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Microbial aerosols generation during various dental procedures in an university hospital

Jyoti Sharma*, Manjula Mehta and Sonia B. Bhardwaj

Department of Microbiology, Dr. Harvansh Singh Judge Institute of Dental Sciences & Hospital, Panjab University, Sector 25, Chandigarh, U.T. – 160014 India

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Abstract: *Background:* Aerosols generated during dental procedures carry potential hazardous microorganisms which may harm the patients and the health care worker attending the clinics. Though the risk of aerosol generating procedures had been already in place but has been highlighted after the pandemic of SARS-Cov-2 has setup. *Objective:* The aim of this study is to determine the microbial profile of air in dental hospital due to aerosol generating procedures during the period of clinical activity. *Methods:* The air sampling was done by active and passive sampling both. Passive sampling was done by settle plate technique. *Result:* The significant contamination of air due to aerosol generation while the regular procedures were reported. The viable count of the bacteria present in air during clinical activity ranged from 6.8 to 28.6cfu/m^2/h with a mean value of 17.8cfu/m^2/h and was more than double than that of period of clinical inactivity. Their difference came out to be statically significant. *Conclusion:* Our results demonstrate a marked increase in air contamination due to substantial aerosol generated while performing various dental procedures specifically ultrasonic scalar and air rotor during conservative treatment and scaling procedures.

Keywords: Contamination, Aerosols, Ultrasonic Scalar, Air Rotor.

Introduction

The instances and unwanted complexity of nosocomial infections has been well researched and documented in the literature for the last several decades. Moreover the risk of transmission of several bacteria as well as viruses like SARS-CoV-2 has been realised specifically in these pandemic times.

This accounts or considerable morbidity and mortality and they continues to escalate at an alarming rate. These infections results in the prolonged hospital stay, additional diagnostic and therapeutic interventions finally posing high financial burden on healthcare system. Research has shown that infective hazards are present in dental practices, because many infections can be transmitted by blood or saliva, through direct and indirect contact, droplets, aerosols or contaminated instruments and equipments [1].

Patients and staff of dental clinics are frequently at risk for infections. Many of the procedure carried out in the dental clinics results in the production of aerosol and spatter eg tooth preparation, ultrasonic scaling and tooth polishing [2]. Smaller particles can float in the air and have the potential to penetrate in the passages of the lungs, while the larger ones settle easily onto the environmental surfaces which can become contaminated during patient care [3-4].

The microbial cross contamination is particularly dangerous when considering immunodeficiency patients. Since these infections indicate quality of patient care and a patient safety issue, identifying the microbial profile of air is of special importance. In this paper we tried to quantify the microbes present in the air samples of various dental units using both active and passive sampling techniques.

Material and Methods

Site & Sampling: The study was carried out in the department of Microbiology at Dr. Harvansh Singh Judge Institute of Dental

Sciences & Hospital, Panjab University, Chandigarh. Microbial air contamination was evaluated using active and passive sampling techniques [5]. Samples were collected from different clinics during the full working days when the clinics were running all its dental procedures from 9am to 5pm. Control samples were collected on the day of no clinical activity.

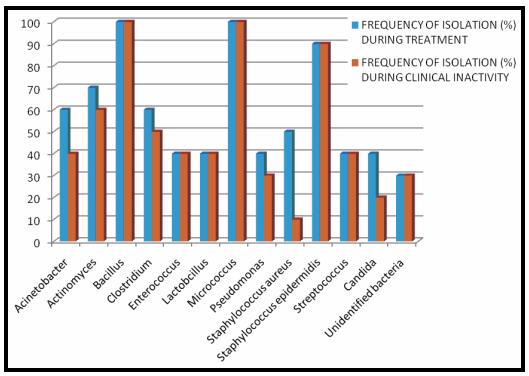
Active sampling Technique: Air samples for active sampling was collected using LA002 (Himedia) system with a flow rate of 280L/min and a sampling volume of 2000L. The number of colony forming units was adjusted using the conversion table provided by the manufacturer and was expressed in colony forming units per meter square per hour cubic meters (cfu/m^2/hr)

Passive sampling Technique: Passive sampling was done by using settle plate method using petriplate of 9cm diameter containing trypticase soya agar. The plates were placed open and exposed to air for four hours [6]. Two plates were inserted in each location. The plates were placed in the monitored room about 1m above the floor and about 1m away from the walls and the other visible obstacles. The microbes transported by inert particles deposit on the surface of agar.

