Quantitative analysis of bacterial aerosols in two dental departments

Abstract

In the present work an attempt has been done to analyze bacterial aerosols and to check the effect of chlorhexidine mouthwash on bacterial aerosols generated during routine dental treatment in department of Periodontics and Conservative dentistry. The bacterial aerosols generated at different treatment sessions in department of Periodontics were high as compared to the department of Conservative dentistry however there was no significant difference statistically. A significant difference was observed before (105.2 CFU/m$^3$) and after (51.4 CFU/m$^3$) using mouthwash in the department of Periodontics while there was no significant difference (P=0.068) was observed before (61.8 CFU/m$^3$) and after (42.6 CFU/m$^3$) using mouthwash in the department of Conservative dentistry. The result of the study demonstrates that ultra sonic scaling is more air contaminant dental treatment procedure as compared to high-speed dental drill. Pre-procedure rinsing is effective to control dental clinic air contamination and decrease the risk of infection for dental professionals and patients.

Key words: Bacterial load, Chlorhexidine, dentists, infection control
1.0 Introduction
The oral cavity is a unique environment which provides an ideal medium for bacterial growth. Microorganisms present in the oral cavity may be transmitted from person to person through aerosol, water contamination or surface contact. Aerosol produced during use of ultra-sonic scaler or airotor of dental chair has droplet nuclei particles which stay in the environment for long periods of time, and is a source of infection for the patient as well as the health care provider [1]. All dental personnel including dentists, nurses, and hygienists are at risk of cross-infection due to frequent exposure to microorganisms living in patients blood, droplets of saliva and instruments contaminated with blood, saliva and tissue debris. These micro-organisms include pathogenic bacteria, viruses and fungi [2] and, in some instances, may be responsible for direct transmission of highly infectious diseases including Mycobacterium Tuberculosis, Hepatitis B and C, Staphylococci, Herpes simplex virus 1 and 2 and the Human Immunodeficiency Virus [3,4]. In addition, exposure to viruses that cause upper respiratory infections such as mumps, influenza and rubella also poses a considerable health risk to dental personnel [2-4]. Transmission of infection during dental treatment or surgery can occur through several routes: direct contact with blood, saliva or tissue debris; indirect contact with contaminated instruments or surfaces that have been improperly sterilized; or contact with infective agents present in either the droplets or aerosol particles from saliva and respiratory fluids [3]. During dental treatments, saliva may become aerosolized and microorganisms from the oral cavity will contribute to the spread of infection [5]. In the past 15 years, many studies have shown that antimicrobial mouth rinses when used as pre-procedural rinses can decrease the number of microorganisms aerosolized during clinical procedures [6]. Clinical studies assessing the effect of chlorhexidine rinses on aerosols have in general used the 0.12% concentration in North America have shown that typical suppression rates for 0.2% chlorhexidine products shown 84-87% reduction immediately after rinsing, and an 88-92% reduction up to 5 hours after mouth rinsing [7]. Through extensive literature review it was revealed that there are no previous data on bacterial contamination of the air in multi-chair dental clinics, such as those found in dental institutes. Therefore, the present study aimed to determine the levels of airborne bacteria (aerosols) and to check the effect of Chlorhexidine mouthwash (Hexidine®) on bacterial aerosols generated during routine dental treatment in Department of Periodontics and Conservative dentistry of Ahmedabad Dental College and Hospital (ADCH).

2.0 Materials and methods
A comparative study was conducted to analyze the quantitative bacterial aerosols generated during routine dental procedure in the department of Periodontics and Conservative dentistry of ADCH. Before the commencement of the study, study protocol was approved by the Ethics committee of ADCH and the permission was obtained from the concern authorities of the respective department. Total ten participants (five from each department) were selected randomly from the out patients department. The ten samples were selected based on the power analysis at confidence interval (α) of 95% and power of study (β) at 80%. Participants ranged in age from 25 to 45 years. Criteria for participation included having a minimum of 20 permanent teeth with chronic generalized periodontitis and having dental caries both in upper and lower arch. Participants who were suffering from any medical conditions like hypertension, respiratory complications, rheumatic heart disease and pregnancy or were taking medications like immunosuppressive drugs, anticoagulant medications, or need for antibiotic prophylaxis were excluded from the study. The aerosols samples were collected by using nutrient agar plates (Himedia, Mumbai, India) from the multiple dental chair (central) clinics which were
used by the dental students for ultra sonic scaling and high speed drilling for tooth preparation. Total ten samples (five from each department) were collected. The air samples were collected by placing the nutrient agar plates at the distance of two feet away from the dental unit. Each sample were collected at four different sessions during the treatment procedures: 1) 30 minutes prior the treatment sessions starts, 2) at the time of treatment before rising with chlorhexidine mouth wash, 3) at the time of treatment after rinsing with chlorhexidine mouth wash and 4) 30 minutes after the treatment session ends. Air samples were collected on Mondays for five consecutive weeks. The participants were assigned with 10 ml of 0.2% Chlorhexidine mouth wash (Hexidine®, ICPA, Mumbai, India) and asked to rinse their mouth for one minute. During the treatment the dentists were wearing the face mask and eye glass however rubber dam was not used by the patients.

