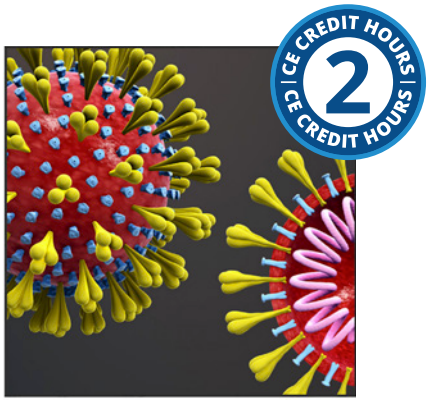
# Aerosols in the Dental Office: Best Practices for Patient and Practitioner Safety

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**CE Credits:** 2 hours
**Intended Audience:** Dentists, Dental Hygienists, Dental Assistants, Dental Students, Dental Hygiene Students, Dental Assistant Students
**Date Course Online:** 04/27/2020
**Last Revision Date:** 04/26/2023
**Course Expiration Date:** 04/25/2026
**Cost:** Free
**Method:** Self-instructional
**AGD Subject Code(s):** 148, 750

**Online Course:** *www.dentalcare.com/en-us/ce-courses/ce619*

**Disclaimer:** Participants must always be aware of the hazards of using limited knowledge in integrating new techniques or procedures into their practice. Only sound evidence-based dentistry should be used in patient therapy.

**Please Note:** This course may not satisfy individual state requirements on CDC/Infection Control. Please check with your State Board to verify.

## Conflict of Interest Disclosure Statement

- The author reports no conflicts of interest associated with this course.

## Short Description

This course seeks to assess the risks posed by aerosols in the dental office and assess infection control measures that can be implemented during dental practice to block the person-to-person transmission routes through standard and transmission-based precautions.

## Course Contents



## Overview

This course seeks to assess the risks posed by aerosols in the dental office and assess infection control measures that can be implemented during dental practice to block the person-to-person transmission routes through standard and transmission-based precautions.

## Learning Objectives

**Upon completion of this course, the dental professional should be able to:**

- Explain the risk factors and basic properties of aerosols generated during routine dental procedures.
- Describe what types of dental procedures result in significant dental aerosol production.
- Understand the types of pathogens and resultant illnesses are associated with such aerosols.
- Differentiate between standard and transmission-based precautions and their utility in the dental office for safe delivery of care.
- List infection control and aerosol mitigation techniques that may reduce the risk of cross-contamination to patients and providers.

## Introduction

A novel β-coronavirus (SARS-CoV-2) causing severe and potentially fatal pneumonia (COVID-19) originating from Wuhan city, Hubei province, China was introduced to the human population in 2019 and initiated a pandemic that caused worldwide suffering and countless deaths.[1-3] Clinical symptoms of SARS-CoV-2 infection in a patient without immunity include fever, dry cough, myalgia, fatigue, and pneumonia with abnormal chest CT. Less commonly observed symptoms include sputum production, headache, hemoptysis, and diarrhea.[4-6] A zoonotic origin for SARS-CoV-2 is presumed. SARS-CoV-2 demonstrates 96.2% of whole-genome identity to the horseshoe bat (Rhinolophus affinis) virus RaTG13 and SARS-CoV-2 demonstrates over 99% genetic similarity to β-CoV samples found in pangolins, (scaly anteaters).[7,8] While approximately 70% of viruses become pathogenic in humans after moving from animals to humans, the exact source of this virus has not yet been well-established. The person-to-person transmission of SARS-CoV-2 include direct transmission, such as cough, sneeze, saliva and other droplet inhalation transmission, and contact transmission, such as the contact with oral, nasal, and eye mucous membranes.[9-12]

Dental health care personnel (DHCP) and their patients were presumed to be at increased occupational risk associated with aerosols in the dental office due to the frequency of close, personal face-to-face communication and exposure to saliva, blood, and other body fluids, and—indirectly—by the handling of sharp instruments and touching contaminated dental surfaces.[13-16] Studies involving other, similarly sized viral particles have shown that microorganisms in the mouth and respiratory tract can be transported in aerosols, splash and spatter generated during dental procedures and can contaminate the skin and mucous membranes of the mouth, respiratory passages,

and eyes of DHCP as well as environmental surfaces and materials exposed to such aerosols and droplets. As such, DHCP play an important role in preventing disease transmission within the dental practice.[17-24] This course seeks to assess the risks posed by aerosols in the dental office and assess infection control measures that have been shown to be effective to significantly reduce occupational risk for DCHP and patients through standard and transmission-based precautions.[25-27]

## Aerosols in the Dental Office: How, When, and Where?

Airborne transmission of various pathogens has been demonstrated in both healthcare and community settings. Airborne transmission of tuberculosis and measles is noted on commercial aircraft and in the clinic waiting area, where increased proximity to infected persons conveyed increased transmission risk.[28,29] Viral transmission after airborne droplets/particles have settled on surfaces in these environments has also been demonstrated.[28,29] Furthermore, isolation of several different pathogens capable of aerosol transmission have been noted in dental offices.[30,31] For these reasons, as the COVID-19 pandemic began much attention was paid to the potential risk for airborne disease transmission in the dental office.[25]

### Airborne Droplets: Aerosols vs. Splatter?

Aerosols are defined as liquid or solid particles less than 50 micrometers in diameter.[20,21,32,33] 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 after inhalation.[20,21] Smaller particles of in aerosols (droplets and droplet nuclei 0.5 to 10 µm in diameter) have the potential to enter the lungs and settle within the bronchial passages, reaching as far as the pulmonary alveoli.[20,21] These droplets are thought to convey a high level of risk infection transmission in the dental office.[32,33]

