# AAID White Paper: Management of the Dental Implant Patient During the COVID-19 Pandemic and Beyond

James L. Rutkowski, DMD, PhD[1]*
Daniel P. Camm, DDS[2]
Edgard El Chaar, DMD, MS[3]

The scientific community's understanding of how the SARS-CoV-2 virus is transmitted and how to best mitigate its spread is improving daily. To help protect patients from acquiring COVID-19 from a dental office nosocomial infection, many state or local governments have classified dental treatments as "nonessential" and have paused routine dental care. Dentists have been instructed to perform only procedures designated as emergencies. Unfortunately, there is not a good understanding of what a dental emergency is among governmental leaders. What a government agency may perceive as an elective procedure may be seen as "essential" by the dental clinician responsible for maintaining the oral health of the patient. Each dental specialty understands the effects delayed care has on a patient's oral and systemic health. Dentistry has made extensive progress in improving oral health through prevention of the dental emergency. The dental profession must work together to prevent the reversal of the progress dentistry and patients have made. This American Academy of Implant Dentistry (AAID) White Paper discusses what COVID-19 is and how it impacts dental treatments, presents guidelines for dentistry in general and for dental implant related treatments, specifically. Recommendations for implant dentistry include the following: (1) what constitutes a dental implant related emergency, (2) how patients should be screened and triaged, (3) what personal protective equipment is necessary, (4) how operatories should be equipped, (5) what equipment should be used, and (6) what, when, and how procedures can be performed. This paper is intended to provide guidance for the dental implant practice so patients and dental health care providers can be safe, and offices can remain open and viable during the pandemic.

***Key Words: AAID, COVID-19, implant dentistry, dental office, infection, pandemic, saliva, SARS-CoV-2, white paper***

## INTRODUCTION

A novel coronavirus pandemic has taken the world by storm and put normal life activities on hold. The scientific name of this strain of coronavirus is severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The disease caused by this virus is clinically referred to as coronavirus disease 2019, or COVID-19.[1]

During the pandemic, various states and areas of the United States have limited dental care to emergency care only. The definition of "emergency care" may vary with each state and within each dental specialty. When a state or locality reopens to commerce, some routine dental treatments return for dental offices. However, there are 4 pressing questions at this point:

1) What are the primary COVID-19 factors that put patients and dental health care providers at risk?
2) What is the proper way to equip dental offices to mitigate the associated risk factors?
3) With regional spikes in COVID-19 cases, many dental offices may be mandated to close again except for emergency care. What constitutes an emergency for the implant dental practice?
4) Is it possible to collect data to assess the impact that the initial dental care "pauses" had on the oral health of dental implant patients?

Guo et al[2] investigated the impact of the COVID-19 pandemic on the utilization of emergency dental services and found 38% fewer patients presented for dental care at the beginning of the COVID-19 epidemic than before the pandemic began. The nature of dental problems changed significantly from prepandemic visits. The proportion of dental-related infections increased from 51.0% pre-COVID-19 to 71.9% during COVID-19. Nonurgent or nonemergency cases declined to 30% of pre-COVID-19 levels. They concluded that the COVID-19 pandemic has had a major effect on the utilization of dental services.[2] The pandemic has also had a major effect on dental manpower resources. Employment in California dental offices decreased by 60% between February and April 2020, representing a loss of 85 000 jobs.[3]

## BACKGROUND

Much of what is known regarding SARS-CoV-2 comes from previous studies of other coronaviruses, especially SARS-CoV-1

[1] Editor-in-Chief, *Journal of Oral Implantology*; University of Buffalo School of Dental Medicine, Buffalo, NY.
[2] Private practice, New Brunswick, Ohio.
[3] College of Dentistry, New York University, New York, NY; private practice, New York, NY.
* *Corresponding author,* e-mail: jamesrutkowski@me.com
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(the SARS outbreak of 2003). Modes of transmission are similar, but there appears to be a distinct difference in the progression of the infection between the 2 viruses. With SARS-CoV-1, the appearance of symptoms was very close to the time of infection (1–2 days). This helped tremendously, because infected patients were identified quickly, isolated, and traced early on. With SARS-CoV-2, the appearance of symptoms occurs much later in the course of infection (up to 14 days), while some individuals never exhibit symptoms. Thus, it is more difficult to identify, isolate, and trace people infected with the SARS-CoV-2 virus because they are often carriers/transmitters for a longer period of time before they are identified. This difference made the SARS-CoV-1 epidemic of 2003 easier to contain than the present SARS-CoV-2 (COVID-19) epidemic. This also means that we have to treat every dental patient as a potential "infector" or "spreader."[4,5]

The American Dental Association (ADA) has published criteria on what constitutes a "dental emergency" and outlined treatment guidelines.[6] However, the various specialty dental organizations have neither outlined distinct positions for what constitutes a "dental-specialty-recognized-emergency," nor offered procedural options that would be acceptable treatment for a specialty-specific dental emergency. Each of the dental specialties provides unique procedures for treating specialty-related dental diseases. Often treatments are unique or limited to a specialist's scope of practice. Therefore, each of the dental specialty groups (associations) should define what constitutes an emergency and subsequent acceptable emergency care.

Two federal government agencies, the Centers for Disease Control and Prevention (CDC) and the Occupational Safety and Health Administration (OSHA) provide guiding principles that are relevant to maintaining a healthy dental office environment.[7,8] The CDC bears the responsibility for monitoring the introduction and spread of infectious diseases. OSHA provides guidance for safe and healthful working conditions by setting and requiring health safety standards for the workplace. State and local health departments provide guidance on how dentists should provide safe patient care.[9] The ADA, unlike many specialty organizations, has state constituent dental societies that lobby state health departments to assure that mandates are reasonable, applicable, and maintainable.

The purpose of this paper is to review the relevant pandemic recommendations and literature that have influence on dental practices generally and dental implant practices specifically. Unique therapies provided by implant clinicians include implant placement, onlay-bone grafting, subantral sinus augmentations, implant prosthetics, etc. These procedures are generally regarded as elective procedures and therefore fall outside the definition of emergency care. However, long-term delay of these treatments can lead to, or exacerbate, systemic or oral disease states and/or negatively affect clinical success rates. For example, if an onlay-bone graft was placed in early February 2020, the clinician must proceed with implant placement or risk the loss of generated bone volume and quality. Placement of the implant(s) may not be considered an emergency, but allowing excessive time to pass would be to the detriment of the patient's oral health and may necessitate redoing the graft. This paper will discuss whether implant related treatments should be performed, and how clinicians can perform implant related procedures without putting patients or dental health care providers (DHCPs) at risk.

