



Title:

Reducing the Risk of COVID-19 Transmission in Dental Offices: A Review

Running title: Dental Offices and COVID-19

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Abstract:

The COVID-19 epidemic has become a major public health challenge around the world. According to the World Health Organization (WHO), as of August 2020 there are more than 833,556 dead and over 24,587,513 people infected around the world. This pandemic has adversely affected many professions around the globe, including dentistry. COVID-19, caused by the Corona virus family, is transmitted mainly by direct contact with an infected person or through the spread of aerosol and droplets. Dentistry by nature is considered to be one of the most vulnerable professions with regards to the high risk of transmission between the dentist, dental team, and patients; therefore, a protocol for infection control and the prevention and spreading of the COVID-19 virus in dental settings is urgently needed. This article reviews essential knowledge about this virus and its transmission and recommends preventive methods based on existing scientific research and recommendations to prevent the spread of this virus in dental offices and clinics.

Keywords: COVID-19, Dental Offices, Review, Reducing transmission

As the world is well aware, in the last months of 2019, a severe form of COVID viral pneumonia was reported in Wuhan, China.^{1,2} The disease quickly spread and infected a large number of Chinese citizens and due to the frequency of worldwide travel, it managed to disperse to neighboring and distant countries.

The further isolation of the virus and determination of its genome³ revealed that it belongs to the Corona family of viruses and is capable of infecting humans. On February 11, 2020, the World Health Organization (WHO) named the new virus COVID-19. It is the seventh member of the Corona family of viruses that is able to infect humans. Two other member of this family named SARS-CoV and MERS-CoV, also caused fatal respiratory diseases in 2002 and 2012 respectively and regrettably they still continue to cause respiratory diseases.⁴⁻⁶

In terms of nucleotide sequence, COVID-19 is about 80% similar to its other two noxious family members. It has the ability to cause deadly respiratory infections but is also able to spread much faster than other members of its family⁷ and as a result, the virus has spread extremely quickly to countries around the world.⁸ WHO declared COVID-19 an International Public Health Emergency on January 31, 2020.⁹

According to a WHO announcement, as of August 2020, there have been over 833,556 deaths and in excess of 24,587,513 people infected.

Symptoms and Transmission

Common symptoms of the disease include fever, cough, muscle pain, excessive fatigue, sore throat, and/or reduction/loss of smell or taste¹⁰⁻¹² which can be present along with abnormal radiographic findings in the lungs. However, in a few cases, the disease can be present but symptomless or resemble a common cold (runny nose) or a stomach upset (nausea and diarrhea).¹³⁻¹⁵

The virus can be transmitted by direct contact with an infected person or through the spread of aerosol droplets (e.g. coughing, shouting, or sneezing)¹⁶ as well as through contact with contaminated surfaces. The virus can also be transmitted to mucosal surfaces of the face such as the oral environment, nose, and eyes^{17,18} by an infected hand. These are all documented transfer modes in respiratory tract infections.¹⁹

Studies have shown that respiratory viruses are transmitted directly or indirectly through salivary droplets^{18,20} as well as through aerosols dispersed in the air from coughing, sneezing, or medical procedures.^{21,22} Although the COVID-19 virus is detectable in a patients' feces on day 7²³, the possibility of transmitting of the COVID-19 virus via feces is still under investigation.²⁴

Receptors of COVID-19 in Humans

Understanding the path of the virus to the human body can demonstrate the variety of transmission routes. Both SARS-CoV and COVID-19 use ACE2 cell receptors to infect humans.^{25,26} This receptor is found in the lung and in small intestinal mucosa cells;²⁷ therefore, the virus is capable of infecting both the upper respiratory and digestive system.^{27,28} There have been some reports of upset stomachs as a symptom, especially in the younger age groups.²⁹ The ACE2 receptors are particularly seen in epithelial cells of salivary glands.^{28,30} This receptor is also found extensively in epithelial cells of the tongue.^{31,32} Locations of this receptor indicate where the body is infected and how the virus is transmitted, including saliva and respiratory droplets and therefore the oral environment is a notorious transfer zone for potential transmission of the virus.

Dentistry and Transmission of Disease

Production of aerosols and droplets during dental treatment are the main route for airborne pathogens.^{33,34} Dental treatments can spread a large amount of these virus-containing nano, small, and large particles in the air^{22,34,35} causing consequent spread of the illness to dental health workers and subsequent patients.^{36,37} Also dental patients can be asymptomatic carriers of COVID-19 at the time of dental treatments.^{15,38} The droplets released from the dental treatment can survive for several hours in the air and ultimately be a potential source of multiple transmissions.^{21,22,31,35}

Current infection control strategies for dentistry recommended by the Center for Disease Control (CDC) have been focused mainly on Blood Born infections and dentists are well-trained in this area but the guidelines about Airborne Diseases in dentistry is not as strong.³⁹⁻⁴² The likelihood of cross-contamination of this pathogen between dental offices and dental laboratories is also unclear and more standardized worldwide guidelines should be provided in this area as a result of further studies.

