# Microbial Contamination Level of Water Supply System at the Faculty of Dentistry, USIM, Malaysia

## (Tahap Pelumusan Mikrob pada Sistem Bekalan Air di Fakulti Pergigian, USIM, Malaysia)

NORMALIZA AB. MALIK*, ROHAZILA MOHD HANAFIAH & WAN MOHAMAD NASIR WAN OTHMAN

ABSTRACT

*This study was to evaluate the microbial contamination level in direct water supply at the Polyclinic, Faculty of Dentistry, USIM, Malaysia. Water samples were collected randomly from water supplied via the cup filler outlet of 20 dental units and 20 side water taps at Level 16 and 17 of Polyclinic, Faculty of Dentistry, USIM. All the samples were placed and spread evenly on the surface of prepared agar media (the nutrient agar) using the spread technique. Each sample consists of 0.5 mL water. The microbial count was done using a magnifying glass and the total number of bacteria concentration was reported as colony forming unit in 1 mL of water (cfu/mL). In this study water from an aquarium was used as positive control with 220 cfu/mL, while the distilled water taken from the CSSD was used as negative control with no colony of microorganism. The study demonstrated that there were low contamination before the treatment that was beginning of the session in water supplied via the cup filler outlet and side water tap from the sink with 2 cfu/mL. However, two cup fillers water and one side water taps from Polyclinic level 17 showed a slightly higher bacterial colonies with 4 cfu/mL and 6 cfu/mL of microbes. At the end of the session, result showed that higher bacterial count from Polyclinic level 17 than Polyclinic level 16 with the highest reading of 40 cfu/mL. The findings were considered low and the water was safe for the dental procedures. The quality of water supplied at the Faculty of Dentistry, USIM was within the limits recommended by the American Dental Association, i.e. bacterial loads of not more than 200 cfu/mL for dental procedures.*

*Keywords: Dental unit water system; filter system; microbial contamination*

ABSTRAK

*Kajian ini telah dijalankan bagi menilai tahap pelumusan mikrob di dalam bekalan air di Poliklinik, Fakulti Pergigian, USIM. Sampel air telah diambil secara rawak daripada air yang dibekalkan untuk cawan pengisi di 20 unit pergigian dan 20 sampel lagi daripada sumber air paip di sinki di unit pergigian di tingkat 16 dan 17 Poliklinik, Fakulti Pergigian, USIM. Semua sampel telah diletakkan dan diratakan di atas permukaan media agar (agar nutrien) menggunakan teknik merebak. Setiap sampel terdiri daripada pencairan 0.5 mL. Kiraan mikrob telah dilakukan dengan menggunakan kanta pembesar dan jumlah bakteria mengikut kepekatan direkodkan sebagai unit membentuk koloni dalam 1 mL air (cfu/mL). Dalam kajian ini sampel air daripada akuarium telah digunakan sebagai kawalan positif dengan 220 cfu/mL, manakala sampel air suling yang diambil dari Unit Pensterilan digunakan sebagai kawalan negatif dengan tiada koloni mikroorganisma. Kajian ini menunjukkan bahawa terdapat pencemaran rendah sebelum rawatan pada permulaan sesi di dalam air yang dibekalkan kepada cawan pengisi dan paip air dari sinki dengan 2 cfu/mL. Walau bagaimanapun, dua air daripada sumber cawan pengisi dan satu air paip daripada Poliklinik 17 telah menunjukkan bacaan koloni bakteria yang lebih tinggi sedikit dengan 4 cfu/mL dan 6 cfu/mL mikrob. Pada akhir sesi, kajian menunjukkan bahawa kiraan bakteria yang lebih tinggi di Poliklinik 17 daripada Poliklinik 16 dengan bacaan tertinggi 40 cfu/mL. Penemuan ini masih dianggap rendah dan air adalah selamat untuk prosedur rawatan pergigian. Oleh yang demikian, kualiti air yang dibekalkan di Fakulti Pergigian, USIM adalah dalam had yang disyorkan oleh Persatuan Pergigian Amerika, iaitu bacaan bakteria tidak melebihi daripada 200 cfu/mL untuk prosedur rawatan pergigian.*

*Keywords: Pencemaran mikrobial; sistem air unit pergigian; sistem penapis*

## INTRODUCTION

Water from the dental unit water system (DUWS) is essential in many dental procedures. It is used to cool dental instruments, irrigate oral cavity and also service a wide range of dental procedures (Kamma et al. 2007). A major concern of this water supply is microbial contamination. Blake first reported on the level of bacteria in DUWS way back in 1963 (Jolanta 2007). This was followed by identification of bacterial colonies termed as biofilm in DUWS by Kelstrup et al. (1977).

