MENACE IN THE AIR

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ABSTRACT

Aerosols produced during dental therapy poses a great occupational health hazard to the dental professionals and a great risk of transmitting infectious diseases to the patients. This review discusses about aerosols generated from ultrasonic scaling and methods to control it.

KEY WORDS: Aerosols, splatter, airborne infection.

INTRODUCTION

Dental aerosol has been a great concern for the dental practitioners during the past several years. These airborne particles are composed of debris and microorganisms propelled into the air from the oral cavities of the many people treated throughout the day within the clinic. Dentists presume they have enhanced immunity developed over the years of practice. Yet the most common reason reported by them for falling sick is respiratory infection. Mick R.E et al (1969)1 showed that bacterial concentration in dental aerosols exceeded those produced during coughing or sneezing.

What is an Aerosol?

Air suspended liquid or solid particles that measure less than 50 μm in diameter, remain airborne for extended periods and are subject to inhalation unless protective measures are implemented.

DEFINITION

1. Mick R.E et al (1969)1 defined dental aerosols as being particles smaller than 50 μm, with any particles larger than 50 μm described as splatter.
2. Cooley R. L. (1984)2,3 defined an aerosol as suspensions of extremely fine airborne particles that are liquid, solid or combinations of both and that are 50 μm or less in diameter.
3. OSHA (Occupational Safety and Health Administration) 19942 described infectious aerosols are capable of causing illness and are composed of two types. (1) Dust borne aerosols, (2) Droplet nuclei.
4. Dust borne aerosols are larger in size, easily removed by sedimentation or filtration and not a direct threat of infection control.
5. Droplet nuclei are smaller in size, settle out of the air slowly, remain viable for a longer period and a greater threat to the patient and clinician.

MICRO ORGANISMS AND AEROSOLS

Checchi et al 3,4 reported that about 150 million micro organisms can be found in 1 gm of fluid from gingival crevice of a patient who has poor oral hygiene and about 6 billion are present in 1 ml of saliva. Water samples from ultrasonic scalers, high-speed handpieces, and water syringe lines showed microbial concentrations of upto 2.6 million, 3.3 million and 1,90,000 colony forming units per ml respectively (Gross et al.).5 Larato et al (1966)6 found that the amount of bacteria expelled into the air after using an ultrasonic scaler for 5 minutes had increased by 3000%. Mick R.E et al (1969)1 showed that bacterial concentration in dental aerosols exceeded those produced during coughing or sneezing. Earnest et al (1991)7 revealed a high proportion of Streptococci mutans and Streptococci sanguis with the extra oral...
bacterial level reaching around 200 colony forming units per 10 seconds of drilling, during cavity preparation by a high speed handpiece with spray.

POTENTIAL PATHOGENS
Aerosol produced by ultrasonic scalers may contain potentially infectious blood borne and airborne pathogens such as

**Bacteria**
*Pneumococci*  
*Staphylococci*  
*Streptococci*  
*Mycobacterium tuberculosis*

**Viruses**
*Epstein–Barr virus*  
*Cytomegalovirus*  
*Herpes simplex virus*  
*Hepatitis virus*  
*Influenza virus*  
*Common cold virus*

How Aerosols are produced

![Diagram of ultrasonic scaling process]

- The coolant water interacting with the rapidly vibrating scaler tip produces copious aerosols that are routinely contaminated with bacteria.
- The water lavage has three beneficial effects
  - Acoustic microstreaming – unidirectional fluid flow
  - Acoustic turbulence – an intensified swirling effect
  - Cavitation activity – formation of bubbles

The combined effect of all three disrupts the microbial flora.

