Journal of Hospital Infection 103 (2019) e115–e117

Available online at www.sciencedirect.com

Journal of Hospital Infection

journal homepage: www.elsevier.com/locate/jhin

Short report

Microbial water quality management of dental unit water lines at a dental school

C.M.C. Volgenant [a,b,*], I.F. Persoon [a]

[a] Department of Preventive Dentistry, Academic Centre for Dentistry of Amsterdam, University of Amsterdam and Vrije Universiteit Amsterdam, Amsterdam, the Netherlands
[b] Department of Oral Kinesiology, Academic Centre for Dentistry of Amsterdam, University of Amsterdam and Vrije Universiteit Amsterdam, Amsterdam, the Netherlands

ARTICLE INFO

Article history:
Received 7 September 2018
Accepted 1 November 2018
Available online 10 November 2018

Keywords:
Dental unit water lines
Dental chair unit waterlines
Biofilm
Dental infection control
Water quality

SUMMARY

Contaminated dental unit water lines (DUWLs) are a possible source for spreading micro-organisms in dental practices. This study reports the microbial load of the water from DUWLs of a large dental school over time. The water quality of 231 dental chairs was tested three times over 1.5 years; 175 DUWLs at student clinics and 56 DUWLs at staff clinics. DUWLs at the staff clinics met the Dutch requirement of 100 colony-forming units/mL. An increasing number of DUWLs at the student clinics complied with this requirement, indicating that the local protocols are adequate but that compliance can be improved.

Introduction

When treating patients using a dental unit, the use of water is essential to cool the equipment during treatment. However, water from dental unit water lines (DUWLs) is a potential source of pathogenic micro-organisms in dental practices. This water can become contaminated from two sources: aspiration of patient secretions through handpieces into the water lines, and micro-organisms in the incoming water (the main source of contamination) [1,2]. Patients and oral care providers are exposed to this water directly (by splatters or drinking) and indirectly (by aerosols produced by dental hand pieces) [3].

Very soon after the first use of a dental unit, biofilms will form on the inside of the DUWL. This biofilm is the most important source of contamination of the water from the DUWL. In cases where the microbial content exceeds the microbiological quality requirements, this can result in disease in susceptible hosts. Nevertheless, the overall healthcare risks due to DUWL water quality are likely to be minimal [4].

In the Netherlands, the guideline concerning infection control was renewed in 2016, to require testing of microbial water quality from all dental chairs twice per year. Although this frequency of testing does not exclude outliers in between

* Corresponding author. Address: Academic Centre for Dentistry Amsterdam, Gustav Mahlerlaan 3004, 1081 LA Amsterdam, the Netherlands.
E-mail address: c.volgenant@acta.nl (C.M.C. Volgenant).

https://doi.org/10.1016/j.jhin.2018.11.002
0195-6701/

those two moments, it provides more insight into the water from DUWLs. The aim of this study was to evaluate the quantitative contamination of water from DUWLs of dental units in a dental school.

Methods

This study was conducted at the Academic Centre for Dentistry Amsterdam (ACTA). The dental school has 231 identical dental units (A-dec 300 series, Newberg, OR, USA), of which 175 units are used in student clinics (both dentistry and oral hygiene). The other 56 units are used in seven staff clinics [Departments of Cariology and Endodontology ($N = 7$), Implantology ($N = 8$), Material Sciences ($N = 3$), Oral Kinesiology ($N = 4$), Orthodontics ($N = 17$), Pedodontology ($N = 3$) and Periodontology ($N = 14$)]. All units were functioning with a separate bottle for the water supply (closed water system). The quality requirements for water from DUWLs in the Netherlands are described in a renewed national guideline [5]. The microbiological requirements of water from a DUWL are equal to the Dutch drinking water requirements [heterotrophic plate count levels <100 colony-forming units (cfu)/mL at 22 °C], and the water quality from all dental chairs must be determined at least twice per year.

Current protocols

All protocols concerning infection control are available to students and staff via the intranet of ACTA. The protocol for cleaning and disinfection of DUWLs consists of continuous actions to limit efflux of micro-organisms out of DUWLs, and regular shock treatment aiming to remove the internal biofilm. When using the protocols and products as prescribed by the manufacturer, it proved to be impossible to achieve the water quality required for DUWLs at ACTA. Therefore, different products were used after consultation with the manufacturer.

The continuous actions consist of the use of legionella-filtered (UFKS Legionella filter, PB International BV, Zelhem, the Netherlands) tap water from a single supply system originating from the municipal mains supply, and a manually added hydrogen peroxide solution (KaVo Oxygenal 6, KaVo Dental GmbH, Warthausen, Germany) resulting in a 0.02% H_2O_2 solution used during dental treatments. Also, all DUWLs of a dental chair are flushed for 30 s (per line) before starting any patient treatment. At the end of the working day, all DUWLs are purged with air.

