



## COMPARING THE EFFICACY OF THREE DIFFERENT COMMERCIALY AVAILABLE DISINFECTANTS IN DECONTAMINATING DENTAL UNIT WATER LINES

### Dental Science

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### ABSTRACT

Dental unit water systems (DUWS) are used to irrigate the oral cavity and also used for various operative and endodontic procedures. Water delivered from these devices is not sterile and has been shown to contain high numbers of bacteria. Biofilms accumulate on the inner surface of the tubing and it can be responsible for high levels of contamination of water delivered by DUWS that puts both the patient and the dentist at risk.

**Aim:** The purpose of the study is to evaluate the bacterial contamination of Dental unit water lines and compare the efficacy of three different disinfectants in eliminating the biofilms from DUWS to acceptable levels.

**Materials and Methods:** Nine dental units were used in the studies which were disinfected using three commercially available disinfectants Sterilex Ultra, Alkazyme W and Noni and randomly divided into three groups. Baseline water samples were collected before treatment and samples collected on day 1, 3, 7 respectively after treatment. Total of 108 samples were collected and subjected to microbiological analysis.

**Results:** The study results showed that untreated dental units were highly contaminated with multiple species of bacteria. Statistical analysis showed that bacterial reduction at the end of first day for all three disinfectants was statistically significant. Maximum disinfecting potential was achieved with Sterilex (97.7%).

**Conclusion:** It can be concluded that bacterial contamination of dental unit water lines in the untreated dental units used in this study exceeded ADA recommendations. Sterilex ultra can be used as Dental unit waterline disinfectant for a period of seven days, Alkazyme-W for a period of three days, Noni for one day effectively.

### KEYWORDS

Dental unit water lines, Sterilex Ultra, Opportunistic infections, Disinfection, Biofilms.

### INTRODUCTION:

With so many advances taking place in the field of dentistry to provide successful treatment with a good long term prognosis, sterilization and disinfection protocols become an essential part of dental treatment. Sterilization not only applies to the armamentaria used but the entire dental unit setup including the water that gets delivered during dental procedures.

Water from Dental Unit Water Systems (DUWS) are used to irrigate the oral cavity and also for various operative and endodontic procedures. The main source of microbial contamination in Dental Unit Water Lines (DUWL) is thought to be from the micro-colonies of bacteria and fungi that proliferate on the inner surface of the water lines, forming a biofilm<sup>1</sup>. Frequent periods of water stagnation in DUWLs and the properties of the plastic used in DUWLs construction can promote the attachment and colonization of biofilm forming microorganisms<sup>2</sup>. Hence water which gets delivered from these devices is not sterile and has been shown to contain high numbers of bacteria<sup>3</sup>. It was reported as early as the 1960's that water from DUWL is heavily contaminated with microorganisms<sup>1</sup>. There are various species of microorganisms which have been isolated from dental unit water lines include Gram -ve organisms like *Pseudomonas* species, *E. Coli*, *Legionella*, *mycobacterium*, others like *Staphylococcus*, *Bacillus*, *Actinobacter*, *Xanthomonas*, *A. xyloxidans*, *P. haemolytica*, *Klebsiella*, *pneumoniae*, *S. marcescens*, *Micrococcus* and *Flavobacterium*<sup>2</sup>. There is little epidemiological evidence that microbial contamination of dental unit water lines constitutes a potential risk of infection to either patients or their dentists<sup>4</sup>. However among immunocompromised individuals, patients under radiotherapy, pregnant women, and patients under prolonged anti coagulant therapy, organ transplant recipients, patients with chronic burns, and patients on steroid therapy there is undoubtedly a potential for infection via this route<sup>5</sup>. The purpose of this study was to compare the efficacy of three different commercially available disinfectants in decontaminating DUWLs.

### MATERIALS AND METHODS:

Three preliminary water samples were collected at random from the

main source of water supplying the Dental Unit Water Lines in the Department of Conservative Dentistry and Endodontics, SRM Kattankulathur Dental College and Hospital. The samples were subjected to microbiological analysis to acknowledge the presence of multiple colonies of micro-organisms. Subsequently, nine dental units used in the study were randomly divided into three groups based on the disinfectant used.