## COVID-19 Transmission

COVID-19 symptoms can range from very mild to severe and include some or all of the following: loss of taste, loss of smell, cough, fever, shortness of breath, muscle pain, sore throat, decreased mental acuity, chest pain, headache, rhinorrhea, diarrhea, nausea/vomiting, and severe respiratory compromise. Severe symptoms can lead to death. Some patients may test positive for the disease and be asymptomatic, while other patients may have some or all of the above-mentioned symptoms. Median incubation period is reported to be 5.1 days (95% CI: 4.5–5.8 days); however, the incubation period can sometimes surpass 14 days.[10] Patients can be contagious prior to the onset of clinical symptoms.[11] It is of concern that patients presenting with mild or subclinical symptoms were found infective and can remain contagious for up to 3 weeks after recovery.[12–15] Upwards of 60% of infected patients remain asymptomatic.[16,17] The SARS-CoV-2 virus spreads human-to-human either by direct transmission through cough, sneeze, or salivary droplet inhalation, or by contact transmission to ocular, nasal, and oral mucous membranes.[1,18,19]

### *Role of saliva*

The etiology and pathogenesis of COVID-19 can be directly related to the saliva of infected patients. Oral epithelium and salivary glands have angiotensin-converting enzyme-2 (ACE2) transmembrane receptors. The ACE2 receptor is composed of 3 geometric portions: (1) large ectodomain segment, (2) transmembrane anchor, and (3) short intracellular tail.[20] The ACE2 receptor's normal biologic actions can be divided into 2 categories: (1) peptidase dependent function and (2) peptidase independent function. The peptidase dependent function is involved in the conversion of angiotensin I into angiotensin II. The peptidase dependent function of the receptor is limited to the ectodomain portion of the receptor. The peptidase independent function is associated with the transmembrane portion of the receptor. This transmembrane portion of the receptor binds with the coronavirus. After binding occurs, the transmembrane portion of the receptor separates (cleaves) from the ectodomain portion. Once cleaved, the transmembrane portion is internalized which carries the bound SARS-CoV-2 virus into the cell.[21,22] Once in the cell, nuclear mechanisms allow for the virus to proliferate, resulting in the individual becoming infected.

There are 3 known routes by which SARS-CoV-2 can enter saliva: (1) liquid droplets or drainage expectorate from the upper or lower respiratory tract and enter the oral cavity, (2) serum containing the virus leaks from inflamed gingival tissues into gingival crevicular fluid,[23] and (3) major and/or minor infections of the salivary gland(s). Any of these will lead to the presence of the SARS-CoV-2 virus in saliva.[24] SARS-CoV-2 RNA can be detected in the saliva prior to the emergence of pulmonary lesions. This may explain the occurrence of asymptomatic infections. The saliva found within the salivary glands can be a major reservoir of the virus. The positive rate for virus cultures of saliva of infected individuals is 92%. This suggests that SARS-CoV-2 transmission may occur by cross-contamination with contaminated saliva.[24–26] Therefore, finding SARS-CoV-2 in saliva should obviously be of interest to the implant dentist when performing procedures.

### *Transmission of saliva droplets*

Transmission person-to-person is far more frequent than previously thought. Spread is dependent upon many things, but one of the key factors is the carrier's personal habits. Infectivity can vary from one person to another by billions of viral particles. The viral particles are contained within saliva droplets. Individuals, when exposed, can develop infections when saliva droplets enter through the oral, eye, or nasal membranes.[18] When permitted to escape the mouth, large salivary droplets typically fall to the ground quickly, while smaller particles may become aerosolized and thus float for long distances and/or remain airborne for extended time-periods. The distance traveled is also dependent upon local environmental factors (size of enclosed space, air circulation/currents, humidity, etc). Baghizadeh Fini[18,24] recently reported that when individual's breathe, speak, cough, or sneeze, droplets of saliva are produced. These saliva droplets are a mixture of moisture and microorganisms (a nuclei). The degree of infectious intensity and likelihood of transmission of a saliva droplet(s) will vary with the quantity, size, and travel distance of the droplet(s).[18,24,27]

A single cough can produce approximately 3000 droplets of saliva nuclei. The release of 3000 nuclei is comparable to the number generated when one speaks for 5 min. One sneeze generates approximately 40 000 droplets of saliva. Under the right conditions, these 40 000 droplets can travel several meters into the surrounding air. A single routine breath exhalation can generate saliva droplets that project 1 m or more into the surrounding environment. Depending upon the surrounding air movement, smaller droplets will travel quickly and longer distances. This is similar to how clouds move on a windy day. Larger, heavy droplets, with more mass, will fall to the ground in a rock-like fashion.[28–33] The World Health Organization (WHO) has determined that close contact or short-range transmission of infectious saliva droplets is a primary mode for SARS-CoV-2 transmission. Furthermore, indoor spaces with limited ventilation are of the most concern.[31,32]

Aerosol-generating procedures found within dental offices are of great concern. Fortunately, there is no evidence to support that the SARS-CoV-2 virus unto itself remains present in the localized air flow for extended periods of time. However, Van Doremalen et al[34] demonstrated that when aerosolized, the SARS-CoV-2 remained viable (within the aerosol) for 3 hours.[34] Thus, to prevent the formation of infectious saliva droplets, it is important to systematically decontaminate indoor air, assure air movement, and block cross-contamination via saliva droplets. These 3 actions could slow down the spread of SARS-CoV-2, especially in the dental setting.[24,35]

Individuals with greater infectivity are referred to as "super spreaders." These super spreaders may or may not be symptomatic. Regardless of the presence of symptoms, these individuals produce more aerosol particles than others.

### *Dental aerosols*

A dental aerosol is a suspension aerosol of fine particles in liquid droplets that is produced from dental instrumentation, dental hand pieces, three-way air/water syringes, and other high-speed instruments. These aerosols are suspended in the clinical environment and pose a potential risk to the DHCPs and other patients. The heavier particles ($>50$ μm) of the aerosols are suspended in the air for reasonably short time-periods and settle down quickly. However, lighter particles tend to remain suspended for longer time-periods. If the aerosol contains the SARS-CoV-2 virus and these droplets enter the nose or oral cavity of surrounding individuals, the virus can bind to the ACE2 receptors of the mucosal tissues. Once the virus has activated an ACE2 receptor, it may proliferate and eventually enter the bronchioles and lungs. This may lead to an infection in the recipient and enable this individual to retransmit the virus.[36]

