AEROSOLS IN DENTISTRY

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ABSTRACT

In the current pandemic scenario much is debated over the aerosol production in dentistry. As everyone is aware, production of aerosols and splatter in dental procedure is inevitable. Infectious aerosols in dental setting is known to contribute indoor air pollution and has been associated with occupational health hazards. With the advent of diseases like SARS, COVID -19, dental operatory seems a potential risky area for dentist, auxiliaries and patients. This article comprehensively reviews various aspects of aerosol production and enlists the precautions that are to be adhered while practicing dentistry.

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INTRODUCTION

Production of aerosols and splatter in dental procedure is inevitable. Aerosol cloud containing particulate matter and fluid is particularly obvious during procedures such as ultrasonic scaling, tooth preparation, polishing and use of air water syringe. This cloud contains materials from treatment site as well as material from dental unit waterlines (DUWL). Infectious aerosols in the dental setting known to contribute indoor air pollution and have been associated with occupational health hazards. Infective agents may include bacteria, viruses, fungal organisms and possibly even prions, however little has been published on virus, fungus and prion-containing aerosols in the dental clinic.[1] With the advent of diseases like SARS, COVID - 19, dental operatory seems a potential risky area for dentist, auxiliaries and patients.

Dental Aerosol and Splatter

Aerosols were defined by Micik and Colleagues 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 10µm in diameter) have the potential to penetrate and lodge in the smaller passages of the lungs and are thought to carry the greatest potential for transmitting infections.[2,3,4]

Splatter was defined by Micik and colleagues as airborne particles larger than 50 µm in diameter. Micik and colleagues stated that these particles behaved in a ballistic manner. This means that these particles or droplets are ejected forcibly from the operating site and arc 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 are airborne only briefly.[2-5]

The greatest air-borne infection threat in dentistry comes from aerosols due to their ability to stay air- borne and potential to enter respiratory passages.[6] However splatter also has the potential for infection. As the droplet begins to evaporate, the size of the droplet becomes smaller, and it then has the potential to stay airborne or to become re-airborne as a dust particle.[5] Splatter and droplet nuclei also have been implicated in the transmission of diseases like TB, SARS, measles and herpes viruses etc.

Sources of Airborne Contamination During Dental Treatment

There are at least three potential sources of airborne contamination during dental treatment:

1. Dental instrumentation
2. Saliva and respiratory sources
3. The operative site.

Dental Instrumentation

Contamination during the dental instrumentation result from the contaminated dental instruments and also from Dental unit waterlines. All instruments should wash thoroughly using soap and water and should undergo the proper sterilization protocols. To minimize contamination from DUWL, CDC recommended methods of treatments of DUWL should be followed.

The risk of cross-infections in dental settings can be tackled by implementing appropriate systems of proven efficacy. There are different chemical, physical or chemo-physical treatment systems of DUWLs, (e.g., per acetic acid, glutaraldehyde, chlorhexidine, chlorine dioxide, filtration, flushing, reverse osmosis, etc.)[7].

The Centre for Disease Control and Prevention (CDC) recommend that manufacturers should provide dental units with a separate reservoir, typically a container of about 1-liter capacity, from which tap water, deionized water and/or distilled water can be fed to the drill in order to cool it. Moreover, these separate reservoirs are also better suited for the input of biocides.[8] Use of hand pieces and turbines fitted with anti-reflux valves are recommended particularly when sterile safe water is not guaranteed. These valves are triggered when the turbine stops and prevent liquids, and hence also micro-organisms, from being aspirated when rotating instruments are used.

Particularly recommended by the CDC is flushing, which should always be carried out for 20-30s after each patient is treated. This

should be done for all devices that connect to a water line and enter patients' mouths, such as hand pieces, ultrasonic scalers and air/water syringes. This procedure is intended to physically flush outpatient material that might have entered the turbine, air or water lines.[8] As per a recent study, Flushing alone is not sufficient and that other strategies are required in order to improve water quality in dental practices.[9]

In order to reduce microbial contamination, and/or the formation of biofilm in DUWLs, Italian Health Ministry recommended the following guidelines.[10]

1. Any sections excluded from the flow currents should be eliminated from the network.
2. Install anti-stagnation devices to keep the water circulating continuously, particularly during non-working hours.
3. Supply the network with sterile solutions, after isolating it from the main water supply.
4. Disinfect the water by means of continuous or discontinuous treatments. These latter, which may be carried out periodically or between one patient and the next, prevent chemical contamination of the operating field, reduce the exposure of staff and minimize the risk of selecting resistant micro-organisms; however, they require a greater commitment of resources and attention than continuous treatments.
5. All devices that connect to a water line and enter patients' mouths, such as hand pieces, ultrasonic scalers and air/water syringes, should be switched on and flushed through before use: for at least two minutes at the beginning of each working day and for at least 20-30 s before each patient is treated.
6. Filters (≤0.2µm) that can trap micro-organisms coming from inside the water supply network should be installed immediately upstream of hand pieces.

In addition, in the case of invasive surgical procedures, only sterile water should be used.

