

REVIEW ARTICLE

Cross Infection in Dentistry and the Dental Aerosols - A Potential Health Hazard

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ABSTRACT

Many hazards are often associated with different occupations and known as occupational hazards. Dentistry is also one of those professions having many occupational risks. Such hazards are broadly categorized into chemical, biological, physical, mechanical and psychological factors. Cross infection is one of such hazards faced by the health care providers' particularly dental workers. Cross infection is the transmission of infectious agents between patient and staff in clinical environment. Control of cross infection has remained the major concern of the dental community for decades. Various vectors are involved in cross infections in Dentistry including patients, environment (water, air), instruments etc. Particularly among the environmental factors, airborne route is one of the major routes of cross contamination and so aerosols produced in dental environment carry greatest pathogenic potential. Production of aerosols and splatters occur because of many procedures carried out in mouth including crown preparation, ultrasonic scaling, caries excavation etc. Patients, dental instruments and dental unit waterlines (DUWL) are the important sources of contaminated aerosol production in dental operator. Use of personal Protective equipments, regular use of pre-procedural mouth rinses and high evacuation devices are few of the suggested methods to reduce risk of cross contamination especially through aerosols and splatters in the dental offices. The related articles were searched through PubMed and Google Scholar.

Keywords: Dental Aerosols; Cross Infection; Airborne Contamination; Dental Operator; Personal Protective Equipment; Saliva.

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INTRODUCTION

Certain employments are often associated with certain risks, which are known as occupational hazards¹. Such hazards may include any material, substance or process that predispose or itself cause accidents or disease at workplace². According to the estimation of WHO, there is annual exposure of about 3 million health care workers to blood borne viruses³.

Among different professions, Dentistry is also one of them which is surrounded by many occupational risks⁴. These hazards often cause different diseases in dental health care workers which sometimes develop and intensify with time⁵.

Majority of dental practitioners and public consider the profession of dentistry as extremely hazardous⁶. Hazards found in dentistry are broadly categorized as chemical, physical, biological, mechanical and psychological factors⁷. Physical hazards include cuts or puncture wounds from needles or other sharp instruments, eye injuries occurring from projectiles etc⁸. Hazardous radiation including ionizing (X-rays) and non-ionizing radiation (visible and UV light) can badly affect the lives of dental health care providers⁹.

Hearing problems are usually caused by noise producing devices used in dental setup including hand pieces, ultrasonic scalers etc¹⁰. Mechanical hazards may include different musculoskeletal problems arising as a result of wrong body postures

or repeated body movements¹¹. While chemical hazards can be organic (gases, resins, solvents), inorganic (mercury toxicity), caustics (hydrogen peroxide, formaldehyde) or Latex glove allergy (contact dermatitis)¹². Stress, excessive work load and lack of job satisfaction can give rise to different psychological problems⁶. Biological hazards can occur due to cross contamination, infections and allergens of biological origin¹³.

DISCUSSION

Bernadino Ramazzini, known as the "Father of Occupational Medicine" recognized the role of occupation in health and disease in the 18th century. Occupational hazard is defined as risk to a person arising out of employment and can refer to any material, substance or situation that predisposes or itself causes accidents or disease at a work place¹⁴. Cross infection is one of the greatest health risk and occupational hazard confronted by the dental health care providers¹⁵.

1. Cross Infection in Dentistry

Cross infection is the transmission of infectious agents between patient and staff in clinical environment¹⁶. The world's health care system is facing a serious threat because of large number of cases of hospital-acquired infections¹⁷. Dental community is also combating this issue and so the control of cross infections is one of its biggest target¹⁸. The dental community's main concern for decades has been the spread of infection and its control in the clinical environment¹⁹. Accordingly a study by Mahboobi et al., dental practitioners among all health care workers is greatly exposed to infectious agents²⁰. On the other hand, it was reported in a study that five patients got HIV infection from an American dentist and this issue raised the concern of infection control among the dental communities²¹. The factors, which are predisposing dentists or patients to microbial infections, are the surgical nature of the dental practice and close proximity to patient's mouth²². Various vectors are involved in the spread of infections in dentistry including instruments and air²³. Particularly patient's blood, saliva and respiratory secretions are most significant vectors involve in cross infection²⁴. Cases have been reported regarding the exposure of dental workers to infectious materials, including contaminated equipment, body substances, environmental surfaces, water, or air²⁵. The major biological risk is those microorganisms that are present in non-sanitized or contaminated surfaces, biological matrices (blood, saliva and gingival fluids), dental unit water lines, or emitted by patients²⁶.

