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Treating Dental Unit is More Ideal than Treating Illness

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Abstract
Microorganisms spread through various medium in the environment, but the fastest and highest modes of transmissions are by aerosolized particles. Aerosols less than 50 *µm* in diameter linger and recirculate in the air current for about 35 minutes to 17 hours within the dental office due to positive pressure engineered rooms and HVAC systems [1,2]. Splatters and droplets that carry suspended microbes include Legionella, Streptococcus, Staphylococcus, Leptospira (20%), Sphingomonas (14%), Bacillus (7%), Escherichia (6%), Geobacter (5%) and Pseudomonas (5%) and Hepatitis B & C virus and also causative agents of Measles, Influenza, Cryptococcosis, and Tuberculosis [4].
Keywords
Dental Units, HVAC systems.

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INTRODUCTION:
Microorganisms spread through various medium in the environment, but the fastest and highest modes of transmissions are by aerosolized particles. Aerosols less than 50 *µm* in diameter linger and recirculate in the air current for about 35 minutes to 17 hours within the dental office due to positive pressure engineered rooms and HVAC systems [1,2]. Splatters and droplets that carry suspended microbes include Legionella, Streptococcus, Staphylococcus, Leptospira (20%), Sphingomonas (14%), Bacillus (7%), Escherichia (6%), Geobacter (5%) and Pseudomonas (5%) and Hepatitis B & C virus and also causative agents of Measles, Influenza, Cryptococcosis, and Tuberculosis [4]. The suck- back phenomenon that contributes for contamination of DUWL is due to intake pressure, inertial rotation time and flow resistance at the front and back of the handpiece [19]. The Dental Chair Unit (DCU) circuit and air turbine handpiece (turbine, ball race bearings, and exhaust for moving air in and out) has intricate water line tubing made of polyurethane and polyvinyl chloride. This serves as an ideal environment for most microbial niche to colonize. They are ubiquitous in existence and can thrive in the presence of moisture and a solid bed. Particles in running water accumulate as a "pellicular coating" on the surface of tube lumen, which allows early colonizers to bind tentatively by weak van der Waals force and, at a later stage, through a strong cellular adhesion mechanism, allowing multiple adhesion sites for secondary colonizers [6]. A biofilm which forms later are characterized by patchy, sporadic round cell aggregates has a heterogeneously interspersed channels allowing water to flow in between to provide minerals and micronutrients for colonizers [8]. This water source which generate an enormous amount of planktonic microbial flora is used for oral rinsing, ultrasonic scalers, 3-way air water syringe and handpiece coolants. Infected saliva from patients' mouth is drawn back into air turbine handpiece retraction valves, contaminating the DUWL are reported with higher failure rates for 15, 30 and 60 days of usage [9].
The CDC (Center for Disease Control and Prevention) recommends to flush the DUWL for a duration of 30 sec before commencing any treatment. CDC advises that water utilized for any dental use, should comply with the regulations of EPA (Environmental Protection Agency) which has a microbial load of less than 500 *cfu/ml*. Research studies reported that flushing did not affect the integrity of biofilm and

dislodges only the planktonic microbes [10]. Although it looks safer to use a sterilized handpiece in DCU, the contaminated saliva can seep inside the head of the handpiece and will be expelled through the exhaust line and lead to cross infection [19]. This might also unload some amount of microbes into the DUWL and contribute to biofilm colonization, eventually the water line will release contaminated water as it flows through and will be no longer safe.
In light of this information, the present study was planned with the objective of finding the effectiveness and duration of disinfectants used between treating procedures by implementing disinfection protocols that minimize the microbial inhabitants in DUWL.

