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Brief report

Microbial control of dental unit water: Feedback on different disinfection methods experience

Julie Lizon PharmD^{a,*}, Arnaud Florentin MD, MSc^{a,b}, Jean-Marc Martrette DDS, PhD^{c,d}, Alexandre Rivier PharmD^e, Celine Clement DDS, PhD^c, Christian Rabaud MD, PhD^f

^a Equipe Opérationnelle d'Hygiène Hospitalière - CHRU Nancy, Nancy, France

^b EA 7298 INGRES, Université de Lorraine, Vandoeuvre-Les-Nancy, France

^c Service Odontologie - Centre Hospitalier Régional Universitaire (CHRU) Nancy, Nancy, France

^d EA 3450 DevAH, Université de Lorraine, Vandoeuvre-Les-Nancy, France

^e Laboratoire de Biologie Environnementale - CHRU Nancy, Nancy, France

^f Service des Maladies Infectieuses et Tropicales - CHRU Nancy, Nancy, France

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A water quality study of dental units showed biofilm and opportunistic microorganisms. We report the steps that ultimately allowed us to obtain water quality as water for standard care with no pathogens throughout all dental units. In summary, treatment with continuous disinfection associated with use of sterile water allowed us to restore the water quality at the output of dental care units while ensuring the safety of care.

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Water is essential in dental care units. Water allows cooling of rotating equipment causing local heating or rinsing of mouth. The water flows from tap water or reservoir through the internal circuit of the dental care units, particularly in flexible multichannel probes, before being taken to instruments. Water contamination of dental care units is especially caused by biofilm formation within the circuits. The complexity of the dental care units promotes biofilm formation.¹ Regarding the literature, 2 immunocompromised patients have contracted a dental abscess caused by *Pseudomonas aeruginosa* after exposure to a dental care unit's water contaminated by the same microorganism.² The death of an 81-year-old patient who contracted legionellosis after a proven contamination of the dental care unit's circuits was reported in Italy.³ In our hospital, a first microbiologic surveillance of armchair water highlighted the presence of aerobic mesophilic flora at 22°C and 36°C (≥ 300 colony forming units [CFU]/mL) and the presence of *Legionella* sp. In response, a working group was created with the mission to coordinate the action to control water quality at the output of dental care units. The objective of the working group was

to determine the best way to maintain acceptable microbial contamination of dental armchairs.

MATERIAL AND METHODS

Tested protocols

According to the literature, working group determined water quality levels.⁴ The chosen criteria are presented in Table 1. At first, all dental armchairs (43 armchairs) were disconnected from the drinking water network and supplied with sterile water, and microvalves and microtubes were changed. Three methods were tested. The first and second methods used discontinuous disinfection made from Dialox (Schülke, Fairfield, NJ) (1 time disinfection and 3 weekly repeated disinfections, respectively). The third method used discontinuous and continuous disinfections made from a mix of Bilpron-Alpron (Alpro, St. Goergen, Germany). Dialox is mainly made up of peracetic acid, hydrogen peroxide, and acetic acid. Dialox was introduced in vials at 10% concentration and then was rinsed after 30 minutes of contact time. Alpron is mainly made up of ethylenediaminetetraacetic acid, polyaminopropyl biguanide, and sodium tosylchloramide. The compounds are without hazards for human, even if swallowed, or for valves-microtubes. Because of the presence of phenylalanine, the use of Alpron is forbidden for

* Address correspondence to Julie Lizon, PharmD, Equipe Opérationnelle d'Hygiène Hospitalière - CHRU Nancy, Nancy, France.

E-mail address: julie.lizon@univ-lorraine.fr (J. Lizon).

Conflicts of interest: None to report.

Table 1
Interpreting the results of dental armchair microbial controls

Results		Interpretation
Criteria to be followed	Aerobic mesophilic flora at 36°C ≤10 CFU/mL and Aerobic mesophilic flora at 22°C ≤100 CFU/mL and Absence of pathogens (<i>Legionella pneumophila</i> , <i>Pseudomonas aeruginosa</i> , ...) Aerobic mesophilic flora at 36°C between 10 and 100 CFU/mL or Aerobic mesophilic flora at 22°C between 100 and 300 CFU/mL and Absence of pathogens (<i>L pneumophila</i> , <i>P aeruginosa</i> , ...) Aerobic mesophilic flora at 36°C >100 CFU/mL or Aerobic mesophilic flora at 22°C >300 CFU/mL or Presence of pathogens (<i>L pneumophila</i> , <i>P aeruginosa</i> , ...)	Target level Continued use Compliant Alert level Continued use with monitoring or preventive actions Compliant Action level Prohibition of use and corrective actions Noncompliant

CFU, colony forming units.

