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ORIGINAL ARTICLE

Aerosol contamination in a rural university dental clinic in south India

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Abstract

Aerosol and splatter are a concern in dentistry because of possible transmission of infectious agents and their potential effects on the health of patients and dental personnel. The aim of this study was to assess and compare amount of aerosol contamination produced by ultrasonic scaler and high speed air turbine hand piece in immediate vicinity of patient's mouth during dental procedures and to determine level and type of microbial contamination present on white coats of dental personnel in a rural dental setting. The study was conducted in two parts, with assessment and comparison of amount of aerosol contamination produced by ultrasonic scaler and high speed air turbine hand piece in first part and examination of fifty one white coat's contamination of dental personnel in second part. Higher colony count was seen during oral prophylaxis which was significantly than during cavity preparation; and the count was highest from patient's chest area. Dental procedures like scaling and cavity preparation cause considerable aerosol contamination in the immediate vicinity of the patient's mouth and of dentists' barrier clothing.

Key Words

Infection control, Aerosol contamination, White coat, Rural.

Introduction

The spread of infection through aerosol and splatter has long been considered one of the main concerns in the dental community because of possible transmission of infectious agents and their potential effects on the health of patients and dental personnel. Even before the discovery of specific infectious agents such as bacteria and viruses, the potential infection by the airborne route was recognized.[1]

The terms "aerosol" and "splatter" in the dental environment were used by Micik R E *et al* in his pioneering work on aerobiology.[2] Aerosols were defined as particles less than 50 micrometers in diameter. Particles of this size are small enough to stay airborne for an extended period before they settle on environmental surfaces or enter the respiratory tract. The smaller particles of an aerosol (0.5 to 10 µm in diameter) have the potential to penetrate and lodge in

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the smaller passages of the lungs and are thought to carry the greatest potential for transmitting infections. Splatter was defined as airborne particles larger than 50 µm in diameter behaving in a ballistic manner,[2] which are ejected forcibly from the operating site and are in a trajectory similar to that of a bullet until they contact a surface or fall to the floor. These particles are too large to become suspended in the air and hence airborne only briefly.

The possible sources of airborne contamination during dental treatment are dental instrumentation, saliva and respiratory sources, and the operative site. The oral cavity harbors numerous bacteria and viruses from the respiratory tract, dental plaque, and oral fluids. Any dental procedure that has a potential to aerosolize saliva will cause airborne contamination with organisms from some or all of these sources.

Dental hand pieces, ultrasonic scalers, air polishing devices and air abrasion units produce airborne particles by the combined action of water sprays, compressed air, organic particles, such as tissue and tooth dust, organic fluids, such as blood and saliva from the site where the instrument is used. This form of contamination also involves the personal protection equipments (PPE) defined by OSHA regulations 1992,[3] as "specialized clothing or equipment worn by an employee for protection against infectious materials". The PPE includes gloves, gowns/ white coats, masks and respirators, eye and face shields etc. Also, many articles of clothing and equipment, such as neckties, stethoscopes, pens, lanyards, identity badges along with the doctor's coat have been noted to carry potential pathogens. Almost all PPEs are used as disposable forms but the white coats are less frequently changed and hence it could be an important link in the chain of infection.

It is known that dental personnel's clothing or uniforms (white coat) are spattered by blood, aerosol and saliva. There is a definite risk of infection with various transmissible agents. Contamination of skin and clothing by "splashes" or touch is practically unavoidable in hospitals. The white coat worn over personnel clothing, is a means of protection from such contamination.[4]

Majority of the documented studies[1, 2] have been carried out in isolated operatories under stringent aseptic techniques with well maintained high-velocity suctions and constant ventilation facilities. However no study done in a rural dental clinic setting, in developing countries, with less than optimal facilities, has been reported in the literature. Also in tropical countries like India the temperature and humidity play a paramount role in spreading infections in a rural clinical setup.

Hence the objectives of the present study were:

- To assess and compare the amount of aerosol contamination produced by ultrasonic scaler and high speed air turbine hand piece in the immediate vicinity of the patient's mouth during dental procedures in a rural dental clinic.
- To determine the level and type of microbial contamination present on the white coats of dental personnel in a rural dental setting.

