

Identification of Infectious Bacteria in Dental Units

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Abstract

Aim: The aim of this study was to determine the bacterial contamination of surfaces and water of dental units of Qazvin University of Medical Sciences. **Methods:** This cross-sectional descriptive study was conducted on the surgery and periodontal units at the Faculty of Dentistry, Qazvin University of Medical Sciences in 2017. Totally, 108 samples were collected from different parts of the dental units. Total *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Legionella pneumophila*, and *Escherichia coli* were counted before and after disinfection by deconex. **Results:** The results of this study showed that before and after disinfection, *S. aureus*, *P. aeruginosa*, and *Coliforms* were the most frequent bacteria in periodontal (100%, 100%, and 100%, respectively) and surgery wards (100%, 100%, and >83%, respectively). There was no significant relationship between pre and postdisinfection in terms of *S. aureus* and *P. aeruginosa* for other parts of the surgery and periodontics units ($p > 0.05$). Furthermore, the statistical results indicated that all parts of the surgery and periodontics surfaces were statically significant pre and postdisinfection in term of *Coliforms* ($p < 0.05$). **Conclusion:** It can be concluded that the rate of microbial pollution in water lines and surfaces of the dental units is high. Furthermore, since a significant number of bacteria were identified after disinfection, it indicates the improper use of disinfectants.

Keywords: Bacteria, contamination, dentistry, *Escherichia coli*, *Legionella pneumophila*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*

INTRODUCTION

Controlling the transmission of infection in the dental workplace is one of the special priorities in dental centers due to the constant contact with infected oral secretions and bloodstains of patients.^[1] Disinfection of contaminated surfaces and tools in medical settings is an ongoing challenge and an important aspect in preventing infection and ensuring patient safety. Infectious agents are transmitted through direct and indirect contact, swallowing, skin, or mucosal absorption.^[2] The surface of dental units is exposed to bacterial contamination due to blood, tissue, and saliva aerosols. Aerosols have transmission potential of various diseases thorough suspending in the air for many hours.^[3] Equipment and surfaces in a dental office or center are constantly exposed to suspended particles that are contaminated with patients' blood and saliva. Most infections of these aerosols are Gram-positive cocci of *Streptococcus viridans* and *Staphylococcus*.^[1] Furthermore, microbes can survive on surface in various periods of time unless removed by disinfection or sterilization.^[4]

The surfaces of dental units can also be contaminated with a variety of microorganisms and also can produce biofilm in

dental units' water systems.^[5] Biofilms comprise heterogeneous bacteria forming on the surface in touch with water. Biofilm matrix is more resistant than flotation bacteria in water to chemical disinfectants and antibiotics, so they can be a source of direct contamination.^[6]

Following the entry of microorganisms into the body, infection occurs which can lead to serious concern such as heart disease, mitral valve prolapse, and endocarditis.^[7]

Among the microorganisms identified in surfaces and waterlines of dental units, Gram-positive bacteria such as *beta-hemolytic Streptococcus pyogenes* Group A and *Staphylococcus aureus* and also Gram-negative bacteria such as *Pseudomonas*,

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Helicobacter pylori, *Legionella*, and *Coliforms* are more frequent.^[8,9] Various scientific evidence of cross-infection cases by human pathogenic bacteria such as *Escherichia coli*, *Pseudomonas aeruginosa* and death due to *Legionella* have been reported.^[10] One way to measure the health of the surfaces and waterlines of dental units is to count the bacteria through the colony counting. The number of bacteria in dental unit should be <200 colony forming units/ml, although if the Gram-negative bacteria or respiratory pathogens exist even in low numbers, they may also cause disease.^[10,11] Since no study has been done on microbial evaluation of dental units at Qazvin Dental faculty, this study was aimed to microbial evaluating in dental units waterlines and surface at before and after routine dental work.