The supply of water to DUWS is mainly from community water supply (direct water supply) and from within the dental units (indirect water supply). The main source of contamination in the DUWS is from the community water supply (Panagakos et al. 2001). This was due to the fact that very few earlier models of dental units

were designed to incorporate containers attached to the dental unit for indirect supply of distilled or sterile water (Barbeau et al. 1996).

Clinical procedures in dentistry also involve reducing and eliminating bacterial contamination of patients and dental team. Therefore, it is important to take necessary precautions from the possibility of opportunistic infection from water used in dentistry. This may pose a risk to personal and patient's health (Uzel et al. 2008).

Formation of biofilm in the dental unit water lines has been shown to be the prime factors that contribute to the high number of bacteria count in the water from the dental unit (Barbeau et al. 1996; Williams et al. 1996). The Polyclinics in the Faculty of Dentistry, USIM, Malaysia has been running for almost three years. The concern of the management on infection control and increasing of awareness of water contamination in DUWS has lead to this study. The objective of this study was to evaluate the microbial contamination level in direct water supply at the Polyclinic, Faculty of Dentistry, USIM.

## MATERIAL AND METHODS

This was a cross-sectional study on microbial contamination of water derived from DUWS. It was carried out in the Polyclinic at levels 16 and 17 of the Faculty of Dentistry, USIM. Ten (10) dental units were randomly selected from each Polyclinic at Level 16 and level 17. Three 2 mL water samples were collected from cup filler outlet and side water tap from sink for all the dental units sampled from the Polyclinic at levels 16 and 17.

These water samples were collected aseptically at the beginning of the session before the dental units were used and after the dental units were used at the end of the session. The same volume of water samples were also collected from nearby aquarium as a positive control and distilled water taken from CSSD as negative control.

All the samples were placed and spread evenly on the surface of prepared agar media (the nutrient agar) using the spread plate technique. Each sample consists of 0.5 mL water. The culture media were then dried and incubated for 24 h at 37°C. After incubation, the microbial count was done using a magnifying glass and the total number of bacteria concentration was reported as colony forming unit in 1 mL of water (cfu/mL). The highest reading from the three collected samples was taken for the assessment.

## RESULTS

There were a total of 67 dental units in Polyclinic at Level 16 and 17. The proportion of dental dental units sampled was 30%. The number of dental units in the Polyclinics and number sampled were presented in Table 1.

A low number of contamination was noted before the usage of the dental unit in water samples obtained from water supplied via the cup filler outlet and side water tap of sink for both polyclinics. The side water tap of sink F1 and cup fillers A12, C12 and J12 on level 16 were noted to have bacterial count of 2 cfu/mL (Table 2). Whereas the side water tap of sinks from level 17; G2 has the reading of bacterial count of 2 cfu/mL and H2 of 4 cfu/mL. The water from cup fillers of C22 and J22 from Polyclinic level 17 have the reading of 4 cfu/mL and 6 cfu/mL of microbes, respectively (Table 3).

At the end of the session, higher bacterial colonies were noted from water samples taken from cup filler outlets and side water tap of sinks from both polyclinics. However, none were detected from the side water tap of sinks on polyclinic level 16 and low bacterial count of 6 cfu/mL was found only from cup filler C12 (Table 2). The bacterial counts of samples taken from Polyclinic level 17 were found to be higher than Polyclinic level 16 samples. From the side water tap of sink E2 and J2 were 10 cfu/mL and 2 cfu/mL. The highest cup filler samples reading were 40 cfu/mL from C22 and G22. The bacterial count on F22 and J22 were 2 cfu/mL and 32 cfu/mL (Table 3).

In this study water from the aquarium was used as positive control and the colonies were found to be 220 cfu/mL, meanwhile, the distilled water that was used as a negative control showed no colony of microorganism (Table 4).