Splash and splatter a mixture of air, water, and/or solid substances larger than 50 µm in diameter are visible to the naked eye[20,21] and behave in a ballistic or projectile manner.[20] These mixtures are ejected forcibly from their origin in an arc and travel along a bullet-like trajectory until they contact a surface or fall to the ground under the influence of gravitational forces.[20] Unlike aerosols, splash and splatter are airborne only briefly.[20,21] Because of this, they demonstrate limited penetration into the respiratory system.[20,21]

Within the dental office, airborne droplets and droplet nuclei present unique risks to DHCP and patients.[32,33] They can remain in the air for a long time, may be transported with air flows for long distances, and can contaminate wide areas within the dental operatory.[32-34] Splash and splatter, on the other hand, are generally deposited on surfaces closer to their origin, an estimated 15-120 cm from the source.[33,34] These particles are a risk due to their contact with mucous membrane and close surfaces, including DHCP.[33,34] Furthermore, there is evidence that some microorganisms may survive within splash and spatter and when the contaminated surfaces dry organisms may become airborne as dust particles.[33,34]

### Dental Procedures Associated with Aerosols

Airborne contamination during dental procedures may come from a variety of sources. Foremost among these are: dental instrumentation, salivary, and respiratory sources.[35] Dental handpieces, ultrasonic scalers, and the air-water syringes used in common dental practice are capable of producing aerosols, which are usually a mix of air and water derived from these devices and the patient's saliva.[36] Dental instruments, surfaces within the dental operatory, and dental equipment, when improperly cleaned, sterilized, and stored, or disinfected can also serve as fomites and contribute to cross-infection.

The oral environment is naturally wet and contains a high number of microorganisms. Dental plaque is a major source of such organisms, containing more than 700 known pathogens,[37] but the mouth also harbors bacteria from the respiratory tract, including the nasopharynx and the lower pulmonary system.[32] Gingival crevicular fluid, debris from tooth preparation, and dental materials may

also be aerosolized during dental procedures and contribute to disease transmission.[38,39]

The most intense aerosol and splash and splatter has been shown to occur during use of ultrasonic scalers and high speed handpieces without a rubber dam;[32,34,38] however, aerosols in the dental setting have also been associated with the use of low-speed handpieces, air/water syringes, patient coughing, and intraoral radiography.[36] Because of the ability of aerosols to remain suspended in the air and travel further than splash and splatter, and distant contamination may occur, and there is potential for disease transmission, even after the infected person has left the vicinity.[36,40-42] While initial reports indicated that SARS-CoV-2 could survive on environmental surfaces for prolonged periods of time,[43] further research indicated that the risk of fomite transfer on contaminated surfaces may have been overestimated based upon the typical viral SARS-CoV-2 viral load in aerosol particles.[44] It should also be noted that the sources of microbial contamination in dental aerosols have been shown to be predominantly from dental irrigants with a low and/or undetectable contribution from salivary microbial sources.[45]

## Infectious Diseases Associated with Aerosols

In addition to the common cold (caused by rhinoviruses, coronaviruses, and other viruses), several types of bacteria and viruses have demonstrated airborne person-to-person transmission (Table 2).[32,46-49]

For many of these microorganisms, the overall microbial load within aerosols, splash, and splatter vary greatly predicated on disease status and the particular microorganism.[11-13,25] While SARS-Cov-2 has been isolated from the saliva of asymptomatic patients, dental aerosols from such patients had undetectable SARS-CoV-2 viral loads.[45] It is well-established the reproduction number (R0) differs significantly between microorganisms and that as a microorganism mutates, the R0 may be altered.[50] The R0 is the number of cases, on average, an infected patient will cause during their infectious period. This number, from a public health perspective, is also influenced by the overall susceptibility within the population (e.g., vaccination rates, previous infection rates, cross-immunity from similar diseases, the novelty of a pathogen).[50] Lastly, the likelihood of transmission is also influenced

| Dental Devices/Procedures | Airborne Contamination Potential | Potential Mitigation for Droplet/Aerosols |
|---|---|---|
| Ultrasonic/Sonic Scalers | Considered to be the greatest source of aerosol contamination in dental practice | High-volume evacuation during powered scaler use reduces airbourne contamination by >95% |
| High Speed Handpiece Use without Rubber Dam Barrier | High aerosol production | Rubber dam use and high volume evacuation during high speed use can significantly reduce aerosol production |
| Air polishing | Airborne bacteria counts indicate aerosol production nearly as high as with ultrasonic scalers | High-volume evacuation during powered scaler use reduces airbourne contamination by >95% |
| Air-water syringe | Airborne bacteria counts indicate aerosol production nearly as high as with ultrasonic scalers | High-volume evacuation during powered scaler use reduces airbourne contamination by >99% |
| Tooth preparation with Air Turbine Handpiece | Minimal airborne contamination if proper placement of a rubber dam is in place | Use of a rubber dam and high-volume evacuation is indicated |
| Tooth preparation with Air Abrasion | Microbial contamination is unknown. Extensive contamination with abrasive particles has been shown | Use of a rubber dam and high-volume evacuation is indicated |