Once every week (staff clinics) and once every two weeks (student clinics), a biofilm removal treatment is performed using a shock dose of a chlorine solution [staff clinics: a chlorine tablet is dissolved in water to a 1000 ppm chlorine solution (Bakta, Ecolab Europe BV, Oegstgeest, the Netherlands); student clinics: using a 500 ppm Anoxyl (SKW Biosystems B.V., Enschede, the Netherlands)]. First, the water bottle from the dental chair is rinsed with a chlorine solution, and all DUWLs of the dental chairs are exposed to a fresh chlorine solution for 5 min. Monitoring of compliance with these protocols is accomplished using a paper (staff clinics) or digital (student clinics) logbook. The digital logbook consists of a computer system with colour codes to indicate which protocol must be followed that day (standard protocol or shock treatment protocol). If the results revealed a DUWL that did not meet the requirements, it received shock treatments until the requirements were met. If a unit was out of use for several weeks or adherence to the protocols was severely violated, an additional shock treatment was performed with subsequent testing of water quality.

Table I
Presence of colony-forming units (cfu) per millilitre from the dental units

		N	Average cfu/mL (SD)	Range cfu/mL
Spring 2017	Staff	49	2.7 (8.7)	0–54
	Students[a]	165	140.9 (212.0)	0–968
Autumn 2017	Staff	56	2.6 (7.3)	0–38
	Students[b]	175	55.4 (93.0)	0–760
Spring 2018	Staff	56	4.5 (8.6)	0–36
	Students	175	27.0 (55.0)	0–382

SD, standard deviation.
[a] In Spring 2017, two units from the student clinics scored >1000 cfu/mL, which were not taken into account when calculating the depicted scores.
[b] In Autumn 2017, one unit from the student clinics scored >1000 cfu/mL, which was not taken into account when calculating the depicted scores.

Sample collection

Due to a change in guidance, six-monthly samples were taken from all dental units in use, starting in Spring 2017. Water samples were taken before starting the first patient treatments in the morning from the dental chair. First, regular protocols were completed. After flushing a fresh solution containing 0.02% H_2O_2 through all DUWLs of the dental unit for 30 s (standard protocol), a 50-mL water sample was taken using an air/water syringe. Samples were not collected on days when shock treatment was performed. Therefore, no neutralizer was added, as a pilot experiment using sodium thiosulphate showed no effect of residual disinfectant on the results (data not shown). The sample was stored on ice and 500 μL was cultured on plate count agar (Oxoid, Basingstoke, UK). Plate count agars were incubated aerobically at 22 ± 2°C for seven days, as specified by the Dutch guideline for infection control in dentistry.

Results

In Spring 2017, 214 units were sampled. The missing samples were due to construction work (seven units at the orthodontic staff clinic, Table I) and due to early closure of one student clinic (10 units at the oral hygiene education clinic, Table I). All 231 dental units were tested in Autumn 2017. The third round of water quality testing was performed in Spring 2018.

In all three test periods, no dental chairs with >100 cfu/mL heterotrophic aerobic bacteria in the DUWL water were found in the staff clinics (Figure 1). In Spring 2017, 59 DUWLs (36%) of the dental units in the student clinics exceeded the norm. As the results from the student clinics differed remarkably from the results from the staff clinics, the frequency of shock treatment at the student clinics was increased to once weekly from Summer 2017. The students and teaching staff received instructions concerning this change in protocol. All dental units that scored above the norm received an additional shock treatment before they were retested and eventually met the requirements.

