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Exposure to the Dental Environment and Prevalence of Respiratory Illness in Dental Student Populations

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Abstract

Objective: *To determine if the prevalence of respiratory disease among dental students and dental residents varies with their exposure to the clinical dental environment.*

Methods: *A detailed questionnaire was administered to 817 students at 3 dental schools. The questionnaire sought information concerning demographic characteristics, school year, exposure to the dental environment and dental procedures, and history of respiratory disease. The data obtained were subjected to bivariate and multiple logistic regression analysis.*

Results: *Respondents reported experiencing the following respiratory conditions during the previous year: asthma (26 cases), bronchitis (11 cases), chronic lung disease (6 cases), pneumonia (5 cases) and streptococcal pharyngitis (50 cases). Bivariate statistical analyses indicated no significant associations between the prevalence of any of the respiratory conditions and year in dental school, except for asthma, for which there was a significantly higher prevalence at 1 school compared to the other 2 schools. When all cases of respiratory disease were combined as a composite variable and subjected to multivariate logistic regression analysis controlling for age, sex, race, dental school, smoking history and alcohol consumption, no statistically significant association was observed between respiratory condition and year in dental school or exposure to the dental environment as a dental patient.*

Conclusion: *No association was found between the prevalence of respiratory disease and a student's year in dental school or previous exposure to the dental environment as a patient. These results suggest that exposure to the dental environment does not increase the risk for respiratory infection in healthy dental health care workers.*

MeSH Key Words: *dental equipment/microbiology; infection control, dental; respiratory tract infections*

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There has been some concern over the past several decades that exposure to the dental environment, in particular dental workplace aerosols (DWAs), increases the risk of respiratory disease in dental health care workers and patients.[1] Patients and health care workers may acquire respiratory infection in the dental environment through person-to-person contact (e.g., spread via airborne particles or droplet nuclei generated by sneezing, coughing or speaking). This route of transmission could be exacerbated by generation of aerosols through the use of dental handpieces or ultrasonic instruments during dental treatment. In addition, the water used to irrigate these devices harbours relatively high numbers of bacteria.[1] Several epidemiologic studies have demonstrated a greater prevalence of the bacteria that commonly colonize dental unit waterline (DUWL) biofilms in the nasal flora of dentists than nondental personnel (or greater prevalence of an immune response to these bacteria).[2–4] Although several

case reports have suggested that DWAs were the cause of infection,[5,6] another study found that the risk of respiratory infection for patients with cystic fibrosis (who often suffer from infection with *Pseudomonas*, a common inhabitant of dental waterlines) who were exposed to the dental environment was equal to the annual rate of respiratory infection for this population as a whole.[7] More recently, dental treatment has been associated with a hyperactive airway response that diminishes lung function in children with asthma.[8] Exposure to DWAs was offered as a possible explanation, but no evidence was offered in support of this hypothesis.

DWAs may be contaminated with bacteria transferred from patient microbial flora during the course of treatment or from DUWL biofilms. Microbial biofilms are ubiquitous on the inner surface of DUWL tubing.[9] The formation of these complex structures follows adhesion and growth of saprophytic bacteria normally found in potable water.[1,10–14] The bacteria secrete a polymeric substance (slime) that helps to anchor them to surfaces.[15] Although most of the biofilm remains attached to the internal surface of the waterline, single bacterial cells and aggregates of bacteria often become detached. Consequently, organisms can be carried in the effluent water via a dental handpiece, a sonic scaler or water spray. Concern has been expressed by both dental health care professionals and the lay media[16] that exposure to bacteria in DWAs may cause disease, particularly respiratory infections, in both patients and dental health care workers following inhalation of aerosols generated from high-speed handpieces or ultrasonic scalers.

Most bacterial species that colonize the oral cavity and form DUWL biofilms are not pathogenic. However, several potentially pathogenic bacteria, for example, *Pseudomonas* spp. and *Legionella pneumophila*, have been isolated from DUWLs.[6,17] In addition to harbouring bacteria, waterline effluents also contain high concentrations of biologically active bacterial products such as lipopolysaccharide,[18] which may have untoward effects on important physiologic processes such as wound healing.

