CPD | Core Topic | 1 Hour Verified

Read this article and answer the 10 questions below for 1 hour of Core Topic CPD.

If you'd like to have this CPD verified, please register for free at http://dental.cpdpro.org.uk and answer the questions online. Once you've completed the test, your certificate will be added to your account automatically and your eGDC account will be updated.

Your CPD - Hassle Free.

Disinfection and Decontamination | Infection Control
Aerosols and Splatter as an Occupational Hazard in Dentistry

Objectives

After reading this paper, the you should understand:
• The presence and make up of dental aerosols and splatter.
• The threats that may be inherent in airborne material, including the risk potential to patients and the dental team.
• Regulatory and legal concerns regarding infection control.

Contents

o Overview
o Dental Aerosol and Splatter
o Composition of Dental Aerosols
o Sources of Airborne Contamination During Dental Treatment
  1) Blood
  2) Saliva and respiratory sources
  3) Dental instrumentation
  4) The operative site
o Composition of Dental Aerosols
o Methods of Reducing Airborne Contamination/Exposure to Dental Aerosol
o Regulatory and Legal Concerns
o Conclusions
o Questions
o References
o Overview
• Airborne material is produced during all procedures performed with the use of dental hand-pieces.
• This airborne material includes aerosol and splatter, which is usually contaminated with fungi, viruses, bacteria and often blood.
• Dentists, auxiliary staff and patients are all affected by this airborne material.
• An aerosol, which is a cloud of particulate matter and fluid, can be seen during the use of an ultrasonic scaler, during tooth preparation with a rotary instrument or air abrasion, during the use of an air-water syringe, or during air polishing.
• Aerosol produced from dental hand-pieces is a mixture of air coming from the hand-piece, water from dental unit waterlines (DUWL) and the patient’s saliva.
• Aerosol is almost always accompanied by splatter. The principal difference between the two is the size of the particle from which they are made.
• This airborne material has the potential for transmission of diseases and various infections to the practitioners and patients, and has become a source of increased concern to the dental profession.
• This article reviews relevant literature on the presence and makeup of dental aerosols and splatter.
• This article assesses the threats caused by this airborne material, including the risk potential to patients and the dental team. It also focuses on the control of dental aerosols and splatter.

0 Dental Aerosol and Splatter

• Aerosols are defined as liquid or solid particles less than 50 µm in diameter.
• Particles of this size are small enough to remain suspended in air for a long period before they settle on environmental surfaces or enter the respiratory tract.
• They may be easily inhaled by dental staff or patients.
• Smaller particles of aerosol are more infectious, in terms of both the degree of infectivity and the severity of illness that can result.
• Aerosol particles that are 0.5 to 10 µm in diameter are capable of penetrating and lodging deep into the lungs, reaching as far as pulmonary alveoli, and are thought to carry the greatest potential for transmitting infections.
• Splatter is defined as airborne particles larger than 50 µm in diameter and is sometimes visible to the naked eye.
• Splatter is a mixture of air, water and/or solid substances, such as fragments of carious tissues, dental fillings and sandblasting powder.
• Splatter particles move ballistically; i.e. they are ejected forcibly from the operating site, move along the trajectories and settle quickly on an object.
• Splatter particles can come into contact with the skin, eyes, mucosa of the nose and the open mouth.
• Being larger in size, these particles are only briefly airborne, and they have limited potential to penetrate into the respiratory system.
• The greatest threat in dentistry comes from airborne infection through aerosols (<50 µm in diameter) due to the aerosol particles’ ability to stay longer in the air and their potential to enter respiratory passages.
• However, with the resurgence of tuberculosis (TB), splatter droplets must also be considered a potential infection threat.
• Splatter and droplet infection are also involved in the transmission of various diseases other than TB, such as SARS, measles and herpetic viruses. Some of the
diseases known to be spread through an airborne route are listed in the table below.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Method of Transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles</td>
<td>Spread easily from person to person, when droplets of viruses are circulated through the air from an infected person sneezing or coughing.</td>
</tr>
<tr>
<td>Influenza</td>
<td>Spread through droplets caused by coughing or sneezing. May require direct contact with the patient. One can get infected by touching the surface or object that was recently contaminated by the virus and then touching one’s nose or mouth.</td>
</tr>
<tr>
<td>Severe Acute Respiratory Syndrome</td>
<td>Spread by close contact with infected person and aerosolised droplets.</td>
</tr>
<tr>
<td>Legionnaires’ Disease</td>
<td>Does not spread from person to person contact. Aerosolisation of <em>Legionella pneumophilia</em> has been associated with air conditioning systems, evaporative condensers and hot tub spas.</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>Transmission of <em>tubercle bacilli</em> occurs through the inhalation of droplet nuclei of expectorated sputum-positive tuberculosis patients during coughing and sneezing. TB was once considered to be an occupational disease for dentists.</td>
</tr>
</tbody>
</table>