Materials and methods

The present study was conducted in a rural dental care centre of Department of Community Dentistry. This center caters to a large rural population and provides free dental care with the help of local voluntary organizations. In pursuit of the stated objectives, the study was conducted in two parts.

Study 1

The first part of the study was conducted to assess and compare the amount of aerosol contamination produced by ultrasonic scaler and high speed air turbine hand piece in the immediate vicinity of the patient's mouth during the dental procedures.

Ten voluntary participants with a minimum of twenty permanent teeth and a mean Plaque score of 1.8 to 3.0 on the Simplified Plaque Index[5] were considered for oral prophylaxis and ten patients with carious cavities requiring restoration were selected for the study with their informed consent**.** Patients with medical conditions contraindicating the use of ultrasonic scalers and high speed air turbine hand pieces and those on systemic or topical antibiotics were excluded from the study.

The sample size was based both on the study by Logothetis DD *et al.*[5] and on statistical analysis of four sample sites. Four standardized locations of the operatory were chosen to be evaluated for each patient using blood agar plates placed at - operator's chest area, patient's chest area and at a distance of 12 and 24 inches from the operating area attached with the help of a headrest extension device [6] on a standardized chair with controlled frequency and water pressure during treatment procedures. The average distance between patient's mouth and his own chest was 12 inches and to dentist's chest was 10 – 12 inches. Johnston *et al.*[7] have proved that blood agar plates are a valid medium for culturing airborne bacteria.

Treatment for all the study patients was carried out by the same dentist on all the days and only one patient was treated per day to allow the room to be free of aerosols. Before each appointment, all operatory surfaces were cleaned and disinfected using 80 percent isopropyl alcohol. Appropriately laundered white coats and drapes were used for each appointment.

Prophylaxis was carried out with a Magnetostrictive scaler working at a speed of 30 kHz, with a water pressure of 0.3 MPa during each treatment. A high speed air turbine handpiece, working at a speed of 400,000 rpm and with air drive pressure of 0.25 MPa was used for preparing cavities on carious teeth.

Treatment was carried out by placing four sterile coded agar plates uncovered at predesignated sites to collect samples of aerosolized bacteria.

Study 2

This part of the study was done to determine the level and type of microbial contamination present on the lab coats of dental personnel in the dental clinic.

A survey of the 51 white coats of dental interns, graduate students and faculty was done. All the participants wore the white coats as per the protocol to be maintained in the dental school. All white coats were full sleeved, made of cotton- polyester material with two pockets at the bottom, one on each side. Also the guidelines of dental school for the students are to launder their own white coats, which they do with varying degrees of regularity.

A pre-tested questionnaire was distributed to the participants assessing the duration of use of their white coats, frequency of washing white coats and practice of exchanging them. The participants were also asked to grade arbitrarily, their white coat as clean, moderately clean or dirty. In addition the cleanliness of the coat in appearance was assessed subjectively [8] by the investigator as clean, moderately clean or dirty. The white coat of each participant was sampled using sterile saline- moistened swabs from the two pre-determined areas i.e. chest area of the white coat and the pocket mouth both on the side of the dominant hand.

Microbiological procedure

After the samples were collected, they were taken to the Department of Microbiology, Kasturba Medical College, Manipal for further analysis.

In the first study, ten percent sheep blood agar plates [5] were used which were incubated at 37 degree Celsius for 24 hours after collecting the sample. Counting of the colony-forming units was performed by a microbiologist who was blinded regarding the time of exposure and location of agar plates. Alpha haemolytic streptococci producing a green or hazy discoloration with colonies of about 1mm in diameter on blood agar plates were expressed as colony-forming units per media plate (CFU/plate).

The swabs collected in the second study were streaked onto the agar plates which were then incubated overnight at 37 degree Celsius.[8, 9] Examination for total bacterial count and the presence of potentially pathogenic bacteria was done.

Suspected colonies were indentified and antibiotic sensitivities were determined by standard laboratory methods in both the studies.[9]

Statistical analysis

T-test was performed to compare mean CFU/plate during the two procedures. The cut-off level for statistical significance was taken at 0.05. Data was analyzed using SPSS version 14.

Results

Table I shows mean colony forming units/agar plate (CFU/plate) according to treatment procedures and location, during use of use of ultrasonic scaler and high speed dental hand piece. The highest number of colonies was from patient's chest area and least CFU/plate was at a distance of 24 inches away from the operating area during both procedures. Significantly higher colony count was seen during oral prophylaxis than during cavity preparation.

