Clinical Abstracts

The Clinical Abstracts section of the JCDA features abstracts and summaries from peer-reviewed dental publications. The purpose of this section is to provide JCDA readers with an overview of articles currently being published that are relevant to the practice of dentistry. This month's selection consists of articles dealing with dental unit waterlines (DUW). The articles summarized here have been chosen by Dr. Edward Putnins from the department of oral biological and medical sciences at the University of British Columbia. Dr. Putnins provides a commentary that puts these articles into context for readers.

Commentary

Dental Unit Waterline Contamination: Evolving Issues

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The issue of dental unit waterline contamination continues to receive significant attention as concerns about microorganism levels and microbial biofilm persist. Water samples collected from dental units tend to have higher levels of heterotrophic microorganisms than is thought safe for some immunocompromised individuals. Three related issues must also be addressed in the discussion on water quality and risk to patients: water quality assessment procedures, water quality for surgical dental procedures and product selection and use.

Water Quality Assessment Procedures. It has been suggested that heterotrophic plate counts from dental unit water samples should ideally have a recoverable microbial count of <200 CFU/mL. However, laboratory handling of water samples (selection of plating media, incubation time and temperature) may dramatically affect the number of recovered microorganisms. As a result, water analysis agencies use standard methods to assess water quality. Dental professional organizations should establish water analysis protocols based on these methods and inform dentists of the existence of the protocols.

Water Quality for Surgical Dental Procedures. A number of agencies have suggested that sterile water should be used for surgery. Part of the problem lies in defining which dental procedures are considered surgical procedures. Surprisingly, practitioners have a variety of opinions on this matter. As well, the grade of sterile water that should be used needs to be established. Although the literature has focused on microbial counts, the enumeration of bacterial numbers alone may not be sufficient when considering surgical water quality. The presence of bacterial products in the water (e.g., endotoxin) may be high and may exert local cellular and/or general systemic pyrogenic effects. Finally, consideration must be given to delivery mechanisms to ensure sterile water is delivered in a sterile manner. Sterile water passing through nonsterilized dental tubing will probably not remain sterile. In addition, leaving sterile nonchlorinated water in standard nonsterilized dental tubing will likely result in significantly higher microbial counts because the antibacterial effect of chlorine is not present.

Product Selection and Use. Organized dentistry has encouraged manufacturers to develop products to deal with dental unit waterline contamination. Fortunately, this development is progressing. As dentists become inundated with products, however, they should move with cautious optimism. Products and disinfection techniques must be proven to be effective and safe, and cleared for marketing in Canada. In addition, they should deliver the quality of water desired for either nonsurgical or surgical procedures. Finally, devices must be used and maintained according to manufacturers' instructions. Failure to do so could result in higher levels of bacterial contamination in the water. ❖

The views expressed are those of the author and do not necessarily reflect the opinion and official policies of the Canadian Dental Association.

1 What is the nature and significance of dental unit waterline biofilms?

Barbeau J, Gauthier C, Payment P. Biofilms, infectious agents, and dental unit waterlines: a review. *Can J Microbiol* 1998; 44:1019-28

Purpose

With the aging of the population, chronic and debilitating diseases have emerged that can weaken the immune system and make individuals more susceptible to infectious disease. Opportunistic infections have been on the rise in recent years. The advent of conditions like AIDS and antibiotic-resistant infections makes it essential to have a better understanding of the relationship between opportunistic organisms and their environment.

Methods

A narrative review of the literature relating to biofilms and waterborne bacteria as sources of nosocomial infections.

Results

The pathogens that cause nosocomial infections can exist outside the human body and are resistant to antimicrobials. Low concentrations of opportunistic pathogens can be found in drinking water. Some types of gram-negative bacteria can

thrive in the aqueous environments provided by certain types of medical equipment.

Most investigators believe that *Pseudomonas aeruginosa*, *Legionella pneumophila* and the non-tuberculous mycobacteria found in low concentrations in drinking water are pathogens. These pathogens are responsible for over 10% of nosocomial infections, they grow in biofilms and they resist common disinfection methods.

DUW are extensively colonized because their bore tubes are narrow, they are mainly supplied by municipal water sources and they are not routinely disinfected. The population groups that are most susceptible to waterborne pathogens are patients with cystic fibrosis or AIDS, elderly and chronically ill patients, and members of the dental profession regularly exposed to pathogen-loaded aerosols.