Results

Microorganisms isolated: The various microorganisms isolated from air samples during dental treatment and during the period of clinical inactivity along with their frequencies have been depicted in Table 1. The difference between the various microbes isolated during the treatment and during clinical inactivity has been depicted in figure 1.

Fig-1: Comparative frequency of isolation of microorganisms in the dental clinics during treatment and during period of clinical inactivity



The majority of the organisms were non-pathogenic ones which are either part of cutaneous flora or oral flora. The commonest of them are *Micrococcus*, *Staphylococcus epidermidis* etc. However some pathogenic organisms like *Pseudomonas*, *Staphylococcus aureus*, *Acinetobacter* and *Enterococcus* were also isolated from few units when air was sampled during the dental treatment.

Additionally yeast, Candida was also isolated besides these bacteria. The frequencies of these isolates varied from 30 to 100%. Though higher frequencies were associated with that of non-pathogenic ones and these frequencies of isolation dropped when the air was sampled during the period of clinical inactivity. In this study we also encountered few unidentified gram negative rods.

Table-1: Frequency of isolation of microorganisms in the dental clinics during treatment and during period of clinical inactivity

Microorganism	Frequency of Isolation (%) During Treatment	Frequency of Isolation (%) During Clinical Inactivity
Acinetobacter	60	40
Actinomyces	70	60
Bacillus	100	100
Clostridium	60	50
Enterococcus	40	40
Lactobcillus	40	40
Micrococcus	100	100
Pseudomonas	40	30
Staphylococcus aureus	50	10
Staphylococcus epidermidis	90	90
Streptococcus	40	40
Candida	40	20
Unidentified bacteria	30	30

Morphotypes & Viable count: The number of morphotypes ranged from 2 to 13. Table 2 describes the viable count of the microorganisms and number of distinct colony morphotypes isolated from air sampling

during both periods of clinical treatment and clinical inactivity. The viable count ranged from $6.8X10^2$cfu/m^2/h to $28.6X10^2$cfu/m^2/h with a mean value of $17.8X10^2$cfu/m^2/h_from the air which was sampled during the treatment and this viable count was reduced to more than half when air was sampled during clinical inactive period.

The difference between the colony forming units during the treatment and during clinical inactivity has been depicted in figure 2 and figure 3 describes the difference between the morphotypes count during treatment and during no treatment.

Fig-2: Comparative Viable Count (cfu/mm^2/hr) during treatment and during the period of clinical inactivity detected by passive sampling of air

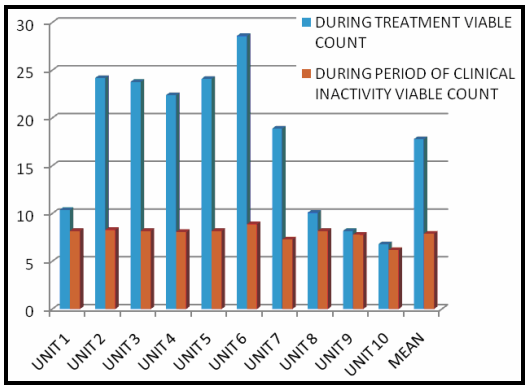
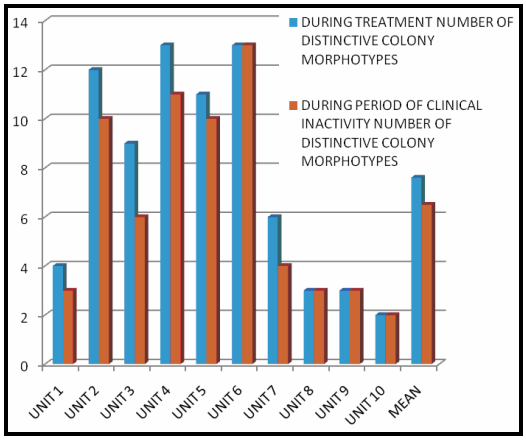