Since saliva can host several viruses, including SARS-CoV-2, the transmission of viruses through saliva is highly feasible and perhaps unavoidable if a dental office does not take extra precautions to minimize aerosols. Baghizadeh Fini[18] theorized that based on experience in combating the COVID-19 outbreak, stopping disease transmission by saliva in the dental facility is vital to the safety of DHCPs and patients. Vulnerable healthcare workers can minimize SARS-CoV-2 contamination by donning proper personal protective equipment (PPE) as necessitated by patient and procedural risk factors.[18,26,31,36,37]

## Methods for Mitigation

The CDC has implemented Interim Infection Prevention and Control Recommendations for Healthcare Personnel During the Coronavirus Disease 2019 (COVID-19) Pandemic with periodic updates.[38] The recommendations detail the management of the patient throughout the health care facility with appropriate measures to equip the healthcare clinic.[38] These recommendations are in concert with OSHA requirements. The most important general recommendations for implant dentistry are as follows:

1) Recognize that dental settings have unique characteristics that warrant specific infection control considerations.
2) Prioritize the most critical dental services and provide care in a way that minimizes harm to patients from delayed care yet balance with efforts to minimize harm to the DHCPs (and other patients) due to possible exposure to a COVID-19 patient(s).
3) Proactively communicate to both personnel and patients the need for them to stay at home if they are sick or feel sick.
4) Know the steps to take if a patient with COVID-19 symptoms enters your facility. Refer to Figure 1 for a schematic of patient triage recommendations.
5) Optimize the use of engineering controls to reduce or eliminate exposures by shielding DHCPs and other patients from infected individuals. Examples of engineering controls include:

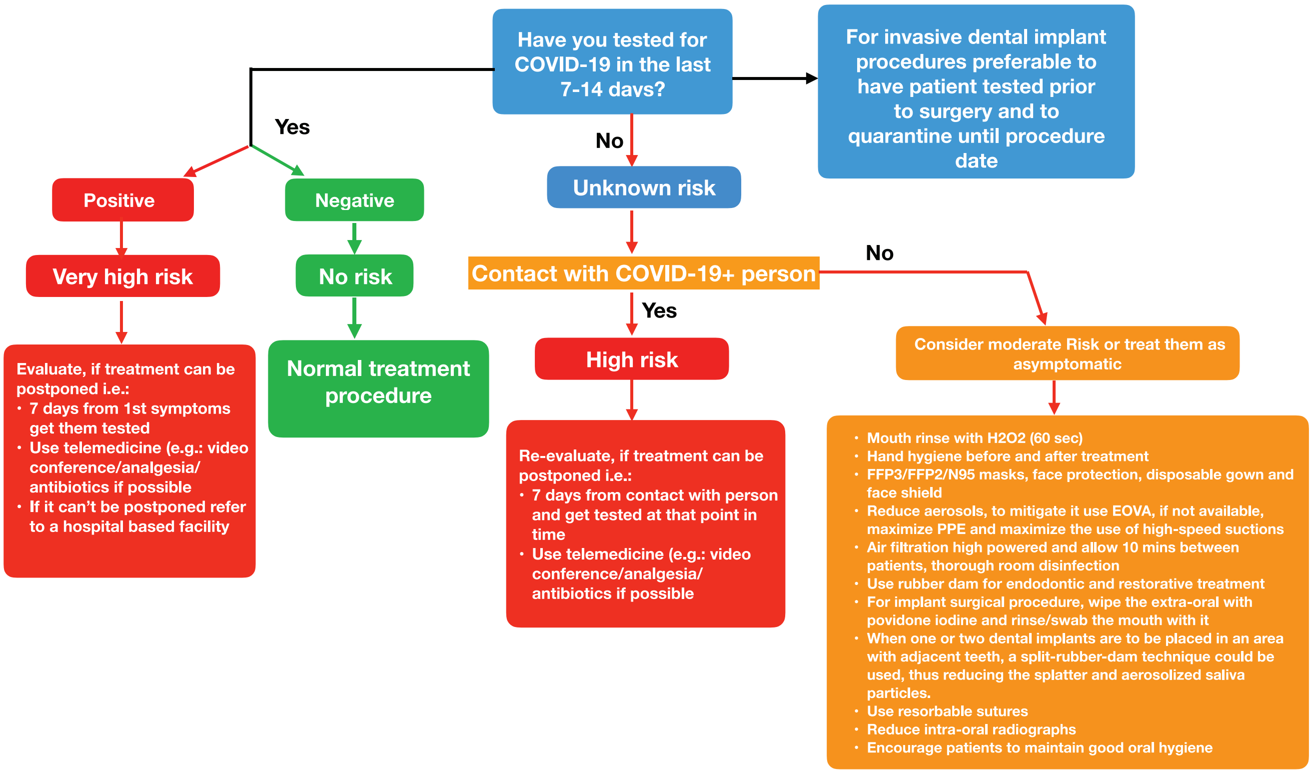


**Figure 1.** Patient management recommendations flowchart.

   a) Physical barriers and dedicated pathways to guide symptomatic patients through triage areas
   b) Remote triage facilities for patient intake areas
   c) If climate permits, outdoor assessment and triage stations for patients with respiratory symptoms
   d) Using vacuum shrouds (also known as extra-oral high-volume suction [EOHVS], extra-oral suction [EOS]) for surgical procedures likely to generate aerosols
   e) Reassess the use of open bay treatment areas

6) Explore options to improve indoor air quality in all shared spaces, including:
   a) Optimize air-handling systems, ensuring appropriate directionality, filtration, exchange rate, proper installation, and up to date maintenance.
   b) Consider the addition of portable solutions (eg, portable HEPA filtration units) to augment air quality in areas when permanent air-handling systems are not a feasible option.

7) Air filtration, high speed suction, and ultraviolet light as a means of mitigating aerosol spread.
   a) A PubMed search found 68 articles on the subject of aerosols in dental offices, 9 articles on the subject of air filtrations in dental offices, and no articles on the subject of external high-speed suctions in dental offices and/or high-speed suctions in dental offices. When the search was adjusted to include extra-oral vacuum aspirator, 4 additional articles were found.
   b) Background information:
      i) Teanpaisan et al,[39] in 2001, used dust-collecting aspirators as an extra-oral vacuum aspirator (EOVA). They found a statistically significant reduction in both the *Escherichia coli* aerosol and the oral bacterial aerosol during dental treatment procedures.[39]
      ii) In 2003, Godwin et al[40] postulated that improved capture, exhaust, and filtration would decrease indoor contaminate concentrations. Furthermore, they warned, "If contaminants are pathologic, the ramifications for practitioners may be considerable, and some specialists may be particularly at risk." With that, other studies looked into the use of EOVA to complement air purifiers.[40]
      iii) Junevičius et al,[41] in 2005, found that a small-sized pump system in conjunction with an experimental EOS system best eliminated the aerosol formed during tooth preparation.[41]
      iv) In 2010, Hallier et al[42] conducted a pilot study to test the levels of bioaerosols generated during dental procedures. They examined if these aerosols could be reduced with the use of an air cleaning system (ACS). They found a significant reduction ($P = .001$) in the mean bioaerosols (cfu/m$^3$) in 3 tested clinics compared with baseline measurements. The mean level of bioaerosols recorded during the procedures, with or without the ACS activated respectively, was 23.9 cfu/m$^3$ and 105.1 cfu/m$^3$