Percutaneous Exposure Incidents

Health care workers including dentists are greatly affected by percutaneous incidents including needle stick and sharp injuries¹⁴. Restricted field of

vision and limited access in the working area make dentists more prone to such sharp injuries¹⁴. Percutaneous exposure incidents facilitate the spread of blood borne infections including HIV, HEP B and HEP C²⁴.

Aerosol – A Potential Vector of Cross Contamination

Many studies reported that many infectious agents are airborne and so the hospital air has been found to be a potential route of transmission of hospital-acquired infections. Broad spectrum of microbial species have been isolated from hospital air whose source of origination can either be hospital staff, patients and their visitors, ventilation and air conditioning system etc¹⁷.

Cross contamination in dentistry can also occur as a result of various vectors including contaminated instruments, body substances, equipments, environmental surfaces, water and aerosols containing different pathogens²⁷. Formation of aerosols and splatters occur as a result of many dental procedures carried out in mouth containing many pathogens²⁸. Cross contamination through aerosols has remained a main concern for the dental community²⁹. Health care providers including dental personnel are at greater risk of exposure to pathogenic microorganisms found in these aerosols because they frequently perform aerosols producing procedures³⁰.

2. What are Aerosols?

Significant work done by Micik and colleagues in the domain of Aerobiology enabled them to use the two terminologies that are aerosol and splatter in the dental environment³¹. Aerosols are solid and liquid particles with particle size 50µm or less and suspended in air by humans, instruments or machines³². The generation of aerosols by human occurs because of breathing, talking, sneezing or coughing³³. Most pathogenic aerosols are considered to be those having particle size less than 50 µm³². Studies have reported that these aerosols can contaminate surfaces in range of one meter (3ft.). Respiratory passages and lungs are easily penetrated by small aerosol particles carrying the greatest pathogenic risk³⁴. Certain factors increase the chances of getting infections including: the host's immune response and dose, virulence; and pathogenicity of the micro-organism³³.

Pathogenic Potential of Aerosols

Mycobacterium tuberculosis, Streptococcus pyogenes, Corynebacterium diphtheriae and Neisseria meningitides are the main pathogens transmitted through air borne route and cause hospital acquired infections. 10–20% of such infections are caused by air borne bacteria¹⁷. Dental aerosols have been found to contain those microorganisms associated with various diseases such as staphylococcal infection, viral infections, tuberculosis, skin infections, conjunctivitis etc³².

When discussing infection control, consideration of bacterial aerosols is at top of list because of having greater pathogenic potential³⁵. Because of their smaller size, aerosols can remain airborne for longer duration and studies reported the survival of microorganisms in the aerosols for a week³⁶. Aerosols smaller particles carry the greatest pathogenic potential and can easily invade the respiratory passages²⁹. Staphylococcus and Micrococcus species are predominant microorganisms isolated from bio aerosols in dental clinics (Table 1)³⁷.

Table 1: Diseases spread by aerosols.

DISEASES KNOWN TO BE SPREAD BY DROPLETS OR AEROSOLS	
DISEASES	METHOD OF TRANSMISSION
Pneumonic Plague	Patient to patient without the usual insect vector (flea); apparently by inhalation of the causative bacteria
Tuberculosis	Droplet nuclei expelled from the patient by coughing; once considered an occupational disease for dentists
Influenza	Apparently associated with coughing but may require direct contact with the patient
Legionnaires' Disease	Aerosolization of Legionella pneumophila has been associated with air conditioning systems and hot tub spas
Severe Acute Respiratory Syndrome	Spread by direct contact and aerosolized droplets

From Harrel and Molinari, 2004³¹.

Composition of Dental Aerosols

Variations in the composition of dental aerosols is reported in studies with the operative site and patients³¹. Dental aerosols have been found to contain components of nasopharyngeal secretions, saliva, plaque, blood, tooth components, restorative or other materials used in the dental procedure³⁸.

Formation of Aerosols

The use of compressed air and water by high-powered devices result in production of aerosols³⁹.