Clinical Significance

Solutions for dealing with the problem of contamination should be consistent with the level of risk. Research is needed to assess the risk of infection associated with DUW microorganisms. The total number of bacteria cannot be used as the sole indicator of health risk, since it is not an adequate measure of the disease-causing potential of water. ◆

2 How many numbers and species of bacteria can be isolated from DUW?

Barbeau J, Tanguay R, Faucher E, Avezard C, Trudel L, Côté L, Prévost AP. Multiparametric analysis of waterline contamination in dental units. *Appl Environ Microbiol* 1996; 62:3954-9

Purpose

This investigation set out to look at the dynamics of bacterial colonization of DUW through species identification, distribution and fluctuation.

Methods

Test water samples were collected from 121 dental units at the University of Montreal dental school, including samples from newly installed units that had never been used. Control samples were obtained from taps in the clinics.

Samples were collected at the beginning of the work day and after a two-minute purge. The bacteria were cultured and identified according to various characteristics. Water from three of the dental units was repeatedly sampled at the beginning of the day to investigate the variation in the total number of bacteria and the proportion of the predominant bacterial species.

Results

All waterlines were contaminated with bacteria and there were significant differences between samples taken at the beginning of the day and those taken after a two-minute purge. Differences were also found between water from the turbine and the air/water syringe. Random variation occurred mainly between measurements (80%) and between units (20%).

Newly installed waterlines reached a peak level of contamination in less than five days. *P. aeruginosa* showed a non-random distribution, since almost 90% of all the isolates were found in just three of the nine clinics tested.

Dental units contaminated by *P. aeruginosa* showed significantly higher total bacterial counts than other units. By comparison, *P. aeruginosa* was never isolated in tap water remote from or near the contaminated DUW.

Clinical Significance

DUW provide an ecosystem in which opportunistic pathogens colonize surfaces, raising the concentration of pathogens in water to potentially dangerous levels. The less a waterline is used, the more likely it is to be contaminated by *P. aeruginosa*. Draining waterlines for several minutes reduces bacterial counts significantly. The authors express concern that the length of purge time needed to lower bacterial concentration to 500 CFU/mL is impractical in the normal dental office.◆

3 What is the prevalence of *Legionella* species in DUW samples?

Atlas RM, Williams JF, Huntington MK. *Legionella* contamination of dental-unit waters. *Appl Environ Microbiol* 1995; 61:1208-13

Purpose

Dentists and dental staff have higher rates of respiratory infection than the general population. It has been suggested that *Legionella* species in DUW may be an important factor in this high rate of respiratory infection. This study aims to determine the level of *Legionella* in DUW and compare it with the level in the drinking water supply.

Methods

PCR-gene probe, fluorescent-antibody microscopic, and viable-plate-count detection methods were used to examine 265 water samples collected from 28 dental clinics in six U.S. jurisdictions for the presence of *Legionella pneumophila* and other *Legionella* species.

Results

With the PCR-gene probe method, *Legionella* species were detected in 68% of the DUW samples and *L. pneumophila* was detected in 8%. Concentrations of *Legionella* species in dental unit water were 1,000 organisms per mL in 36% of samples, and 10,000/mL in 19% of samples.

L. pneumophila never reached concentrations of 1,000/mL. Microscopic examination indicated that the contamination was in the DUW rather than in the handpieces. *Legionella* species were present in 61% of drinking water samples collected for comparative analysis; this percentage was not significantly different than levels in DUW. *Legionella* species reached concentrations of 1,000 organisms per mL in only 4% of the drinking water samples, and none was in the 10,000 organisms-per-mL category. Therefore, health-threatening levels of *Legionella* species in drinking water were significantly lower than in dental unit water.

Clinical Significance

Dental unit water is a potential source of exposure to *Legionella* species. While it is difficult to prove a cause and effect relationship, the authors believe that aerosols from DUW may possibly pose a risk to some individuals. ➧

4 Can patients with cystic fibrosis become contaminated with *P. aeruginosa* from DUW?

Jensen ET, Giwercman B, Ojeniyi B, Bangsborg JM, Hansen A, Koch C and others. Epidemiology of *Pseudomonas aeruginosa* in cystic fibrosis and the possible role of contamination by dental equipment. *J Hosp Infect* 1997; 36:117-22

Purpose

Cystic fibrosis (CF) patients often suffer from *P. aeruginosa* lung infection, yet the source of the organism is not known. This investigation sets out to determine whether CF patients might be contaminated with *P. aeruginosa* from dental equipment.