($P = .02$) for cavity preparations; 23.9 cfu/m$^3$ and 62.2 cfu/m$^3$ ($P = .04$) for history taking and oral examinations; 41.9 cfu/m$^3$ and 70.9 cfu/m$^3$ ($P = .01$) for ultrasonic scaling; and 9.1 cfu/m$^3$ and 66.1 cfu/m$^3$ ($P = .01$) for extractions.[42]

v) Devker et al,[43] in 2012, studied combining both mouth rinsing with a bis-biguanide (chlorhexidine gluconate 0.2%) and a high-volume evacuator attachment. They found a reduction of the microbial load of aerosols produced during ultrasonic scaling.[43] They concluded that air purifiers need to be efficient and fast to circulate and purify air that has a high concentration of aerosols, and replenish the local air continuously during treatments that generate aerosols.

vi) In 2020, Ong et al[44] found that ventilation is important to circulate the air in treatment areas.

vii) Also in 2020, Yeu et al[45] and Zhao et al[46] findings' support having air purifiers in treatment areas to remove aerosols that are stagnating in the localized environment air during dental treatment. Air purifiers appear to be more efficacious than the use of ultraviolet.[45,46]

viii) Heilingloh et al, in 2020,[47] found that the SARS-CoV-2 virus was highly susceptible to ultraviolet light: "A viral stock with a high infectious titer of $5 \times 10^6$ TCID50/ml was completely inactivated by UV-C irradiation after 9 min of exposure. The UV-C dose required for complete inactivation was 1048 mJ/cm$^2$." However, UV-A exposure demonstrated only a weak effect on SARS-CoV-2 inactivation over a 15-min exposure. "Hence, inactivation of SARS-CoV-2 by UV-C irradiation constitutes a reliable method for disinfection purposes in health care facilities and for preparing SARS-CoV-2 material for research purpose"; but UV-A exposure is not a reliable method.[47] Additionally, Simmons et al[48] found that when hard surfaces were exposed to UV-C from a pulsed-xenon source (PX-UV) for 1 min, there was a 3.56 $\log_{10}$ load reduction (99.97%) of SARS-CoV-2 PFUs, and when inoculated N95 masks were exposed for 5 min, there was a 4.79 $\log_{10}$ load reduction (99.998%) in PFUs.[48]

### *Additional recommendations for all dental procedures*

1) Tele-screen patients 24 hours prior to the in-office appointments for possible COVID-19 symptoms.[18]
2) Follow a consistent patient assessment and care protocol.
   a) Patients should fill out a comprehensive medical history, a questionnaire regarding recent travel, a questionnaire regarding possible COVID-19 exposures, and an evaluation questionnaire regarding the dental emergency or pending treatment.
   b) Dental practitioners should evaluate the body temperature of a patient via a noncontact forehead thermometer or cameras with infrared temperature sensors. Elective dental treatments for patients with a fever over 100.4 °F (or 38 °C) and/or signs of respiratory disease should be postponed for a minimum of 2–3 weeks.
   c) Individuals with a suspected COVID-19 infection should be seated in a distinct, well-ventilated waiting area separate from all other patients. A COVID-19 diagnostic test should be performed on all "COVID-19 suspect" patients. If a test or results are not available in a timely manner, then routine dental care should not be performed.
   d) Social distancing should be practiced for all patients, even those not suspected of having COVID-19. Social distancing is defined as "the practice of maintaining a greater than usual physical distance (such as 6 feet or more) from other people or of avoiding direct contact with people or objects in public places during the outbreak of a contagious disease in order to minimize exposure and reduce the transmission of infection."[49] This recommendation is compliant with social distancing guidelines of the CDC.
   e) Patients should wear a surgical mask and practice correct respiratory hygiene, ie, use a tissue to cover the mouth and nose when coughing or sneezing, and then discard the tissue.
   f) Surface disinfection:
      i) Coronavirus maintains a presence on inert surfaces, especially under high humidity conditions, for up to 9 days at room temperature.
      ii) The dental staff should disinfect inert surfaces using chemicals known to be effective against COVID-19.
      iii) The dental environment should be a dry atmosphere in order to mitigate SARS-CoV-2 spread.
      iv) Effective surface disinfectants include: 62–71% ethanol, 0.5% hydrogen peroxide, and 0.1% (1 g/L) sodium hypochlorite. After each operatory use, all surfaces should be thoroughly cleansed.[18]
      v) Hypochlorous acid (HOCl) is a surface disinfectant that has been recommended by the US Environmental Protection Agency (EPA).[50] It is endogenous to all mammals and is effective against a broad range of microorganisms. Neutrophils, eosinophils, mononuclear phagocytes, and B lymphocytes produce HOCl in response to injury and infection.[51,52] HOCl flogging is an inexpensive and efficient method of disinfection. Block et al[51] provide instructions on how HOCl solutions can be made in the dental office. They concluded that HOCl fogs, wipes, and sprays are an inexpensive and efficient method for surface disinfection against the SAR-CoV-2 virus in the maxillofacial surgery office.[51]
   g) For microbiological control of the dental unit and handpiece water system, routinely perform periodic

disinfection of the unit water system via application of chemicals and distilled water.[53]

h) Use high-speed dental handpieces with antiretraction valves that prevent aspiration of debris and fluids. The aspirated debris and fluids from high speed handpieces without antiretraction valves may contaminate the air and water systems of the dental unit and therefore, lead to cross infection between patient treatments.[53]

3) For suspected or confirmed COVID-19 cases that are in need of emergency dental treatment, an attempt should be made to utilize pharmacologic treatment(s) in lieu of invasive treatments.[18] Pharmacological management may include antibiotics and/or analgesics. If emergency invasive treatments are required, and the clinician does not have the proper PPE and/or the facility is not properly equipped, then a referral to a properly equipped facility is recommended.

