AEROSOLS AND INFECTION RISK IN THE DENTAL OPERATORY

This is a quick and far from thorough review of the literature around dental office aerosols and infection risk. But it captures some of the highly relevant information that can be useful as a guide until more formal reviews are available.

Basic answers that I could find around dental aerosols and infection risk are summarized as follows:

Note: Dental aerosols can carry viruses and transmit infection.

Aerosol Risk

High risk for aerosol production:

- Ultrasonic and sonic scalers
- Air Polishing
- Air/Water syringe.
- Air Turbine handpiece without rubber dam or high speed evacuation

Considerably less risk for aerosol production

- Air Turbine handpiece with rubber dam and high speed evacuation

Unknown risk for aerosol production:

- Air Abrasion
- Hall/Stryker drill

Important Points:

1. Using high volume evacuators and/or rubber dams greatly reduces aerosols (preferably both – as one can layer on protection with each intervention.)
2. Aerosols (versus spatter) are the big risk here. In a dental operatory, aerosols are produced and can linger in the air for 30 min. to 2 hours. (an argument for using "new" rooms after patient care – and waiting 2 hours to clean the previous room to allow aerosols from previous patient care to settle out)
3. Microbes from dental procedures fill the entire room – they can be found in high concentrations quite far from the patient – walls, table tops, etc. (Another argument for new room use)
4. Traditional masks only seem to work for spatter. They do not protect against aerosols.
5. N95 masks require fitting to work properly
6. When there is no aerosol (only spatter) then regular masks should be ok.

Terminology

- **Aerosols** (the big concern): particles less than 50 µm 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 the smaller passages of the lungs and are thought to carry the greatest potential for transmitting infections. The greatest airborne infection threat in dentistry comes from aerosols
- **Spatter** (less of a concern): Airborne particles larger than 50 µm in diameter. 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.

FINDINGS FROM DIFFERENT STUDIES (Most are direct quotes from the papers)
Below are some quotes from some various studies I found. (I have the full manuscripts if you want me to send them)

There are at least three potential sources of airborne contamination during dental treatment: dental instrumentation, saliva and respiratory sources, and the operative site. Most dental procedures that use mechanical instrumentation will produce airborne particles from the site where the instrument is used. Dental handpieces, 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.

(Pippin et al, J Oral Max Surg 1987)
Face Mask Efficacy: Use of surgical face masks has been advocated to protect clinicians from inhalation of aerosols containing organic and inorganic particulates. This study examined the ability of a 22 μm tracer particle to bypass the filtering capability of face mask material by peripheral marginal leakage of inspired air. For two popularly used face masks taped to a facial moulage, recovery of the tracer particle by an in vitro system was very low. When the masks were placed in the manner in which the product is commonly worn, however, significantly higher numbers of particles were recovered. Passage of inspired air around the periphery of two types of face masks appears to circumvent the masks' ability to screen airborne contaminants.
https://www.joms.org/article/0278-2391(87)90352-1/pdf

(Brown CK, Health Security 2019)
A mix of laboratory and clinical studies offers support, albeit more limited than evidence to the contrary, for the notion that face masks and respirators provide similar protections against exposure to infectious bioaerosols and can be used somewhat interchangeably. One example is a laboratory-based, in vivo comparison that found that RPDs similar to those used in Hong Kong hospitals during the 2003 SARS outbreak filtered out at least 95% of a potassium chloride solution meant to simulate viral particles.23 **In that study, N95s performed only marginally better than surgical masks.** As the focus of the literature shifted from SARS preparedness to influenza preparedness, a randomized controlled trial in a group of nurses with exposure to patients with influenza also compared RPD performance. The trial found that the number of infections among nurses who were provided face masks was not significantly different from the number of infections among nurses given N95 respirators, suggesting the face masks were not inferior to the respirators for preventing influenza among the nurses.24 Importantly, this result may have been affected by a failure to monitor and control for factors such as compliance with the intervention or use of hand hygiene and other PPE.

(Micik et al. JDR, 1969):
Aerosol particles usually are less than 50 microns in diameter, are invisible, and remain airborne for long periods. Under the conditions of this study, dental procedures incorporating the use of water sprays or rotary instruments generated aerosols with significantly greater numbers of bacteria than were produced by all the oral activities surveyed. It appears appropriate to modify certain dental procedures or to use devices or technics such as special high velocity air suction, that will reduce microbial aerosol production or dispersion during those procedures to levels comparable to those produced by group 1 oral activities such as breathing or speaking.