Uncertainty and fear in the community around visiting dental offices can have many adverse economic effects on the dental community and also negative effects on the dental health of the population. New strategies are absolutely essential to alleviate fear and bring people back into dental offices as needed.^{43,44}

Based on the possible direct and indirect methods of transmission, the protection of Health Care Workers (HCW's) as well as patients is extremely important.^{45,46} The Corona virus family has produced three worldwide dangerous epidemics over the past 18 years which shows that attention to airborne diseases is extremely essential in dentistry. This pandemic has shown that dentists around the world need to unite to contain the risk of infection in their practices.

Methods for Protecting Against Airborne Diseases in Dentistry

Due to the worldwide spread of diseases that can be transmitted by droplets and aerosols, it is necessary to pay meticulous attention to this topic and include them in infection control guidelines for dental offices.³¹ Implementing and following recommendations are important to keep dental offices a safe place for all patients and personnel and to prevent the spread of such respiratory diseases.

Tele-Screening and Communication Before Appointments

Tele-screening of patients by phone or other internet-based communication system is recommended before attending in office. This includes asking the patients about any symptoms resembling a cold, flu, or even stomach/digestive issues as well as about any recent travel. Based on worldwide recommendations for observing social distancing rules, it is recommended to observe personal hygiene and coughing etiquette as well as the use of effective face masks. Patients should also be encouraged to do so in public as well as when attending a dental office. It is

recommended to instruct patients to come alone for dental appointments and to avoid bringing any unnecessary items with them. There must be an appropriate interval between patients' appointments in order to allow for enough time for disinfection and airing of the dental office which will help significantly to reduce possible aerosol contact between patients.

All common decorative, promotional, or unnecessary devices/tools such as pamphlet, magazines, books, etc., should be removed from the waiting area. The reception area must be disinfected routinely and also have good ventilation. There must be a protocol in place for payment and the subsequent disinfection of credit cards.

Patient Arrival

All patients must wear a shoe cover that is put on immediately before entering the dental office and also disinfect their hands immediately upon entering the office. The dentist should be able to assess the patient's health based on observations, depending on the type and symptoms of the common illness^{40,41}, so completing a questionnaire at each treatment session is helpful in this process. Questions should reveal information such as having a fever in the past 14 days, any reduced sense of smell or taste, have flu-like symptoms, cough, difficulty breathing, body ache or diarrhea, history of traveling to high risk areas or contact with people who have recently travelled to high risk areas;⁴¹ however, we should always consider that some patients can be carriers of the virus and symptomless and therefore can still spread the virus by cross contamination.³⁸ If a patient is a suspected carrier, other symptoms should also be considered. Since the last three epidemics have been transmitted by the Corona family of viruses over the past two decades, the assessment of body temperature must become routine in-patient evaluation.

Dental Radiographs

Intraoral radiographs are commonly taken for diagnosis of dental diseases. If possible, try to use extra oral radiography including panoramic tomography, CBCT's, or oblique lateral views. If intraoral radiographs are absolutely necessary, the use of pre-radiographic disinfectant mouthwashes such as peroxides are recommended³¹ as well as the use of plastic disposable covers to avoid infection through cross-contamination. Disinfection of the X-ray equipment is also vital and there must be meticulous attention given to the ventilation of radiograph room.⁴⁷

Hand-Hygiene

Indirect transmission by touching infected surfaces is one of the proven methods of transmission of airborne diseases;⁴⁸ therefore, reinforced hand hygiene must be made compulsory and all members of the dental team and other staff should follow the guidelines in place.^{48,49} The recommendation for hand hygiene is before the patient's examination, before the dental treatment, after contact with the patient, after touching the materials and equipment that have not been disinfected, and after examination of oral mucosa, damaged skin, blood or body fluids, exudates, and human waste. This is known as "Two Before and Three After" and this protocol is needed to enhance and improve hand hygiene.⁴⁹ The potential for Fecal-Oral transfer of COVID-19 should be considered and hand hygiene is the key element of prevention in this regard too.⁴¹ In the protocol, Two Before/Three After, the dentist and the rest of the medical staff should wash their hands as indicated above.^{41,50} It is recommended that the hands should be washed after removing the gloves as well due to the permeability of latex gloves.^{51,52} The system of washing hands before and after wearing latex gloves was recommended even before the SARS outbreak. It is also recommended that HCW's do not wear any jewelry or watches to the dental practice if possible, and to remove them before seeing any patients.