Table 2
Results of water samples on dental armchair after each treatment method

Treatment method	Global results for each surveillance day (noncompliance rate (no. of armchairs tested))												
	Day -1	Day 1	Day 8	Day 15	Day 22	Day 30	Day 45	Day 60	Month 2	Month 3	Month 6	Month 12	Month 18
First method	N.A.	9 (43)	63 (43)	79 (43)	89 (43)	89 (43)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Second method	89 (43)	5 (22)	13 (8)	35 (23)	0 (8)	50 (44)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Third method	50 (6)	0 (6)	0 (6)	0 (6)		0 (6)	0 (6)	0 (6)	N.A.	N.A.	N.A.	N.A.	N.A.
Surveillance after third method	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	0 (29)	0 (14)	0 (22)	0 (21)	0 (22)

NOTE. Values are n (%). Days represent the number of days after disinfection, and months represent the months of surveillance with use of a continuous disinfection. D-1, day before the disinfection; N.A., not applicable.

patients with phenylketonuria. Alpron was introduced daily in vials at 1% concentration. Bilpron is a disinfectant used during periods of inactivity to stabilize the development of the biofilm in flexible multichannel probes. Therefore, it was used pure in bottles and circuits in any period of inactivity >24 hours.

Microbiologic control

Microbiologic water controls were carried out by the laboratory of environmental biology. Samples were taken simultaneously on all instruments and directly put in vials containing inhibitors of various disinfectants. Analyses were performed according to standards: aerobic mesophilic flora at 22°C and 36°C (ISO 6222⁵), total coliforms (ISO 9308-1⁶), *Legionella* sp (ISO 11731-2,⁷ 100 mL), and *P aeruginosa* (ISO 16266⁸).

RESULTS

All results are presented in Table 2. After the first method results, the noncompliance rate increased rapidly from 9% at day 1 to 89% at day 28. At the end of the first method, 8 dental armchairs presented critical noncompliance with presence of *L pneumophila* serogroup 1 (7 armchairs) and *P aeruginosa* (1 armchair). Others noncompliant armchairs presented high counts of aerobic mesophilic flora (≥300 CFU/mL at 22°C and 36°C).

After the second method, the noncompliance rate increased progressively from 5% to 50% at day 30. This represented 22 dental armchairs with a noncompliance. All noncompliances were caused by aerobic mesophilic flora at 22°C or 36°C, who sign growth of a biofilm.

A pool of 6 dental armchairs were chosen to test the third method. Efficiency of the continuous treatment of water was consistent over the whole period of monitoring. At day 60, microbiologic contamination was very low (average of 1 CFU/mL [±4] and 2 [±4] for aerobic mesophilic flora at 22°C and 36°C, respectively). No control revealed pathogenic microorganisms (*Legionella*,

coliforms, *P aeruginosa*). Therefore, the method of continuous disinfection has been expanded to the whole dental park. All dental armchairs remained compliant for several months.

DISCUSSION

The continuous disinfection process associated with sterile water use has normalized the water quality of our dental care units. In the absence of European recommendations, water quality must meet the criteria provided by the American Dental Association in 2004, corresponding to a concentration of aerobic mesophilic flora <200 CFU/mL.⁹ Our results are respectful of American Dental Association recommendations.

The first and second methods highlighted the infectiveness of 1-time and repetitive Dialox disinfection. After 1-time disinfection, 8 armchairs were detected with critical noncompliance caused by the presence of pathogenic microorganisms (*P aeruginosa* or presence of *L pneumophila*). The prevalence of *L pneumophila* (18.5%) was consistent with the literature (20%-86.7%).¹⁰

Several hypotheses could explain the reappearance of aerobic mesophilic flora at 22°C or 36°C. The most probable hypothesis is the persistence of biofilm initially present because of drinking water network use and water stagnation for several years (no purge or setting off water). Various disinfectants (hydrogen peroxide, tetra-sodium ethylenediaminetetraacetic acid, and sodium hypochlorite) have proven effectiveness in reducing the microbial load of biofilm.^{11,12} However, total elimination of biofilm may take several months despite repetitive disinfection.¹² During our study, compliance and adherence to procedures were not complete. Also, tap water (instead of sterile water) was used in several dental armchairs. This is the most probable cause of failure to properly disinfect dental care units' waterlines reported in the literature.¹³ Similar to our study, some studies showed that in the long run, use of biofilm removal solutions is necessary to eliminate the biofilm formed over time.¹⁴

CONCLUSION

Infection risk related to the use of the water during dental care is a major concern for health professionals, more specifically dentists and hygienists. Our study highlighted that only continuous disinfection associated with sterile water allowed for sustainably normalization of the microbiologic quality of water. The interest of bacteriologically controlled water (filtration) use instead of sterile water must be tested to facilitate the handling and storage of the water and reduce the costs associated with the use of this water.

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