ORIGINAL PAPER

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Aerosols, Essential Dental Hygiene Procedures and Concerns for Personal Safety: A balanced approach for back-to-work treatment recommendations.

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Introduction

Recommendations on how to navigate a return to regular dental care in the current climate of the COVID-19 pandemic have varied widely. Knowingly, recommendations should emerge from a combination of a review of the available science, clinical judgment, practicability of implementation and risk vs. benefit analyses. This paper was written to provide evidence based information to assist regulatory bodies with their decision making, as they consider recommendations for the provision of effective dental therapy in a way that maximizes the safety of everyone that enters the dental treatment space.

The need for periodontal debridement

Adequate debridement is essential for periodontal inflammation to resolve. Persistence of inflammation in periodontal tissues contributes to the systemic burden of inflammation (Cardoso et al. 2018). Low grade systemic inflammation has the potential to increase the risk for subsequent infections (Kaspersen et al.2016). Patients at high-risk for severe illness from COVID-19 included those with underlying conditions that deactivate mechanisms of the body's immune system (CDC 2020). Up to 94% of hospitalized patients diagnosed with COVID-19 had one or more underlying conditions (Richardson 2020). The most common comorbidities were hypertension, obesity, and diabetes, all of which can be affected by chronic inflammatory periodontal disease (Aguilera 2020, Sundar 2018, Goodson 2020). It is conceivable that chronic inflammatory periodontal disease (CIPD) may be one of the underlying conditions which can affect the severity of the COVID-19 illness (WHO 2020).

Effective periodontal debridement involves removal of clinically detectible debris and interruption of pathogenic microscopic biofilm. While still commonly used during debridement, evidence has long suggested that even the most intensive mechanical treatment, (i.e. hand instrumentation) on its own cannot consistently yield adequate control of the bacterial etiology (Cobb CM. 1996; Ciantar M. 2014). In the case of the COVID-19 pandemic, many interim recommendations for the provision of dental care suggest using hand instrumentation solely and avoiding the use ultrasonic instrumentation. This may not be the most prudent strategy.

Rather than protocols suggesting avoidance of evidence-based procedures that are essential to patient health (i.e. ultrasonic instrumentation), developing protocols in which ultrasonic therapy can be implemented with minimal risk to the dental health care provider, especially in times of pandemic, seems prudent. If aerosol reduction strategies are combined with updated infection control procedures, including the use of effective personal protective equipment (PPE), the risk of pathogen transference from patient to provider can be reduced or eliminated even when using ultrasonic instrumentation.

The extent of the problem

Ultrasonic, compressed air driven highspeed handpieces, three-way water/air syringes, prophy cups/paste and air polishing devices all have the potential to generate aerosols which can spread and persist, if not adequately captured. When measured via colony forming units (CFU), collected onto non-specific growth media placed at locations distant from the device being used, ultrasonic instrumentation, when inadequately controlled, is suggested to have the greatest potential to create potential aerosol contamination. (Harrell 2004). However, it is important to note that studies documenting the spread or persistence of ultrasonic generated aerosols have all been performed when the device was used without any attempt at aerosol capture. This research was crucial in identifying the potential risk that existed among aerosols within dentistry, further prompting the quest for a solution. There is significant evidence that using a large bore capture device (8+mm) on a properly functioning dental vacuum system removes 90-98% of any generated aerosol preventing it from leaving the operative site. (Micik R 1969, Bentley C 1994, Harrel S 1996, King T 1997, Klyn L 2001, Jacks M 2002).

The amount of aerosol capture via HVE is subject to the basic laws of air flow dynamics. Air flow rate depends on the suction force at the point of capture and the diameter of the opening to the HVE suction line. Many manufactures suggest that since their devices attach to an HVE line, they can be expected to capture 90% of aerosols. Such claims are inaccurate. The actual diameter of the device attached to the HVE is what determines the effectiveness of the capture device. Devices designed with numerous holes, even if the total surface area of the holes equals that of an 8mm orifice, will not remove as much aerosol due to the basic laws of fluid dynamics.

A reasonable approach going forward

For safe use of ultrasonic instrumentation, a layering of protections has long been suggested (Harrell 2004). Currently, there is no data to determine and rank the impact of each of the potential protective steps on transmission reduction and studies concerning aerosol generation and capture in dentistry have focused on bacteria, little has been published on virus and fungus. Availability of resources can also affect the implementation and adherence to the steps involved in an overall aerosol contamination reduction strategy. Any developed strategy to improve the safety of the dental treatment environment should include steps that are reasonably implemented and have data supporting the benefit of implementation.

