] patient visits to 1.2/1000 patient visits [9]. Callan [11] separated clinical and non-clinical rates, 5.24/10,000 patient visits and 15.5 incidents per year. The studies measuring only percutaneous injuries used different strategies to gather this information. Some studies included only dental students, whereas others included the entire dental faculty. Because of the differences in methods of data collection, it is difficult to make a direct comparison between the studies.

Importance of this study

It is important for all occupational exposures to be reported to the school. Stewardson [5] suggested that by identifying common factors, it may be possible to develop protocols and procedures to reduce the number of incidents that occur.

The results of this study will help us understand the factors associated with occupational exposures at the Dalhousie Dental Clinic. With this information, necessary policies and procedures can be implemented in the Clinic to decrease the frequency of student percutaneous injury. The study will examine the 'who, what and when' of student injuries occurring within the dental school. In addition, we want to know 'why', despite all the supervision, education and caution requested, there exists so many student injuries. This study will examine these important questions, while beginning to look at how to determine the influential factors. The HFACS (Human Factors Analysis Classification System) methodology "has been shown to be comprehensive, diagnostic, reliable, usable, and valid to determine the cause of workplace errors across several industries" [18]. This system is a tool the authors will examine to determine usefulness and eventually adapt to the dental school curriculum.

Human factors analysis classification system

The Human Factors Analysis Classification System (HFACS) methodology is designed to investigate why human and system errors occur in the workplace. This methodology was originally designed to determine the cause of aviation-related accidents within the US Navy and Marine Corps. Since its inception, HFACS has been implemented by the US Department of Defense, and by other organizations within aviation. HFACS has been adapted to meet the needs of non-aviation industries including rail, shipping, mining, petroleum/gas, construction, and, most pertinent to this study, healthcare [18]. According to the literature search, HFACS has yet to be adapted to the particular healthcare profession of dentistry. An outcome of our study will be the development of a questionnaire based on the HFACS that will aid to classify the reason for the injury.

The aim of this study is to analyze the percutaneous injuries of dental students at Dalhousie University, and to provide a comparison to the literature published by other investigators. This study will be the foundation for future investigation that will focus on determining causal factors using an adaptation of the HFACS system.

Methods

A literature search was performed using English-language articles from the year 1995 to 2014 that were published in scientific, peer-reviewed journals, and that related to the topic of injuries among dental professionals. The databases searched were PubMed, CINAHL, Embase, Web of Science, and the Cochrane library. After selecting a few initial studies from the databases, the reference lists from the journal articles were examined to find additional publications related to the topic of percutaneous injuries in dental teaching facilities.

The investigators conducted a quality assurance study of records of student injury data within the Faculty of Dentistry at Dalhousie University, Halifax, N.S., Canada. As it was classified as a quality assurance study, Dalhousie University's Health Sciences Research Board stated that the study did not require Institutional Human Ethics Research approval.

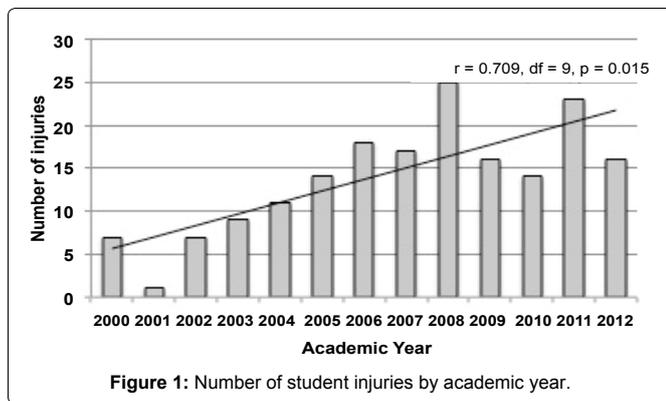


Figure 1: Number of student injuries by academic year.

Table 1: Student injuries - instrument and location of injury.