Table I: Mean colony forming units/agar plate (CFU/plate) according to treatment and locations during use of use of ultrasonic scaler and high speed dental hand piece

Sample sites of agar plates	CFU/plate ultrasonic scaler Mean ± SD	CFU/plate high speed dental hand piece Mean ± SD	P - Value
Patient's chest area	102.4±14.5	72.2±13.7	0.02
Operator's chest area	72.4±15.7	49.3±16.5	0.05
12 inches from operating area	40.3±20.4	53.4±14.5	0.06
24 inches away from operating area	25.7±11.1	24.6±15.0	1.01
Mean contamination during procedures	74.6±12.1	50.1±16.3	0.06

Table II: Frequency distribution of the participant's response according to the study variables

		n (%)
Participants	Faculty	12 (23.5)
	Graduates	19 (37.3)
	Interns	20 (39.2)
Gender	Male	25 (49)
	Female	26 (51)
Frequency of washing white coat	Everyday	4 (7.8)
	Twice a week	13 (25.5)
	Once a week	31 (60.8)
	Once fortnightly	2 (3.9)
	Once a month	1 (2)
Practice of exchanging white coat	Yes	3 (5.9)
	No	48 (94.1)
Self grading white coat cleanliness	Clean	14 (27.5)
	Moderately clean	36 (70.6)
	Dirty	1 (2)
Examiner grading white coat cleanliness	Clean	14 (27.5)
	Moderately clean	29 (56.9)
	Dirty	8 (15.7)
Spills on white coat	Aerosol	39 (76.5)
	Saliva	4 (7.8)
	Others	8 (15.7)

Table III: Frequency distribution of the white coats showing growth of microorganisms

		Faculty n (%)	Graduates n (%)	Interns n (%)
No growth	chest area	1 (8.3)	5 (26.3)	3 (15)
	pocket area	5 (41.7)	5 (26.3)	4 (20)
	Total (%)	6 (25)	10 (26.3)	7 (17.5)
Gram positive organisms	chest area	9 (75)	13 (68.4)	13 (65)
	pocket area	8 (66.7)	12 (63.1)	12 (60)
	Total (%)	17(70.8)	25 (65.8)	25 (62.5)
Gram negative organisms	chest area	2 (16.7)	4 (21)	4 (20)
	pocket area	1 (8.3)	0 (0)	3 (15)
	Total (%)	3(12.5)	4 (10.5)	7 (17.5)

49% males and 51% females participated in the study. Majority of the participants washed their white coats once weekly and the practice of exchanging white coats was confirmed by 5.9% participants. White coat cleanliness was self graded by 70.6% participant's as moderately clean, whereas only 56.9% were graded by the examiner as moderately clean (Table II).

The presence and absence of microbial growth in the chest area and pocket area of the white coats of faculties, graduates and interns have been shown in Table III. 26.3% of the graduates showed no growth in the chest area and pocket area of their white coats. Majority of the faculty, graduates and interns showed growth of gram positive organisms in the second study sites of their white coats. However, growths of gram negative organisms in the two areas were comparatively lesser.

Discussion

Almost all dental procedures involving the use of dental hand pieces, ultrasonic scalers, air polishing devices and air abrasion units produce aerosols. The propelling force of a high-speed dental drill and the cavitation effect of an ultrasonic scaler, combined with a water spray, can generate numerous airborne particles derived from blood, saliva, tooth debris, dental plaque, calculus, and restorative materials. A safe environment is hence, an important consideration in a dental clinic.

The objectives of the present study were to assess and compare the amount of aerosol contamination produced by ultrasonic scaler and high speed air turbine handpiece in the immediate vicinity of the patient's mouth during dental procedures under controlled conditions and to determine the level and type of microbial contamination occurring on the white coats of dental personnel in a rural dental clinic under general conditions.

