**Observed infection control compliance in a dental school: A natural experiment**

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**Objective:** The objective of this study was to determine student adherence to infection control policies at 1 dental school. A secondary objective was to determine the influence of Ebola virus disease (EVD)-related training on student infection control behaviors.

**Methods:** An instrument to assess and record infection control behaviors was developed to reflect Centers for Disease Control and Prevention guidelines as well as current teaching. Third- and fourth-year dental students were observed during patient-care appointments and behaviors were recorded and analyzed. Behaviors observed before the EVD outbreak and subsequent mandatory in-service training were compared with behaviors observed after completion of the training.

**Results:** Use of personal protective equipment was nearly universal. Overall compliance with infection control parameters was 88%. However, only a minority of students demonstrated no breaches of protocol. Most violations involved improper mask use and improper glove use during the intraoperative phase of an appointment and failure to wash hands after removing gloves. There were no significant overall differences in observed behavior pre- and post-EVD training.

**Conclusion:** Overall compliance with recommendations was high but some areas showed room for improvement. Future training in infection control should focus on these areas. Training related to EVD had no influence on student behavior.

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MATERIALS AND METHODS

Subjects

Subjects observed were third-year (D3) and fourth-year (D4) dental students assigned to the comprehensive care clinic. The data were gathered anonymously. This study was deemed exempt by the State University of New York at Buffalo Social and Behavioral Sciences Institutional Review (No. IRB00003128).

Instrument

An instrument to assess and record infection control behaviors was developed using items designed to reflect CDC guidelines as well as current teaching. Items were reviewed for face validity by 3 clinical faculty members in the Department of Oral Diagnostic Sciences. The faculty reached consensus that the items reflected behaviors that were observable and represented best practices in infection control. The final instrument consisted of 13 items related to infection control behaviors.

Data collection

D3 and D4 dental students were assigned to operatories by senior dental assistants who were unaware of this research. The investigator collecting the data used an available operatory to observe behavior of students in neighboring operatories. Thus, students were selected for observation based on chair assignment and proximity to an operatory that permitted such observation.

Data were collected 2 days per week over a period of 24 weeks. D4 students were in clinic both of these days, and D3 students were in clinic 1 of the 2 days. Of the 214 observed encounters, 155 were with D4 students and 55 with D3 students. Ninety-four encounters occurred before the implementation of the mandated EVD protocol on September 27, 2014, 27 encounters occurred while the screening and training initiatives were being implemented, and 93 encounters occurred after the screening protocol was in place and mandatory training had been completed on January 1, 2015. Other than year of graduation, no record was kept of which students were observed during a particular clinic session and it is likely that some students were observed on multiple occasions. To avoid the issue of interrater reliability, all observations were made by 1 author (NT). Due to faculty time constraints, students were not observed for the entire 3-hour appointment but intermittently throughout the appointment.

Data analysis

The variables “Wash hands before mask” and “Wash hands before gloving” were combined into 1 variable (“Handwashing pre”) to more closely align with CDC guidelines that call for hand hygiene before gloving but not before donning a mask.

Data were examined at both the encounter (defined as 1 student, 1 clinic period, multiple behaviors) and item (defined as multiple students, multiple clinic periods, 1 behavior) levels. For encounters, we examined the total number of observed infractions, calculated as the sum of infractions across observed behaviors. Percent compliance was also calculated: for each encounter, the number of behaviors recorded as “yes” (“no” for improper mask use and improper glove use) was divided by the total number of behaviors observed.

At the item level, we determined percent compliance based on recorded observations. That is, for all compliant behaviors, the number of times the behavior was recorded as “yes” divided by the total number of recorded observations (“yes” + “no”). For improper mask use and improper glove use, percent compliance was the number of times the behavior was recorded as “no” divided by the total number of recorded observations.

The items were also categorized by operative stage: preoperative, intraoperative, and postoperative. Preoperative behaviors occur before any contact with the patient and include proper placement of protective barriers in the operatory; handwashing before donning of PPE; and donning of gown, gloves, and mask and protective eyewear with side shields.

Intraoperative behaviors were breaches related to mask and glove use. These include having a mask on one’s chin, reusing a mask, touching items with contaminated gloves, and placing contaminated gloves or mask on a counter. Intraoperative behaviors are reported in the negative because they involved protocol violations.

Postoperative behaviors include proper glove removal, proper mask removal, and handwashing after glove removal, which were observed either at the end of an appointment or when a student broke scrub during the appointment.

To compare operative stages, percent compliance was determined for each operative stage by aggregating items within the stage and then applying the calculation described for item-level compliance.

All analyses were performed using SPSS Statistics version 23 (IBM-SPSS Inc, Armonk, NY) and R (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Encounter level

The distribution of violations per encounter is shown in Figure 1. Before the EVD mandate, 23% of encounters exhibited no infractions of infection control policy. The number ranged from zero to six with a mean ± standard deviation of 1.3 ± 1.17. After the mandate, 30% of encounters showed no infractions with a range of 0-4, and a mean ± standard deviation of 1.29 ± 1.09. No statistically significant difference was seen premandate versus postmandate.