MATERIALS AND METHODS:

The study was conducted with 15 dental chairs in the Department of Conservative Dentistry and Endodontics at Saveetha Dental College, Saveetha University, Chennai, India. The DCU was divided into three groups, with five DCU in each group. Group A (n=5) was used with 2% Glutaraldehyde disinfectant, group B (n=5) dental chair units were disinfected with Alprojet and group C remained as control, where no disinfectant was used at any time during the study. For each DCU, 15 separate air turbine handpiece (Kavo M8700L) was used and never swapped between groups. In the beginning of the day prior to treating the first patient, 15 separate self-contained bottles were attached to the respective dental chairs and water samples (n=15) were aseptically procured from all water reservoirs by flushing through the air turbine handpiece. It is performed first every morning, before disinfecting the DUWL to evaluate and compare between the disinfected groups and the control group, prior to and after disinfection (Table 1). The bacterial population was enumerated from the collected water samples using dilution plate method by incubating in nutrient agar medium at 37ºC for 24 hours and the population was expressed as *cfu/ml.* After collecting baseline samples, the disinfectants were mixed as per manufacture's protocol. For group A DCUs, 2% Glutaraldehyde was used in 1:10 dilution and Alprojet used in group B was mixed to 1:50 dilution and transferred to separate bottles, which are connected to their respective DCUs. Thereafter, the group A and B DUWL and the handpieces were disinfected by flushing with their corresponding disinfectants for 60 seconds and samples (n=10) were collected. A bottle filled with fresh water was attached to the waterline and flushed to remove the residual disinfectants for 30 sec. The bottles used, were never interchanged between DCUs at any stage during the study. The treatments were started promptly after disinfecting and recommended to treat minimum of two patients before collecting the next sample. After treating patients for three hours, samples from 15 DCUs were obtained at the mid-day in an airtight container before disinfection. Later, group A and group B DCUs were disinfected again and samples collected to assess the microbial population. Fresh water bottles were then attached back to the respective units to flush the residual chemicals. No disinfectants were when the units were not in use. At the end of the day, after the final treatment (approximately 3 hours following treatment) samples were drawn from all the 15 DCUs (group A, B and C) and enumerated for microbial load. The chairs were neither used after collecting the final sample nor disinfected until next day. All the handpieces used were collected at the end of the day to clean, oil and autoclave. The samples from group A, B and C were collected for five consecutive days and incubated in nutrient-agar medium for 24 hours at 37ºC to ascertain the microbial growth. The findings were evaluated statistically using one way analysis of (ANOVA) by the SPSS software 20.0. Standard deviation, mean and standard errors were determined for the samples obtained from 15 DCUs for five continuous days with p value <0.05 as level of significance.

RESULTS AND DISCUSSION:

The samples collected from group A and B were compared among themselves and with the control group C to assess the effectiveness of the disinfectants used. Analysis of the observed data showed that group A and group B did not differ significantly, with the exception of few days. There was no difference between disinfected groups (A and B) in the samples obtained from 10 DCUs prior to the first patient, after disinfection. But the findings shows a significant difference from the control group on day 2 and 4 with p value 0.01 (Table 2). Samples collected in the post-meridiem from 10 DCUs showed significant difference between disinfectant groups and the control group with p value of 0.03 and <0.01 on days 1 and 2 respectively (Table 3). At the end of the day, there was no significant difference between group A and B and the control group (Table 4). The statistical data revealed no significant difference within and between group A and B at various time intervals for five days, before and after disinfection (Tables 5 and 6).
The majority of microbes in the dental unit are not a public health concern, but certain microbes such as gram negative rods, spore forming bacteria, gram positive rods, Hepatitis B, C virus and non-