(Bauman et al. J of Multidisciplinary Care 2018)

Aerosols are differentiated based on particle size: spatter (> 50 µm), droplet (≤ 50 µm), and droplet nuclei (≤ 10 µm). In dental settings, 90% of the aerosols produced are extremely small (< 5 µm). Spatter, being the larger particle, will fall until it contacts other objects (e.g., floor, countertop, sink, bracket, table, computer, patient or operator). Droplets remain suspended in the air until they evaporate, leaving droplet nuclei that contain bacteria related to respiratory infections. Droplet nuclei can contaminate surfaces in a range of three feet and may remain airborne for 30 minutes to two hours. Ultrasonic scalers and high-speed handpieces produce more airborne contamination than any other instrument in dentistry.
https://decisionsindentistry.com/article/transmission-precautions-for-dental-aerosols/

(Bauman, J Hospital Infection, 2006)
Significant **contamination of the operatory** occurred at all distances sampled when high-speed instruments were used (mean 970 colony-forming units/m2 /h). The bacterial density was found to be higher in the more remote sampling points. The area that becomes contaminated during dental procedures is far larger than previously thought and practically encompasses the whole room. These results emphasize the need for developing new means for preventing microbial aerosols in dentistry and protection of all items stored temporarily on work surfaces. This is especially important when treating generally ill or immunocompromised patients at dental surgeries in hospital environments.

(Harte. JADA, Vol. 141 2010)
PPE. Because surgical masks protect the mouth and nose only from splashes, spray and spatter from large-particle droplets and not the smaller aerosol particles, they cannot be used when Airborne Precautions are indicated. When breathing with a surgical mask in place, much of the inhaled air comes in around the sides of the mask, along with airborne organisms. According to CDC's 2007 isolation guideline, HCP should don fit-tested N95 respirators approved by CDC's When HCP use respirators while treating patients with diseases requiring Airborne Precautions, they should use the respirators in the context of a complete respiratory protection program. This program should include training and fit testing to ensure an adequate seal between the edges of the respirator and the wearer's face.

(Harrel and Molinari, JADA 2004)
As noted previously, if the ADA's recommendations for sterilization of instruments and treatment of water lines are followed, these major sources of potentially contaminated dental aerosols can be controlled. However, it should be recognized that the aerosol created by the interaction of coolant water and ultrasonic vibrations or by compressed air and a rotary motion are visible to patients and dental personnel. It is important that this aerosol cloud be controlled to the greatest extent possible to reassure patients and dental personnel. It also should be recognized that contaminated aerosols are produced during dental procedures when there are little or no visible aerosols. As has been shown in the study of aerosol production by ultrasonic scalers when no coolant water was used, even in the complete absence of coolant water there is aerosolization of material from the operative site. During routine dental treatment, there is a strong likelihood that aerosolized material will include viruses, blood, and supra- and subgingival plaque organisms.
At this time, it is impossible to determine the exact infection risk represented by aerosolized material. The potential for the spread of infection via an almost invisible aerosol, however, must be recognized and minimized o eliminated to the greatest extent feasible within a clinical situation.

The use of personal barrier protection such as masks, gloves and eye protection will eliminate much of the danger inherent in spatter droplets arising from the operative site. However, any infectious material that is present in a true aerosol form (particles less than 50 µm in diameter) or spatter that becomes re-airborne as droplet nuclei has the potential to enter the respiratory tract through leaks in masks and contact mucus

membranes by going around protective devices such as safety glasses. A true aerosol or droplet nuclei may be present in the air of the operatory for up to 30 minutes after a procedure. This means that after a dental procedure, if the operator removes a protective barrier such as a face mask to talk to a patient when a procedure is completed, the potential for contact with airborne contaminated material remains. 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.

During many dental procedures, the use of a rubber dam will eliminate virtually all contamination arising from saliva or blood. If a rubber dam can be used, the only remaining source for airborne contamination is from the tooth that is undergoing treatment. This will be limited to airborne tooth material and any organisms contained within the tooth itself. In certain restorative procedures such as subgingival 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.

From a practical point of view, it is easiest 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

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. This layering of infection control steps needs to be followed in reducing the potential danger from dental aerosols.

The dental team should not rely on a single precautionary strategy. In the reduction of dental aerosols, the first layer of defense is personal protection barriers such as masks, gloves and safety glasses. The second layer of defense is the routine use of an antiseptic preprocedural rinse with a mouthwash such as chlorhexadine. The third layer of defense is the routine use of an HVE either by an assistant or attached to the instrument being used. An additional layer of defense may be the use of a device to reduce aerosol contamination that escapes the operating area, such as a HEPA filter.

- Universal barrier precautions should be followed;
- A preprocedural rinse should be used before treatment;
- A rubber dam should be used where possible;
- An HVE should be used for all procedures.

DEVICE	ADVANTAGES	DISADVANTAGES
Barrier Protection—Masks, Gloves and Eye Protection	Part of “standard precautions,” inexpensive	Masks will only filter out 60 to 95 percent of aerosols, subject to leakage if not well-fitted, do not protect when mask is removed after the procedure

Preprocedural Rinse With Antiseptic Mouthwash Such as Chlorhexidine	Reduces the bacterial count in the mouth, saliva and air; inexpensive on a per-patient basis	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
High-Volume Evacuator	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	When an assistant is not available, it is necessary to use a high-volume evacuator attached to the instrument or a "dry field" device; a small-bore saliva ejector is not an adequate substitute
High-Efficiency Particulate Air Room Filters and Ultraviolet Treatment of Ventilation System	Effective in reducing numbers of airborne organisms	Only effective once the organisms are already in the room's air, moderate to expensive, may require engineering changes to the ventilation system

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