**GROUP 1-** Dental units disinfected with **Sterilex ultra liquid** (STERILEX CORPORATION ®, Hunt valley, USA, Batch no: 63761-6)

**GROUP 2-** Dental units disinfected with **Alkazyme -W** (Alkapharm UK limited, UK, Lot no: 7241)

**GROUP 3-** Dental units disinfected with **Noni (Morinda citrifolia)** (Noni Biotech Pvt Ltd, India, Batch no: 45177)

Water samples were collected from the water booster, three way syringe and air rotor points before and after disinfectant application. Water samples were collected in a sterile disposable container (Sterile Uricol, Himedia Lab Pvt Ltd) and sent for microbiological analysis. Baseline samples were obtained at the beginning of the study. Samples were then collected before the commencement of the working day. The tested disinfectants were loaded into the booster at the end of the day as per manufacturer's recommendation and left overnight. The next day, the disinfectant solution was evacuated through the air rotor and three way syringe outlets and the booster rinsed with distilled water to eliminate the tested solutions completely. The booster was then filled with distilled water to be used for routine procedures. Water samples were then collected on day 1, day 3, day 7 after application per unit (n=12) for a total of 108 samples.

### STATISTICAL ANALYSIS AND RESULTS:

#### COMPARISON OF EFFICACY OF THREE DISINFECTANTS:

The comparison of efficacy of three disinfectants were carried out using ANOVA followed by Kruskal Wallis test using software SPSS 18.0

**Comparison of efficacy of disinfectants in Dental units one, two and three:**

	GROUP 1 (Sterilex Ultra)		GROUP 2 (Alkazyme- W)		GROUP 3 (Noni)		P value
	Mean	SD	Mean	SD	Mean	SD	
Baseline Values	17	9.84	12	8.54	16.5	6.53	0.646
Day 1	0	0	0.67	1.15	3.33	3.35	0.199
Day 3	0	0	7.33	3.78	12.33	5.03	0.046
Day 7	3.33	3.05	15.00	2.00	11.33	3.21	0.044

Table 1

### Disinfecting capacity of each disinfectant for a duration of seven days:

The maximum disinfecting potential of each disinfectant for a period of seven days was evaluated using paired sample statistics test and Wilcoxon signed rank test

	STERILEX ULTRA	ALKAZYME-W	NONI
Maximum disinfecting efficiency in % for 7 days	97.7	50.6	31.3

Table 2

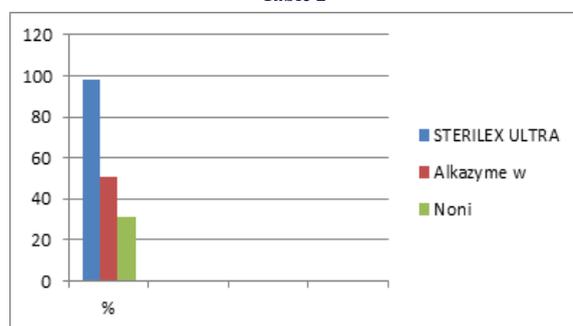


Chart 1

### DISCUSSION:

The purpose of the present study was to establish the clinical relevance of opportunistic infections picked up from contaminated Dental Unit Water Lines and methods employed to minimize it. The current study evaluated the efficacy of three commercially available disinfectants Sterilex ultra, Alkazyme W, Noni for a period of seven days.

The American Dental Association through its council on scientific affairs and board of trustees in 1995 recommended that a goal of less than 200 CFU/ml in unfiltered output water from DUWLs for all dental procedures was desirable by the year. Fiehn et al showed that bacterial colonies in dental units before any disinfection protocols were as high as 3000 CFU/ml which is much higher than the recommended standards<sup>5</sup>. Several methods have been recommended to disinfect dental unit water lines. They are independent water systems, sterile water delivery systems, filtrations, chemical treatment protocols, use of anti-retraction valves.