Cross Infection through Aerosols

The potential sources of microbes found to contaminate dental aerosols are the dental unit water lines, saliva, plaque/calculus, blood, contaminated equipments etc³⁰. *Mycobacterium tuberculosis*, *streptococci*, *Pneumococci*, *staphylococci* are frequently reported bacteria to be present in dental aerosols. Viruses found to be present in aerosols include influenza virus, common cold viruses, Cytomegalovirus, hepatitis virus, herpes simplex virus and Epstein-Barr virus³². Presence of fungi is also reported in studies and found to be an important risk for health care workers³⁷. Some studies reported the exposure of dental health care workers to up to 1.86 E + 05 bacteria/m³ of air while according to other studies; it could be up to 4.3 E + 05 bacteria/m³, generated during dental procedures³⁷. Studies reported higher levels of aerosols for cavity preparation (24-105 CFU/m³) and for ultrasonic scaling (42-71 CFU/m³), and lower levels were reported for

extraction (9-66 CFU/m³) and for oral examination (24-62 CFU/m³)³⁷. After conclusion of dental treatment ,time taken by bio aerosols to return to baseline is approximately 2 hours³⁷(Figure 1).

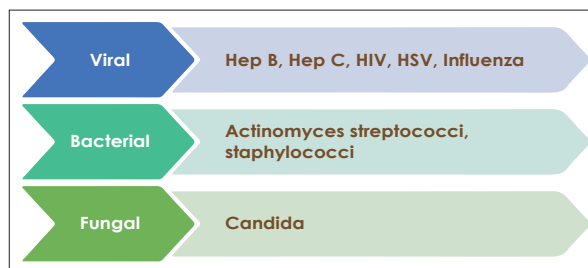


Figure 1: Common transmissible infections in dentistry.

3. Airborne Contamination During Dental Treatment

Airborne route has been documented in studies as one of the greatest potential source of spreading infection in clinical settings⁴⁰. Studies reported the spread of different microorganisms in dental office as a result of different procedures⁴¹. Many procedures that are performed in dental offices result in production of aerosols and splatters including crown preparation, ultrasonic scaling ,caries excavation⁴² etc. The use of certain equipments such as ultrasonic scalers, air polishers, dental hand pieces and air abrasion units produce most visible and viable bio aerosols³⁰. Patients, dental instruments and dental unit waterlines (DUWL) are the important sources of aerosol production in dental operatory⁴³.

Saliva and Respiratory Sources of Contamination

Numerous bacteria are harbored by the oral cavity from the dental plaque, the respiratory tract and oral fluids⁴³. Air borne contamination through these microorganisms can easily occur when saliva is aerosolized by mechanical instrumentation³¹.

Contamination from the Operative Site

Bio aerosols are produced from the operating site because of different dental procedures using mechanical instrumentation including ultrasonic scalers, hand pieces, air abrasion units, air polishing device etc¹⁵. The materials removed by these instruments from the operative site becomes aerosolized by the action of the rotary instrument, ultrasonic vibrations or the combined action of water sprays and compressed air³¹.

Aerosols Producing Instruments in Dental Operatories

Ultrasonic scalers, air-polishing devices, dental hand pieces and air abrasion units produce airborne particles by the combined action of compressed air, water sprays, organic particles, such as tooth dust and tissue, organic fluids such as saliva and blood from the site where instrument is used⁴³. Studies reported the greatest production of aerosols as a result of ultrasonic and sonic scalers,

air turbines, and air polishers⁴⁴. A water spray is required by these instruments to prevent heat production, lavage the working area and for cooling the working tip. A potentially pathogenic aerosol is formed when this water spray mix with patient's saliva or blood²⁷. Studies reported that these instruments can result in about four fold increase of airborne bacteria in the dental operatory³⁹.

Contamination through Dental Unit Water Lines (DUWL)

Dental unit water lines are found to be an important source of contaminated aerosol production⁴⁵. Pathogens isolated from dental unit water are the *Legionella pneumophila* and *Pseudomonas* species and found to be aerosolizing by high powered devices including ultrasonic scalers and hand pieces⁴⁶.

4. Ultrasonic Scalers - Greatest Producers of Aerosols

Studies reported ultrasonic scalers and air polishers as the greatest producers of aerosols in dental operatory⁴⁷. Ultrasonic scaling produces considerable amount of aerosol spray, which can act as a vector for microorganisms and aid in spread of infection. These scalers when used produce a mixture of compressed air and water which spurts from the hand piece, further mixing with patient's saliva and blood forming a fine spray which ejects from the patient's mouth⁴⁸. Aerosols producing devices reduce the air quality in dental office due to increased air contamination³⁹. Aerosol from ultrasonic instrumentation always contains blood and lingers in the air for 30 min or longer in the dental offices or nearby areas³² (Figure 2).