Other than scaling aerosols are produced during
- Air polishing
- Use of high speed hand pieces in tooth preparation for restoration
- Air water syringes

Holbrook et al (1978)8 found an increase in the number of airborne bacteria when ultrasonic scalers were used in a periodontal clinic as opposed to similar clinics in which ultrasonic scalers were not used. Glenwright et al (1985)9 compared the usage of air polishing with conventional polishing with rubber cup and paste and suggested aerosols produced more in air polishing. Barnes J.B. et al (1998)10 showed the presence of aerosols containing blood during subgingival scaling with ultrasonic scalers. Stevens R.E (1963)11 demonstrated the existence of spray contaminated with microorganisms in the areas of operation with the use of air turbine handpiece. They pointed out that spraying with water and solid particles could create health problems.

RADIUS OF AIRBORNE INFECTION
The greatest amount of aerosol are found during all time trials in the 30-90 cm range (1-3 feet), which is in the operator’s work zone. The particulate concentrations are present for 240 cm (nearly 8 feet), the greatest concentration present at the end of the procedure while a mean aerosol amount present even after two hours.
Bentley et al (1994) demonstrated high counts on the operator's mask and chest of the patient, when using high speed dental equipments.

AEROSOLS – TRANSMISSION OF INFECTION
Dental patients fall into several risk categories
1. Patients suffering only from dental or oral diseases.

Prevention of Aerosols Infection

**Personal Protection**
* Immunization
* Hand washing
* Gloves
* Masks
* Eye wear
* Clothing
* Hair covering

**Patient Protection**
* Plastic Drape
* Towel
* Eye wear
* Hair covering

**Reduction of Aerosols**
* Patient Position
* Pretreatment rinse
* Water control
* Suction
* HV Evacuator (ARD)
* Air filtration
* DUWL
* Environment

Flow Chart - II

I. Personal Protection
A. Immunisation

* Vaccinations for hepatitis B, measles, mumps, rubella, tetanus, polio, diphtheria, pertussis.
  * With a gentle and effective * antimicrobial antiseptic soap

B. Hand Washing

* Reduces microorganisms in folds and grooves of skin
  * If break in skin, prevents autogenous infections

C. Gloves

D. Protective barrier for mouth nose and eyes

1. **Masks**
   An effective mask will
   
   Prevent inhalation and direct contact with aerosols and splatter
   Filter particles (95% of droplets 3.0 to 3.2 µm)
   Have minimal marginal leakage
2. Healthy carriers
3. Symptomatic or asymptomatic carriers of a transmissible disease at a contagious or non contagious stage.

Dissemination of micro organisms occur by three routes (Molinari J.A.et al 1992)13
1. Direct contact with infectious lesions, blood or saliva.
2. Indirect transmission – through contaminated objects.
3. Aerosolization – airborne transfer of infected blood, saliva, nasopharyngeal secretion droplets.

INFECTIONS SPREAD THROUGH AEROSOLS
* Conjunctivitis
* Respiratory tract infections
* Common cold
* Pneumonia
* Tuberculosis
* Influenza

Herpetic & Hepatitis infections
Gross et al (1992)14 suggested that the airborne microbes expelled during ultrasonic scaling have the potential to penetrate deep into the respiratory tract. Miller R.L (1995)15 studied about the airborne route for Hepatitis B infection in dental professionals.

Prevention and Protection
- Personal Protection
- Patient Protection
- Control of aerosol production

Mick R.E et al (1971)16 evaluated the efficacy of commercial surgical masks and noted that all the particles those with 5 µm or less in diameter, penetrate the masks which are hazardous to health.

Type of Masks
a. Glass fiber mat and synthetic fiber mat - most effective filters
b. Dome mask with elastic band - distance from face decreases rate of moistness
c. Surgical tie on mask or ear loop mask
* Better filtration
* Closer adaptation to face
* Becomes moist quickly - moistness compromises effectiveness of barrier
d. Disposable particulate respirator
* Provide increased protection when treating patients with infectious tuberculosis.
* Tight face seal and proper fit.
* Greater filtration efficiency.

1. Protective Eyewear
To protect eyes and mucous membranes from physical projectiles, chemical damage and microbial injury.