**Table 1.** Dental Devices and Procedures Known to Produce Airborne Contamination.[32]

| Disease | Causative Microbe | Method of Transmission |
|---|---|---|
| Pneumonic Plague | Yersinia pestis | Most transmission was through an insect vector (flea), but person-to-person contact through bacterial inhalation |
| Tuberculosis | Mycobacterium tuberculosis | Droplet nuclei expelled from an infected patient by coughing |
| Influenza | Influenza virus types A and B | May be associated with coughing, but more likely with direct patient contact |
| Legionnaires' Disease | Legionella pneumophila | Aerosolization has been associated with HVAC systems and hot tub spas, which have been linked to outbreaks |
| Severe Acute Respiratory Syndrome (SARS) | SARS-COV-1 | Spread by aerosolized droplets, through fomite transfer, and direct contact |
| COVID-19 | SARS-COV-2 | Spread by aerosolized droplets, through fomite transfer, and direct contact |

**Table 2.** Diseases Known to be Spread by Droplets or Aerosols.[32]

by the susceptibility of the host and related factors such as, overall health status, genetic influences, immunocompetence, vaccination/infection history, and previous exposure to similar diseases.[47,48] In fact, emerging evidence suggests that pre-existing oral diseases may increase the risk for developing severe forms of COVID-19.[51-53]

## SARS-CoV-2 (Viral Cause of COVID-19) and Aerosol Transmission

### Characteristics of SARS-CoV-2

Coronaviruses (*Coronaviridae*, of the order Nidovirales) are large, single stranded RNA viruses.[56,57] Currently, there are four known genera of coronaviruses: α-CoV, β-CoV, γ-CoV, and δ-CoV.[58,59] Coronaviruses have been identified as the causative agents of diseases in humans and other vertebrates. In particular, it is estimated that 15-35% of common cold cases are caused by coronaviruses.[60] SARS-CoV-2 belongs to the β-COV family, which along with α-CoV viruses, are known to infect a variety of mammals and humans.[49,53,54,56,61,62] SARS-CoV-2 possesses an ultrastructure typical of other coronaviruses, namely a membrane envelope with multiple "spike glycoprotein" (S-protein) extensions (Figure 1).[63] The viral capsule has also been found to express other polyproteins, nucleoproteins, and membrane proteins, including specifically RNA polymerase, 3-chymotrypsin-like protease, papain-like protease, helicase, glycoprotein, and accessory proteins.[7,63,64] The S-proteins from coronaviruses binds to receptors on host cells to facilitate viral entry into the target cells. For SARS-CoV-2 the target receptor is the human angiotensin-converting enzyme 2 receptor (ACE2).[65-68] Affinity for the ACE2 receptor is postulated to explain increased viral loads seen in older individuals, since ACE2 expression increases with age.[69]

It is well-established that RNA viruses have higher rates of mutation than DNA-viruses.[70] On a per-site level, DNA viruses typically have mutation rates on the order of 10−8 to 10−6 substitutions per nucleotide site per cell infection (s/n/c). RNA viruses have mutation rates that range between 10−6 and 10−4 s/n/c. Given this rapid mutation rate, RNA viruses with high rates of pathogenicity are able generally to develop and propagate more frequently in the environment.[70] It should also be noted that an evolutionary advantage for a mutating pathogen includes increasing infectivity and decreasing virulence and/or longer latency periods to allow for increased replication rates. Data suggest that coronavirus variants differ in thermal stability, replication rate, and size, which may influence their transmissibility.[71] The reproduction number ($R_0$) of SARS-CoV-2 has

