REVIEW ARTICLES AAEM

Ann Agric Environ Med 2004, 11, 9–12

RISK OF EXPOSURE TO *LEGIONELLA* IN DENTAL PRACTICE

Jolanta Szymańska[1, 2]

[1]Annals of Agricultural and Environmental Medicine, Lublin, Poland
[2]Department of Paedodontics, Skubiszewski Medical University of Lublin, Lublin, Poland

Szymańska J: Risk of exposure to *Legionella* in dental practice. *Ann Agric Environ Med* 2004, **11**, 9–12.

Abstract: Aerosols generated in dental operations are a source of exposure to microorganisms proliferated within dental unit waterlines (DUWL) biofilm. It has been suggested that presence of *Legionella* species in these aerosols may contribute to potential health hazards for dental staff and patients. The article attempts to provide a brief overview of the current knowledge about *Legionella*, its prevalence in DUWL, immunological reactions of the dentists and concepts for prophylaxis of *Legionella* in dentists' work place.

Address for correspondence: Jolanta Szymańska, DMD, AAEM Editors, Instytut Medycyny Wsi, Jaczewskiego 2, P.O. Box 185, 20-950 Lublin, Poland.
E-mail: adpunctum@adres.pl

Key words: Legionella, dental unit waterlines, occupational hazards.

INTRODUCTION

Bacteria of the *Legionella* species are small Gram-negative rods belonging to the family Legionellaceae. They are intracellular pathogens and in the human body develop in the alveolar macrophages, and less frequently in other macrophages, monocytes and leucocytes. They are characterized by complex nutritional requirements and special culture conditions, a long generation time, and low biochemical activity [11].

Legionella commonly occurs in natural and artificial water reservoirs, less often in soil and organic matter. Its proliferation is favoured by the water temperature of 25-42° C, the presence of algae or protozoa, and calcium or magnesium salt-containing sediments.

The source of infection may be plumbing water, air-conditioning systems, air-moisturising appliances, showers, fountains, spas equipped with whirling devices and other mechanisms producing water mist.

Infection occurs by the inhalation of bacteria-laden water droplet aerosol or dust, or by choking. The incubation time is 2-10 days.

The Legionellaceae comprises more than 45 species but *Legionella pneumophila* is isolated from ≥ 90% of culture proven clinical cases with *L. pneumophila* serogroup 1 being the most common cause of Legionnaires' disease [16].

Infection with the *Legionella* rod causes legionellosis. Three clinical types of legionellosis can be distinguished: 1. sporadic or epidemic infection in the form of legionellosis pneumonia, described as Legionnaires' disease; 2. Pontiac fever - a flu-like form having a mild course; 3. an extra-lung form in immunosuppressed patients, often taking a severe clinical course, with the septic syndrome, coagulation disorders, acute cardio-vascular deficiency and nephritis [15].

Legionellosis pneumonia most often occurs in patients with decreased immunity, chronic diseases of the respiratory system, renal deficiency, and old age, as well as in people treated with corticosteroids, tobacco smokers, and alcohol abusers. The highest risk group include patients taking immunosuppressive drugs or people with immunodeficiency. Individuals occupationally exposed to water aerosols (workers of cooling towers, turbine

Received: 20 January 2004

operators, gardeners and others) are also under increased risk of infection with *Legionella* [19].

Legionellosis diagnostics is based on serological studies of the blood serum to indicate the level of antibodies, on the patients' urine analysis to determine the presence of a specific antigen with the immunoenzymatic (ELISA) and radioimmunological (RIA) tests and on the bacteriological examination of the bronchial tree secretion, broncho-alveolar washings, lung biopsy material and sputum [16].

High- and low-speed handpieces, ultrasonic instruments and air-water syringes produce air-water aerosols, which may be source of infection. Both the dental team and the patient are exposed to the infected aerosols by inhaling them and choking. The air-water aerosol with the droplets of 0.2-5.0 μm in diameter, can contain, apart from other microorganisms, *Legionella* [17, 18], whose survival increases from 3–15 minutes, together with the increase of relative humidity up to 30–80% [4]. The source of microbial contamination of the water used at the work with dental handpieces is the microflora prevalent in dental unit waterlines (DUWL). According to ADA [1] dental unit waterlines are sites for the development of biofilm of aerobic, mesophilic, heterotrophic micro-organisms commonly found in fresh drinking water systems, including *Legionella.*

PREVALENCE

Microorganisms present in DUWL have been identified and characterized in numerous studies [20, 21]. On the basis of the literature, Wirthlin *et al.* [24] listed some of the species recovered by flushing from DUWL. Among the *Legionella* species that had been isolated from dental unit waterline are listed: *Legionella bozemanii*, *Legionella dumoffii*, *Legionella longbeachae*, *Legionella pneumophila* [23].