Instrument	% (n)
Needle	23.5 (44)
Bur	16.0 (30)
Scaler	15.5 (29)
Lab knife	15.0 (28)
Scapel	9.1 (17)
Sonics/Ultrasonics	9.1 (17)
Other	11.8 (22)
Location of Injury	
Finger	45.5 (85)
Thumb	31.0 (58)
Hand	15.0 (28)
Wrist	3.7 (7)
Other	4.8 (9)

The data comprised student injury report forms collected during the academic years 2000/01 to 2012/13. Any injury reported by students within the dental hygiene, dentistry or graduate dental programs that occurred during preclinical, clinical or laboratory sessions held on weekdays was included. For the purposes of this research, all students were referred to as dental students.

In the Dalhousie Faculty of Dentistry, each time students injure themselves with a periodontal or dental instrument, they are required to fill out an injury report form and report the incident to the infection control officer. The infection control officer reviews the report to ensure that the form is filled out according to policy and forwards the report to the Director of Clinics where it is then kept on file. The collection form includes information on student gender, program of study, date, time of day, instrument that caused the injury and the location of injury (body part).

Data was analyzed using the Statistical Package for Social Sciences (SPSS) (Version 21). Descriptive statistics (mean, standard error, frequencies) were calculated for all variables as appropriate. Bivariate analysis (chi square test) was used to examine any effects of gender, program of study, time of day, beginning or end of a clinic session, day of the week and month of the year on injury rates. Partial correlation analysis was used to examine trends in the injury rates over time, while controlling for any variation in student enrolment and patient numbers. The significance level for all tests was set at 0.05.

Results

Students in the Dalhousie University Dental Clinic reported a total of 187 percutaneous injuries during the academic years 1999/2000 to 2012/13. The mean number of injuries per academic year was 13.7 ± 1.8 (mean \pm SE), ranging from a low of 1 to a high of 25. During this time period the mean number of students enrolled in the Faculty of Dentistry was 238.5 ± 3.3 (range 220-258). The mean number of patient appointments per year was $22,971.1 \pm 528.4$ (range 20,387-25,569). Partial correlation analysis indicates that the rate of reported injury (controlling for both number of students and number of patient appointments) rose over this 13-year period ($r = 0.709$, $df = 9$, $p = 0.015$) (Figure 1).

Table 2: Student Injuries - Effect of Gender, Program and Time.

	Percentage (n)		P value (chi-square test)
	Observed	Expected	
Gender			
Male	27.9 (50)	30.0 (53.7)	0.546
Female	72.1 (129)	70.0 (125.3)	
Academic Program			
DH/BDH	21.1 (37)	25.1 (44)	0.222
DDS/QP	78.9 (138)	74.9 (131)	
Time of Day			
Morning	51.2 (87)	55.5 (94.4)	0.235
Afternoon	48.8 (83)	44.5 (75.6)	
Clinic – Beginning or End*			
Beginning of Clinic	34.8 (62)	50.0 (89)	< 0.001
End of Clinic	65.2 (116)	50.0 (89)	
Day of the Week			
Monday	19.3 (36)	22.4 (42)	0.594
Tuesday	17.1 (32)	18.9 (35.3)	
Wednesday	11.8 (22)	12.4 (23.2)	
Thursday	24.6 (46)	20.8 (38.9)	
Friday	27.3 (51)	25.4 (47.5)	
Month of the Year			
January	13.4 (25)	11.4 (21.3)	0.069
February	14.4 (27)	9.7 (18.1)	
March	7.5 (14)	12.6 (23.6)	
April	8.6 (16)	9.7 (18.2)	
May	5.9 (11)	6.0 (11.2)	
June	4.3 (8)	5.1 (9.5)	
July	3.2 (6)	4.7 (8.8)	
August	0.5 (1)	3.6 (6.7)	
September	9.6 (18)	9.1 (17.1)	
October	12.8 (24)	11.6 (21.7)	
November	16.0 (30)	11.8 (22.1)	
December	3.7 (7)	4.5 (8.6)	

*beginning of clinic = 0800-1000 h and 1300-1500 h; end of clinic = 1001-1200 h and 1501-1700 h

The most common instrument causing injury was the needle (either suture or local) (23.5% of cases), followed by the bur (16%), scaler (15.5%) and lab knife (15%) (Table 1). The most common body part injured was the finger (45.5% of cases), followed by the thumb (31%) and the hand (15%) (Table 1).

