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Research Article

Purge- and intensive-purge decontamination of dental units contaminated with biofilm

Sanierung von mit Biofilm kontaminierten Dentaleinheiten durch Purgen und Intensivpurgen

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Abstract

Introduction: During hygienic-microbiological monitoring of the water quality in dental units, the total bacterial colony count was found to exceed the limits for drinking water quality; in addition, mold contamination was detected. The presumed cause was irregular decontamination of the units through purging and intensive decontamination.
Methods: To decontaminate the units, the manufacturer's recommended program for cleaning and intensive decontamination was intensified by shortened intervals over a 2-week period. For Sirona units, instead of once a day, the automatic purge program was run every morning and evening for 20 min each time, and instead of once a month, intensive decontamination was performed every two weeks; this schedule has been maintained since then. For KaVo units, cleaning with the hydroclean function was carried out for 2.5 min every morning and evening. The automatic intensive decontamination was run daily instead of weekly. A maintenance log book was introduced, in which decontamination/cleaning was confirmed by the operator's signature.
Results: Within 5 weeks, all previously contaminated units were decontaminated.
Discussion: By shortening the cleaning and intensive decontamination intervals in a 2-week period with subsequent control that the recommended maintenance intervals were kept, it was possible to guarantee drinking-water quality in the dental units of both manufacturers.

Keywords: cooling-water contamination dental unit, decontamination, purging, intensive, decontamination, maintenance log book

Zusammenfassung

Einleitung: Im Rahmen der hygienisch-mikrobiologischen Überwachung der Wasserqualität von Dentaleinheiten wurden eine Überschreitung der für Trinkwasser zulässigen Gesamtkoloniezahl und zusätzlich eine Schimmelpilzkontamination auffällig. Als Ursache wurde die unregelmäßige Dekontamination der Einheiten durch Purgen und Intensivdekontamination vermutet.
Methode: Zur Sanierung der Einheiten wurde für einen Zeitraum von 2 Wochen das vom Hersteller empfohlene Programm zur Reinigung und Intensivdekontamination durch verkürzte Intervalle intensiviert. Für Sirona-Einheiten wurde das automatische Purge-Programm statt einmal täglich morgens und abends für die Dauer von 20 min eingeschaltet und die Intensivdekontamination wurde anstatt monatlich im Abstand von 2 Wochen durchgeführt und seitdem so beibehalten. Für KaVo-Einheiten erfolgte morgens und abends die Reinigung mittels Hydrocleanfunktion für die Dauer von 2,5 min. Die automatische Intensivdekontamination wurde anstatt wöchentlich täglich durchgeführt. Zur Kontrolle wurde ein Wartungsbuch eingeführt, in dem die Durchführung der Maßnahmen durch Unterschrift bestätigt wird.

Ergebnisse: Innerhalb von 5 Wochen waren alle zuvor kontaminierten Einheiten saniert.
Diskussion: Durch Verkürzung der Intervalle zur Reinigung und Intensivdekontamination in einem Zeitraum von 2 Wochen mit nachfolgender Gewährleistung der Einhaltung der empfohlenen Wartungsintervalle war es möglich, in den Dentaleinheiten beider Hersteller Trinkwasserqualität zu gewährleisten.

Schlüsselwörter: Kühlwasserkontamination, Dentaleinheit, Sanierung, Purgen, Intensivdekontamination, Wartungsbuch

Introduction

As part of the routine hygienic-microbiological monitoring of dental units which had been in operation for one year after moving into a new building, a total bacterial colony count which exceeded the limit for drinking water quality (100 cfu/ml) was discovered for the first time. Molds were also detected, which is a sign of biofilm formation. As the root cause analysis showed that the intervals for daily purging and the recommended, less frequent intensive decontamination had not been kept to, the intent of this work was to determine whether, after initial intensification of cleaning and decontamination followed by regular maintenance control as documented in a maintenance log book, it was possible to guarantee drinking water quality in every dental unit.