Many years earlier, other authors described the results of their work on the *Legionella* species identified in dental unit waterlines. Reinthaler *et al.* [18] reported the prevalence of *Legionella* in around 10% of the specimens taken from dental turbines, while Borneff [6] found the bacteria in around 40%. Oppenheim *et al.* [13] reported that *Legionella* had been isolated from 50% of the specimens taken from the water delivered by air-water syringes and rotary instruments. Lück *et al.* [10] isolated *Legionella* from 50% of dental units in 12 dental offices.

Atlas *et al.* [2] claimed to have detected *Legionella* in 78% of the specimens taken. In 8% of the cases the species isolated was *Legionella pneumophila pneumoniae*, which is highly pathogenic for man and causes Legionnaires' disease. Concentrations of *Legionella* spp. in dental unit water reached 1,000 organisms per ml or more in 36% of the samples, and 19% of the samples were in the category of 10,000/ml or above. *Legionella pneumophila*, when present in dental unit water, never reached concentrations of 1,000/ml or more. Williams *et al.* [22] studied 47 dental units installed in a dental centre in Maryland, and found in 62% the presence of *Legionella*; in 19% the concentration exceeded 100 cfu/ml.

Legionellae are often found within protozoan cells in dental unit biofilms. Amoebae might serve as a host cells for intracellular proliferation and for spreading of *Legionella* spp. [2, 3].

In Polish studies to detect and isolate bacteria of the *Legionella* species from the dental turbine water, *Legionella* was found in 24.2% of the samples. Among the isolated strains, the following serogroups were identified*: L. pneumophila* serogroup (SG) 1, *L. pneumophila* serogroup 2–14 and other *Legionella* species. *Legionella* concentration per 1000 ml water was from 1×10^3–2×10^5. *L. pneumophila* constituted 4% of all isolated bacteria of *Legionella* species. *L. pneumophila* serogroup 1, the most dangerous to health, made up 13% of isolates [12].

Serological studies conducted over the years have allowed the assessment of the exposure of a dental staff to *Legionella* infection. Reinthaler *et al.* [18] examined serum from 107 dentists, dental assistants, and dental technicians with a test for antibodies to *Legionella pneumophila* SG1-SG6, *L. micdadei*, *L. bozemanii*, *L. dumoffii*, *L. gormanii*, *L. jordanis*, and *L. longbeachae* SG1+2. 34% of dental personnel showed a presence of antibodies to *Legionella pneumophila* in comparison with 5% from a control group. Dentists had the highest prevalence - 50% of *L. pneumophila* antibodies, followed by assistants (38%) and technicians (20%).

Similarly, Lück *et al.* [9] found that in comparison with a control group of healthy people, dentists had a higher prevalence of anti-*Legionella* antibodies. The difference was less in the case of dental nurses and technicians.

Pankhurst *et al.* [16] studied blood samples taken from 246 general dental practitioners in London and Northern Ireland for the presence of anti-*Legionella* antibodies. The dentists recruited for the study had spent a mean of 10.8 years working in the inspected dental surgery. The prevalence of antibodies against *L. pneumophila* in the examined population of dentists did not exceed the background levels seen in a London blood donor control group. In fact, the titres were significantly lower for the dentists compared to the blood donors for the *L. pneumophila* serogroups 3, 6, and 8. These results seem to indicate that the risk from potential occupational exposure to *Legionella* was minimal among examined British dentists.

Until recently, only little has been known about occupational legionellosis among dentists. Atlas *et al.* [2] reported the case of fatal legionellosis in a California dentist which was probably due to occupational exposure.