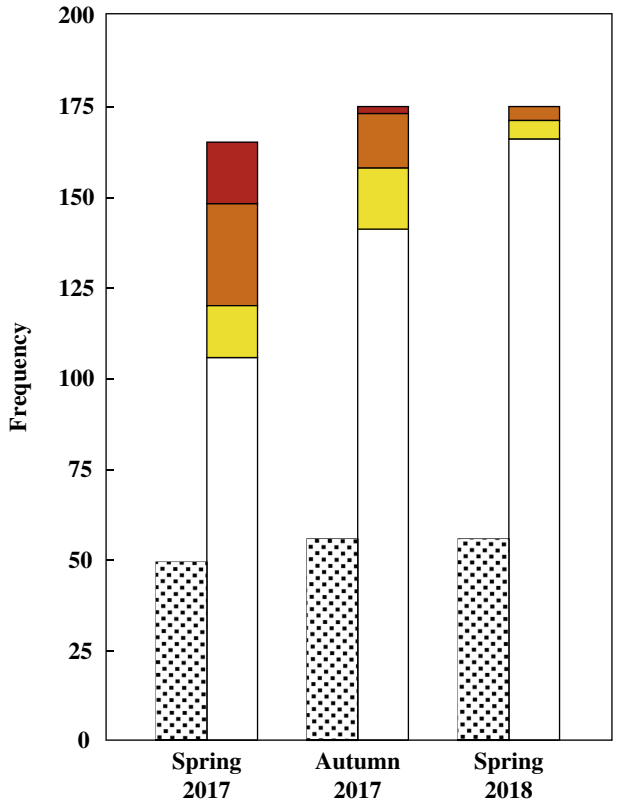

Figure 1. Summary of the total colony-forming units per millilitre (cfu/mL) at three timepoints for the dental unit water lines (DUWLs) at the dental school. The stippled bars depict the staff clinics (no DUWLs with >100 cfu/mL) and the open bars depict the student clinics. White bars, 0–99 cfu/mL; yellow bars, 100–199 cfu/mL; orange bars, 200–499 cfu/mL; red bars, ≥500 cfu/mL.

In Autumn 2017, a clear effect of this intervention was measured; 34 of the DUWLs (19%) in the student clinics scored >100 cfu/mL (Figure 1). Again, additional instructions were given to students and teaching staff, and additional controls on the execution of protocols at ACTA were performed. In Spring 2018, only nine DUWLs (5%) in the student clinics exceeded the requirements (Figure 1).

Discussion

The microbial water quality of all DUWLs from the staff clinics at ACTA met the Dutch requirements at all three test moments. Unfortunately, the water quality of the DUWL output water at the student clinics has not yet reached 100%. The implementation of two interventions, namely an increase in the frequency of shock treatment and giving instructions to both students and teachers, only led to partial improvement.

Several factors can influence DUWL water quality [3]. In the current situation, lack of compliance with the protocols by students is the most likely explanation for failing the DUWL water quality requirements. However, due to limited personnel and the size of the dental school, a 100% control system by infection control personnel is not possible. Therefore, the teachers in the student clinics were actively engaged to guide the students in their fulfilment of the daily and weekly protocol steps.

A previous survey described the difficulty that students have complying with infection control guidelines [6]. Unfortunately, compliance with DUWL protocols was not discussed in this study from Saudi Arabia. A European survey on the attitudes of general dental practitioners in Europe regarding the microbial risk associated with DUWLs found that the majority of dentists did not clean, disinfect or determine the microbial load of DUWLs [7]. A random sample of 116 DUWLs in the Netherlands in 2013 reported that only 34% of the DUWLs scored <200 cfu/mL, which was the requirement at that time [8]. The requirement of the new guideline to determine the DUWL microbial load twice per year may aid dentists to develop and execute protocols for cleaning and disinfecting their DUWLs. Random sampling of DUWLs insufficiently reflects which dental units pose a problem, as different dental units did not meet the requirements in each sampling period. In the future, the authors will focus on intensifying the instructions and checks in the student clinics to ensure that, ultimately, all DUWLs will always meet the requirements. Simultaneously, the authors will research products and protocols that are less labour intensive.

Acknowledgements

The authors wish to thank C.J. Bosch-Tijhof, F. Boer and S. Verwoerd for their assistance with obtaining and processing the samples, and Dr J.J. de Soet and Ing M.A. Hoogenkamp for their assistance preparing the manuscript.

Conflict of interest statement
None declared.

Funding sources
None.

References

[1] Ji XY, Fei CN, Zhang Y, Zhang W, Liu J, Dong J. Evaluation of bacterial contamination of dental unit waterlines and use of a newly designed measurement device to assess retraction of a dental chair unit. Int Dent J 2016;66:208–14.
[2] Bagga B, Murphy RA, Anderson AW, Punwani I. Contamination of dental unit cooling water with oral microorganisms and its prevention. J Am Dent Assoc 1984;109:712–6.
[3] Coleman DC, O'Donnell MJ, Shore AC, Russell RJ. Biofilm problems in dental unit water systems and its practical control. J Appl Microbiol 2009;106:1424–37.
[4] Petti S, Vitali M. Occupational risk for legionella infection among dental healthcare workers: meta-analysis in occupational epidemiology. BMJ Open 2017;7:e015374.
[5] Koninklijke Nederlandse Maatschappij tot bevordering der Tandheelkunde. Infectiepreventie voor mondzorgpraktijken. Utrecht: KNMT; 2016.
[6] Ahmad IA, Rehan EA, Pani SC. Compliance of Saudi dental students with infection control guidelines. Int Dent J 2013;63:196–201.
[7] Kamma JJ, Bradshaw DJ, Fulford MR, Marsh PD, Frandsen E, Ostergaard E, et al. Attitudes of general dental practitioners in Europe to the microbial risk associated with dental unit water systems. Int Dent J 2006;56:187–95.
[8] Exterkate RAM, Crielaard W. Waterkwaliteit units blijven controleren. Nederlands Tandartsenblad 2013;68:32–4.