Method

Sampling

Samples were taken from the turbine tips of 12 KaVo (1058 Primus) dental units and 23 Sirona dental units of type C5+. 0.5 ml of 0.2% sodium thiosulfate solution was put into sterile, pre-cooled sampling vessels in order to neutralize the doses of hydrogen peroxide which are automatically added to the dental units while treatment is performed. The aseptically taken samples were immediately cooled with ice packs, brought to the laboratory in coolers, and microbiologically plated within 2 hours.
Before sampling, the water from the turbine tip was let run for 3 to 5 min until the water temperature remained constant for 1 min. The turbine tip was then cleaned and disinfected with 70% ethanol. Samples were subsequently taken by investigators wearing disposable gloves. One liter each was used to identify *Legionella* spp and molds, and 350 ml each was used to identify coliform bacteria, *Escherischia coli*, *Pseudomonas aeruginosa*, fecal enterococci, and total colony count at incubation temperatures of 22°C and 36°C. The sampling bottles for *Legionella* diagnostics were not cooled.

Diagnostics

The total colony count was determined using the Koch inoculation plate procedure according to DIN EN ISO 6222 [1]. Counting was done at 6 to 8X magnification using loupes. *E. coli* and coliform bacteria were detected following DIN EN ISO 9308-1 [2]. In detecting *E. coli* and coliform bacteria, the standard distinguishes between the standard test (reference method) and an optional quick test. This examination was conducted in accordance with the standard test. Testing for fecal enterococci and *P. aeruginosa* also conformed to the DIN standard [3], [4]. *Legionella* spp were detected in accordance with the recommendation of the German Federal Environmental Agency [5]. Although the federal drinking water directive does not provide for mold detection, this study tested for mold contamination because it gives strong indication for biofilm formation.
To detect molds, the water filters (pore size: 0.45 µm) were placed on 4% Sabouraud Glucose Agar (Oxoid Deutschland GmbH, Wesel) and examined after incubation for 3 d at 37°C followed by 4 d at 22 °C. Mold cultures were microscopically identified at 400X magnification after staining with Lactophenol-Cotton Blue (Merck, Darmstadt, Germany).
In 4 follow-up examinations after 28, 21 (mornings and evenings) and 23 days, only those dental units were examined which had previously exhibited excessive total colony counts and/or mold contamination.

Decontamination

To decontaminate the units affected, purging was performed for 2 weeks in both types of units by flushing the unit for 20 min each morning and evening with the same H_2O_2 concentration that is automatically added to the unit during every treatment (0.02% for KaVo, 0.0141% for Sirona). Instead of monthly as recommended by the manufacturer, the automatic intensive decontamination program was run in the Sirona units at 2-week intervals. For the KaVo units, intensive decontamination was performed every day instead of at the manufacturer-recommended weekly intervals. The H_2O_2 concentration in the Sirona units was lower (0.02%) than in the KaVo units (0.25%).

Results

The results of the first examination showed clear differences in terms of water contamination in the KaVo and Sirona dental units. Of 12 KaVo units, three exhibited mold contamintaion and two exhibited an increased total

Table 1: Contamination (cfu/ml) of dental units in excess of drinking water limits

Dental unit	Initial value			1st Control		
	Bacteria		molds	Bacteria		molds
	22°C	36°C		22°C	36°C	
Sirona						
1	90	110	0.2	36	34	11.6
2	3,970	77	0	115	38	0
3	82	38	0.3	35	23	3.4
4	2,790	1,620	23.6	4	12	4.2
5	67	29	1.3	9	18	0.8
6	3,830	2,510	6.8	4	7	6
7	800	99	0	7	5	
8	55	33	1,000	11	9	2.4
9	54	850	15	369	6	6.2
10	72	11	0.7	2	18	0.5
11	43	168	5.2	4	7	24.2
12	62	101	19.4	6	7	13.2
13	29,800	475	0	3	9	0
14	279	297	0	17	9	0
15	1,280	656	100	296	26	28.3
16	51	34	100	35	18	6.2
17	1	3	0.1	20	27	230
18	750	13	0.2	104	17	6
KaVo						
19	110	1,130	0	16,920	5,280	8.8
20	20	2	0.7	9	17	13.5
21	16	4	0.5	12	19	29.8
22	31	125	23	244	113	11.2

colony count (Table 1). In the remaining units, the total colony count varied between 6 and 36 cfu/ml.