## DISCUSSSION

The microbial contamination was measured to determine the water quality of the dental units at the Polyclinics, Faculty of Dentistry, USIM, Malaysia. The water supplied to the Faculty of Dentistry, USIM came from the municipal water supply. This direct water supply went into the reservoir tank on the top of the roof. The water was then went through the five units water filter (the reinventing type) before it went down to the Polyclinics to supply the side water tap. The filtered water will also go to the dental unit; this water will further filtered through a 40 μm

TABLE 1. Proportion of dental units sampled

| Location | Number of dental units | Number (%) of dental units sampled |
| --- | --- | --- |
| Policlinic Level 16 | 32 | 10 (31%) |
| Polyclinic Level 17 | 35 | 10 (29%) |
| Total | 67 | 20 (30%) |

TABLE 2. Number of colonies found at the beginning and end of the session in Polyclinic 16

| Sample | Site | Sample taken at the beginning of the session | | Sample taken at the end of the session | | Sample | Site | Sample taken at the beginning of the session | | Sample taken at the end of the session | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Means no. of colonies | Colonies/mL | Means no. of colonies | Colonies/mL | | | Means no. of colonies | Colonies/mL | Means no. of Colonies | Colonies/mL |
| A1 | Sink | 0 | 0 | 0 | 0 | A12 | Cup filler | 1 | 2 cfu/mL | 0 | 0 |
| B1 | Sink | 0 | 0 | 0 | 0 | B12 | Cup filler | 0 | 0 | 0 | 0 |
| C1 | Sink | 0 | 0 | 0 | 0 | C12 | Cup filler | 1 | 2 cfu/mL | 3 | 6 cfu/mL |
| D1 | Sink | 0 | 0 | 0 | 0 | D12 | Cup filler | 0 | 0 | 0 | 0 |
| E1 | Sink | 0 | 0 | 0 | 0 | E12 | Cup filler | 0 | 0 | 0 | 0 |
| F1 | Sink | 1 | 2 cfu/mL | 0 | 0 | F12 | Cup filler | 0 | 0 | 0 | 0 |
| G1 | Sink | 0 | 0 | 0 | 0 | G12 | Cup filler | 0 | 0 | 0 | 0 |
| H1 | Sink | 0 | 0 | 0 | 0 | H12 | Cup filler | 0 | 0 | 0 | 0 |
| I1 | Sink | 0 | 0 | 0 | 0 | I12 | Cup filler | 0 | 0 | 0 | 0 |
| J1 | Sink | 0 | 0 | 0 | 0 | J12 | Cup filler | 1 | 2 cfu/mL | 0 | 0 |

TABLE 3. Number of colonies found at the beginning and end of the session in Polyclinic 17

| Sample | Site | Sample taken at the beginning of the session | | Sample taken at the end of the session | | Sample | Site | Sample taken at the beginning of the session | | Sample taken at the end of the session | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Means no. of colonies | Colonies/mL | Means no. of colonies | Colonies/mL | | | Means no. of colonies | Colonies/mL | Means no. of Colonies | Colonies/mL |
| A2 | Sink | 0 | 0 | 0 | 0 | A22 | Cup filler | 0 | 0 | 0 | 0 |
| B2 | Sink | 0 | 0 | 0 | 0 | B22 | Cup filler | 0 | 0 | 0 | 0 |
| C2 | Sink | 0 | 0 | 0 | 0 | C22 | Cup filler | 1 | 4 cfu/mL | 20 | 40 cfu/mL |
| D2 | Sink | 0 | 0 | 0 | 0 | D22 | Cup filler | 0 | 0 | 0 | 0 |
| E2 | Sink | 0 | 0 | 5 | 10 | E22 | Cup filler | 0 | 0 | 0 | 0 |
| F2 | Sink | | | 0 | 0 | F22 | Cup filler | 0 | 0 | 1 | 2 |
| G2 | Sink | 1 | 2 cfu/mL | 0 | 0 | G22 | Cup filler | 0 | 0 | 20 | 40 cfu/mL |
| H2 | Sink | 2 | 4 cfu/mL | 0 | 0 | H22 | Cup filler | 0 | 0 | 0 | 0 |
| I2 | Sink | 0 | 0 | 0 | 0 | I22 | Cup filler | 0 | 0 | 0 | 0 |
| J2 | Sink | 0 | 0 | 1 | 2 cfu/mL | J22 | Cup filler | 1 | 6 cfu/mL | 16 | 32 cfu/mL |