Table-1: Colony forming units (CFU/m³) of bacterial aerosols generated at various treatment sessions in department of Periodontics and Conservative dentistry

<table>
<thead>
<tr>
<th>Number of samples</th>
<th>30 minutes before treatment start</th>
<th>Before rinsing</th>
<th>After rinsing</th>
<th>30 minutes after treatment ends</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
<td>CD</td>
<td>P</td>
<td>CD</td>
</tr>
<tr>
<td>1</td>
<td>170</td>
<td>265</td>
<td>229</td>
<td>187</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>31</td>
<td>107</td>
<td>34</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>26</td>
<td>74</td>
<td>31</td>
</tr>
<tr>
<td>4</td>
<td>46</td>
<td>14</td>
<td>46</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>78</td>
<td>51</td>
<td>70</td>
<td>47</td>
</tr>
<tr>
<td>Mean value</td>
<td></td>
<td></td>
<td>82.2</td>
<td>77.4</td>
</tr>
<tr>
<td>P value</td>
<td>0.47(1)</td>
<td></td>
<td>0.12(1)</td>
<td></td>
</tr>
</tbody>
</table>

P= Department of Periodontics; CD= Department of Conservative Dentistry

(1) Mann-Whitney U test; not significant at P > 0.05

Based on report of Logothetis DD et al.[7] it has been confirmed that by 30-minute exposure of nutrient agar plates was adequate to collect airborne bacteria during different treatment sessions. The microbial aerosols were allowed to settle under gravity. These samples were labeled, recorded and transported to a Microbiology laboratory in an ice box at 4°C. The nutrient agar plates were incubated at 37°C for 24 hours in the Microbiology laboratory of Gujarat Art and Science College, Ahmedabad. Using Colony Counter a laboratory technician counted the colony-forming units. The laboratory technician was not aware which plates had been exposed during two dental procedures. Bacterial colonies were counted as colony-forming units (CFUs) per plate by using colony counter. The numbers of colonies were expressed as CFUs/ m³ of air samples. The data were analyzed using SPSS software (ver. 17; SPSS, Inc., Chicago, USA). The bacterial counts were expressed as mean value. Mann-Whitney U test was used to assess if there was any significant
difference between the overall bacterial counts obtained from department of Periodontics and Conservative dentistry at different sessions during treatment procedures. The Wilcoxon test was used to assess the significant difference before and after mouth rinsing. A value of P ≤ 0.05 was considered statistically significant.

3.0 Results and discussion

3.1 Bacterial aerosols generated in the Department of Periodontics

Table-1 shows the bacterial aerosols counts generated at four different treatment sessions in the Department of Periodontics. The total count of bacterial aerosols shows high variability ranging from 17 to 170 CFU/m$^3$ count (mean value of 82.2 CFU/m$^3$) at 30 minutes prior to the start of the treatment and from 26 to 156 CFU/m$^3$ (mean value of 80.6 CFU/m$^3$) after 30 minutes of treatment ends. The count of bacterial aerosols for five different samples before rinsing with chlorhexidine mouth wash ranges from 46 to 229 CFU/m$^3$ having mean value of 105.2 CFU/m$^3$. While the total count of bacterial aerosols after rinsing with chlorhexidine mouth wash was from 2 to 140 CFU/m$^3$ having mean value of 51.4 CFU/m$^3$. This decrease in the count shows a significant difference statistically (P=0.043, Figure-1).

3.2 Bacterial aerosols generated in the Department of Conservative dentistry

Table-1 shows the bacterial aerosols counts generated at four different treatment sessions in the Department of Conservative dentistry. The total count of bacterial aerosols shows ranges from 14 to 265 CFU/m$^3$ count (mean value of 77.4 CFU/m$^3$) at 30 minutes prior to the start of the treatment and from 18 to 173 CFU/m$^3$ (mean value of 57.6 CFU/m$^3$) after 30 minutes of treatment ends. The count of bacterial aerosols for five different samples before rinsing with chlorhexidine mouth wash ranges from 10 to 187 CFU/m$^3$ having mean value of 61.8 CFU/m$^3$. While the total count of bacterial aerosols after rinsing with chlorhexidine mouth wash ranges from 10 to 110 CFU/m$^3$ having mean value of 56.0 CFU/m$^3$.
to 120 CFU/m$^3$ having mean value of 43.6 CFU/m$^3$. This decrease in the count shows no significant difference statistically (P=0.068, Figure 2). There was no statistical significant difference (P > 0.05) found when the mean number of CFUs between the two departments at different session of the treatment was compared (Table-1). Most dental treatment procedures have the potential for creating contaminated aerosols and splatter. The results obtained in this study confirm high levels of bacterial aerosol generated during dental procedure, which represent an important source of health care associated infections. The number of disseminated aerosols in clinical environments, during dental treatments was manifested by colony forming units per plate. This number just only demonstrated the quantity of aerobic bacteria on the nutrient agar plates. It is so clear that the real number of existing bacteria on the collected samples was more than the counted values on the plates. Furthermore, cultural medium and the growth (aerobic) conditions which were used in this study were not appropriate for all kinds of organisms, including more fastidious bacteria, viruses and mycetes. In the current study, the level of bacterial aerosol was lower than found in the previous studies. Grenier [8] in 1995 reported a level of contamination of 216 CFU/m$^3$ for ultra sonic scaling treatment and 75 CFU/m$^3$ for operative treatment. One more report by Azari et al.[9] in 2008 found 120-280 CFU/m$^3$ in the air in dental surgeries. The highest level of bacterial contamination was reported by Bărlean el at..,[10] showing the high variability of bacteria ranging from 42-273 CFU/m$^3$ at the beginning of the day and from 105 to 1018 CFU/m$^3$ after four hours of clinical activity.