Many factors affect the generation, composition and spread of aerosols in the dental treatment room. Although it is impossible to determine the exact infection risk to a clinical dental professional when using an ultrasonic device, a prudent goal is to reduce or eliminate as many of the factors as possible.

The three basic strategies to reduce the impact of ultrasonic generated aerosols include:

1. Reduce the likelihood that carriers of SARS-CoV-2 are seen the office.
2. Affect the generation, spread and duration of potentially infectious aerosols.
3. Protect against any potential contaminants in the room.

Adopting the following recommendations could allow patients to receive the level of dental care necessary to affect their oral and overall health in a manner that reduces risk to dental providers beyond that afforded by previous dental hygiene visit protocols.

1. Screen potential patients prior to visit to identify and reschedule patients who may be asymptomatic carriers of SARS-CoV-2.
2. Temperature screen patients on arrival to office and reschedule patients with temperature ≥ 100.4º.
   (https://www.ada.org/~/media/CPS/Files/COVID/ADA_COVID_Int_Guidance_Treat_Pts.pdf).
3. Have patients pre-rinse with 1.5% hydrogen peroxide.
   (https://www.ada.org/~/media/CPS/Files/COVID/ADA_COVID_Int_Guidance_Treat_Pts.pdf).
4. Follow standard precautions for infection control (principles of infection control which can be found in the October 2016 publication: "Centers for Disease Control and Prevention. Summary of Infection Prevention Practices in Dental Settings: Basic Expectations for Safe Care."
5. Consider alternatives to the use of prophy cup delivery and 3-way syringe use.
6. Wear appropriate PPE
   a. Disposable full coverage gown
   b. Head cover
   c. Face Shield
   d. Surgical N-95 mask. If surgical N-95 masks are not readily available, consider a Level 3 mask with face shield (only if the other recommended steps are followed).*
7. Follow manufacturer instructions for use for operation and cleaning of ultrasonic device.

*Certainly, the use of a surgical N-95 respirator is preferable. However, data concerning the effectiveness of surgical N-95 respirators, Level 3 masks and face shields used alone or in combination during procedures with the potential to procedure viral-laden aerosols, is sorely lacking. Those knowledge gaps must be filled in. In the absence of available data, the current need for periodontal debridement (especially considering the adverse effect that chronic oral inflammation can have on the immune response), mandates that risk vs need vs availability analyses must be considered to develop realistically implementable protocols for providing dental health care safely and effectively.

The CDC recommends to hospitals and other ambulatory medical settings that a second tier of infection prevention called Transmission-Based Precautions (Siegel, JD, et al. 2007), be followed when aerosol generating procedures are being performed. Transmission-Based Precautions include the use of surgical N-95 respirators and environmental controls including negative pressure room with minimum rates of air exchanges per hour.

While it is tempting to apply CDC regulations designed for medicine to dental procedures, there are distinct differences. The location of any generated aerosol is not as predictable in medicine compared to dentistry. For example, when a breathing tube is removed from a patient, potential pathogens will be spread based on the highly variable path that the tube takes upon removal and continue onto any surface on which the tube makes contact. In dentistry, the operative site where aerosols may be created is easily identified and more importantly, able to be effectively controlled as air flow rates of suction devices in medical treatment rooms are typically much lower than those used in dentistry.

The use of surgical N-95 respirator by dental professionals would be ideal. However, surgical N-95 respirators are not readily available currently or in the foreseeable future. Also, considerable time and resources will be necessary for dental providers to adhere to published guidelines

(OSHA guideline 1910.134 - Respiratory Protection). Medical clearance, verified fitting, regular fit testing a required written respiratory control protocol and training program, are not readily available for dental personnel.

Realizing that a multi-tiered approach to aerosol control in the dental setting, (large bore capture device attached to adequately functioning vacuum system, pre-procedural rinse, avoiding use of 3-way syringe), will greatly reduce aerosol generation and pathogenic potential, one of the first states to recommend reopening recommendations for dental offices noted that substitution of a facemask/level 3 surgical mask for a surgical N-95 respirator is acceptable assuming that other steps for aerosol control are followed (https://www.kyda.org/res/uploads/media/Phase-I-Reopening-Dentistry-s-Plan.pdf accessed 04/30/20).

It is important for every dental professional to perform a risk assessment to determine what is safe and effective for them and the patient before proceeding with treatment. Dental hygiene therapy is an essential component of oral and overall wellness and guidelines for the delivery of patient care must be able to be implemented in a reasonable manner.

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