tuberculous mycobacterium pose risk of becoming an opportunistic pathogen. As the biofilm in a water line tubing acts as a microbial source of water line pathogens, it must be eliminated by disinfecting DUWL between patients to reduce microbial build up and subsequent infection. Though autoclaving is the desirable method to sterilize handpieces, it is practically less feasible to perform between patients. To overcome this problem, several attempts were made towards mitigation of the microbial population. Methods used are flushing air turbine handpiece prior to use and after each patient, employing anti-retraction valves in order to prevent retrograde aspirations of oral secretions, ultraviolet and ozone disinfection, use of in-line water filters [12], and disinfectant solutions like Glutaraldehyde, Hydrogen-peroxide, Chlorhexidine gluconate, Sodium-hypochlorite, Chlorine-dioxide, Povidone–iodine, and Listerine, and electro-chemical activation of water. The economically feasible and imminent method of disinfection should be used to manage water reservoirs efficiently in busy private practices and college-attached hospitals. In this study, 2% Glutaraldehyde and Alprojet were the two disinfectant solutions used to disinfect water line tubing attached to DCU. Glutaraldehyde has long been used as a medical disinfectant for its microbicidal effects against spores, fungi, bacteria and virus [18]. The mechanism of action include alkylation of hydroxyl, amino, sulfhydryl, and carboxyl groups affecting RNA, DNA and protein synthesis [18]. Its effect is mainly determined by the pH of the solution, though acid glutaraldehyde is an effective microbicide they are inferior to alkaline glutaraldehyde. The Alprojet consists of a three-component formulation comprising aminodosulphonic acid, amphoteric-tensides and dimethyldioctyl ammonium chloride with alkaline pH (12.0) exhibiting antimicrobial property which has the potential of damaging the microbial cell membranes. Samples collected before disinfection from 15 DCU from group A, B and C showed no significant variance. Though the DCU units in group C (n=5) flushed according to CDC guidelines for 30 sec, the pathogen count has not gone down. When the groups were statistically analyzed after disinfection prior to first patient there was no significant difference between group A and B. However, they differed from the control group at day 2 and 4 with p value 0.01 (Table 2) with less microbial colony count. In the post-meridiem, following 3 hours of treatment, the samples were collected from group A and B and the microbial population enumerated showed a higher number of colony forming units compared with the population of samples drawn before the first patient of the day. Following disinfection of DCU (n=10) at mid-day, the treated groups (A and B) recorded substantial reduction in microbial population compared to group C, which is statistically significant, on day 1 and 2 with p Value 0.03 and <0.01 respectively; however, no significant difference in the microbial population was observed between group A and B (Table 3) (Fig 3). The samples obtained before and after disinfection at the mid-day, from group A and B were compared within the group and the number of colonies counted before disinfection were higher than after disinfection, but reported no significant difference (Table 5 and 6) (Fig 1 and 2). Those samples were only compared within groups (A, B) at the post-meridiem after treating patients, because of the increased chance of pathogens suck-back from patients' saliva into internal coupling of the handpiece [19]. At the end of the day, the control group reported higher number of microbial count compared to disinfected groups but again there was no significant statistical difference (Table 4). The results of this study suggest that frequent DCU disinfection between patients almost reduced the amount of pathogens harbored in the waterline tubing; nevertheless, they did not show any statistical significant difference and the duration of the disinfectant that remained active was unclear. Although it appears that the water lines are safe at the beginning of the day before treating any patient, the internal surface of the conduit that operates at warm temperature are providing a perfect habitat for microbes to double every 15 minutes [14]. The sterilized handpiece collect mibrobes drawn back from oral cavity and contaminate the DUWL. This study is a quantitative assessment for monitoring and regulating microbial population on regular basis and hence not focused on the quality of pathogen and it is prudent to assess the microbial counts for a longer period by accurately assessing the biofilm and its nature. An integrated approach must be maintained in order to reduce the microbial population, which includes waterline flushing, regulated independent water reservoir systems, inline micro pore filtration, anti-retraction valves and periodic disinfection.

CONCLUSION:

Due to multiple portals of entry, no single method will substantially eliminate pathogens. Hence, dental health care workers (DHCW) are chronically exposed to aerosolized microbes and they can act as a symptomatic or asymptomatic carriers. Those airborne microbes are a threat, and jeopardize the patients with defective immune system, especially patients' undergoing immunosuppressive therapy,

dialysis, endocarditis, recent myocardial infarction, etc. This study focused to mitigate the pathogens inhabiting complex circuits of DUWL and handpieces. The research found higher microbial populations in the untreated control group DUWL compared to disinfected groups. Disinfectants can play a role in reducing the microbial population from DUWLs to more acceptable levels in the short-term. However the long-term solution for controlling the microbial contamination of DUWLs will depend upon redesigning the water flow system through the air turbine handpieces and with a safer impregnable disinfectants. To achieve a better water quality, a combination of currently available technologies must be implemented with constant monitoring, which could contribute to higher success rate of the treatments.

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