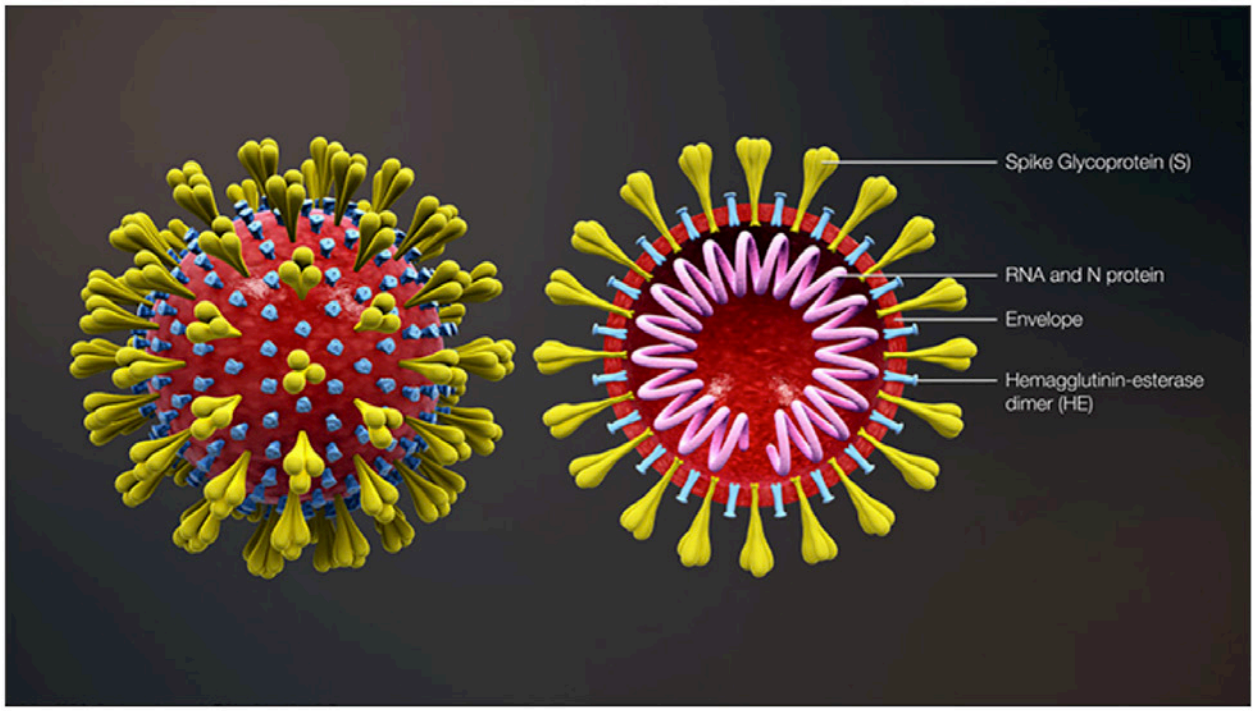


**Figure 1.** Diagram of the ultrastructure of the SARS-CoV-2 virus.[105]

been estimated to be between 1.5-6.49 with a median value of 2.78.[72] As variants changed during the pandemic an adjusted $R_0$ of 1.86 for COVID-19 cases and 1.34 for excess COVID-19 deaths.[73] This $R_0$ is greater than that of SARS-CoV-1 (median $R_0$=1.3)[74] and H1N1 influenza (median $R_0$=1.46),[75] but less than that of measles (median $R_0$=16.1).[76]

SARS-CoV-2 shares numerous similarities with SARS-CoV-1 [the causative agent in the severe acute respiratory syndrome (SARS) outbreak in 2002-2003], but there are some significant differences. Both originated in China and both demonstrate stability in the environment. In an *in vitro* study, SARS-CoV-2 was detectable in aerosols for up to three hours, up to four hours on copper, up to 24 hours on cardboard and up to two to three days on plastic and stainless steel.[77] However, while SARS-CoV-1 was eradicated by intensive contact tracing and case isolation measures and no cases have been detected since 2004.[78] SARS-CoV-2 has proven to be significantly more difficult to eradicate. Emerging evidence suggests that asymptomatic people infected with SARS-CoV-2 are able to transmit the virus prior to onset of symptoms.[79] This occurrence of asymptomatic transmission decreases the effectiveness of symptom screening and disease control measures that were effective against SARS-CoV-1.[79]

Both SARS-CoV-2 and SARS-CoV-1 viruses demonstrate binding affinity to the ACE2 receptor to enter host cells. However, the S-proteins from SARS-CoV-2 are less stable than those of SARS-CoV-1 and polyclonal anti-SARS S1 antibodies that inhibit entry of SARS-CoV-1, are not effective against SARS-CoV-2 pseudovirions.[80] Further studies using recovered SARS and COVID-19 patients' sera show limited cross-neutralization, suggesting that recovery from one infection might not protect against the other, but there does seem to be some protection from previous SARS-CoV-2 infections, even with infections across viral variants.[80,81]

## Evidence of SARS-CoV-2 Transmission in the Dental Office

Evidence suggests that SARS-CoV-2 can be transmitted both directly from person-to-person by respiratory droplets with significantly less likelihood of indirect fomite-mediated transmission.[4,5,82] A recent study found that up to two-thirds of patients with COVID-19 could transmit the virus 5 days after the onset of symptoms, and one-fourth of patients could