Personal Protective Equipment

Indications and correct utilization of Personal Protective Equipment (PPE) play a key role in COVID-19 protection for the patient and for personnel. Aerosols and droplets are common methods of transmitting airborne diseases and are created in ample amounts with ultrasonic and dental hand pieces; therefore, wearing masks, shields, goggles, disposable caps, gloves, and protective clothing should be made compulsory for all dental health professionals in the operatory.³⁴ For those who do not deal with the patient directly (such as office personnel) surgical masks are recommended while chair side personnel must use N-95 masks. It is also recommended to observe the sequence of donning and discarding personal protective equipment. The donning sequence has been recommended to be as follows: washing hands, wearing gown, face mask, scrub hat, face shield, and surgical gloves.

The doffing sequence is as follows: first remove surgical gloves in the formats recommended, face shield, scrub hat, and face mask, and finally the body gown and then subsequent surgical hand washing.

Reprocessing of PPE due to lack of supply can be essential. Concerning respirator reuse, highly energetic, short-wave, ultraviolet germicidal irradiation (UVGI) at 254 nm was determined to decontaminate N95 respirators from viral respiratory agents, but UVGI requires careful consideration of the type of respirator and of the biologic target. Most studies suggest surgical masks are not inferior compared with N95 respirators in terms of protective efficacy among healthcare workers. Therefore, the use of N95 respirators should be limited to high-risk situations. Also, for N95 masks the fit test is recommended.^{53,54}

Antimicrobial Mouthwashes

Use of mouthwash prior to treatment reduces the number of microorganisms in the mouth and subsequently decreases airborne microorganisms following dental treatments.^{40,41,55,56}

Chlorhexidine is commonly suggested as a pre-treatment mouthwash⁵⁶ but it is not effective against the Corona virus.⁴¹ Oxidizing mouthwashes such as hydrogen peroxide 1%, povidone or cetylpyridinium chloride (CPC) 0.10% to 0.05% are recommended for protection against Corona viruses.^{40,55,56,57,58} Povidone-iodine can safely be used in the mouth with up to 2.5% and it rapidly inactivates coronaviruses when applied for 15 seconds.⁵⁹

Reduce Oral Aerosols and Droplets

Airborne particles can be one of the main causes of disease transmission. These particles will be suspended in the air³³ and their suspension time will be depend on their size and weight.²¹ These droplets can spread up to several meters in the environment and if smaller than 5 μ , they will remain in-air for more than 3 hours.^{31,35} They infect the surfaces by sedimentation, so decreasing the quantity of aerosol and droplets during dental procedures is very critical. There are different ways to reduce aerosol and droplets as shown in Table 1.^{31,41,60,61,62,63,64}

Dental High Speed Hand Piece

Due to the heat generation on the tooth during preparation, continual water coolant is required. The coolant collides with the bur and cavity causing many suspended aerosol and droplets. Some articles describe the use of disinfectant liquids instead of water as coolants⁶⁵⁻⁶⁷ which may reduce the microbial load on airborne droplets and disinfect the waterline.⁶⁸⁻⁷⁰ Although these liquids may interfere with dental bonding techniques,⁷¹ the use of 0.1% of CPC is recommended due to its disinfection capability which has no effect on the adhesive and bonding process. In general, the use of

anti-retraction hand pieces is recommended for dental treatments for waterline protocols.⁷²⁻⁷⁴

Reducing Treatment Sessions

If possible, it is recommended to increase the number of treatments per session in order to minimize the number of patient appointments.

Surface Disinfection

Surfaces can be contaminated directly or indirectly by the deposition of droplet particles and the lifetime of the virus on surfaces varies depending on the materials and the presence of moisture.^{19,21} The CDC Guidelines provide good protocols for cleaning contaminated surfaces.^{76,77} It is naturally advisable to utilize disinfectants that work on both airborne and blood born viruses and microorganisms.⁷⁷