MATERIALS AND METHODS

This cross-sectional study was carried out to investigate bacterial contamination arising from some of the most common bacteria including *S. aureus*, *P. aeruginosa*, *Legionella pneumophila*, *Coliforms*, and *E. coli* in surfaces and waterlines of the periodontics and surgery wards of Qazvin Dentistry Faculty in 2017. A number of 108 samples were collected from different parts of the dental unit surfaces (96 samples) including lamp handle, lamp ON and OFF power button, open and close bolt of unit water and water setting button, and the inlet and outlet water of dental units (12 samples). Sampling was carried out during the peak hours (preferably in the middle of the week) and in two stages (before and after the use of Deconex as a disinfectant). Sterile containers (containing 10 ml of sodium thiosulfate to neutralize disinfectants) were utilized to collecting inlet and outlet water.

The water samples were immediately filtered using a multipore nylon membrane filtration system (0.22–0.45 μm).^[12] For better isolation of the bacteria from the filter, the samples were shaken at medium speed for 30 min.^[13] Temperature and pH were measured using thermometer (ZEAL) and pH meter (HANNA, HI98100), respectively. Residual chlorine content measured by a colorimetric chemical test kit (HANNA, HI3831F).

Sample inoculation and culture

Coliforms were evaluated based on the multiple tube fermentation method (probabilistic, confirmatory, and complementary).

All the samples were cultured in blood agar culture (SIGMA) medium and buffered charcoal yeast extract, SIGMA, specific *Legionella* culture medium (SIGMA) containing antibiotics (polymyxin B, vancomycin, and cycloheximide) and incubated in the candle jar at 37°C to detect *Legionella*. Plates were examined after 3 days; in case of colony observation, gram staining and catalase, oxidase as well as sodium hippurate hydrolysis tests were used for definite diagnosis. Otherwise, due to the slow growth of the *Legionella*, incubation continued for 12 days.

To examine the samples for *S. aureus* contamination, mannitol salt agar was used, while to determine *P. aeruginosa*, cetrimide agar culture medium (SIGMA) was used. These media were also evaluated after 24 h of incubation at 37°C. To confirm the colonies suspicious of *S. aureus*, the catalase and coagulase tests were used, while oxidase and O/F medium tests were employed to confirm suspicious colonies of *P. aeruginosa*. Data were analyzed using *t*-tests on SPSS software (IBM SPSS Inc., Chicago, IL, version 23).

RESULTS

The average number of *S. aureus*, *P. aeruginosa*, *L. pneumophila*, *Coliforms*, and *E. coli* detected in the surgical and periodontics unit surfaces as well as the results of the statistical test are presented in Table 1. According to the results presented in Table 2, before disinfection, 100% of the samples were positive culture in the terms of *S. aureus*, *P. aeruginosa*, and *Coliform* while 100% of the samples were negative culture in the term of *L. pneumophila*. However, after disinfection, 48 (100%) of samples were positive in terms of *S. aureus* and *P. aeruginosa*.

Table 2 shows the percentage of positive samples and numbers of the studied bacteria before and after disinfection.

Before the disinfection, *S. aureus*, *P. aeruginosa*, and *Coliforms* were the most frequent in periodontal and surgery wards while *E. coli* and *L. pneumophila* were the least prevalent bacteria in surgery and periodontal.

The average number of *S. aureus*, *P. aeruginosa*, *L. pneumophila*, *Coliforms*, and *E. coli* measured in the waterlines of dental units are given in Table 3. As shown in this table, all samples collected from inlet and outlet water of the surgery and periodontal units were positive in terms of all the studied bacteria.

Table 4 also shows the temperature, pH, and residual chlorine content in water samples.

DISCUSSION

The present study demonstrated that bacterial contamination is the main factor contributing to contamination. According to the results of this study, all the samples collected from different surfaces of the surgery, and periodontics units were positive culture in terms of *S. aureus*, *P. aeruginosa*, and *Coliforms* before and after disinfection by deconex. It is noteworthy that *E. coli* was detected just on the lamp handle and water setting switch button in surgery units while was not found for other parts of the dental units. Furthermore, *L. pneumophila* was not observed before and after the disinfection on the studied surfaces.