Fayle et al reviewed several methods of decontaminating dental unit water lines and stated that the use of chemical disinfectants could be a reliable and a practical method to obtain dental water output adhering to the ADA guidelines of 200 CFU/ml<sup>6</sup>

The FDA has approved various products intended to improve the microbial quality of dental unit water. Several chemical agents such as chlorhexidine gluconate, hydrogen peroxide, sodium hypochlorite, povidone iodine have been used as disinfectants<sup>7</sup>

This study used Sterilex Ultra liquid which received the approval of FDA seal in 2000 for controlling bio films. It is an alkaline peroxide based chemical disinfectant. Multiple mechanism of action of Sterilex has been attributed to its individual components. The constituents of Sterilex include sodium bicarbonate, sodium percarbonate, alkyl benzylammonium chloride and tetra sodium ethylene diamine tetra acetic acid. Sodium bicarbonate has an effervescent action while sodium percarbonate acts as a detergent, bleaching agent with a

strong fungicidal effect and aids in the removal of stains with deodorizing capability. Alkyl benzyl dimethylammonium chloride, a medical disinfectant and tetra sodium ethylene diamine tetra acetic acid act as chelating agents. The various components act synergistically to remove biofilms. However there are also some drawbacks associated with Sterilex ultra. Tuttle bee et al in 2002 stated that the use of the alkaline peroxide based detergent was associated with blocking or clogging of Dental unit water lines<sup>6</sup>

Alkazyme W is an enzyme based detergent consisting of protease enzyme and quaternary ammonium compounds. It mainly acts on the bacterial cellular components and the enzyme produces proteolytic action thereby rendering microorganisms inactive.

Though chemicals seem to be the effective method of decontaminating DUWL there are several drawbacks associated with the use of chemical disinfectants. Water tubings can be corroded by higher concentrations of chemical treatment, and this may lead to leakage and eventual failure of the DUWS. Also the remnants of disinfectants could come into contact with the oral cavity, and this might affect the bonding of resins to both enamel and dentin, leading to premature failure of restorations<sup>7</sup>. The risk of chemical exposure to the patient needs to be considered when using chemical disinfectant products in DUWS.

To overcome the drawback of chemicals, a herbal product Noni has been introduced. Rita et al have shown that *M. citrifolia* (Noni) has good antibacterial, antiviral, antifungal, anti-inflammatory, and immune enhancing properties<sup>8</sup>. *M.citrifolia* inhibits the growth of various organisms including *S. aureus*, *Pseudomonas aeruginosa*, *Proteus morgani*, *Bacillus subtilis*, *E. coli*, *Helicobacter pylori*, *Salmonella* species and *Shigella* species, most of which are usually to be present in biofilms of Dental unit water line<sup>9</sup>. The mechanism of action of Noni is attributed to the secondary metabolic phenolic compounds such as, L-asperuloside, alizarin, acubin and anthraquinones and scopoletin. Noni has been used effectively as a chelating agent and as irrigant in endodontics<sup>10-12</sup>. However there are no studies evaluating the efficacy of Noni in disinfecting Dental unit water lines.

As far as contamination is concerned, the results of this study confirmed that DUWLs are highly contaminated when dental units in use for several months have received no decontaminating treatment. This finding is in accordance with a previous study by Schel et al<sup>11,13-15</sup>. Our study discovered the presence multiple bacterial colonies in the nine dental units including *pseudomonas aeruginosa*, multiple sub species of *pseudomonas*, *acinetobacter*, *E.coli*, non-fermenting gram negative bacilli, coagulase negative staphylococci and gram positive cocci.

The overall results evaluating the efficacy of the three disinfectants indicated that Sterilex Ultra was effective for a period of seven days, Alkazyme W was effective for a period of three days and Noni was effective only for a period of one day.

One of the limitations of the study was that the number of pre-treatment bacteria in each unit could not be standardized to compare the efficacy of disinfectants between groups and within the groups.

### CONCLUSION:

Within the limitations of the study it can be concluded that

- Bacterial contamination of Dental Unit Water Lines in untreated dental units is significantly higher than ADA recommended levels.
- Sterilex ultra can be used as Dental unit waterline disinfectant for a period of seven days, Alkazyme for a period of three days, Noni for one day effectively.

