RISK OF EXPOSURE TO LEGIONELLA IN DENTAL PRACTICE

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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.

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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 cardiovascular 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
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 secretions, 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 microorganisms 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 pneumoniæ, 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 × 10³–2 × 10⁵. 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. Detachment 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, inline, 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 periodic or continuous application of chemical germicides; 4. use of microfiltration to trap microbes before they reach the dental client [5].

To preserve the acceptable 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 ≥ 10^3/100 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**