WATER QUALITY AND HEALTH RISK

The water used for cooling dental handpieces comes from the city water distribution system or containers belonging to a unit. Operating conditions of dental unit waterline are favourable for microorganisms proliferation. The typical temperature of dental waterlines (23°C)

combined with *Legionella*'s ability to form biofilms, stagnation of the water in the lines and a low chlorine residual - all potentially create a unique niche for these microorganisms. Detachement of microorganisms from dental unit biofilm and passing to aerosols produced during the work may infect dental staff and patients. Therefore it is important to guarantee the high quality of the water coming from: 1. the plumbing system or from water storage tanks (microorganisms present in water or on the inner surface of a tank); 2. a DUWL (microorganisms forming a biofilm on the tube surface and, as above, in a tank). The infection from patient to patient through repetitive use of handpieces during the work is also possible.

It is also known that DUWL are contaminated by numerous species of microorganisms, and it is very difficult to demonstrate a clear link between the presence of contamination in the sprays and the spreading of disease among exposed dentists and patients. A large part of the microorganisms isolated from dental unit water are characterised by low pathogenicity, although they may become extraordinary aggressive in the case of immunocompromised hosts. According to Williams [23], these aspects should be taken into serious consideration as dental care centres receive a growing number of patients with physiological immunodeficiencies related to age or pathological conditions. The immunocompromising conditions decreasing the resistance to pathogenic microorganisms are: neoplasia, nutritional deficiencies, alcoholism, systemic lupus erythematosus, asthma, cystic fibrosis, tuberculosis, progressive HIV, and diabetes [14].

PREVENTIVE MEASURES

The aim of preventive measures is to significantly limit the proliferation of microorganisms.

The plumbing water feeding dental units should be of appropriate quality, at least as high as potable water. Filtration of water at the point of use with replaceable, in-line, approved, 0.22-micrometer pore size filters is recommended for minimizing risk to patients and staff in dental facilities (Food and Drug Administration - FDA).

Four methods are now widely advocated to reduce the level of bacterial contamination in dental water: 1. flushing waterlines for several minutes at the beginning of the day and after periods of disuse; 2. using an independent water reservoir system separate from the municipal water source (sterile water); 3. use of an independent water reservoir system combined with periodical or continuous application of chemical germicides; 4. use of microfiltration to trap microbes before they reach the dental client [5].

To preserve the appropriate water quality in DUWL, water stasis in the tubes should be limited in order to prevent biofilm formation, and the equipment rinsed before work and between each patient. Flushing for 2 minutes in the morning and for 20–30 seconds between patients should be considered the norm for dental surgery procedures, and longer flushing is suggested after weekends [22].

In the case of using storage tanks, they should be frequently washed and disinfected, filled with distilled sterile water at a temperature not exceeding 20°C.

Periodical, adequately frequent monitoring of the water quality, including bacteria count and detection of *Legionella* species and *Pseudomonas aeruginosa* is necessary; this concern both the water supplied to handpieces and the water used to flush a cuspidor and to rinse patients' mouth. Exner *et al.* [7] suggested guidelines for hospitals concerning the acceptable number of *Legionella* species bacteria in water samples. The number of *Legionella* cells in a water sample $\leq 10^1$/100 ml, is not a reason to limit the use, except in high-risk departments, and monitoring should be performed annually; the number of cells, 10^1–10^3/100 ml of water, indicates that it should not be used in medical-technical appliances, and monitoring should be performed twice a year. The major limitation to the use of the water applies when the number of *Legionella* cells in 100 ml of water is more than 10^3.

The water in a DUWL should be monitored, and also a periodical, appropriately frequent disinfection carried out with chemical disinfectants and other methods eliminating biofilm (flushing, using filters, drying, using biocides UV-irradiation, etc) should be applied. It is known that passing the water at 70–80°C kills *Legionella* rods.

The appropriate care for the sterility of the dental handpieces and the application of personal protection measures is necessary.

CONCLUSIONS

To sum up, the higher concentration of anti-*Legionella* antibodies repeatedly found in dental personnel in comparison with general population is a further demonstration that water in dental unit waterlines is potential source of infection [8, 9, 18]. Nevertheless, an actual, work-related risk to dentists' health from a potential long-term exposure to *Legionella* seems to be rather low and requires further examination.

REFERENCES

1. ADA Council on Scientific Affairs. Dental unit waterlines: approaching the year 2000. *J Am Dent Assoc* 1999, **130**, 1653-1664.

2. Atlas RM, Williams JF, Huntington MK: *Legionella* contamination of dental-unit waters. *Appl Environ Microbiol* 1995, **61**, 1208-1213.

3. Barbeau J, Buhler T: Biofilm augment the number free-living amoebe in dental unit waterlines. *Res Microbiol* 2001, **152**, 753-760.