Fig-3: Comparative number of morphotypes during treatment and during the period of clinical inactivity detected by passive sampling of air



The difference between the both values is statistically significant. (*t*-value is 3.83912 and *p*-value is .000601. The maximum number of morphotypes and the highest viable count were recorded where the patients with inflammatory periodontal conditions were being treated with ultrasonic aerosol producing instruments and from where the patients were undergoing conservative treatment involving aerosol producing hand pieces and air rotors.

Table-2: Viable count and number of morphotypes during treatment and during the period of clinical inactivity detected by passive sampling of air

	During treatment		During period of clinical inactivity	
Unit no	**Viable count $X10^2$ CFU /m^2/h**	**Number of distinctive colony morphotypes**	**Viable count $X10^2$CFU /m^2/h**	**Number of distinctive colony morphotypes**
1	10.4	4	8.2	3
2	24.2	12	8.3	10
3	23.8	9	8.2	6
4	22.4	13	8.1	11
5	24.1	11	8.2	10
6	28.6	13	8.9	13
7	18.9	6	7.3	4
8	10.1	3	8.2	3
9	8.2	3	7.8	3
10	6.8	2	6.2	2
Mean	17.8	7.6	7.9	6.5

Discussion

Currently there is raised anxiety and stress amongst dental health professionals in relation to the risk of contracting and transmitting COVID-19 in light of this pandemic. Several factors contribute to air contamination in health care centres. Inappropriate air conditioning system, ineffective aseptic procedures, doors and open windows remains the main cause of concern [7].

Most of the treatment procedures carried out in dental settings have potential source of creating spatter and aerosols. Hence the microbial load in air increases during the treatment procedures. In the present study the mean viable count during the period of treatment came out to be 17.8X10cfu/m^2/h. Our results are in concordance with the few earlier studies [8-9].

The present result shows that there is more than two fold increase in the viable count of microorganisms during clinical treatment procedure as compared to period of clinical inactivity. A study by Grenier D [10] reported that for ultrasonic treatments the level of contaminants was 216cfu/m^3 and for operative treatment it was 75cfu/mm^3. However in another study by Azari et al [11] the level of contamination was as high as120-280cfu/mm^3 during dental surgeries. Benett et al [12] reported that the microbial aerosol peak concentration in dental treatment room were associated with scaling procedures (47% of procedures giving rise to a peak) and to a lesser extent by cavity preparation. (11%)

In our study few bacteria like *Staphylococcus epidemidis* and *Micrococci* which are normal inhabitant of skin were predominantly found in both the occasions i.e period of treatment and clinical inactivity as well. Similar findings have been reported by Decraene et al [4]. Osorio et al [13] reported *Staphlyococcus* as predominant air borne microbe in dental clinic both before and after clinical activity. The frequency of isolation of *Streptococci* was 40% in the present study. They also concluded that during clinical activity the detection rate of Streptococci decreased with increasing distance from the dental chair.

Miller et al [14] described that particles present in splatter originating from oral cavity do not remain air-borne for long and quickly settle on neighbouring surfaces. The microorganisms prevalent in environment were also isolated from air samples besides those present as part of human normal flora. The most common of such microbial isolates in the present study are *Bacillus* and *Clostridium*.

Conclusion

The result of present study must be used for increasing awareness and qualifying the risk of exposure of health care workers breathing spaces to aerosolised pathogens in the dental clinics. Our study also emphasizes the role of regular monitoring of biological risk for both patients and health care workers, especially in detecting alert values. The result would be useful in planning appropriate strategies to locate and reduce air microbial load in order to minimizing their survival and spread in these areas of concern.

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*All correspondences to: Dr. Jyoti Sharma, Senior Assistant Professor, Department of Microbiology, Dr. Harvansh Singh Judge Institute of Dental Sciences & Hospital, Panjab University, Sector 25, Chandigarh, U.T. – 160014 India. E-mail: contactjyotisharma@yahoo.co.in