### REFERENCES:

- Sonia Pareek,1 Anup Nagaraj,1 Prateek Sharma,2 Mansi Atri,3 Satinder Walia,4 Shrivani Naidu,1 and Asif Yousof1. Disinfection of Dental Unit Water Line Using Aloe Vera: In Vitro Study. International Journal of Dentistry Volume 2013 (2013), Article ID 618962, 6 pages
- Venkatesh VK, Vidyashree NV, Velmurugan, Parameswaran A, Kandaswamy D. Evaluation of bacterial contamination of dental unit water Lines and the efficacy of a commercially available disinfectant. J Conserv Dent 2006 [cited 2014 Oct 22];9:93-8
- Irfana Fathima Shajahan, Kandaswamy D, Padma Srikanth1, Lakshmi Narayanan, Selvarajan. Dental unit waterlines disinfection using hypochlorous acid-based disinfectant. J Conserv Dent 2016;19:347-50.
- A J Smith1, S McHugh2, I Aitken3 & J Hood4. Evaluation of the efficacy of Alprol disinfectant for dental unit water lines. British Dental Journal 193, 593 - 596 (2002)
- A. J. Schel,1,2 P. D. Marsh,3,11 D. J. Bradshaw,3,† M. Finney,3 M. R. Fulford,4 E. Frandsen,5 E. Østergaard,5 J. M. ten Cate,2 W. R. Moorer,2 A. Mavridou,6 J. J.

- Kamma,6 G. Mandilara,6 L. Stösser,7 S. Kneist,7 R. Araujo,8 N. Contreras,8P. Goroncy-Bermes,9 D. O'Mullane,10 F. Burke,10 P. O'Reilly,10 G. Hourigan,10 M. O'Sullivan,10 R. Holman,12 and J. T. Walker3. Comparison of the Efficacies of Disinfectants To Control Microbial Contamination in Dental Unit Water Systems in General Dental Practices across the European Union. *Appl Environ Microbiol.* Feb 2006; 72(2): 1380-1387.
6. Atlas, R. M., J. F. Williams, and M. K. Huntington. 1995. Legionella contamination of dental-unit waters. *Appl. Environ. Microbiol.* 61:1208-1213.
  7. Bagg, J., C. Sweeney, K. M. Roy, T. Sharp, and A. Smith. 2001. Cross infection control measures and the treatment of patients at risk of Creutzfeldt Jakob disease in UK general dental practice. *Br. Dent. J.* 191:87-90.
  8. Barbeau, J. 2000. Waterborne biofilms and dentistry: the changing face of infection control. *J. Can. Dent. Assoc.* 66:539-541.
  9. Barbeau, J., C. Gauthier, and P. Payment. 1998. Biofilms, infectious agents, and dental unit waterlines: a review. *Can. J. Microbiol.* 44:1019-1028.
  10. Bennett, A. M., M. R. Fulford, J. T. Walker, D. J. Bradshaw, M. V. Martin, and P. D. Marsh. 2000. Microbial aerosols in general dental practice. *Br. Dent. J.* 189:664-667.
  11. Challacombe, S. J., and L. L. Fernandes. 1995. Detecting Legionella pneumophila in water systems: a comparison of various dental units. *J. Am. Dent. Assoc.* 126:603-608.
  12. Fotos, P., H. Westfall, I. Snyder, R. Miler, and B. Mutchler. 1985. Prevalence of legionella-specific IgG and IgM antibody in a dental clinic population. *J. Dent. Res.* 64:1382-1385.
  13. Karpay, R. I., T. J. Plamondon, and S. E. Mills. 1999. Comparison of methods to enumerate bacteria in dental unit water lines. *Curr. Microbiol.* 38:132-134.
  14. Karpay, R. I., T. J. Plamondon, S. E. Mills, and S. B. Dove. 1999. Combining periodic and continuous sodium hypochlorite treatment to control biofilms in dental unit water systems. *J. Am. Dent. Assoc.* 130:957-965.
  15. Kettering, J. D., C. A. Munoz-Viveros, J. A. Stephens, W. P. Naylor, and W. Zhang. 2002. Reducing bacterial counts in dental unit waterlines: distilled water vs. antimicrobial agents. *J. Calif. Dent. Assoc.* 30:735-741