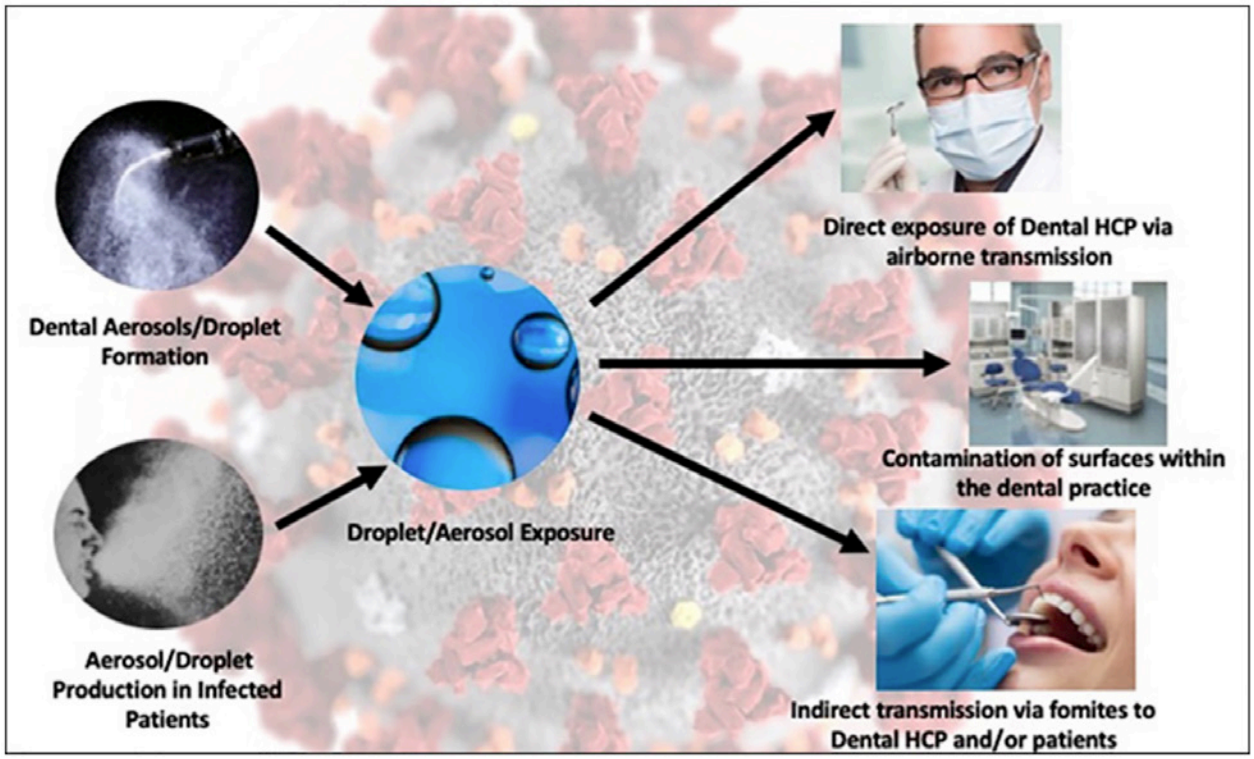


**Figure 2.** Potential transmission pathways for SARS-CoV-2 in the dental office.[25]

transmit the virus after 7 days. They also found that infectiousness lasts a median of 5 days after symptoms began. [83] Live SARS-CoV-2 viruses have been isolated from saliva of infected individuals and the concentration of virus in saliva has been shown in some cases to be significantly higher than that on nasopharyngeal testing swabs.[13,84,85] Not surprisingly, ACE2+ cells are abundant throughout the respiratory tract and salivary gland duct epithelium.[25,74] Tissues in the oral cavity, including salivary gland ducts and epithelial cells have been identified as targets for infection and potential reservoirs for post-acute COVID-19 syndrome.[86]

In the initial stage of the pandemic, transmission of SARS-CoV-2 was thought to be increased in the dental setting due to the close interpersonal contact between individuals involved and by nature of the procedures performed during the delivery of dental care.[87-89] Many precautions were put into place due to an assumption that both DHCPs and patients are at risk due to droplets containing microorganisms or direct contact with conjunctival, nasal, or oral mucosal tissues.[17-20,32,87-90] It is established that, like many other viruses, the likelihood of such transmissions may be dependent upon the viral load of the infected individual and the susceptibility of the host individual.[91] Potential pathways of SARS-CoV-2 transmission in the dental office are outlined in Figure 2.

As the pandemic progressed, newly unfolding discovery demonstrated that dental care delivery conveyed a relatively low risk of disease transmission in a care-delivery setting.[26,27] Investigations demonstrate that in real-world settings, low amounts of microbial contamination were found in dental aerosols.[45,92,93] In fact, it has been estimated that the risk of COVID-19 transmission during aerosol generating procedures is approximately equivalent to the risk conveyed during non-aerosol-generating procedures.[94] It has become apparent that early in the pandemic all aerosols, including medical, dental, and respiratory aerosols, were considered to be potentially highly infectious. However, as the majority of material present in dental aerosols is derived from irrigation rather than salivary or respiratory sources, which means that

extrapolation on risks conveyed by aerosol-generating dental procedures are likely not equivalent to risks demonstrated in medical procedures.[95] It should be noted that the presence of COVID-19 viral particles in the saliva of both symptomatic and asymptomatic COVID-19 infected individuals and implementing strategic advanced risk-mitigation procedures is critical to promote safety for patients and dental healthcare workers in the dental office.[96]

## Standard and Transmission-based Precautions: Best Practices for Dental Professionals

In 1985, the Centers for Disease Control [now the Centers for Disease Control and Prevention (CDC)] introduced the concept that all blood and body fluids that might be contaminated with blood should be treated as infectious.[97] Initial infection control measures were introduced largely because of the human immunodeficiency virus (HIV) epidemic; it was expanded to Universal Precautions to include other bloodborne pathogens such as hepatitis B virus (HBV) and hepatitis C virus (HCV), which has been expanded in the intervening years to include other potentially infectious material (OPIM). Today infection prevention is predicated on Standard and Transmission based Precautions.[98-103] There are three categories of Transmission-based Precautions: contact precaution, droplet precautions, and airborne precautions associated with droplet nuclei.[101-104]

Airborne precautions include administrative controls, environmental controls, and respiratory-protection controls. While typical outpatient dental facilities must incorporate administrative controls into their infection prevention protocol, they are not expected to be in full compliance with environmental and respiratory-prevention controls.

### Prevention of Airborne Disease Transmission Dental Office

Infection control standards were initially developed for dentistry in response to the HIV epidemic and included Standard and Transmission-based Precautions. Based upon emerging evidence regarding SARS-CoV-2 and previous investigations studying other coronaviruses, spread is thought to occur mostly from person-to-person via respiratory droplets among close contacts. Close contact can occur while delivering patient care and is currently defined by the CDC as: 1) being within approximately 6 feet (2 meters) of a patient with COVID-19 for a prolonged period of time (≥30 minutes) or 2) having direct contact with infectious secretions from a patient with COVID-19. Infectious secretions may include sputum, saliva, serum, blood, and respiratory droplets.[103,104]

Current recommendations from the CDC and regional/state dental boards include risk-based assessment of community infection rates and individual patient and practitioner risk assessments to reduce COVID-19 transmission in the dental office. The following current best-practices to address high-risk pandemic outbreaks:[106]

- *Patient Triage:* Telephonic or entrance triage including symptom screening and/or body temperature check, and limited patient proximity in public areas/waiting areas, and informed consent discussion about the risk of contagion.
- *Infection control measures for Patients:* These include proper hand hygiene and preprocedural mouthrinse.
- *Arrangement of the Clinical Environment:* These include proper ventilation and evacuation and segregation of COVID-19 positive patients in need of emergent care.
- *Cleaning:* Cleaning includes decontamination of contaminated surfaces with disinfectants that have been shown to be effective against SARS-CoV-2.[107]
- *Surveillance:* Post-treatment surveillance to determine if COVID-19 symptoms or positivity develops in patients and practitioners.
- *Personal protective equipment for Practitioners:* The use of disposable or sanitizable gowns, eye protection, and appropriate level masks for non-aerosol generating procedures and the addition of surgical caps and respirators for aerosol-generating procedures.