Methods

Bacteriological examinations were conducted on 103 water samples from 25 dental sessions attended by non-CF sufferers in Frederiksberg (Denmark) municipal dental clinics. As well, 327 water samples from dental sessions attended by 83 CF patients in various clinics in Danish cities were examined.

Results

Three per cent of the Frederiksberg samples were positive for *P. aeruginosa*. Eighteen of the other Danish samples (5.5%) from nine sessions (11%) were positive for the organism. In one case, identical *P. aeruginosa* strains were found both in water from the dental equipment and in the sputum of CF patients.

Clinical Significance

There is a small risk for acquiring *P. aeruginosa* from dental treatment, which is equal to the annual "natural" incidence (1 to 2%) of acquisition of *P. aeruginosa* in a CF centre. ➧

5 What is the potential health risk from heterotrophic microorganisms isolated from drinking water?

Edberg SC, Kops S, Kontnick C, Escarzaga M. Analysis of cytotoxicity and invasiveness of heterotrophic plate count bacteria (HPC) isolated from drinking water on blood media. *J Appl Microbiol* 1997; 82:455-61

Purpose

Heterotrophic plate count (HPC) bacteria are present in all water environments. These bacteria multiply in drinking water, especially in closed containers. A study was undertaken to estimate health risk from these naturally occurring bacteria by the determination of cytotoxicity and invasiveness in human cells.

Methods

HPC bacteria were isolated from bottled and tap water samples. All HPC bacteria were examined at different phases of their growth cycles. Bacterial broth supernatant fluids were also tested as controls.

Results

Naturally occurring HPC bacteria demonstrated low invasiveness and cytotoxicity, with over 95% of samples being equivalent to broth supernatant fluid. When either invasiveness or cytotoxicity was evident, only a small number of cells from any particular culture were positive. Active growth phase HPC bacteria were significantly more cytotoxic and invasive than those in stationary phase. Bacterial broth controls often demonstrated marked cytotoxicity.

Clinical Significance

There is scarcely any documented evidence to prove that HPC organisms cause adverse health effects. Future water regulations should be directed to eliminating specific pathogens and exogenous contamination. ➧

6 What are the health implications of DUW contamination as new technologies become available?

ADA Council on Scientific Affairs. Dental unit waterlines: approaching the year 2000. *J Am Dent Assoc* 1999; 130:1653-64

Purpose

This article provides an update on biofilm formation in DUW and explores the potential health impact of this phenomenon. A review of current research in the field and available means to reduce contamination is presented.

Methods

The conclusions of an expert panel brought together by the American Dental Association (ADA) board of trustees formed the basis of this article.

Results

DUW provide a favourable environment for biofilm formation because of their small bore size and long quiescent periods. Flow rates are lowest at the edges of the lumen. Organisms often slough off the biofilm and make their way to the patient's mouth through the handpieces or the air/water syringe. Biofilm counts may be as high as millions per millilitre in untreated units.

The issue of biofilm and bacterial contamination of waterlines appeared in the dental literature 30 years ago. It has received greater prominence recently because of the increase in the number of immunocompromised patients attending dental offices.

Since the first ADA panel on waterlines met in 1995, many products have been developed to improve the quality of the water used in dental treatment. The four main categories of product are: independent water systems (don't seem to be effective on their own), chemical treatment protocols (dentists need to enquire about compatibility from unit manufacturers before installing), point of use filters (probably need to be used in combination with other methods) and sterile water delivery systems (expense and convenience are issues).

Clinical Significance

The profession should be aware of the potential health effects of microbial contamination of DUW. Efforts to improve the quality of dental unit water should continue. Research should continue to examine the implications of biofilm in waterlines for dental practice.

The article containing the 1995 position of the American Dental Association on dental unit waterlines appeared in JADA in 1996: Shearer BG. Biofilm and the dental office. J Am Dent Assoc 1996; 127:181-9. ➧

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