**Composition of Dental Aerosols**

- Aerosol composition varies with each patient, the operative site and the type of treatment procedure (e.g. tooth preparation, scaling, or polishing) in the oral cavity.
- Aerosol may consist of saliva, nasopharyngeal secretions, dental plaque, gum secretions, blood, tooth components and any material used in the dental procedure, such as abrasives for air polishing and air abrasion.
- The microbiological composition of dental aerosol depends on the microflora present in the patient’s oral cavity and the water from dental unit waterlines (DUWL) attached to the hand-piece. They are usually contaminated with bacteria, viruses and fungi.
- The types of bacterial genus present in aerosol are Streptococcus, (constituting about 42 per cent of total bacteria), Staphylococcus (41 per cent) and gram negative bacteria (17 per cent).
- A non-selective growth medium such as a blood agar has been commonly used to measure the number of airborne bacteria.
- Studies show that the microflora of air in a dental surgery has the highest prevalence of Staphylococcus epidermidis (37.1 per cent of total bacteria), Micrococcus spp. (32.6 per cent), nondiphtherial corynebacteria (28.2 per cent), Staphylococcus aureus (0.6 per cent) and fungi (0.9 per cent).
- Aerosol produced during conservative treatment consists of bacteria of the genera Streptococcus mutans/ratti and Lactococcus lactis in numerous amounts.
**Sources of Airborne Contamination During Dental Treatment**

- Potential sources of airborne contamination during dental treatment are:
  1) Blood.
  2) Saliva and respiratory sources.
  3) Dental instrumentation.
  4) The operative site.

1) **Blood**

- The presence of blood (or its components) in dental aerosol is an important problem.
- Dentists and their assistants are often accidentally splashed with blood due to an incorrect working technique with dental unit handpieces, scalers, or during minor surgery.
- The greatest risks for dentists are viruses spread through blood (hepatitis B and C, HIV virus). These viruses cause life threatening diseases.
- The Hepatitis B virus constitutes an occupational hazard to dentists as the disease is easily transmitted, highly infectious, and highly resistant to disinfection, sterilisation and environmental agents.
- Hepatitis C is also a serious health problem as the infection is asymptomatic and may develop into chronic liver inflammation and then into cirrhosis and liver cancer.

2) **Saliva and respiratory sources**

- The oral cavity is almost always wet with saliva that continuously replenishes the fluid in the mouth.
- The mouth is part of the oro-nasal pharynx. As part of this complex, the mouth harbours bacteria and viruses from the nose, throat and respiratory tract.
- The fluids in the mouth are grossly contaminated with bacteria and viruses. Dental plaque, both supra-gingival and sub-gingival, is a major source of these organisms.
- Any dental procedure that has the potential to aerosolise saliva will cause airborne contamination with organisms from some or all of these sources.
- Saliva includes a vast range of microorganisms. The Herpes simplex virus (HSV) and Mycobacterium tuberculosis (TB) are the most important risk factors.
- HSV-1 and HSV-2 are particular hazards for dental workers because of their common occurrence and high infectivity. They cause herpetic whitlow, recurrent labial herpes and keratitis.
- Mycobacterium developing in the pharynx of a TB patient can be emitted into the air during a procedure, most often during coughing. This, together with dried saliva or sputum droplets (called droplet nuclei), can lead to occupational TB for dentists.
- Aerosols produced during treatment in an active TB patient can be controlled using special respiratory precautions.
- Patients with undiagnosed, active, infectious TB remain a risk for the dental team and other patients, however.
- Saliva and nasopharyngeal secretions may also contain other pathogenic
organisms. These include the herpes virus, influenza, common cold viruses, pathogenic Streptococci and Staphylococci, and the SARS virus.

- During treatment, it should be assumed that all patients may have an infectious disease that can spread by dental aerosols. Therefore, universal precautions to limit aerosols should be taken.