The number of *S. aureus*, *P. aeruginosa*, and *E. coli* on the lamp handle before disinfection were found 148 ± 28.7 , 87.2 ± 41.1 , and 43.8 ± 28.7 , respectively, which were statistically significant with the detected bacteria after disinfection by deconex (15.3 ± 10.8 , 7.2 ± 7 , and 0, respectively). However, there was no significant relationship between pre and

postdisinfection in terms of *S. aureus* and *P. aeruginosa* for other parts of the surgery and periodontics units ($P > 0.05$). Furthermore, the statistical results indicated that all parts of the surgery and periodontics surfaces were statically significant pre and postdisinfection in term of *Coliforms* ($P < 0.05$).

In general, before and after disinfection, *S. aureus*, *P. aeruginosa*, and *Coliforms* were the most frequent bacteria in periodontal (100%, 100%, and 100%, respectively) and surgery wards (100%, 100%, and >83%, respectively). Furthermore, *E. coli* was the least prevalent bacteria in surgery (25%) and periodontal (31.2%)

Table 1: Average number of *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Legionella pneumophila*, *Coliforms*, and *Escherichia coli* detected at various surfaces of dental units in surgery and periodontics wards

	<i>Staphylococcus aureus</i>		<i>Pseudomonas aeruginosa</i>		<i>Escherichia coli</i>		<i>Legionella pneumophila</i>		<i>Coliform</i>	
	1	2	1	2	1	2	1	2	1	2
Unit lamp handle										40
Surgery	148±28.7	15.3±10.8	87.2±41.1	7.2±7	43.8±28.7	0	0	0	45.4±20.7	157.2±63.7
<i>P</i>		0.045		0.031		0.015		-		0.031
Periodontal	63.4±21.4	46.9±62.9	53.3±6	21.2±13.3	0	0	0	0	4.05±3.9	56.6±28.7
<i>P</i>		0.04		0.047		-		-		0.04
Lamp on/off power button										
Surgery	129.8±61.6	43.01±25.9	87.6±37.1	34±25.2	0	0	0	0	8.74±6.2	72.4±89.1
<i>P</i>		0.062		0.15		-		-		0.017
Periodontal	48.3±48.3	13.6±10.7	73.5±30.8	12.4±5.1	0	0	0	0	15.2±8.7	0
<i>P</i>		0.07		0.075		-		-		0.032
Open/close bolt of water										
Surgery	61.4±36.3	28.72±18.7	49.1±12	8.12±5.07	0	0	0	0	5.8±4.7	48.2±24.2
<i>P</i>		0.063		0.061		-		-		0.03
Periodontal	73±22.6	7.84±6.33	126.6±46.5	28.2±25.62	0	0	0	0	4.4±1.4	90.4±55.7
<i>P</i>		0.06		0.077		-		-		0.035
Water setting switch button										
Surgery	61.4±36.7	28.72±18.7	49.1±12	8.1±5	6.2±5.6	15.6±8.8	0	0	14.07±4.36	0
<i>P</i>		0.056		0.061		0.35		-		0.042
Periodontal	32.2±12.7	12.6±5.4	64.3±39.4	28.2±25.6	0	0	0	0	5.8±4.7	37.7±28.5
<i>P</i>		0.064		0.061		-		-		0.035

1-Number of bacteria before disinfecting with deconex (CFU/ml), 2-Number of bacteria after disinfecting with deconex (CFU/ml)

Table 2: The number and percentage of positive samples bacteria before and after disinfection

	<i>Staphylococcus aureus</i>	<i>Pseudomonas aeruginosa</i>	<i>Escherichia coli</i>	<i>Legionella pneumophila</i>	<i>Coliform</i>
Before disinfection (%)					
Surgery	48 (100)	48 (100)	12 (25)	0	48 (100)
Periodontal	48 (100)	48 (100)	0	0	48 (100)
After disinfection (%)					
Surgery	48 (100)	48 (100)	15 (31.2)	0	40 (83.3)
Periodontal	48 (100)	48 (100)	0	0	41 (85.41)

Table 3: Average number of *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Legionella pneumophila*, *Coliforms*, and *Escherichia coli* detected in the inlet and outlet waterlines