TABLE 4. Microbial assessment of positive and negative control

| Sample source | Type/Site | Location | No. of colonies | Colonies/mL |
| --- | --- | --- | --- | --- |
| J | Positive control | Aquarium | 110 | 220 cfu/mL |
| L | Negative control | Distilled water | 0 | 0 |

ceramic filter that was embedded in each of the dental unit. The samples were taken from the water that undergone one filtered system and also the two filtered systems. The use of water filter has increased and widely used worldwide as people are becoming increasingly aware about the pollution present in the direct water supply (Prabhakar et al. 2008). The basic purpose of using all these systems was to remove or modify impurities in the water.

Generally, the water that was supplied for domestic used was treated and cleaned. As for the Malaysian population, about 1,000 water sample were taken every months by the Ministry of Health to monitor the quality of the supplied water. However, contamination may occur along the piping systems. The same things goes for the DUWS. It consisted of many interconnected narrow-bore tubes that supplied water to the dental chair unit instruments, cup-fillers and spittoons (O'Donnell et al. 2005). The diameter of the tubing was small and therefore predispose to the formation of biofilm.

The American Dental Association recommended that the bacterial loads for dental procedures is not more than 200 cfu/mL and this is within the accepted infection control principles (Govoni 2010). Furthermore, it also emphasized that the dental unit water supply should have the same quality of water for public drinking. In this study, a higher number of bacterial count was noted to be at the end of the session; with the highest total bacteria count was found to be 40 cfu/mL unit from two cup fillers of Polyclinic level 17 (C22 and G22). The cup filler water supply was through the double water filtered system. Despite the number of bacteria count found from the cup fillers water at the end of the session, the bacteria count was well below the recommended limit. The bacteria colonies from the DUWS can be influenced by the environment such as the aerosol, splashes and contact from the dental procedures (Watanabe et al. 2008). The contaminants may also come from substances used throughout the treatment procedures or an unintended result of the disinfection processes even though the number of bacteria colonies in this study was low (Uzel et al. 2008; Watanabe et al. 2008). It does indicate the need for more stringent regulatory measures and proper DUWS management to reduce the cross-infection in the dental clinic (Uzel et al. 2008).

This study also found that there was no bacteria colonies at the end of the session on side water tap from sinks in Polyclinic level 16 and lower number of colonies on level 17. This finding was noted to be below the recommended limit and safe to use for patient. This water was filtered through one single water filtered system that located on the main roof. A study done by Taheri et al. (2002), found that the microbial contamination at the side water tap in dental units was really high about 3578 cfu/mL without any water filter. These results indicated that the water at the Polyclinic, Faculty of Dentistry, USIM, Malaysia from the single filtered unit was safe to use. The finding at the beginning of the session, may be due to the colonization of bacteria in the tab systems from the previous day and not from the formation of biofilm in the pipes system (Jolanta 2003). However, it also can be noted that the formation of biofilm at its stage of initial attachment. Watanabe et al. (2008) also found that the number of bacterial count were reduced with the new dental chair as compared with the old dental chair. This can be due to the fact that the dental chair units in Polyclinic are still new and in used for about three and a half years. In this study, it was also found that the bacterial counts was higher from Polyclinic level 17 than Polyclinic level 16. This can be due to the fact that the usage of Polyclinic level 17 was more than the Polyclinic level 16. It was used by year 4 and year 5 dental student, whereas the level 16 was for the year 3 with less treatment procedures.

This study has shown that filtered water does help in reducing the number of bacterial counts compared with the control samples. This study has shown that low contamination occurs with the use of filter system. However, this result may only be applicable at this stage because the dental units in the Faculty of Dentistry, USIM, Malaysia are considered new. Many studies have shown that most dental unit's water supply has unacceptable standard of the number of total bacteria count obtained from the dental unit water supply (Govani 2010; Jolanta 2007; Taheri 2002). The untreated direct water supply may have the influence to the microbial counts in the dental unit water system. Watanabe et al. (2008) showed that the filtered tap water has low level of bacteria contamination than the non-filtered water.