Fogging or “Aerosol disinfection” is also an option for disinfection of surfaces without touching between the patients. There are some chemicals which can be used as vapor disinfectant including hydrogen peroxide and hypochlorous acid. The recommended method for hydrogen peroxide is 20% (w/v) working solution of hydrogen peroxide (stabilized by 0.01% of silver nitrate) prepared. The amount of solution required is approximately 1000 mL per 1000 cubic feet. For use of chemical in the form of vapor, we must consider the contact time, concentration of active disinfectant, dilution of material in air, and last but not least the possible negative effect on respiratory system of health care workers. To reduce the time between the patients, we may accelerate the removal of infected aerosol by using heavy ventilation or accelerate the surface disinfection by means of HOCL fogging for 10 minutes by 20 micron vapor.^{78,79}

Disposable Barrier

The dentist and his/her assistant may need to touch different devices that may not always be fully disinfected. On the other hand, sterilizing chemicals can cause lung damage and environmental pollution,⁸⁰ therefore, these surfaces may be covered with disposable barriers and the barrier discarded immediately after each dental treatment. Examples of such barriers include full chair coverage, counter coverage, and dental microscope coverage. Also, implementing 4-handed dentistry or working closely with your assistant and preplanning can avoid the need to touch surfaces with infected gloves.

Ventilation

Infected droplets suspend in the air for hours^{20,61,81,82} so attention to ventilation is essential. The use of declared guides is very effective in controlling droplets but cannot remove the contaminated particles completely.⁶¹ Research carried out by Zemouri in 2017³⁵ shows that there can be 38 different types of microorganisms dispersed in the air in dental clinics. Although these articles have not investigated the Corona family of viruses specifically, it has been proven that SARS-CoV and COVID-19 viruses are present in the saliva of infected individuals^{28,30,32} and therefore attention to proper ventilation during and after treatment is very important. There are different ways to ventilate dental offices and clinics as shown in Table 2.⁸³⁻⁸⁵

Dental Laboratories and Cross-Contamination

Cross-contamination between dental clinics and laboratories has been proven^{86,87} and the CDC has provided specific guidance on infection control for both laboratories and dental offices. The

general advice in this case is to disinfect all outgoing items before sending them to the lab as well as after receiving items from the lab including packaging and boxes.^{88,90} The routine items and their protocols are shown in Table 3.⁸⁶⁻⁹

Medical Waste

Medical waste is divided into two categories: infectious and non-infectious. The existing guidelines seem to be sufficient and must be closely executed.

Conclusion

COVID-19 has impacted many aspects of our life and dentistry is not excluded. Dental practices should reinforce and follow new guidelines to protect themselves, their patients and their dental team against COVID-19. However, as we learn more about this new infection the guidelines may change. Also, further clinical studies are recommended to investigate the effectiveness of existing guidelines and be able to improve them for a safe environment for practicing dentistry. It is recommended that all dental practitioners and dental auxiliaries keep themselves updated as new scientific data evolves regarding COVID-19.

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Table 1: Different ways to reduce aerosols and droplets in dental offices

1	Abandoning and/or substituting techniques that produce droplets, if possible. For example: decreasing the use of three-way syringe or using manual instruments for caries removal or root scaling
2	High volume evacuation with a large diameter suction tip and expert hands accompanied by four-hand discipline, can prevent a large amount of contamination; however, this type of suction should be disinfected daily and the suction exhaust must be discharged out of the treatment environment
3	Implementation of four-hand dentistry and well-trained dental assistants and also minimizing the presence of personnel in the room during the procedure
4	Use of rubber dams also tends to prevent contamination; ^{31,59} therefore, rubber dam practice should also become a habit and be used whenever possible

Table 2: Recommended effective ways for dental office ventilation

1	Use air purifiers with HEPA (High Efficiency Particulate Arrestor) filters. HEPA filters need to be replaced frequently.
2	Use of strong or industrial fans for ventilation of the clinic is also a convenient and low-cost method but carry the risk of possibly spreading the infected droplets to the outside air.
3	Use of UV light after each patient.
4	Use of a negative pressure room, if possible.
5	Use of antiviral disinfectant sprays such as Nano-Silver disinfectant.

Table 3: The common lab items and their disinfection protocol

1-Dental Impressions	These impressions are routinely sanitized according to the disinfection protocol, and it seems that current methods, are capable for eliminating airborne viruses.
2-Prosthesis	Prosthetic appliances after try-in stage such as fixed and removable prostheses must be disinfected by chemical or physical method by the dentist according to material.
3-Gypsum Dental Models	Existing guidelines have provided methods for sterilizing dental models by chemical solutions, but these methods are not reliable and may damage the model. There are many articles on the use of autoclaves or microwave furnace for disinfecting the gypsum, but dental models usually contain metal parts that limit the use of physical or microwave techniques. As a result, dentists should minimize the contact with dental models during the try-in phase. This can be done by analyzing the model with clean hands or gloves.