It should also be noted that the implementation and utilization of such protocols is currently being revised by OSHA

and the CDC and dental healthcare workers are encouraged to regularly review all of the following:[108]

- The *level of ongoing community transmission* of COVID-19 in their community.
- The *phase of reopening* (if applicable) the community in which the dental practice is located has entered.
- The *risk to dental practitioners and support staff* of being exposed to sources of SARS-CoV-2, including suspected and confirmed COVID-19 cases and people who are infected with SARS-CoV-2 but do not have *signs and/or symptoms of COVID-19* (but who may be able to *spread the virus* to others without knowing it).
- The availability and ability of the employer to implement controls to protect workers from exposure to sources of SARS-CoV-2.

## Assessment of Risk Mitigation Strategies During COVID-19

Aerosol-generating dental procedures including utilization of high-speed handpieces and ultrasonic scaling have demonstrated droplets between 25 and 50mm in diameter that are distributed up to 2.4m (8 ft) away from where they are generated.[109] Given this distribution, mitigation strategies have focused on 1) reducing microbial loads in the droplets, 2) evacuation procedures to reduce aerosol and splatter, and 3) personal protective equipment.

### Antiseptic Rinses

Preprocedural rinses have been shown to reduce overall salivary and aerosol microbial loads.[110] It was, therefore, proposed that the use of antimicrobial mouthrinses, including hydrogen peroxide, chlorhexidine gluconate, cetylpyridium chloride, and/or povidone iodine could be used to reduce overall numbers of SARS-CoV-2 viral particles in saliva. *In vitro* evidence does suggest that oral antiseptics may have efficacy to eliminate SARS-CoV-2 viral particles through a variety of mechanisms[111], but in vivo studies have failed to show statistically significant benefit.[112] Table 3 summarizes the effects of various common antiseptic mouthrinses on SARS-CoV-2. It should be noted that for all of the antiseptics described, rinsing for at least 30 seconds is necessary to see viricidal results.[111]

| Antiseptic Type | Antimicrobial Mechanism of Action Agains SARS-CoV-2 | Viral Disruption |
|---|---|---|
| Hydrogen Peroxide | Production of hydroxyl free radicals<br>Oxygen release<br>Damage lipids, proteins, and viral DNA | Destabilization and disruption of the viral envelope after mouthrinsing for at least 30 seconds |
| Povidone Iodine | Release of iodine<br>Formation of pores in the cell membrane<br>Inhibition of exo and endotoxins<br>RNA oxidation | |
| Chlorhexidine Gluconate | Binding to membrane phospholipids<br>Alteration of osmotic regulation<br>Loss of structural stability<br>Displacement of viral protein cations by anion exchange | |
| Cetyl Pyridium Chloride | Displacement of magnesium and calcium cations<br>Exit of cytoplasmic components<br>Membrane solubilization<br>Reduced viral gene transcription | |

**Table 3:** Mechanism of Action of Oral Antiseptics Against SARS-CoV-2[111]

### Air Cleaning and Evacuation Devices

Air cleaning and evacuation devices have been employed to reduce aerosols and splatter distribution during dental procedures. Studies have shown that the use of HEPA-filtered extraoral suction units and other portable air-cleaning technologies can reduce dental aerosols.[113-115] Further, this reduction is enhanced when such extraoral suction devices are utilized in conjunction with traditional high-volume intraoral evacuation.[116] It has also been demonstrated that HVAC features, including relative humidity, may also impact viral particle survivability.[117]

### Personal Protective Equipment and Barriers

Barrier methods to mitigate aerosols and contamination have been demonstrated to be effective in reducing infection rates and aerosol spread.[118] Utilization of recommended personal protective equipment was high throughout the pandemic and it is proposed that this adherence to governmental and association recommendations was, in part, responsible for the lower than expected rates of disease transmission among dental healthcare workers.[26,27]

## Summary

Since its first identification in Wuhan, China in November-December 2019, the novel coronavirus (SARS-CoV-2) has been identified as the causative agent for the high consequence infectious disease, COVID-19 that has caused a global pandemic. Similar to a previous coronavirus (SARS-CoV-1), SARS-CoV-2 enters host cells through human cell receptor ACE2 but appears to demonstrate higher binding affinity and SARS-CoV-2 demonstrates a longer latency period, asymptomatic/minimally symptomatic spread, and has a higher reproduction number, indicating a higher level of transmissibility. It has also been established that airborne transmission via respiratory droplets from infected individuals (asymptomatic and symptomatic) are the main mode of person-to-person transmission.

The COVID-19 pandemic offered dental healthcare workers an opportunity to evaluate the efficacy of enhanced infection control protocols to address airborne pathogens, which had not been a focus of dental infection control practices, unlike bloodborne pathogens. Through this experience, the dental profession has learned and adopted some practices that may enhance their safety and that of their patients moving forward.