Item level

Percent compliance and total number of observed behaviors are given in Table 1. Preoperative compliance was significantly higher ($\chi^2 = 4.13; df = 1; P = .042$) postmandate compared with premandate. Intraoperative compliance (proper glove use and proper mask use) was significantly lower ($\chi^2 = 24.2; df = 1; P < .001$) postmandate compared with premandate. There was no significant difference in postoperative compliance premandate and postmandate ($\chi^2 = 1.57; df = 1; P = .21$).

When aggregated across all operative stages, overall compliance was 87% both premandate and postmandate ($\chi^2 = .002; df = 1; P = .996$).

DISCUSSION

The mean percent compliance with observed infection control parameters was very high (87%) overall. Use of barriers and PPE are clearly part of the culture of the dental school; compliance was 100% for wearing a protective gown and gloves, 98% for mask use, and 94% for protective eyewear. This compares favorably with a study in Austria that found that 70% of dentists reported always using PPE, including gloves, masks, and eye protection. Another study reported very high rates of glove use but much lower use of masks and protective eyewear. Other studies reported lower rates of compliance with PPE.
Although overall compliance was high, compliance with all infection control parameters was found in only 30% of the encounters. Most violations were in intra- and postoperative behaviors. Side shields were present on protective eyewear 82% of the time. Improper mask use was observed in 24% of the student encounters; all but 1 of these breaches involved having a mask on the chin. Friere et al reported similar findings in a dental student population: masks were used in all but 1 encounter, but they were used properly only 62% of the time. In our study, improper glove use was seen 35% of the time. Friere et al reported glove use in all observed instances and correct use in 92% of contacts. However, correct use in that study was defined merely as changing gloves between patients.

The most frequently observed violation was failure to wash hands after removing gloves (37% compliance). Handwashing after glove removal is explicitly recommended by the CDC as well as our institution’s infection control manual. It is also a component of “excellent compliance,” (ie, routine use of a combination of procedures recommended by the Canadian Dental Association, the American Dental Association, and the CDC). Our low compliance with proper glove use and handwashing postglove removal is probably related to the length of an appointment (3 hours) as well as the fact that a student must typically leave his or her operatory multiple times per appointment to speak with supervising faculty and to obtain necessary instruments and supplies. The latter could be minimized with improved preparation, but the former is inherent in the nature of clinical education. Although it is cumbersome to remove gloves, wash hands, then wash hands and don gloves multiple times per appointment, it is necessary for proper infection control. Future training should emphasize compliance with these procedures.

The EVD crisis and subsequent compliance mandates appear to have had no overall effect on student infection control behaviors. We expected an improvement after international publicity regarding the EVD outbreak led to mandatory online training in use of PPE for students, faculty, and staff as well as mandatory EVD screening of all patients and visitors to the dental school. We found an increase in preoperative compliance, but we do not interpret the difference between 92% and 95% to be clinically significant. We cannot explain the significantly lower intraoperative compliance (proper mask and glove use) postmandate versus premandate.

Overall compliance was not significantly different pre- and postmandate. Students may not have considered themselves to be at increased risk for infectious disease. Because the actual risk for

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Table 1

<table>
<thead>
<tr>
<th>Operative stage</th>
<th>Behavior</th>
<th>Premandate (94 encounters)</th>
<th>Postmandate (93 encounters)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Not observed</td>
</tr>
<tr>
<td>Preoperative</td>
<td>Operatory barriers</td>
<td>88</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Wear a gown</td>
<td>94</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Eyewear</td>
<td>87</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Side shields</td>
<td>65</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Wear mask</td>
<td>92</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Wear gloves</td>
<td>93</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Handwashing</td>
<td>83</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>602</td>
<td>50</td>
</tr>
<tr>
<td>Intraoperative</td>
<td>Improper mask use†</td>
<td>7</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Improper glove use†</td>
<td>8</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Total†</td>
<td>15</td>
<td>92</td>
</tr>
<tr>
<td>Postoperative</td>
<td>Handwashing</td>
<td>19</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Mask removed properly</td>
<td>41</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Gloves removed properly</td>
<td>78</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>138</td>
<td>58</td>
</tr>
</tbody>
</table>

Total across all observations: 87.1

*% Calculations exclude “not observed.”
†Observed behavior represents infection control violation.
EVD transmission was negligible, the failure to find differences in behavior is not surprising. A strength of this study was that the observer was a faculty member who was regularly assigned to the clinic and therefore students were not aware that they were being observed. The fact that no significant improvements were noted over time suggests that our study was not subject to observational bias.

In addition to missing data, a potential weakness of this study is the sampling method. Data were gathered anonymously, as mandated by our Institutional Review Board. As a result, any particular student might have been observed on multiple occasions. This could have led to overrepresentation of any individual’s behaviors. However, the relatively large number of observations should mitigate any effect of duplicate sampling.

Regardless of methodologic weaknesses, this study clearly indicates that preoperative preparation and wearing of PPE are fully ingrained into the culture of our dental school. Improper mask and glove use were unacceptably high, as was the observed failure to routinely perform handwashing after glove removal. Future training should focus on these areas. Our results indicate that student behaviors regarding infection control do not appear to be changed by outside events, particularly if the events are not perceived as posing a credible risk.

CONCLUSIONS

Our observational study of dental students’ infection control behaviors found that institutional focus on EVD awareness had no effect on student behaviors.

Overall compliance was high, but some areas, such as proper mask and glove use and postoperative handwashing, have room for improvement. Future training in infection control should focus on these areas.

References