To minimize the chance for patient infection from waterlines, the American Dental Association recommends that sterile irrigating solutions be used for surgical procedures and that dental instruments using DUWL water be run for 20 to 30 seconds before each patient and for several minutes at the start of each day to reduce the number of bacterial colony-forming units (CFUs) that exit in waterline effluents.[19] The 2003 guidelines for infection control in the dental setting of the Centers for Disease Control and Prevention (CDC) make the same recommendations.[20]

Other than the few case reports of serious infections that may have arisen from DWAs,[4,5] no epidemiologic investigations have demonstrated adverse health effects due to such exposures. In light of the paucity of research either supporting or refuting the possibility that exposure to DWAs induces disease, a study was designed to investigate this problem. Because the exposure of dental students to DWAs varies (first-year students having little exposure to such aerosols and fourth-year students and postgraduate residents having extensive exposure), the null hypothesis was that there is no difference in the prevalence of respiratory disease between senior dental students and more junior students. The goal of this study was to determine if the rates of respiratory illness among dental students and residents in 3 dental schools varies with school year (and hence exposure to the clinical dental environment).

Methods

The University at Buffalo Human Subjects Institutional Review Board approved the protocol for this study. A detailed questionnaire (see **Appendix 1** at http://www.cda-adc.ca/jcda/vol-70/issue-3/170.html) was administered to 817 dental students and postgraduate residents of 3 U.S. dental schools (The State University of New York at Buffalo, Buffalo, New York; Marquette University, Milwaukee, Wisconsin; and University of Southern California, Los Angeles, California) and to 26 dental hygiene students at the University of Southern California. Sample size calculations were based on the estimated average prevalence of pneumonia in the general population. The CDC estimates that pneumonia was the cause of 1.3 million hospital dicharges in 2001,[21] which suggests that the disease affects approximately 0.5% of the U.S. population. This is an underestimate of the true incidence of pneumonia, because many cases of this disease are either not treated, or treated and not hospitalized. Another recent study[22] found hospitalizations for community-acquired pneumonia for all Medicare recipients aged 65 years or older to be 18.3 per 1,000 population. Because our target population was much younger, we set the expected prevalence at 1%. We then assumed that a doubling of the prevalence of pneumonia (to 2%) would represent a significant difference in prevalence. The number of subjects required to detect a doubling in the rate of pneumonia, for a study with a power of 80% and 5% significance level, was calculated to be 793.

Data Analysis

For the preliminary analysis, history of respiratory disease within the past year was considered the dependent variable, and dental class (first, second, third or fourth undergraduate year or postgraduate studies) was considered the independent variable. Demographic and other variables, such as age, sex, race, life habits (smoking and alcohol consumption) and dental school attended, were used as covariates in this analysis.

Descriptive statistics and bivariate analysis (χ^2 test) were used to examine possible associations among the general characteristics of the population. Student's *t*-tests and

Table 1 Prevalence of respiratory condition by dental school

	No. (and %) of students				
School	**COPD**	**Bronchitis**	**Asthma[a]**	**Pneumonia**	**Streptococcal pharyngitis**
A (*n* = 238)	1 (0.4)	4 (1.7)	13 (5.5)	3 (1.3)	14 (5.9)
B (*n* = 349)	4 (1.1)	5 (1.4)	6 (1.7)	2 (0.6)	19 (5.4)
C (*n* = 230)	1 (0.4)	3 (1.3)	7 (3.0)	0 (0.0)	17 (7.4)

COPD = chronic obstructive pulmonary disease
[a]*Significantly greater prevalence of asthma in school A than in schools B and C.*

Table 2 Prevalence of respiratory condition by class year[a]