## Course Test Preview

To receive Continuing Education credit for this course, you must complete the online test. Please go to: *www.dentalcare.com/en-us/ce-courses/ce619/test*

**1. COVID-19 is a disease-causing severe pneumonia in patients infected by _____.**

A. Yersinia pestis
B. SARS-CoV-1
C. SARS-CoV-2
D. BatCoV RaTG13

**2. The main person-to-person transmission route for COVID-19 of concern in dental office is:**

A. Direct transmission through respiratory airborne particles and/or aerosols
B. Direct transmission through airborne particles produced by dental procedures
C. Contact transmission after touching contaminated surfaces and then touching oral, nasal, and eye mucous membranes
D. Fecal transmission

**3. Aerosols are defined as liquid or solid particles less than 50 micrometers in diameter. Particles of this size are small enough to stay airborne for an extended period but can only travel limited distances (less than 120 cm).**

A. Both statements are true.
B. The first statement is true, the second statement is false.
C. The first statement is false, the second statement is true.
D. Both statements are false.

**4. Which of the following is NOT true about splatter droplets?**

A. Splatter particles are usually a mixture of air, water, and/or solid substance and are larger than 50 μm in diameter
B. They may become suspended in air for long periods of time
C. Splatter particles follow a ballistic pattern and travel in an arc after they are emitted until they contact a surface or fall to the ground
D. They may be visible to the naked eye

**5. The highest levels of aerosol and splatter emission has been shown to occur with the use of _____.**

A. ultrasonic scalers
B. intraoral radiograph capture
C. high speed handpiece used with a rubber dam
D. low speed handpiece

**6. The reproduction number (R0) describes _____.**

A. the number of cases, on average, who will become infected annually
B. the percentage of cases, on average, who will be infected, but asymptomatic during the course of a disease outbreak
C. the number of cases, on average, an infectious patient will cause during their infectious period
D. the number of times a virus will replicate prior to one meaningful genetic mutation

**7. Entry into host cells of coronaviruses is facilitated by the S-protein. In the case of both SARS-CoV-1 and SARS-CoV-2, this entry is through binding to the _____.**

A. CD4 receptor
B. Major histocompatibility complex (MHC)
C. Angiotensin II receptor (ARB)
D. angiotensin-converting enzyme 2 receptor (ACE2)

**8. Individuals infected with SARS-CoV-2 demonstrate a median infectious period of _____ days.**

A. 1 day
B. 3 days
C. 5 days
D. 10 days

**9. The likelihood of SARS-CoV-2 infection is dependent upon:**

A. The viral load of the infected individual
B. The size of the viral particle
C. The systemic health of the infected individual
D. The previous history of infection in the infected individual
E. Both A and C are true.

**10. Transmission-based Precautions include all of the following categories EXCEPT:**

A. Airborne
B. Droplet
C. Contact
D. Distance

**11. The United States Centers for Disease Control and Prevention (CDC) states that close contact with a patient infected with SARS-CoV-2 conveys significant risk for development of COVID-19. The CDC defines "close contact" as: 1) being within approximately 6 feet (2 meters) of a patient with COVID-19 for a prolonged period of time (≥30 minutes) or 2) having direct contact with infectious secretions from a patient with COVID-19.**

A. Both statements are true.
B. The first statement is true, the second statement is false.
C. The first statement is false, the second statement is true.
D. Both statements are false.

**12.The CDC recommends that healthcare workers take precautions to avoid direct contact with infectious secretions from patients who are known or possible cases of COVID-19. All of the following are considered infectious secretions, EXCEPT:**

A. Sputum
B. Saliva
C. Blood
D. Sweat

**13. Aerosol-generating dental procedures demonstrate droplets distributed up to _____ away from where they are generated.**

A. 2 feet
B. 3 feet
C. 5 feet
D. 8 feet

**13. The viricidal effects of antiseptic mouthrinses requires rinsing for at least _____ to achieve maximal effects.**

A. 15 seconds
B. 30 seconds
C. 60 seconds
D. 3 minutes

**15. The reduction of aerosols in the dental operatory is enhanced when extraoral suction devices are used in conjunction with which of the following?**