4) Dental treatment guidelines
   a) Practice good hand hygiene.
   b) Wear appropriate PPE.
      i) Protective glasses and/or face shields should be worn when patient contact treatments are performed. Lindsley et al[54] used breathing and coughing simulators to study the efficacy of face shields in reducing contamination exposure. It was determined that face shields are effective in diminishing exposure to large infectious particles; however, smaller particles that remain airborne may eventually flow around the edges of the face shield and be inhaled.[54] Face shields do offer the advantage of protecting more of the face than do goggles, they are easy to wear, and they demonstrate less fogging. Goggles provide highly effective protection to eyes against splashing, but frequently fog which affects visibility while leaving some parts of the face exposed.[55] The combination of goggles and appropriate face masks may offer the most practical protection.
      ii) Using a waterproof surgical mask reduces the spread of SARS-CoV-2 viral contaminated respiratory droplets and decreases the DHCPs risk of acquiring COVID-19 by at least 80%.[56] All clinicians should use a surgical grade mask when operating less than 1 m from the patient.
      iii) A particulate respirator that is at least as secure as a National Institute for Occupational Safety and Health-certified N95 or equivalent (filtering-face-piece respirators [FFP2, FFP3]) should also be used when performing aerosol-generating procedures.[18] A surgical mask should be worn over the N95 (or equivalent) mask. This would conform to the "double-mask" protocol.
      iv) It should be noted that a meta-analysis revealed there was no statistically significant difference between surgical masks and N95 or FFP masks in terms of protection against airborne viral infections ($RR = 0.89$, $P > .05$).[57]
      v) Due to the pandemic and the resulting short supply of N95 face masks, the CDC has recommended techniques for extended use and reuse of these masks.[53] For extended use, the CDC recommends using an N95 mask for up to 8 hours. It also suggests that deference be given to the manufacturer's instructions. Based on the CDC position, it should be noted that N95s and FFPs can be reused up to 5 times when following a mask rotation technique.
         (1) Masks are numbered and used in turn. The minimum time-period for not using a previously used mask is a minimum of 72 hours; as the SARS-CoV-2 loses its viability with time. If a mask is damaged or used in the aerosol-generating process, it should be discarded.[53]
         (2) Reprocessing/decontamination can be accomplished with hydrogen peroxide vaporization, which can be used on N95 models not containing cellulose. UV-C treatments can also be used for decontamination.[53]
         (3) Surgical masks are graded 1–3 by the American Society for Testing and Materials (ASTM):
            (a) Level 1: Provides low barrier protection and should not be used when aerosols, spray, or fluid exposures are expected
            (b) Level 2: Can be used when low to moderate levels of aerosols, spray, and/or fluids are generated
            (c) Level 3: Provides maximum barrier protection. Should be used when there is a high risk of fluid, spray, or aerosol exposure.
            (d) Only Level 2 or 3 masks should be used by DHCPs. The choice is determined by the level of risk.[58]
      vi) Head covers for clinicians are a less frequently used form of PPE in dentistry and are not mandated by OSHA; however, they should be considered if contamination from spraying and spattering of blood or aerosols is possible. Head covers are especially beneficial during ultrasonic scaling, procedures that utilize rotary or ultrasonic instrumentation, and manual decontamination of dental instruments. Additionally, head covers for patients protect them during aerosol-generating, spraying, and blood spattering procedures.[59] Therefore, disposable hair covering bouffants should be considered for DHCPs and patients.
      vii) Shoe coverings are also less frequently used in dentistry and are not mandated by OSHA. DHCPs may want to consider using shoe covers when contamination of footwear is possible. Procedures that generate aerosols, heavy bleed-

ing, and splatter may contaminate the footwear of the clinicians which could be tracked into other areas of the clinic. Therefore, shoe coverings should also be considered and changed when exiting the operatory.[59]

viii) Outer gowns should be changed between each patient. Gowns and gloves should be removed simultaneously. It is recommended that gowns fit tightly at the neck area to reduce the risk of contamination.[60]

5) One of the most effective ways to minimize the concentration of microorganisms in oral aerosols is to have the patient perform a preprocedural mouth rinse. Yoon et al[61] found that the SARS-CoV-2 virus is in the nasopharynx and oral cavity of COVID-19 patients. The viral load was the highest in the nasopharynx (patient $1 = 8.41$ $\log_{10}$ copies/mL; patient $2 = 7.49$ $\log_{10}$ copies/mL), but it was also remarkably high in the saliva of both patients (patient $1 = 6.63$ $\log_{10}$ copies/mL; patient $2 = 7.10$ $\log_{10}$ copies/mL). SARS-CoV-2 was detected in the saliva of both patients for extended time-periods (hospital-stay day 6 for patient 1; illness day 9 for patient 2). The viral load in the saliva decreased transiently for 2 h after using a chlorhexidine mouthwash.[61] Swabbing the mouth with povidone iodine (PVP-I) prior to a head and neck mucosal procedure was shown to be more effective than rinsing with chlorhexidine.[62] When considering hydrogen peroxide rinses, Bidra et al[63] found that an in vitro 0.5% PVP-I oral antiseptic rinse, at the lowest contact time of 15 s, inactivated SARS-CoV-2 virus completely. Whereas, hydrogen peroxide rinses (1.5% to 3.0%) for as long as 30 s had a minimal viricidal effect. Therefore, preprocedural rinsing with diluted PVP-I (0.5% to 1.5%) is preferred over hydrogen peroxide during the COVID-19 pandemic.[63]
6) Extraoral imaging (panoramic radiograph or cone-beam computerized tomography [CBCT]) techniques should be used to avoid the gag reflex that may occur during intraoral imaging. If intraoral imaging is necessary, sensors should be double-covered so there is less chance of cross-contamination and cover-perforation.[18]
7) The use of a rubber dam reduces splatter production and decreases airborne particles by 70% within a 1 m radius of the operational field.[64] When possible, a rubber dam should be used during endodontic and restorative treatments, especially when rotary instrumentation is necessary. Additionally, a rubber dam should be used when crown or fixedbridge preparations are performed. The split dam technique can be used. It would be beneficial to position the rubber dam so that it covers the nose, thereby reducing the transmission of SARS-CoV-2.[18,65–67]
8) When possible, clinicians should use single-use devices, eg, syringes, mouth mirrors, and blood pressure cuffs to avoid cross-contamination.[18]
9) Ultrasonic and hand instrumentation have been shown to be equally successful in removing plaque and calculus during tooth prophylaxis. Due to the higher probability of inducing contaminated aerosols with ultrasonic instrumentation, hand instrumentation should be used as often as possible. Also, the practice of using high-speed handpieces and three-way air/water syringes should be minimized during the COVID-19 outbreak.[18]
10) Upon removal, used disposable PPE should immediately be placed in proper medical waste containers and stored at a location distant from clean or sterile instrumentation (and supplies) to prevent cross-contamination. Reuseable instrumentation and materials should be thoroughly cleaned, sterilized, and stored in compliance with the Protocol for the Disinfection and Sterilization of Dental Instruments.[68] The waste created by treating a suspected or confirmed COVID-19 patient should be considered to be infectious medical waste and disposed of in double-layered clinical waste bags with a "gooseneck" knot closure. These waste bags should be labeled and discarded in compliance with the requirements of medical waste disposal.[69]
11) When performing a tooth extraction(s), have the patient in a supine position to decrease the DHCP's exposure to saliva particles discharged from the patient's respiratory tract.[18]
12) When working with a removable partial or complete denture, do not touch other items in the operatory after being in contact with the patient's saliva.[18]
13) Bite registrations and other materials removed from the patient's mouth (dental prosthesis, impressions, etc) should be thoroughly disinfected at the end of the appointment before packaging and sending to the dental laboratory.[18]
14) When suction is used, it should be performed in a manner to prevent stimulation of the gag reflex.[18]
15) Choose and modify trays to have the proper size for doing an impression to prevent gagging, choking, or coughing. Using topical oral mucosa anesthesia applied to the soft palate before performing the impression is a good option for patients with a sensitive gag/cough reflex.[70]
16) Refer to Figure 2 for a schematic of how to prevent DHCPs' infection and nosocomial transmission.