Figure 2: Aerosol production from ultrasonic scalers.

5. Ways of Preventing Microbial Cross Infection

Strict aseptic principles are needed to be incorporated in the clinical practice in order to reduce microbial cross contamination⁴⁹. For minimizing cross contamination, different materials and procedures are recommended such as use of personal protective barriers, decontamination of surfaces, immunization of dental staff, sterilization of

instruments and pre-procedural mouthwashes⁴¹. Dental workers are highly recommended by Centre for disease control (CDC) for using personal protective equipment (PPE) (Masks, goggles and gowns) and barriers to cover clinical surfaces when performing dental treatments⁵⁰. Use of personal protective equipment is extremely important for dental health care providers as they have greater risk to be exposed to pathogenic microbes¹⁴.

6. Aerosols Reduction Ways

For contaminated aerosols reduction, Harrel and Molinari recommended three levels of defense which are as follows²⁹:

1. Use of Personal Protective equipments
2. Regular use of Pre-procedural mouth rinses
3. Use of high evacuation device³⁹.

To effectively minimize bio aerosol contamination, CDC has recommended the use of universal barrier techniques for all dental procedures⁴². Pre-procedural rinsing with effective mouthwashes mainly Chlorhexidine (CHX) in varying concentrations, have also found to be very effective in reducing aerosol contamination specially before ultrasonic scaling and periodontal surgeries⁵¹. For reducing cross contamination, the dental practitioners are strongly recommended to put into practice the control of bio aerosols contamination in their routine infection control protocol¹⁵. Use of expensive methods such as high-efficiency particulate air and ultraviolet chambers in the ventilation system have also been recommended¹⁵ (Figure 3).

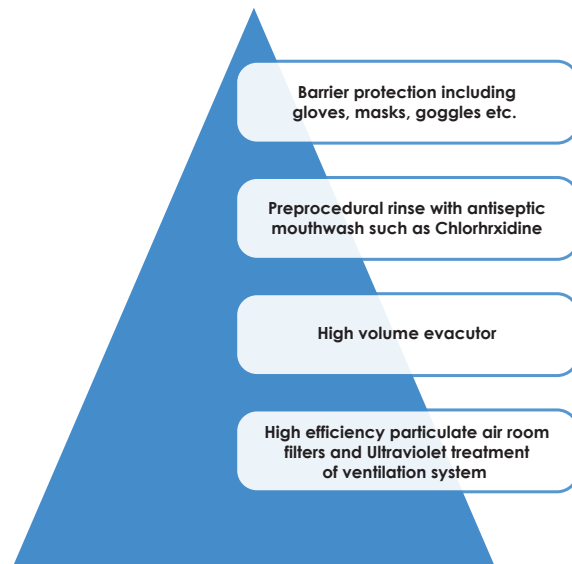


Figure 3: Methods of reducing airborne contamination.

In order to minimize the chances of cross infection, it is strictly recommended to incorporate aseptic principles in the clinical practice. Use of personal protective instruments (gloves, masks, gown and goggles), decontamination of surfaces, immunization of dental staff, sterilization of instruments are strictly recommended for reducing cross infection by Centre for disease control and prevention (CDC), American Dental association (ADA) etc. Pre-procedural rinsing with effective mouthwash (chlorhexidine (CHX), Povidone-iodine (PI), etc.), use of high evacuation device and some expensive methods like high-efficiency particulate air and ultraviolet chambers in the ventilation system has also been recommended to minimize cross contamination through aerosols in the dental operatory.

CONCLUSION

Dentistry is surrounded by many occupational perils. Cross infection through various routes are reported in many studies including air, blood, water etc. Airborne route is of prime concern when discussing the infection control programs in dentistry as this route carries the greatest potential to transmit infections. Aerosols and splatters have remained an important debate for the dental community whenever infection control is taken into consideration. Aerosols and splatter are produced because of many procedures performed in dental set up and so there is a greater chance of cross contamination through these airborne particles.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTION

AA did conceptualization of study and wrote the first draft. SAB and MH revised draft critically and Fakhruddin managed the literature searches.

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