Type of eyewear
Traditional prescription glasses - Offer limited coverage

Safety glasses or goggles
* Cover entire eye orbit
* Frame extensions for expanded facial coverage
* Possible to wear over prescription glasses
* More shatter resistant

Face shields
* Ensure maximum coverage
* Adjunct to glasses and mask for high aerosol generating procedures.
* Not a substitute for mask

E. Protective clothing – gown with high neck and long sleeves
F. Hair Covering – head caps.

II Patient Protection
1) Plastic Drape, 2) Towel, 3) Protective Eye wear, 4) Hair Covering

III Control of Aerosol Production
a) Patient position, b) Pretreatment rinse, c) Water control, d) High volume suction
e) High volume Evacuator, f) Air Filtration, g) Dental unit water lines

Patient Position
a) Normal supine, head turned
b) Cause water to pool in cheek area of the mouth, minimizing aerosol production
c) Retraction of cheek or lip in a cupped position. Tissue cupping to keep water spray inside the mouth.
Pre Treatment Rinse
1) A pre procedural mouth rinsing with 0.2% chlorhexidine and listerine reduced the microbial levels in aerosols.
2) Optimal effectiveness is by two consecutive 30 secs rinsing with 0.2% chlorhexidine or listerine, 10 minutes prior to the procedures.

Mohammed C.I et al (1964)18 evaluated the preoperative use of an antibacterial mouth rinse and concluded that pre procedural mouth rinse reduces the number of bacteria in the oral flora and thus decreases the health hazards in aerosol contamination. Wyler D. et al (1971)19 demonstrated that pre procedural rinsing and hygiene procedures reduced the bacterial counts in the aerosols. Worrall S.F. et al (1987)20 suggested that preoperative rinsing with 0.2% chlorhexidine and high volume aspiration during air polishing reduces airborne contamination. De Paola L.G. et al (1991)21 suggested pre procedural rinsing with Listerine, decreased the aerobic and anaerobic counts in saliva.

Water Control
1) Water control reduces aerosol production, improves visibility of treatment area, patient comfort.
2) Water spray should create a light mist or 'halo' effect with no excess dripping of water.

High Volume Suction
A high volume suction tip reduces aerosol production

High volume Evacuator
1) Use of a large bore high volume evacuator – aerosol reduction device (ARD).
2) ARD attached to the ultrasonic scalers, significantly reduced microbial counts in the aerosols.


Air Filtration
To prevent recirculation of contaminated air and prevent transfer of microbes. Pollok N.C et al (1970)25 found that surface contamination was minimized by the in-between patient environment air washes with laminar air flow. Williams G.H et al (1970)26 also demonstrated the importance of laminar air flow in the improvement of public health in dental operatory.

Filters in ventilation and air conditioning systems. Cellini L et al (2001)27 stressed the usage of effective infection control procedures and a system of air filtration in control of airborne contamination.

High efficiency particulate air filters (HEPA) renewed at regular intervals are very effective. Pelleu G.B et al (1970)28 demonstrated that air filtration in dental clinic through the blower filter module with high efficiency particulate air filters (HEPA) resulted in the significant reduction in the number of viable particles in the air.

In absence of air purifiers, good ventilation with constant fresh air flow will be useful.

Dental Unit water Lines (DUWL)
1) Should have water check valves to prevent aspiration of micro organisms into the water lines
2) Sterile water for hand piece, air water syringe and scaler unit
3) Bacterial filtration unit attached to water lines
4) Flushing water lines with disinfectant

CONCLUSION
Dental surgeons need to keep two important points in mind

Dental procedures inadvertently generate aerosols, containing organisms and debris from
each patient’s oral cavity, and these can be harmful to everyone present in the clinic.

All who enter the office must breathe the dental office air continuously in order to sustain life, so let us strive to minimize dental aerosols.

By looking at patient preference and the operators convenience and to reduce the chair side time the ultrasonic scaler usage is increasing day by day and so we as the operators should always consider the aerosol effects of the particular case handling and should not fail to take preventive steps in pre-sterilization, equipment set-up and the room atmosphere with strict filtration effects and care to be taken for the protection of the patient, the operator and other persons in the clinic.

REFERENCES