***Mitigation considerations specific to the implant practice***

1) When invasive and/or time-consuming implant-related procedures are to be performed, the implant dentist may seek a medical consultation and request a quick-COVID-19 test. Once the test is completed, results may be available within 15 minutes.[71] Patients should self-quarantine once the test has been performed and results known. The patient should remain in isolation until the time of the implant-related appointment. If the COVID-19 test is negative, the patient can be treated with greater confidence and the DHCP may be able to perform the procedure utilizing less cumbersome PPE. If test results are positive, the implant-related procedure should be delayed.
2) Schedule more invasive cases in operatories that do not require a fast turnaround so the operatory can be thoroughly disinfected to decrease the risk of nosocomial infection spread. If available, treat the patient in an isolated, well-ventilated room or negatively pressurized room.

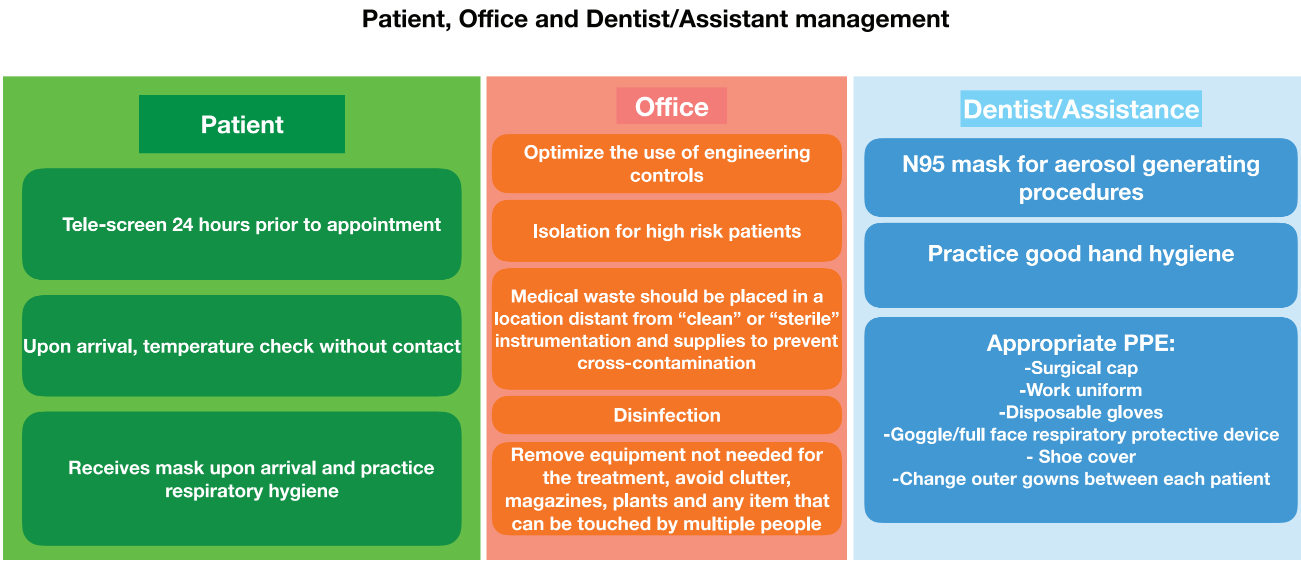


**Figure 2.** Recommendations to prevent nosocomial transmission at the dental office.

3) PVP-I solutions (ranging from 0.23% to 7%) have demonstrated to be the most effective method to reduce viral loads of coronaviruses.[62,63] PVP-I is likely to decrease the risk of viral transmission during upper airway mucosal surgery because it is relatively safe to use in the upper airway, it requires a brief application time, and it may potentially lessen the risk of SARS-CoV-2 aerosolization. The clinician should confirm that the patient does not have an allergy to PVP-I.
4) When 1 or 2 dental implants are to be placed in an area with adjacent teeth, a split-rubber-dam technique may be used. This would reduce splatter and aerosolized saliva particles.
5) Consider using EOHVS to prevent spread of aerosols.
6) An effort should be made to use hand or low-speed instrumentation to reduce splatter and aerosols.
7) Maximum PPE should be worn if splatter or aerosolized saliva particles are anticipated. This includes appropriate face mask(s), head covering, protective eyewear, disposable outer gown, and shoe covering.
8) When possible, use an absorbable suture to minimize the need for a future suture removal appointment. The rate of suture resorption should be dictated by the procedure. However, postoperative evaluations, as needed, are still recommended.
9) Practicing good daily oral hygiene is essential and it needs to be maintained at a high level of proficiency. This includes using an electric toothbrush twice a day for a duration of 2 min each time and using a fluoridated toothpaste. Interdental cleaning should be done a minimum of once a day. Interdental cleaning can be accomplished with either dental floss, interdental brushes, water irrigation, or other floss aids. Regular dental prophylaxis should be performed every 3–6 months to maintain gingival health. Professional examinations with necessary radiographs should be performed every 6 months as needed. Examinations should include evaluations of the soft tissues, implants, teeth, bone proximal to dental implants/teeth, bone levels in edentulous areas, occlusion, destructive parafunctional habits, daily oral hygiene effectiveness, and other items of concern. All of the above are necessary to prolong the longevity of the dental implants and prevent dental implant urgencies or emergencies.[72]

### Dental Implant Emergency

A dental emergency is an issue involving the teeth, dental implants, and/or supporting tissues that would be, if left untreated, harmful to the patient's oral or systemic health in the near-term. Pain may or may not be involved, although it is often a sign that something needs attention. Depending on the cause of pain experienced, it may be classified as a dental emergency. Causes of a dental emergency can include: 1) bacterial, fungal or viral infections; 2) loss of an existing dental restoration; or 3) fractured tooth, restoration, or bone proximal to teeth or implants.