![Figure-2: Bacterial colony counts (CFU/m$^3$) before and after using the mouth wash in department of Conservative Dentistry](image)

In the present study overall bacterial colony count was found to be highest in department of Periodontics as compared to department of Conservative dentistry. This difference was presumed to be due to the difference in the nature of procedure that was carried out in the respective department. However, this apparent difference in the colony counts was found to be insignificant when the statistical analysis was performed. While it is an
established fact that the most intensive aerosol emission occurs during the work of an ultrasonic scaler and the bur on a high speed hand piece [1] when compared to other dental procedures, varying reports are available as regards the difference in the generation of bacterial aerosols between these two procedures. As instance, a study conducted by Arsad et al [11] and Kedjarune et al [12] have suggested that there was no difference in the concentration of total bacterial aerosols generated in the dental clinic after endodontic treatment, scaling with an ultra sonic scaler, and after an operative procedure using a high speed drill. But at the same time, most other studies have reported that the use of an ultra sonic scaler produce the maximum bacterial contamination[9,13,14] when compared to drilling procedure.

In the present study, the air borne bacterial load is still persisting even after the 30 minutes at the end of treatment. These findings suggest that, after many patients have been treated, the microbiological contamination at the end of the day will be worse and many different species of bacteria may be present in a dental clinic [13]. As stated by Bantley et al [15] there are several factors which influence aerosol distribution which includes type of procedure and use of high volume evacuation, the position of the operatory area and levels of microorganisms in the patient’s mouth.

Although clinical benefits of chlorhexidine are well known, chlorhexidine represents the ideal positive control when testing the efficacy of other agents [16]. Results of this study showed that when 0.2% chlorhexidine gluconate was used as a pre-rinse for 30-second, there was a significantly decrease in the number of bacteria in aerosols during scaling procedure. This finding was similar to the results obtained from various studies reported in literature [7, 17-19]. These studies have shown that antimicrobial mouth rinses used by patients before any dental procedure are intended to reduce the number of microorganisms that might release in the form of aerosols or splatter that can contaminate the Dental Health Care Personnel (DHCP). But this finding was contrary to the study conducted by Serdar Toroglu M et al [20] which showed an insignificant reduction in the number of CFUs of aerosols following the use of a chlorhexidine pre-procedural mouth rinse.

The present study confirmed a potential transmission route of infectious agents, and the results support the importance of protecting against cross-infectious agents contained in dental aerosols. Apart from the universal sanitary and epidemiological procedures valid for dental procedures, the following principles should be followed to reduce the risk resulting from the use of a dental unit and exposure to aerosol.

1. It is strictly recommended that a dental team should use personal protection measures (clothes, gloves, masks, protective goggles, visor shields) as per the infection control guidelines of American Dental Association (ADA) [21]
2. Rinsing the oral cavity of a patient with an antiseptic such as Chlorhexidine, before a procedure.
3. The use of high-performance sucking devices during aerosol production.
4. Routine immunizations of all dental staff
5. Need to carry out more studies should be directed towards developing an effective means for controlling and removing dental aerosols.
6. Additional epidemiological surveys of dental personnel and auxiliary mortality and morbidity are needed to define actual infection rates and the influence of such contamination levels of infections rates.

Though the present study demonstrates lack of significant difference in the microbial aerosols produced by the ultra sonic scaling and drilling procedures, it would be too early to come to conclusive remarks, since the present study was not undertaken under strictly standardized conditions, which is one of the limitations of the current study.
4.0 Conclusion
The results of the present study shows that the number of bacterial aerosols generated in both departments, during routine dental procedure increased significantly and hence there are many chances of transmission of infection to dentists and auxiliary staff. Although present study clearly suggests that a routine pre-rinse with chlorhexidine mouth wash may eliminate the majority of bacterial aerosols generated by the use of the ultrasonic scaling, there is a need for carrying out further studies under strictly standardized conditions. There also a need for drafting and implementing national and international standards and effective preventive measures to protect dental staff and patients from the airborne pathogens transmission.

References