4. Berendt RF: Survival of *Legionella pneumophila* in aerosols: effect of relative humidity. *J Infect Dis* 1980, **141**, 689.

5. Bednarsh HS, Eklund KJ, Mills S: Check your dental unit water IQ. *Dent Assist* 1996, **65**, 9-10.

6. Borneff M: Hygiene problems in dental practice with special attention to dental units. *Zentralbl Bacteriol Microbiol Hyg [B]* 1986, **183**, 130-152 (in German).

7. Exner M, Tuschewitzki GJ, Langer B, Werncke F, Pleischl S: Vorkommen und Bewertung von Legionellen in Krankenhäusen und anderen Grossgebäuden. *Forum Städte-Hygiene* 1992, **43**, 130-140.

8. Fotos PG, Westfall HN, Snyder IS, Miller RW, Mutchler BM: Prevalence of *Legionella*-specific IgG and IgM antibody in dental clinic population. *J Dent Res* 1985, **64**, 1382-1385.

9. Lück PC, Bender L, Ott M, Helbig JH, Hacker J: Analysis of *Legionella pneumophila* serogroup 6 strains isolated from a hospital warm water supply over a three-year period using genomic long-range mapping techniques and monoclonal antibodies. *Appl Environ Microbiol* 1991, **57**, 3226-3231.

10. Lück PC, Lau B, Seidel S, Postl U: Legionellen in Dentalenheiten - ein hygienisches Risiko? *Dtsch Zahn Mund Kieferheilkd* 1992, **80**, 341-346.

11. Mainwald M, Helbig JH, Lück PC: Laboratory methods for the diagnosis of *Legionella* infections. *J Microbiol Methods* 1998, **33**, 59-79.

12. Matuszewska R, Krogulska B: Występowanie bakterii z rodzaju *Legionella* w wodzie z turbin dentystycznych. *Mag Stomat* 2000, **10**, 10-13.

13. Oppenheim BA, Sefton AM, Gill ON: Widespread of *Legionella pneumophila* contamination of dental stations in dental school without apparent human infection. *Epidemiol Infect* 1987, **99**, 159-166.

14. Molinari JA: Waterborne microorganisms: questions about health-care problems and solutions - part 2. *Compend Contin Educ Dent* 1995, **16**, 130-132.

15. Pancer K, Stypułkowska-Misiurewicz H, Krogulska B, Matuszewska R, Mészáros J: Legioneloza w szpitalach. *Blok Oper* 2001, **4**, 15-18.

16. Pankhurst CL, Coulter W, Philpott-Howard JJ, Harrison T, Warburton F, Platt S, Surman S, Challacombe S: Prevalence of *Legionella* waterline contamination and *Legionella pneumophila* antibodies in general dental practitioners in London and rural Northern Ireland. *Br Dent J* 2003, **195**, 591-594, discussion 581.

17. Pankhurst CL, Philpott-Howard JN, Hewitt JH, Casewell MW: The efficacy of chlorination and filtration in the control and eradication of *Legionella* from dental chair water systems. *J Hosp Infect* 1990, 16, 9-18.

18. Reinthaler FF, Mascher F, Stünzner D: Serological examination for antibodies against *Legionella* species in dental personnel. *J Dent Res* 1988, **6**, 942-943.

19. Stojek NM, Dutkiewicz J: *Legionella* in sprinkling water as a potential occupational risk factor for gardeners. *Ann Agric Environ Med* 2002, **9**, 261-264.

20. Szymańska J: Control methods of the microbial water quality in dental unit waterlines. *Ann Agric Environ Med* 2003, **10**, 1-4.

21. Szymańska J: Biofilm and dental unit waterlines. *Ann Agric Environ Med* 2003, **10**, 151-157.

22. Williams JF, Johnston AM, Johnson B, Huntington MK, Mackenzie CD: Microbial contamination of dental unit waterlines: prevalence, intensity, and microbial characteristics. *J Am Dent Assoc* 1993, **124**, 59-65.

23. Williams JF, Molinari JA, Andrews N: Microbial contamination of dental unit waterlines: Origins and characteristics. *Compend Contin Educ Dent* 1996, **17**, 538-540, 542 passim; quiz 558.

24. Wirthlin RM, Marshall GW Jr, Rowland RW: Formation and decontamination of biofilms in dental unit waterlines. *J Periodontol* 2003, **74**, 1595-1609.