The results of the study showed that aerosol contamination was more during scaling procedure than during use of high speed air turbine hand piece. This increase in microbial contamination can probably be attributed dental plaque, both supra gingival and sub gingival which are the major sources of pathogenic organisms. During both the procedures, the highest number of colonies was seen on the plates positioned on patient's chest area, which is in conformity with another study [10] where it was concluded that the larger salivary droplets generated during dental procedures settle down rapidly from the air with heavy contamination of a patient's chest area. This was followed by the contamination on operator's chest area and 12 inches from the operating area. Least colonies were formed at 24 inches away from the operating area, which is also consistent with another study. [5]

Contamination of operator's working gear, in this case, the white coat, was also another focus of the study where microbial contamination of the white coats of the interns, graduate students and dental faculty in the dental clinics was assessed. Among the two predetermined sites selected for examination of the white coats, the chest area showed the highest contamination followed by the pocket mouth both on the side of the dominant hand. Loh W *et al*.[4] in their study found the sleeve and the pocket of the white coat as the sites that were most highly contaminated. As the dentists examine patients, the sleeve of the coat, especially the cuff, is the site that most frequently comes into contact with the patient. Furthermore, transfer of bacteria from sleeves to hands (and vice versa) is also possible. Also, Wong D *et al*.[11] and Muhadi SA *et al*.[8] reported in their studies that the cuff and the pocket had significantly higher levels of contamination.

Considerably high percentage of gram positive cocci were isolated from the second study sites on the white coats i.e. 70.8%, 65.8% and 62.5% from the white coats of dental faculty, graduate students and interns respectively. These findings are in accordance with another study [12] where it has been found that bacteria are most likely to be isolated from the pockets and sleeves of white coats since these were the sites of frequent contact. The other most common form of microbes found on various sites was Bacillus species. Gram negative bacilli and other form of microbes which are considered environmental microorganisms with no clinical significance and skin commensals such as coagulase negative staphylococci were also found with previous studies.[13, 14]

Because of the frequency of the patient contact and the busy schedule of students it is reasonable to expect the white coats to become colonized with potentially pathogenic bacteria and this was demonstrated in the study. It has been also seen that the coats become contaminated quickly once worn, as there appears to be little difference between the colony counts according to the frequency of laundering [9]. In the present study, majority (60.8%) of the study participants washed their white coats once a week. The frequency of white coat laundering in the study population was better as compared to the findings obtained by Muhadi *et al*.[8] where 34.4% of students washed their coats once a month; 15.6% once a week and 9.4% twice a month. Remaining 40.6% would wash their coats every two months or even longer. Also another study stated that most students laundered their coats at either one or four weekly interval with over a third of them laundering it monthly.[4]

A grading of the white coats by the study participants and examiner was done separately to acknowledge the perception of the white coat's cleanliness. Majority of the interns, graduate students and faculty considered their white coats as moderately clean whereas the examiner rated cleanliness of the white coats was lower. This reveals that study participants who thought their white coats as clean were not perceived to be clean by the examiner pointing to a possible social desirability bias. Hence there is a need of further training and a stricter regime of laundering should be followed for the students so that they inculcate the habit.

Results of the first study showed that dental procedures like scaling and air turbine usage lead to considerable microbial laden aerosol contamination in the immediate vicinity of the patient's mouth and subsequent contamination of the dentists' barrier clothing. This has a potential to spread infection to dental personnel and patients in the dental office and hence, a safe environment is an important consideration in the dental clinics. The data does not provide a causal link between procedure and white coat contamination, but the literature supports this. However, the data confirm the dispersal of aerosols and the contamination of white coats; therefore, it is important to use PPE and clean white coats in order to protect patients and dental personnel. This should be considered especially under a rural set up where sophisticated infection control regimens is difficult to implement and dental treatment has to be catered to many patients. Simple, readily available methods can be used to minimize both the number of aerosols and clinicians' exposure to the aerosols in the dental office. A routine pre-rinsing with any antimicrobial mouth rinse like chlorhexidine may have potential in-office use as part of an infection control regimen in minimizing the contamination of bacterial aerosols generated during the dental procedures. Also it is recommended that stricter dental school guidelines should be set for handling and washing procedures

of white coats by implementing compulsory hospital laundry service for dental personnel. Along with this, a good means of preventing clothing- borne cross contamination between patient and dentist and any other care provider could be the wearing of impermeable clothing in disposable forms of PPE such as white coats, drapes.

However, since it is virtually impossible to completely eliminate the risk posed by dental aerosols, it is possible to minimize the risk by layering of protective procedures[1] along with universal barrier techniques.

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