	<i>Coliform</i>	<i>Legionella pneumophila</i>	<i>Escherichia coli</i>	<i>Pseudomonas aeruginosa</i>	<i>Staphylococcus aureus</i>
Surgery					
Inlet water	15.96±14.7	0.76±0.54	7.6±7.35	128.42±54.69	134.2±77
Outlet water	32.32±16.08	0.46±0.08	5.6±5.36	121.02±51.14	24.84±7.84
<i>P</i>	0.062	0.27	0.217	0.317	0.29
Periodontal					
Inlet water	79.4±51.7	0.64±0.07	7.92±5.83	143.96±67.15	134.4±67.7
Outlet water	68.8±43.7	0.14±0.017	42.72±4.07	161.68±46.9	149.4±48.55
<i>P</i>	0.17	0.27	0.285	0.275	0.24

Table 4: Average values of temperature, pH, and residual chlorine content in periodontics and surgery wards

	Temperature (°C)	pH	Residual chlorine (mg/l)
Periodontics	23±3.2	7.8±0.18	0.1±0.02
Surgery	24.5±2.3	7.8±0.15	0.1±0.01

wards before and after using disinfection, respectively. However, *L. pneumophila* was not detected in none of the studied surfaces.

Staphylococci are not considered as the normal flora of skin and mouth. Therefore, *S. aureus* existing on different surfaces of dental units is a concern of the contact between staffs, hands, and different parts of the dental units. Valian *et al.* demonstrated that *S. aureus* is the greatest source of contamination in dental staffs, gowns before and after disinfection.^[14]

Environmental Protection Agency standard has established 0 mg/l of Coliform and *E. coli* and 0.5–0.8 mg/l residual chlorine in drinking water.^[15] According to the results presented in Table 4, the mean residual free chlorine in the collected water samples was less than the EPA standard. *Coliform* and *E. coli* presence in water can be attributed to human or animal wastewater contamination. Consistent with this result, Maghami *et al.* reported *E. coli* in dental unit waterlines and confirmed wastewater contamination in waterlines.^[16] Memarian *et al.* also detected *E. coli* in dental waterlines and they announced that contamination of water with wastewater as well as the existence of biofilms in the flow path could be the reason for being high *E. coli* in dental waterlines. The results of the noted study were in line with the present study.^[17]

The finding of the present study was accords with the result obtained by Esfahani *et al.* who investigated bacterial contamination of dental units before and after disinfection. They found that *Staphylococcus* was the most prevalent species (51.9%) in the surface of dental units.^[18]

Rautemaa *et al.* indicated that due to the contamination of the surfaces after dental work and despite various disinfection methods, there is no method that could free the environment from harmful bacteria.^[19]

Pseudomonas is one of the most common causes of hospital infections and can easily transmit mostly through the staffs, hands. The most common site of infection is the urinary tract, scars, blood, and bile ducts. Isolating *Pseudomonas* genus after disinfection indicates that the bacteria were transmitted from dental staff to the units.

Sharkhizan *et al.* surveyed the deconex effectiveness in disinfecting microorganism isolated from dentistry units. They reported that deconex was very effective disinfectants.^[20] It can be concluded from the findings of the present research that dental unit contamination is inevitable and that it is essential to disinfect different surface of dental units once a patient is treated and before another patient receives treatment. This approach can decrease infection transmission.

Hence, isolating the studied bacteria after disinfection can be caused by the presence of biofilms in the path of tubes and connections, as these paths create a good environment for biofilms due to the low flow of water and a high static period and also lack of residual free chlorine in the permissible standard range.

CONCLUSION

It can be concluded that the rate of microbial pollution in waterlines and surfaces of the dental units is high. Before and after the disinfection, *S. aureus*, *P. aeruginosa*, and *Coliforms* were the most frequent bacteria in periodontal and surgery wards.

Our findings showed that there was statistically significant difference between pre and postdisinfection in terms of *Coliforms*. Furthermore, there was no found significant relationship between pre and postdisinfection in terms of *S. aureus* and *P. aeruginosa* in surgery and periodontics units except for the lamp handle.

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Ethics Code

This study was approved by the Ethics Committee, Qazvin University of Medical Sciences (Code: IR. QUMS. RESEARCH. REC.1395.199 and IR. QUMS. RESEARCH. REC.1395.144).

Conflicts of interest

There are no conflicts of interest.

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