Of 23 Sirona units, the total colony count from 13 units clearly exceeded the allowable limit. In 14 units, mold contamination was evident, with a maximum of 1,000 cfu/ml detected. Neither *Legionella* spp nor *Pseudomonas* spp were detected in either the KaVo or Sirona units.

After the first follow-up examination of the KaVo units, a marked increase in mold contamination was observed (Table 1). In unit 19, the total colony count incubated at 22°C increased from 110 to 16,920 cfu/ml, and in unit 22 from 31 to 244. In 3 of the 4 units, mold contamination had increased (Table 1). At the second follow-up, all units met the requirements stipuated in the drinking-water directive.

After 2 weeks of intensive hygienic procedures, the first follow-up of the Sirona units showed improvement. Of the 18 units, only 4 still exhibited excessive total colony counts. The maximum was 369 cfu/ml (Table 1). The response of mold contamination varied. In 10 units, a reduction was evident, but in the other 8 units, an increase was observed. The highest count was found in unit 17, with 230 cfu/ml (Table 1). At the second follow-up, only unit 9 still failed to meet the requirements of the drinking water directive with a total colony count of 890 cfu/ml at 22°C incubation and 5,290 cfu/ml at 36°C. Mold contamination had dropped to 3.6 cfu/ml. The third follow-up showed that values had continued to drop (total colony count at 22°C 107 cfu/ml, and at 36°C 83 cfu/ml; mold contamination: 3.6 cfu/ml). At the fourth sampling on the evening of the same day as well as at the 5th sampling, all requirements of the drinking-water directive in terms of total colony count at both 22°C and 36°C incubation temperatures were met. Similarly, molds were no longer detectable.

Discussion

There are two likely reasons for the differences in contamination between Sirona and KaVo units. The interval recommended by KaVo for intensive decontamination is 7 d; Sirona recommends 28 d. In intensive decontamination, the decontamination solution of both types of unit is left in the unit's hoses over the weekend. Furthermore, the recommended final dilution of H_2O_2 for purging and intensive decontamination is lower in the Sirona than in the KaVo units due to different compounds used.

Because of the 2-week, twice-daily purging and the shortened intensive decontamination intervals in the Sirona units from 4 to 2 weeks and in the KaVo units from

weekly to daily (in the first week), it was possible to decontaminate the units of both manufacturers within 19 days; i.e., the biofilm was apparently eliminated. This permits the confirmation of findings that the compounds employed in decontamination are effective in practice, if properly applied [6], [7].

In addition, these results indicate that when the microbiological water quality of dental units is monitored, testing for mold contamination may be useful. Mold contamination can provide an earlier sign of biofilm formation than the total colony count (Table 1).

In order to prevent renewed biofilm formation, the SOP for the Sirona units now stipulates the following procedure: at the beginning and end of each working day, purge for 20 minutes and perform intensive decontamination every 2 weeks. For the KaVo dental units, automatic decontamination according to the operating instructions is switched on nightly. Intensive decontamination is performed every 7 d. During idle periods (e.g., semester holidays), the purge function is run mornings and evenings for 20 min each time. Intensive decontamination is conducted at the same interval as during regular use of the units.

For every treatment unit, a maintenance log book is kept in which these hygiene measures, i.e., purging and intensive decontamination, are entered with the date and time performed, and confirmed by the signature of the operator responsible.

Notes

Competing interests

The authors declare that they have no competing interests.

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