The above can be classified as dental emergencies as they may have an impact on function, aesthetics, and/or speech. These conditions should be attended to with the same urgency as the loss of a tooth and can be considered a dental emergency. All dental emergencies should be treated in a timely manner.[73]

The nature and rationale for considering the patient's presentation as an emergency should be documented in the patient's dental record. Additionally, the reason(s) for performing the treatment should be documented.

It is not uncommon for patients to present with the need for emergency treatment of a failing implant or one of its prosthetic components. Failure may be due to: infection of the bone or soft tissues surrounding the implant(s), loose abutment screw, fractured abutment, or fractured implant body. These situations should be examined, and appropriate treatment provided in a timely manner.

Early failures are usually associated with acute pain and therefore recognized by patients; however, mid- to late-term failures may be unknown to the patient, as there may be no pain. Implants with moderate bone loss are referred to as being affected by peri-implantitis, while those with severe bone loss and mobility are referred to as "failed implants." Both conditions should be treated as urgencies or emergencies. If left untreated, implant(s) demonstrating peri-implantitis may progress to "failed" implant(s). The loss of implant(s) can be functionally, emotionally, and financially costly.

## Data Collection

In the event there is a 2nd or 3rd wave of a COVID-19 epidemic or pandemic in our future, it would be beneficial to collect data on how the initial pandemic, associated with limited dental implant care, affected patients. This data would help clinicians manage the possible deleterious effects of future "pauses" in dental care. Data collection should include:

1) Degree of periodontal inflammation: bleeding on probing (BOP), plaque index, and probing depth changes;
2) Occurrence of periodontal abscesses;
3) Occurrence of peri-implantitis;
4) Increase rate of caries in nonrestored teeth, restored teeth, teeth adjacent to dental implants, teeth in provisional restorations, and progression of such teeth to an unrestorable status;
5) Prosthetic complications including the loss or fracture of temporaries, implant prosthetic screws, prosthetic crowns, or restored teeth;
6) Occurrence of myofacial pain and temporal mandibular dysfunction (TMD) symptoms; and
7) Increased financial cost of delayed treatments related to the above-mentioned issues.

## Discussion

Information regarding the COVID-19 pandemic is evolving on a daily basis. New information relevant to dentistry is released from multiple media outlets. It is important for each clinician to seek out reliable resources that are consistently updated as society learns more about this virus. Online updates are more likely to provide information faster than print media, though print media provided through peer-reviewed journals is apt to be more reliable.[74]

On August 12, 2020 it was reported by the lay press that the WHO issued the following statement: "[Dentists'] procedures involve face-to-face communication and frequent exposure to saliva, blood, and other body fluids and handling sharp instruments…. Consequently, [DHCPs] are at high risk of being infected with SARS-CoV-2 or passing the infection to patients." The guidance further suggests that "aerosol-generating procedures (AGPs), which include cleanings with ultrasonic scalers and work with high or low-speed hand-pieces, present particular danger for virus spread…. Consequently, all preventive care, checkups, aesthetic procedures, and cleanings ought to be postponed…. However, urgent or emergency oral health care interventions that are vital for preserving a person's oral functioning, managing severe pain or securing quality of life should be provided. Still, anyone seeking urgent dental care ought to be pre-screened through a video call." It was also reported that the WHO's Chief Dental Officer, Benoit Varenne, PhD, advised: "that any treatments of progressive oral disease be done with minimal use of AGPs", and he further voiced "concern about the availability of protective equipment for dental professionals."[3]

The WHO statement was clarified in an August 13, 2020 email to global leaders. Varenne expressed his concerns about media coverage of the interim guidance: "Unfortunately, a number of media headlines intentionally or not—when they are referring to the WHO guidance, did not mention that the recommendation to delay routine oral health care is only suggested in an intense uncontrolled community transmission scenario. A scenario that [does] not fit with the current situation of [most countries] around the world…."[75]

The statement does appropriately warn that AGPs are of concern. The August 13, 2020 statement clarifies that the delay in dental care is recommended only for areas of heightened outbreaks of COVID-19. The concern is also correctly elevated when proper PPE is not available, or facility protection is inadequate. When proper PPE is utilized, and facility protection is adequate, concerns can be successfully managed.

Many dental procedures (and dental-implant related procedures) can be done without the generation of aerosols. If aerosols are generated during a procedure, the suggested maximum guidance provided by this AAID White Paper will minimize the risk of nosocomial infection spread.

The initial August 12, 2020 WHO comment that "… all preventive care, checkups, aesthetic procedures, and cleanings ought to be postponed" initiated a response from the American Dental Association (ADA). ADA President, Dr Chad P. Gehani, stated, "Oral health is integral to overall heath." Dr Gehani further stated, "Millions of patients have safely visited their dentists in the past few months for the full range of dental services. With appropriate PPE, dental care should continue to be delivered during global pandemics or other disaster situations." The ADA Board of Trustees has adopted the ad interim policy: "Dentistry is an essential health care because of its role in evaluating, diagnosing, preventing or treating oral diseases, which can affect systemic health."[76]

The link between periodontal (oral) and systemic health is not novel nor imagined. However, there often is a lack of understanding regarding the complicated relationship between periodontal disease and systemic health.[77]

Healthy individuals with severe periodontitis have elevated inflammatory markers.[78] The pathways connecting periodontal and systemic conditions can be observed through 2 pathways: infectious and inflammatory. These 2 conditions are interrelated and often occur simultaneously.[77,79] Periodontal inflammation results from bacterial inflammatory products and diseased periodontium inflammatory molecules that have the potential to promote systemic inflammation through multiple pathways.[77] This inflammation can exacerbate or act as a comorbidity for inflammatory-related systemic diseases in susceptible patients. Periodontitis and implantitis are bacterial infectious diseases with inflammatory cytokines that regulate their pathophysiology through "crosstalk" between tissue cells and immune cells. A host's response to infection is regulated in part by the cytokine interleukin-6 (IL-6).[80] Various human gingival fibroblast (HGF) reactions to periodontal pathogens or inflammatory cytokines contribute to the development of periodontitis. The lipopolysaccharide derived from *Porphyromonas gingivalis* and IL-1β significantly induce an increase in IL-6 production in HGFs.[80] The effect of healthy periodontium on systemic IL-6 levels was confirmed by the D'Aiuto et al[78] study. In this study, 94 systemically healthy patients with advanced generalized periodontitis were observed over a 6-month blind intervention trial. Periodontal parameters and inflammatory makers (C-reactive protein [CRP] and IL-6) were evaluated prior to nonsurgical periodontal therapy. Six months post nonsurgical therapy (with correction for confounding factors), IL-6 levels were significantly reduced.[78] Ghassib et al[81] confirmed that IL-6 levels were higher in patients with peri-implantitis.