In addition, there are many methods that have been used to lower the bacteria count in the dental unit such as incorporated chemical solution into the dental unit water system, treated dental chair unit waterline with disinfectant (Tuttlebee et al. 2002) and routine flushing of the dental unit water flow (Watanabe 2008). Such procedures should be carried out on the dental chair regularly and the dental practitioner awareness on the possible contamination should be informed.

The total bacteria counts found in this study provides a good indicator for baseline to monitor the effectiveness of the filter system featuring the different parts of the dental unit systems in particular the water supply that are associated with the dental unit.

## CONCLUSION

The direct water supply to the dental units at the Polyclinic, Faculty of Dentistry, USIM, Malaysia is safe to use for the dental treatment. However, the quality of water supply needs to be monitored regularly. A scheduled monitoring is highly recommended to all dental clinic to ensure the water is safe for patients and staffs, thus reducing the cross contamination in the dental clinic.

## REFERENCES

Barbeau, J., Tanguay, R., Faucher. E., Avezard, C., Trudel, Luc., Cote, Ludger. & Prevost, A.P. 1996. Multiparametric analysis of waterline contamination in dental units. *Journal of Applied and Enviromental Microbioloby* 62(11): 3954-3959.

Govoni, M. 2010. What's in your water? Solution control contamination, but how can you be sure. *www.rdhmag. com.*

Jolanta, S. 2003. Biofilm and dental unit waterlines. *Ann. Agric. Envorin. Med.* 10: 151-157.

Jolanta, S. 2007. Bacterial contamination of water in dental unit reservoirs. *Ann. Agric. Environ. Med.*14: 137-140.

Kamma, J.J., Bradwhaw, D.J. & Fulford, M.R. 2007. Attitudes of general dental practitioners in Europe to the microbial risk dental unit water systems. *International Dental Journal* 56(4): 187-195.

Kelstrup, J., Funder-Nielsen, T.D. & Theilede, J. 1977. Microbial aggregate contamination of water lines in dental equipment and its control. *Acta Pathologica Microbiologica Scandinavica* 85: 177-183.

O'Donell, M.J., Tuttlebee, C.M., Falkiner, F.R. & Coleman, D.C. 2005. Bacterial contamination of dental chair units in a modern dental hospital caused by leakage from suction system hoses containing extensive biofilm. *Journal of Hospital Infection* 59: 348-360.

Panagakos, F.S., Lassiter, T. & Kumar, E. 2001. Dental unit waterlines: Review and product evaluation. *Journal of Dental Association* 72: 20-25.

Prabhakar, A.R., Raju, O.S., Kurthukoti, A.J. & Vishwas, T.D. 2008. The effect of water purification systems on fluoride content of drinking water. *Journal of Indian Soc. Pedod. Prevent. Dent.* 26(1): 6-11.

Taheri, J.B., Oliya, P. & Olomi, K. 2002. Bacterial contamination level of water supply in dental units at Shahid Bebeshti University Dental School-2000. *Journal of Dent. Sch.* 21(1): 73.

Tuttlebee, C.M., O'Donnell, M.J., Keane, C.T., Russell, R.J., Sullivan, D.J., Falkiner, F. & Coleman, D.C. 2002. Effective control of dental chair unit waterline biofilm and marked reduction of bacterial contamination of output water using two peroxide-based disinfectants. *Journal of Hosp. Infection* 52(3): 192-205.

Uzel, A., Cogulu, D. & Oncag, O. 2008. Mirobiological evaluation and antibiotic susceptibility of dental unit water systems in general dental practice. *International Journal of Dental Hygiene* 6: 43-47.

Watanabe, E., Agostinho, A.M., Matsumoto, W. & Ito, I.Y. 2008. Dental unit water: Bacterial decontamination of old and new dental units by flushing water. *International Journal of Dental Hygiene* 6: 56-62.

Williams, J.F., Molinari, J.A. & Andrews, N. 1996. Microbial contamination of dental unit waterlines: Origin and characteristics. *Compend Continue Education Dental* 17: 538-540.

Faculty of Dentistry
University Sains Islam Malaysia (USIM)
Aras 15-17, Menara B
Persiaran MPAJ, Jalan Pandan Utama
Pandan Indah, 55100 Kuala Lumpur
Malaysia

*Corresponding author; email: liza_arie2004@yahoo.com