	No. (and %) of students				
Year	**COPD**	**Bronchitis**	**Asthma**	**Pneumonia**	**Streptococcal pharyngitis**
1st (*n* = 221)	4 (1.8)	1 (0.5)	9 (4.1)	2 (0.9)	13 (5.9)
2nd (*n* = 249)	1 (0.4)	5 (2.0)	4 (1.6)	0 (0.0)	17 (6.9)
3rd (*n* = 176)	0 (0.0)	2 (1.1)	6 (3.4)	0 (0.0)	7 (4.0)
4th (*n* = 149)	1 (0.7)	3 (2.0)	7 (4.7)	3 (2.0)	11 (7.3)
Postgraduate (*n* = 20)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (10.0)
Total (817)	6 (0.7)	11 (1.3)	26 (3.2)	5 (0.6)	50 (6.1)

COPD = chronic obstructive pulmonary disease
[a]*No statistically significant associations were noted between prevalence of any disease and class year.*

Table 3 Results of multiple logistic regression analysis for risk of respiratory disease (composite index)

Variable	**Odds ratio**	**95% CI**
Age	1.06	0.96–1.16
Sex		
Female	1.00	–
Male	0.82	0.43–1.57
Race		
Caucasian	1.00	–
Asian	1.23	0.58–2.62
Others	0.97	0.31–3.01
School		
A	1.00	–
B	0.55	0.26–1.15
C	0.49	0.22–1.10
Tobacco use		
No	1.00	–
Yes	0.74	0.23–2.32
Alcoholic drinks/week		
None	1.00	–
1–2	1.91	0.87–4.20
3–5	2.08	0.73–5.90
5–10	1.81	0.57–5.76
Exposed to dental drill		
No	1.00	–
Yes	1.06	0.57–1.95
Dental school year		
1st	1.00	–
2nd	0.50	0.21–1.18
3rd	0.50	0.20–1.23
4th	0.94	0.41–2.14

CI = confidence interval

analysis of variance were used to evaluate and compare the means of the parameters under study. All covariates were also considered in a logistic regression model.

Because of the low prevalence of respiratory disease in this population, a composite respiratory disease index was also constructed, which incorporated bronchitis, asthma, emphysema, chronic obstructive pulmonary disease (COPD, including history of chronic bronchitis or emphysema or both) and pneumonia.

Results

Of the 817 respondents, 512 (62.7%) were male; 238 (29.1%) were enrolled at school A, 349 (42.7%) at school B and 230 (28.2%) at school C.

Table 1 details the prevalence of respiratory illness among the respondents from each school. The only statistically significant association was for asthma, for which there was a significantly higher prevalence at school A than at schools B and C. Streptococcal pharyngitis was the most prevalent respiratory disease, and pneumonia the least prevalent. The inquiry about history of streptococcal pharyngitis was used as a "control" question, because there is no evidence of a link between the acquisition of this infection and exposure to the dental environment.

No statistically significant association was observed between prevalence of any of the respiratory diseases and class year (**Table 2**).

To assess the relation between respiratory disease and exposure of dental students to dental aerosols, the 26 dental hygienists were excluded from the multiple logistic regression analysis, and the analysis controlled for a variety of

potential confounders, including age, sex, race, school, tobacco use, alcohol use, exposure to a dental drill and dental school class. No statistically significant association was found between any of the target respiratory conditions alone and year in dental school or exposure of the students to dental aerosols as a dental patient. No correlations were noted between the composite respiratory disease index and any of the covariates assessed (**Table 3**).

Discussion

The goal of this study was to determine if a correlation exists between exposure to DWAs and respiratory illness in healthy dental students. The results do not indicate any such relationship. This outcome suggests that the microbial species resident in DWAs are inherently nonpathogenic, especially for healthy individuals, despite their abundance in the oral cavity and in DUWL aerosols. Current infection control procedures, including the now-routine use of barriers such as gloves and masks in dental practice, probably prevent transmission of aerosol-borne disease in healthy populations.