Oral Cavity as Source of Contamination

Oral cavity carries microorganisms from deep periodontal pockets, dental plaque, throat, nasopharynx and respiratory tract. So any dental procedure that has the potential to aerosolize saliva will cause airborne contamination with organisms from some or all of these sources. These may include Mycobacterium tuberculosis, pathogenic streptococci and staphylococci, common cold and influenza viruses, SARS virus, Herpes virus and the Novel corona virus 2. It also should be assumed that all patients may have an infectious disease that has the potential to be spread by dental aerosols; thus, universal precautions to limit aerosols also should be in place.[5]

The use of personal barrier protection such as masks, gloves and eye protection will eliminate much of the danger inherent in splatter droplets arising from the operation site.[11] But any dental procedure that creates aerosols and splatter which have the capacity to re-aerosolize can enter the respiratory tree via leaky masks or if the operator removes the mask immediately after the procedure near the operatory.[5] A true aerosol or droplet nuclei may be present in the air of the operatory for up to 30 minutes after a procedure.[6] The airborne material was spread to a distance of at least 18 inches from the operative site.[5] So the operator should keep the above points while removing the personal protective equipments. Also, there is a potential for an airborne contaminant to enter the ventilation system and spread to areas of the facility where barrier protection is not used.

One method of reducing overall bacterial counts produced during dental procedures is the use of a pre procedural rinse. The use of a .01 percent chlorhexidine or essential oil–containing mouthwash for one minute before a dental procedure has been shown to significantly reduce the bacterial count in the air of the operatory.[12,13] 1% povidone iodine pre procedural rinse also found to be effective in reducing the microbial burden.[14] Studies have shown that povidone iodine has higher virucidal activity than other commonly used antiseptic agents, including CHX and benzalkonium chloride.[15] Recent investigations have proposed that 0.23% PVP-I mouthwash for at least 15 seconds before procedures may reduce salivary viral load, indicating its use in COVID-19-positive patients.[16]

During many dental procedures, the use of a rubber dam will eliminate virtually all contamination arising from saliva or blood. But In certain restorative procedures such as sub-gingival restorations and the final steps of crown preparation, it often is impossible to use a rubber dam. The use of a rubber dam also is not feasible for periodontal and hygiene procedures such as root planing, periodontal surgery and routine prophylaxis. This is of particular concern owing to the fact that periodontal procedures always are performed in the presence of blood and instruments such as the ultrasonic scaler, which has been shown to create the greatest amount of aerosol contamination, are used.

Contamination from Operative Site

Dental hand pieces, ultrasonic scalers, air polishers and air abrasion units produce the most visible aerosols. Each of these instruments removes material from the operative site that becomes aerosolized by the action of the rotary instrument, ultrasonic vibrations or the combined action of water sprays and compressed air. Using the bacterial growth method, the ultrasonic scaler has been shown to produce the greatest amount of airborne contamination, followed by the air-driven high-speed hand piece, the air polisher and various other instruments such as the air water syringe and prophylaxis angles.[17]

Two methods are available to reduce airborne contamination arising from the operation site. One method involves using devices that remove the contaminated material from the air of the treatment area after it has become airborne. The other is to remove the airborne contamination before it leaves the immediate area surrounding the operative site. The most frequently mentioned methods of removing airborne contamination from the air of the treatment room are the use of a high efficiency particulate air, or HEPA, filter and the use of ultraviolet, or UV, chambers in the ventilation system. While both of these systems appear to reduce airborne contamination, they are somewhat expensive.[5] Both approaches also have the problem that it takes an extended period for the air in the treatment room to cycle through the filter or UV treatment system.

From a practical point of view, it is easier to remove as much airborne contamination as possible before it escapes the immediate treatment site. The use of a high-volume evacuator, or HVE, has been shown to reduce the contamination arising from the operative site by more than 90 percent.[18] It should be emphasized that for a suction system to be classified as an HVE, it must remove a large volume of air within a short period. An evacuator that pulls a high vacuum, but does not remove a large volume of air, such as is used routinely for hospital suction, is not considered an HVE. The usual HVE used in dentistry has a large opening (usually 8 millimetres or greater) and is attached to an evacuation system that will remove a large volume of air (up to 100 cubic feet of air per minute). The small opening of a saliva ejector does not remove a large enough volume of air to be classified as an HVE.

CONCLUSION

It must be emphasized that no single approach or device can minimize the risk of infection to dental personnel and other patients completely. A single step will reduce the risk of infection by a certain percentage, another step added to the first step will reduce the remaining risk, until such time as the risk is minimal. This can be described as a layering of protective procedures.

In the reduction of dental aerosols, the first layer of defence is personal protective 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. An additional layer of defence may be the use of a device to reduce aerosol contamination that escapes the operating area, such as a HEPA filter. The first three layers of defence are found routinely in most dental operatory, are inexpensive and can be made part of routine infection control practices easily.

Table 1
Differences between aerosols and splatter generated during dental procedures

No	Property	Aerosols	Splatter
1	Size	Size less than 50 micrometers.	Size more than 50 micrometers.
2	Distribution	Wide spread Can widely distribute in the dental clnic.	Immediate surrounding Most Radiated towards patient's chest and operators face.
3	Inhalation	Common	Uncommon
4	Skin and Surface Contact	Common	Common
5	Time	Remains in air for long time	Settle down immediately

Table 2
Methods to reduce airborne contamination

No	Methods	Advantage	Disadvantage
1	Barrier protection Methods-Personal protective devices Gloves, Masks, Eye protective devices, Face shield, Protective aprons	Part of standard precautions. Inexpensive Offers 3excellent protection if all instructions are followed.	Masks filter only 60-95% aerosols. Subject to leakage if fitting is not proper.
2	Pre procedural rinses	Reduces the bacterial count in the mouth, saliva, and air Inexpensive	Does not affect microorganisms in biofilm, and blood
3	High volume evacuation	Reduces most materials, including bacteria, viruses, blood and aerosols from the operatory	Expensive
4	High efficiency particulate air room filters	Highly effective in reducing the number of airborne organisms	Expensive May require engineering changes to the ventilator system

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