3) **Dental instrumentation**

- Unclean instruments and improper sterilisation can lead to the contamination of dental instruments and dental unit waterlines (DUWLs). Routine cleaning and sterilisation procedures should eliminate contamination.
- The aerosol produced from dental handpieces is a mixture of air coming from a handpiece, water from the patient’s saliva and water flowing from DUWLs, and is always accompanied by splatter.
- The application of American Dental Association (ADA) recommended methods to treat the DUWL should minimise or eliminate airborne contamination from the DUWL.

4) **Contamination from the operative site**

- Most dental procedures that use mechanical instrumentation produce airborne particles from the site where the instrument is used.
- Multiple studies have been conducted to determine which dental procedure produces the most airborne bacterial contamination.
- Dental handpieces or drills, ultrasonic scalers, air and water syringing, air polishers and air abrasion units produce the most visible aerosols.
- Each of these instruments removes material from the operative site that becomes aerosolised by the action of the rotary instrument, ultrasonic vibrations, or the combined action of water sprays and compressed air.
- The table below lists the dental instruments and procedures that produce the greatest amount of aerosols.

<table>
<thead>
<tr>
<th>Dental devices and procedures known to produce airborne contamination</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultrasonic and Sonic Scalers</td>
<td>Known to produce the greatest amount of aerosol contamination; use of a high-volume evacuator will reduce the airborne contamination by more than 95 per cent.</td>
<td></td>
</tr>
<tr>
<td>Air Polishing</td>
<td>Bacterial counts indicate that airborne contamination is nearly equal to that of ultrasonic scalers; available suction devices will reduce airborne contamination by more than 95 per cent.</td>
<td></td>
</tr>
<tr>
<td>Air-Water Syringe</td>
<td>Bacterial counts indicate that airborne contamination is nearly equal to that of ultrasonic scalers; high-volume evacuator will reduce airborne bacteria by nearly 99 per cent.</td>
<td></td>
</tr>
<tr>
<td>Tooth Preparation</td>
<td>Minimal airborne contamination if a rubber dam is used.</td>
<td></td>
</tr>
</tbody>
</table>
• The sites showing the highest microbiological contamination due to aerosol and splatter during conservative treatment and scaling are (in decreasing order): dentist’s and assistant’s masks, a unit lamp, surfaces close to spittoons, and mobile instrument-material tables.
• The microbiological condition of air in dental surgeries is considered to be one of the most dangerous contamination carriers in the working environment of a dentist.
• Monitoring and the removal of microbiological contaminated air from dental surgery rooms may reduce the spread of infection.
• Also, poorly maintained ventilation and air-conditioning systems are a potential source of fungal and other microorganisms, resulting in infection, allergic conditions and hypersensitivity.
• Other factors such as temperature, humidity, dispersion of particles and particle size in the operative site may also influence the distribution and potential infectivity of aerosols.

0 Methods of Reducing Airborne Contamination/Exposure to Dental Aerosols

• Methods of controlling aerosol and splatter are simple and inexpensive.
• Major sources of potentially contaminated dental aerosols can be controlled following the American Dental Association’s recommendations for sterilisation of instruments and treatment of dental unit waterlines.
• The aerosol created by the interaction of coolant water and ultrasonic vibrations, or by compressed air and a rotary motion is visible to patients and dental personnel and can be easily controlled.
• Emission of the contaminated particles into the working space should be first reduced, and then contaminated air should be eliminated before it has left the space directly surrounding the treated area.
• Personal protective barriers such as surgical masks, safety glasses with lateral protection and gloves are standard protective measures and can decrease contact with aerosols and splatter.
• However, aerosols of less than 1µm can readily penetrate surgical masks. To reduce such aerosols, industrial respirators have been found to be more effective.
• The potential for the spread of infection through an almost invisible aerosol is also possible. Such aerosols must be recognised and minimised or eliminated to the greatest extent feasible within a clinical situation.
• The use of an antiseptic mouthwash with long lasting antimicrobial activity, such as chlorhexidine gluconate (0.01%), has been found to be effective in reducing bacterial aerosols. The use of such mouthwashes prior to ultrasonic scaling has been found to be very effective in reducing the aerosol.
• Chlorhexidine is an effective and commonly used antiseptic for free floating oral bacteria, but it has no influence on the bacteria present in biofilm such as established dental plaque, does not penetrate sub-gingivally, and does not affect bacteria and viruses harboured in the nasopharynx.
• Pre-procedural rinses reduce the extent of contamination within dental aerosols,
but they do not really eliminate the infectious potential of dental aerosols.