Bacterial counts in water samples from DUWLs can be quite high, sometimes exceeding 1 million CFU/mL effluent. These high bacterial counts are probably related to the large surface area to volume ratio of the waterlines and the low flow velocities therein, which allow planktonic bacterial cells ready access to the tubing wall where they can form biofilms.[1] Previous studies have found potential pathogens such as *Pseudomonas aeruginosa, L pneumophila* and nontubercular mycobacteria in DUWL biofilms.[6,7,17,23,24] Although *Pseudomonas* spp. from DUWLs may be a source of infection in patients with cystic fibrosis, the apparent risk of such a patient acquiring this organism from DUWL biofilms is low. Amoebae have also been found in DUWL effluents.[25] Despite the presence of potential pathogens within DUWLs, there is little published evidence to support the contention that exposure to DWAs is a risk factor for respiratory or other diseases. The results of the present study also do not support the notion that increased exposure to the dental workplace increases the prevalence of respiratory diseases.

Streptococcal pharyngitis is a common infection caused by group A beta-hemolytic streptococci. There is no evidence that these streptococci reside in DUWL biofilms. As expected, the present study found no correlation between exposure to DUWL and streptococcal pharyngitis.

It was assumed that all of the subjects enrolled in this study were healthy individuals with normal immune function. There is at present little published epidemiologic evidence to support an association between exposure to DWAs and the prevalence of respiratory disease in immunocompromised individuals, but this possibility should be the subject of further investigation.

Conclusions

The results of this study do not support an association between dental school year (and hence exposure to the dental environment) and the prevalence of respiratory disease. It can be concluded that short-term exposure of healthy dental health care workers to DWAs is not associated with an increased risk of respiratory disease. Similar studies in immunocompromised individuals are warranted to determine if such an association exists in those populations. ◆

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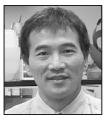

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Appendix 1 Respiratory Illness Questionnaire

1. In what school are you enrolled?_____
2. In what year of dental school are you? (Year 1, 2, 3, 4 or Post-Grad 1, 2, 3, 4)_____
3. What is your age?_____
4. What is your gender? Male_____ Female_____
5. What is your race?
   Caucasian _____ Asian_____
   African American _____ Indian_____
   Native American _____ Hispanic_____
   Other _____
6. Do you use tobacco? Yes____ No_____ # of packs/day_____
7. How many years have you used tobacco?_____
8. How much alcohol do you consume in a week? (one drink = 1 shot of whiskey = 1 glass of wine = 1 (12 oz.) beer)
   1–2 drinks a week _____
   3–5 drinks a week _____
   5–10 drinks a week _____
   Over 10 drinks a week _____
9. Have you seen a physician in the last year for a physical?
   Yes_____ No_____
10. Have you received any of the following diagnoses by a physician within the past year? (may be more than one)
    Chronic obstructive pulmonary disease_____
    Chronic or acute bronchitis_____
    Emphysema_____
    Asthma_____
    Pneumonia or lung abscess_____
    If you answered yes to any of the above questions, when was the illness first diagnosed?_____
    Are you currently being treated for this illness? Yes_____ No_____
    If yes, what is the current treatment (medications, etc.)_____
11. Have you ever been diagnosed with an immunosuppressive disease (HIV, AIDS, hepatitis, etc.) by a physician?
    Yes_____ No_____
12. Do you take immunosuppressive medication(s)?
    Yes____ No_____
    If yes, what type of medication do you take? _____
13. Have you produced increased sputum (green or yellow secretions from the airways) on a daily basis for at least a 3-month period in the last 2 years?
    Yes_____ No_____
14. Do you have or have you had chest pain aggravated by coughing in the last 12 months?
    Yes_____ No_____
    If so, how long did the chest pain last? _____
    How was the chest pain treated? _____
15. Have you ever been diagnosed with pneumonia by a physician prior to dental school?
    Yes_____ No_____
16. Have you been diagnosed with streptococcal pharyngitis ("strep throat") by a physician in the last 12 months?
    Yes_____ No_____
    If so, how long did it last? _____
    Did you receive antibiotics to treat this condition? Yes_____ No_____
    If yes, what antibiotics? _____
17. Have you had strep throat prior to your dental career?
    Yes_____ No_____
18. Have you had treatment from a dentist in the past year?
    Yes_____ No_____
    If so, did the dentist use a drill or sonic scaler? _____