A number of variables were assessed for their effect on injury rates. There were no statistically significant effects of gender, academic program, and time of day, day of the week or month of the year on student injury rates (Table 2). The only variable found to have an effect was the time in the clinic appointment: students were nearly twice as likely to experience an injury at the end of clinic appointment compared to the beginning ($X^2 = 16.38$, $df = 1$, $p < 0.001$; OR 1.90, 95% CI 1.39-2.60).

Following the analysis of the injury reports, the investigators developed HFACS questions that not only would serve as an adjunct to the injury report, but also help to develop the “why” of the increase in student clinician injuries (Table 3).

Discussion

This study was conducted to determine the circumstances under which student clinician injuries occur within the Dalhousie Dental Clinic. The study indicates there is a significant increase in rate of student injuries per year, despite measures taken, and education delivered to our learners about self-care. Primary variables of interest involved determining if there was a significant difference between gender, instrument causing injury, area of injury, time of day, time in clinic appointment, day of week, and month of year.

Table 3: Questions for Human Risk Factor Analysis.

QUESTIONS FOR HUMAN RISK FACTOR ANALYSIS:
A. Organizational Influences
1) The decisions, rules, or policies of The School of Dentistry contributed to your injury.
2) The allocation of clinical instructors/support staff or equipment, or lack thereof, contributed to your injury.
3) The lack of focus on safety by the school, faculty, or support staff contributed to your injury.
B. Supervision
4) Inadequate training, professional guidance, or an oversight by the clinical instructors/or staff contributed to your injury.
5) An issue with clinic scheduling or clinic assignment of work contributed to your injury.
6) Failure of a clinical instructor or support staff to address operator deficiencies, or equipment problems, contributed to your injury
7) The disregard by clinical instructors or support staff of Dalhousie Dentistry protocol or professional rules and regulations has contributed to your injury.
C. Preconditions for Unsafe Acts
8) Psychological state, including excessive fatigue, stress, distraction, or personal conflict contributed to your injury.
9) Physiological state, including illness or prior injury, contributed to your injury.
10) The physical environment (including technological/equipment malfunctions) in the clinic or your cubical contributed to the injury.
11) Lack of preparation for clinic procedures today contributed to your injury.
D. Unsafe Act
12) The injury occurred because of a decision error due to your lack of information, knowledge or experience
13) Even though this task was familiar to you, the injury occurred because of an error in your sensory perception (ie. vision, hearing, smell, or touch).
14) The injury occurred because you thought you could "bend the rules".
15) The injury occurred because you knowingly violated clinic procedures and protocol.
*Adapted from Diller et al. [18]

Gender

A major variable of interest in this study is that of gender. Younai [1] concluded that a larger percentage of females reported injuries, but several other studies countered this finding. Stewardson [5], Machado-Carvalho [4], and Gatto [14] reported from their findings that gender was not a significant factor in the reporting of injuries. Our study was in agreement with the latter authors in that there was no difference in reporting by gender. Kotelchuk [19] concluded from their research that on average, females do tend to report more, but despite many theories, there is still little evidence to support why this might be the case. Wood [10] touched on one such theory of how personal perception or interpretation of the meaning of clinical injuries may influence reporting behavior. Wood's study confirmed that female students reported a greater fear of injury than their male counterparts, and this interpretation plays a significant role in reporting. All of the investigators including the present authors agree that further research is needed to fully understand the role of fear and interpretation and how it does impact reporting of injury.