- The use of a rubber dam during many dental procedures will eliminate all contamination arising from saliva and blood.
- If a rubber dam can be used, the only remaining source of airborne contamination is from the tooth that is undergoing treatment.
- Unfortunately, the use of a rubber dam is not feasible in many procedures, such as sub-gingival restorations, the final steps of crown preparation, periodontal surgery and root planing.
- Two methods are available to reduce airborne contamination arising from the operative site. One method involves the use of devices that remove the contaminated material from the air of the treatment area after it has become airborne. The other removes the airborne contamination before it leaves the immediate area surrounding the operative site.
- The most frequently mentioned methods for removing airborne contamination from the air of the treatment room are the use of high efficiency particulate air (HEPA) filters and the use of ultraviolet, or UV, chambers in the ventilation system.
- UV radiation with the wavelength 254 nm should be used as this shows very high bactericidal, fungicidal and virucidal activity by the destruction of DNA chains and protein denaturation.
- Although the use of HEPA and air filters appears to reduce airborne contamination, the disadvantages of these methods include technical changes and high expenditure.
- The disadvantage of UV radiation is that it takes a long period for the air in the treatment room to cycle through the filter or UV treatment system.
- Considering the practical issues and cost effectiveness, it is much easier to remove as much airborne contamination as possible before it escapes the immediate treatment site. The use of a high volume evacuator (HVE) has been shown to reduce the contamination arising from the operative site by more than 90 per cent.
- The usual HVE used in dentistry has a large opening (usually 8 mm or greater) and is attached to an evacuation system that removes a large volume of air (up to 100 cubic feet of air per minute).
- During restorative dentistry, the HVE will often be used by an assistant who is able to guide and aim the vacuum in a manner that eliminates or greatly reduces the visible water spray produced during dental procedures.
- The water in the dental unit used to cool handpieces has been shown to form a biofilm, which is the most abundant source of microorganisms. The thickness of this biofilm layer equals 30-50µm.
- Therefore, the quality of water used in dental unit handpieces should meet the conditions of potable water. Chemical disinfectants such as hydrogen peroxide are considered to be the most effective measure by which to remove biofilms.
- Further, routine sterilisation of handpieces eliminates patient to patient infection, contamination of waterlines with microorganisms and tissue fragments.
- Regular cleaning, disinfection and sterilisation of the unit water reservoir, using distilled water and the application of chemicals to monitor the microbiological quality of dental unit waterline water, assures the effective microbiological control of water and safety of unit users.
- The position of a patient during dental treatment is also important. Patients should be treated in a supine position, thus avoiding the need for the dentist to work in the breath way of a patient.
• Immunisation of dental personnel against various diseases such as hepatitis B, influenza, measles, rubella, chicken pox and tuberculosis is strongly recommended.
• It must be emphasised that no single approach or device can completely minimise the risk of infection to dental personnel and other patients.
• The dental team should not depend on a single precautionary strategy. In the reduction of dental aerosols, the first layer of defence is personal protection barriers such as masks, gloves and safety glasses.
• The second layer of defence is the routine use of an antiseptic pre-procedural rinse with a mouthwash such as chlorhexidine.
• The third layer of defence is the routine use of an HVE either by an assistant or attached to the instrument being used.
• The first three layers of defence are found routinely in most dental clinics, are inexpensive and can easily be made part of routine infection control practices.
• The table below lists the available methods of reducing aerosols and splatter contamination, as well as their relative effectiveness and costs.