COVID-19 researchers are actively examining the potential role of cytokine storms in the severity of the disease experienced by affected individuals. It is known that COVID-19 patients with elevated IL-6 levels have increased pulmonary complications and the need for mechanical ventilation.[82] Han et al[83] found that the greater the degree of the cytokine storm, the more severe is COVID-19 disease development. IL-6 and IL-10 levels can be used as predictors to determine if there is a higher chance of COVID-19 disease deterioration. Knowing SARS-CoV-2 induces high levels of cytokines and the resultant COVID-19 disease state is more damaging with higher levels of IL-6; COVID-19 treatments should be aimed at reducing IL-6 levels and thereby reducing the risk of disease progression due to inflammation-related lung damage.[83]

The ADA's position that "Dentistry is essential health care" is further supported by the findings of Ayanian et al.[83] Ayanian examined the levels of 4 inflammatory biomarkers: D-dimer, CRP, IL-6, and LDH for 299 COVID-19 patients. The study found a correlation between the concentrations of these inflammatory markers and COVID-19 patient outcomes. Threshold values for all biomarkers were found to be statistically significant and independently associated with a higher odds of clinical deterioration and death in these patients.[84]

Rapid testing techniques are under development. The use of testing prior to dental appointments would help in determining the COVID-19 status of patients. Antigen-based rapid SARS-CoV-19 identifying tests would most likely identify "spreaders" when they are at the peak of their infectious state. Antigen-based test results are less expensive to take/process and have quick turn-around times; however, amplified polymerase chain reaction (PCR)-based tests have greater accuracy, but also greater expense, and unfortunately longer processing times.

The COVID-19 Ag (Antigen) Respi-Strip assay is a new immunochromatographic test that has recently become available for diagnosis of SARS-CoV-2. The projected sensitivity is no higher than 60%; however, it does allow for quick decisions in the management of patients with suspected COVID-19.[85] Unfortunately there is a high incidence of false negative test results.[86] The antigen test involves tagging an antibody with a specific enzyme to speed up the chemical reaction used in the testing process. When an antigen (SARS-CoV-19 virus) and antibody (from the test kit) bind to each other, the enzyme triggers a reaction that produces a color change, which indicates the presence of a SARS-CoV-19 protein.

The amplified PCR test is a molecular biology technique that can take a single fragment of viral DNA (or gene) and make multiple copies of that specific DNA fragment that can be easily detected and quantified.[87] Antigen tests are considered diagnostic tests, whereas amplified PCR tests are genetic tests.[88]

Testing has 2 purposes: to identify positive COVID-19 individuals, and as a public health screening. Antigen tests could possibly be self-administered every 2–3 days. This testing frequency would identify positive individuals, assist in public health screening, and augment contact tracing efforts. Patients with symptoms and/or possible COVID-19 exposure with a negative antigen-based test could be retested with the more accurate PCR-based test. Frequent testing with contact tracing will help not only the community, but also benefit every patient's ability to confidently and comfortably seek dental implant care. Frequent testing and tracing will help assure clinicians that the asymptomatic patient being treated is most likely COVID-19-negative and therefore diminish, but not eliminate, concerns regarding aerosol-generating procedures.[89]

The guidance provided by this AAID White Paper offers comprehensive, realistic, and feasible principles that can be used by dental implant practices to maintain patient and provider safety, while also continuing to maintain patients' oral health, to keep dental implant offices open and viable during the pandemic, and to minimize nosocomial spread of SARS-CoV-19.

Important points to keep in mind:

- Perform a medical/symptom history and social (travel) history review by phone when confirming patients 24-h prior to their dental appointment.
- Perform a medical/symptom and social history review once the patient has arrived at the dental healthcare facility prior to initiating clinical treatment.
- Delay all elective procedures on patients who present with symptoms or social history that puts them at risk of being COVID-19 positive.
- Require that patients be tested for the SARS-CoV-2 virus who have symptoms, or have a social history that puts them at risk and then self-quarantine until the dental appointment.
- Check the patient's body temperature with a touchless thermometer at the beginning of each appointment.
- Consider getting air filtration systems for each operatory.
- Swab the patient's mouth for 15 to 30 s with PVP-I prior to beginning the procedure. If there is an iodine allergy, then consider as the second option a chlorhexidine gluconate (0.2%) mouth rinse for 60 s. The third option, but of markedly less benefit, would be a hydrogen peroxide (1.5% to 3.0%) mouth rinse for a minimum of 30 s (longer could possibly provide greater benefit).
- Consider using an EOHVS when creating splatter or aerosols on patients who are suspected of having, or possibly have been exposed to, SARS-CoV-2.
- Use hand or low-speed instrumentation whenever possible.
- Always practice in a manner that helps mitigate the spread of the easily transmittable SARS-CoV-2 virus.

- Disinfect air and surface environments in common areas frequently, and treatment rooms after each use.
- Encourage patients to practice good, daily oral hygiene.

## Conclusion

The discussion is not meant to imply that the increased levels of IL-6 found in COVID-19 patients is simply (or entirely) due to periodontal diseases, but rather to suggest that any treatments that could decrease systemic levels of IL-6 may be beneficial and lessen the severity of COVID-19 morbidity or mortality. Good personal hygiene (hand washing and mask wearing) habits are recognized as important practices for flattening the COVID-19 community infection curve. Future research should examine the effect good oral hygiene would have on COVID-19 disease progression and community spread of the SARS-CoV-2 virus.

The recommendations are provided as guidelines to prevent the spread of COVID-19 through dental implant office transmission. The profession must recognize that many dental procedures do generate aerosols and a significant number of patients could be unknown asymptomatic carriers. Recommendations will evolve with increased knowledge of SARS-CoV-2 transmission and COVID-19 disease progression. The entire community must remember that viruses have developed the capacity to escape host immune detection and to suppress the type I interferon system.[90] As implantologists, we must expect that some form of the above recommendations will remain routine for the near future, or at least until accurate testing and effective vaccination can be put into place.[74]

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