Instrument causing injury

The instrument found to be the cause of the majority of the injuries was either a suture needle, or a local anesthetic needle, followed by a bur, a scaler, or a blade. This is consistent with studies by Stewardson [5], Shah [7], and Smith [6], all who reported that needle sticks were the most frequent cause of percutaneous injury.

Area of injury

The finger, thumb and hand were also the area's most commonly injured by students. These results are consistent with Callan [11], Smith [13], and Gatto [14].

Time of day

The results showed that time of day (i.e. morning vs. afternoon) had no significant effect on injury rates. This is in contrast to previous research [1,5,8,9,11] showing a higher rate of injury in the afternoon.

Time in clinic appointment

Our results showed the time during the clinic appointment was the major consideration, as it was hypothesized that injury is more likely to occur toward the end of the clinic, for all the reasons mentioned in the literature. Loss of adequate anesthesia, the stress of time management, patient management, and the ability to complete required competencies can all cause students to become tense and stressed. Students are under great pressure to complete competencies and requirements, which may cause them to rush toward the end of

the allotted clinic time. When students are rushed and experiencing stress due to increased demands, the likelihood of injury will increase as well. So, even though the cited literature focused more on the generality of a rise in injury rates in the afternoon as compared to the morning, our results clearly demonstrate that actual time in the appointment is more significant. Kotelchuk et al. [19] confirmed this finding as they reported that students commented the main reason for their injuries was due to feeling rushed near the end of the clinic appointment. Often, as anesthesia is starting to wear off, patients may become jumpy, contributing to injury. A change in appointment guidelines has also placed an increase in responsibility on our students in the amount of paperwork and signatures required, all needing to be completed at the end of each appointment.

Day of week

It was initially hypothesized that more injuries would occur on Fridays. Expected frequencies for day of the week were based on the distribution of patient visits occurring on each weekday, for example, there are more patients seen on Fridays, so we looked at the average number of patient visits per individual weekday. As reported in the literature review, Callan [11] actually reported that clinical injuries were more frequent on Tuesdays, and Gatto [14] found that more injuries occurred on Mondays and Tuesdays. Our findings indicated there was statistically no effect of day of the week on student injury rates.

Month

Our study showed there to be no significant effect of month on the rate of student injuries, contrary to the literature that supported an increase in percutaneous injuries in January and March, and July and September, likely after a student break [11].

Program

This study made consideration for dentistry, dental hygiene, bachelor and qualifying students enrolled in the program, and the respective hours spent in the clinic, and the results showed no significant effect of program. This is consistent with reports from Gatto [14] and Shah [7], who also found there to be no statistical significance between percutaneous injury and professional profile.

Studies show there is general underreporting of injuries by students. We consider this to be a limitation of our study. It is hypothesized that students don't report their injuries due to time constraints, previously mentioned pressures of clinic appointment time and academic schedules. Many may view the reporting as taxing, as they have to physically go to another location in the building, etc.

Another reason for lack of reporting comes in the actual perception and fear of the significance of percutaneous injury. As Kotelchuck [19] has stated, this perception may play a significant role in reporting, which possibly suggests that students do not see the value, or the seriousness of the issue of injury.

It is important to determine why injury rates continue to rise. From our literature search, we have not been able to determine if a risk analysis has been previously carried out, in any health care profession or faculty of dentistry. Therefore, we have adapted a series of questions from HFACS to be incorporated with the student injury reporting protocol, which will allow us to specifically focus on why these injuries continue to be on the rise.

Conclusions

The analysis of student injuries reveals that further investigation is necessary to examine why the rate of injury is increasing. This is of great concern. Now that the variables are known, we must look at the 'why'. Questions to be asked are: Are the students receiving enough instruction before beginning clinical practice on patients? Is it 'timely' information? Are there certain protocols and procedures that need to be reviewed and updated to prevent injuries? Do we need to consult and team with dental suppliers of technology to help in the development of safer products? The plan for future research is the implementation of the questions adapted from Diller's HFACS, [18] which will help the investigators identify and understand the causal risk factors to better answer these questions.

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