<table>
<thead>
<tr>
<th>Methods of reducing airborne contamination</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Barrier Protection:</strong> Masks, Gloves and Eye Protection</td>
<td>Part of ‘standard precautions’; inexpensive.</td>
<td>Masks will only filter out 60-95 percent of aerosols; subject to leakage if not well-fitted; do not protect when mask is removed after the procedure.</td>
</tr>
<tr>
<td>Pre-procedural rinse with antiseptic mouthwash (chlorhexidine)</td>
<td>Reduces the bacterial count in the mouth, saliva and air; inexpensive on a per-patient basis.</td>
<td>Tends to be most effective on free floating organisms; it will not affect biofilm organisms such as plaque, subgingival organisms, blood from the operative site or organisms from the nasopharynx.</td>
</tr>
<tr>
<td>High-Volume Evacuator</td>
<td>Will reduce the number of bacteria in the air and remove most of the material generated at the operative site such as bacteria, blood and viruses; inexpensive on a per-patient basis.</td>
<td>When an assistant is not available, it is necessary to use a high-volume evacuator attached to the instrument or a ‘dry field’ device.</td>
</tr>
<tr>
<td>High-Efficiency Particulate Air Room Filters &amp; Ultraviolet Treatment of Ventilation System</td>
<td>Effective in reducing numbers of airborne organisms.</td>
<td>Only effective once the organisms are already in the room’s air; moderate to expensive; may require engineering changes to the ventilation system.</td>
</tr>
</tbody>
</table>
o Regulatory and Legal Concerns

- The American Dental Association and Centers for Disease Control have recommended that all blood-contaminated aerosols and splatter should be minimised.
- Occupational Safety and Health Administration regulations state that ‘all procedures involving blood or other potentially infectious materials shall be performed in such a manner as to minimise splashing, spraying, spattering, and generation of droplets of the substances.’
- The use of rubber dams and HVEs are considered to be ‘appropriate work practices’ – precautions that always should be followed during dental procedures.
- By following the simple and inexpensive recommendations for controlling aerosols and splatter outlined in this article, dental practitioners will be in compliance with these recommendations and will minimise any legal or regulatory risks that may exist.

o Conclusions

- The aerosols and splatter generated during dental procedures have the potential to spread infection to dental personnel and other people in the dental office.
- It is difficult to completely eliminate the risk posed by dental aerosols; however, it is possible to minimise the risk with relatively simple and inexpensive precautions.
- The following procedures are appropriate as universal precautions whenever an aerosol is produced:
  a) Personal barrier protection.
  b) Pre procedural rinse before treatment.
  c) Rubber dam used whenever applicable.
  d) HVE used for all procedures.
- The use of these precautions will reduce the risk of an aerosolised spread of infection to a minimal level.
Questions

1) Which of the following dental procedures produces aerosol?
   a) Tooth preparation using a rotary instrument.
   b) Use of an air-water syringe.
   c) Scaling using an ultrasonic scaler and during air polishing.
   d) All of the above.

2) The size of an aerosol particle is:
   a) <50 µm in diameter.
   b) >50 µm in diameter.
   c) 50-100 µm in diameter.
   d) 100-150 µm in diameter.

3) Splatter is defined as:
   a) A waterborne particle.
   b) A dust particle.
   c) Airborne particles larger than 50 µm in diameter.
   d) Airborne particles less than 50 µm in diameter.

4) The common diseases known to be spread by aerosols are:
   a) Tuberculosis.
   b) Influenza.
   c) Legionnaires’ Disease.
   d) All of the above.

5) The highest percentage of bacterial genus present in aerosol is:
   a) Streptococcus.
   b) Staphylococcus.
   c) Diplococcus.
   d) Micrococcus.

6) The greatest source of aerosol contamination is which item of dental equipment?
   a) Air-water syringe.
   b) Tooth preparation with air turbine handpiece.
   c) Ultrasonic and sonic scalers.
   d) All of the above.

7) Personal barrier protection comprises:
   a) Surgical masks, gloves and eye protection.
   b) A rubber dam.
   c) A high volume evacuator.
   d) All of the above.
8) Dental procedures for which a rubber dam cannot be used for preventing infection is/are:
   a) Sub-gingival restorations.
   b) Root planning and periodontal surgery.
   c) Final steps of crown preparation.
   d) All of the above.

9) The most frequently mentioned method of removing airborne contamination from the air from a practical and cost effective viewpoint is/are:
   a) A high volume evacuator (HVE).
   b) Ultraviolet chambers.
   c) High efficiency particulate air (HEPA) filters.
   d) None of the above.

10) Universal precautions to be taken to control aerosol is/are:
    a) Use of personal barrier protection.
    b) Use of pre procedural rinse before treatment.
    c) Use of rubber dam where applicable.
    d) All of the above.

If you'd like to have this CPD verified, please register for free at http://dental.cpdpro.org.uk and answer the questions online. Once you've completed the test, your certificate will be added to your account automatically and your eGDC account will be updated.

Your CPD - Hassle Free.