A. Saliva ejector
B. A Low humidity environment
C. High-volume intraoral evacuation
D. An enclosed space

## References


1. Zhu N, Zhang D, Wang W, et al. A Novel Coronavirus from Patients with Pneumonia in China, 2019. N Engl J Med. 2020;382(8):727–733. doi:10.1056/NEJMoa2001017.
2. Wang C, Horby PW, Hayden FG, Gao GF. A novel coronavirus outbreak of global health concern [published correction appears in Lancet. 2020 Jan 29;:]. Lancet. 2020;395(10223):470–473. doi:10.1016/S0140-6736(20)30185-9.
3. Liu T, Hu J, et al. Transmission Dynamics of 2019 Novel Coronavirus (2019-nCoV). The Lancet. 2020 Feb 05. Available at SSRN: doi:10.2139/ssrn.3526307. Accessed March 20, 2023
4. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China [published correction appears in Lancet. 2020 Jan 30;:]. Lancet. 2020;395(10223):497–506. doi:10.1016/S0140-6736(20)30183-5.
5. Guan WJ, Ni ZY, Hu Y, et al. Clinical Characteristics of Coronavirus Disease 2019 in China [published online ahead of print, 2020 Feb 28]. N Engl J Med. 2020;NEJMoa2002032. doi:10.1056/NEJMoa2002032.
6. Wang D, Hu B, Hu C, et al. Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China [published online ahead of print, 2020 Feb 7]. JAMA. 2020;e201585. doi:10.1001/jama.2020.1585.
7. Zhou P, Yang XL, Wang XG, et al. A pneumonia outbreak associated with a new coronavirus of probable bat origin. Nature. 2020;579(7798):270–273. doi:10.1038/s41586-020-2012-7.
8. Wahba L, Jain N, Fire AZ, et al. Identification of a pangolin niche for a 2019-nCoV-like coronavirus through an extensive meta-metagenomic search. bioRxiv 2020 Feb 14. doi:10.1101/2020.02.08.939660. Accessed March 20, 2023
9. Lu CW, Liu XF, Jia ZF. 2019-nCoV transmission through the ocular surface must not be ignored. Lancet. 2020;395(10224):e39. doi:10.1016/S0140-6736(20)30313-5.
10. Belser JA, Rota PA, Tumpey TM. Ocular tropism of respiratory viruses. Microbiol Mol Biol Rev. 2013;77(1):144–156. doi:10.1128/MMBR.00058-12.
11. Rothe C, Schunk M, Sothmann P, et al. Transmission of 2019-nCoV Infection from an Asymptomatic Contact in Germany. N Engl J Med. 2020;382(10):970–971. doi:10.1056/NEJMc2001468.
12. Wax RS, Christian MD. Practical recommendations for critical care and anesthesiology teams caring for novel coronavirus (2019-nCoV) patients. Directives concrètes à l'intention des équipes de soins intensifs et d'anesthésiologie prenant soin de patients atteints du coronavirus 2019-nCoV. Can J Anaesth. 2020;67(5):568–576. doi:10.1007/s12630-020-01591-x.
13. To KK, Tsang OT, Chik-Yan Yip C, et al. Consistent detection of 2019 novel coronavirus in saliva [published online ahead of print, 2020 Feb 12]. Clin Infect Dis. 2020;ciaa149. doi:10.1093/cid/ciaa149.
14. Rodríguez-Morales AJ, MacGregor K, Kanagarajah S, Patel D, Schlagenhauf P. Going global - Travel and the 2019 novel coronavirus. Travel Med Infect Dis. 2020;33:101578. doi:10.1016/j.tmaid.2020.101578.
15. Faecher RS, Thomas JE, Bender BS. Tuberculosis: a growing concern for dentistry?. J Am Dent Assoc. 1993;124(1):94–104. doi:10.14219/jada.archive.1993.0003.
16. Nash KD. How infection control procedures are affecting dental practice today. J Am Dent Assoc. 1992;123(3):67–73. doi:10.14219/jada.archive.1992.0076.
17. Earnest R, Loesche W. Measuring harmful levels of bacteria in dental aerosols. J Am Dent Assoc. 1991;122(12):55–57. doi:10.14219/jada.archive.1991.0187.
18. Travaglini EA, Larato DC, Martin A. Dissemination of organisms bearing droplets by high-speed dental drills. J Prosthet Dent 1966;16:132-9. doi:10.1016/0022-3913(66)90120-X. Accessed March 20, 2023.
19. Miller RL. Generation of airborne infection...by high speed dental equipment. J Am Soc Prev Dent. 1976;6(3):14–17.
20. Micik RE, Miller RL, Mazzarella MA, Ryge G. Studies on dental aerobiology. I. Bacterial aerosols generated during dental procedures. J Dent Res. 1969;48(1):49–56. doi:10.1177/00220345690480012401.

21. Miller RL, Micik RE, Abel C, Ryge G. Studies on dental aerobiology. II. Microbial splatter discharged from the oral cavity of dental patients. J Dent Res. 1971;50(3):621–625. doi:10.1177/00220345710500031701.
22. Holbrook WP, Muir KF, Macphee IT, Ross PW. Bacteriological investigation of the aerosol from ultrasonic scalers. Br Dent J. 1978;144(8):245–247. doi:10.1038/sj.bdj.4804072.
23. Williams GH 3rd, Pollok NL 3rd, Shay DE, Barr CE. Laminar air purge of microorganisms in dental aerosols: prophylactic procedures with the ultrasonic scaler. J Dent Res. 1970;49(6):1498+. doi:10.1177/00220345700490065701.
24. Bentley CD, Burkhart NW, Crawford JJ. Evaluating spatter and aerosol contamination during dental procedures. J Am Dent Assoc. 1994;125(5):579–584. doi:10.14219/jada.archive.1994.0093.
25. Peng X, Xu X, Li Y, Cheng L, Zhou X, Ren B. Transmission routes of 2019-nCoV and controls in dental practice. Int J Oral Sci. 2020;12(1):9. Published 2020 Mar 3. doi:10.1038/s41368-020-0075-9.
26. Estrich C, Mikkelsen M, Morrissey R, Geisinger ML, Ioannidou E, Vujicic M, Araujo MWB. Estimating COVID-19 prevalence and infection control practices among US Dentists. J Am Dent Assoc 2020; 151(11): 815-824.
27. Araujo MWB, Estrich C, Mikkelsen M, Morrissey R, Harrison B, Geisinger M, Ioannidou E, Vujicic M. COVID-2019 among Dentists in the United States: A six-month longitudinal study. J Am Dent Assoc 2021; 152(6): 425-433.
28. Kenyon TA, Valway SE, Ihle WW, Onorato IM, Castro KG. Transmission of multidrug-resistant Mycobacterium tuberculosis during a long airplane flight. N Engl J Med. 1996;334(15):933–938. doi:10.1056/NEJM199604113341501.
29. Bloch AB, Orenstein WA, Ewing WM, et al. Measles outbreak in a pediatric practice: airborne transmission in an office setting. Pediatrics. 1985;75(4):676–683.
30. Prospero E, Savini S, Annino I. Microbial aerosol contamination of dental healthcare workers' faces and other surfaces in dental practice. Infect Control Hosp Epidemiol. 2003;24(2):139–141. doi:10.1086/502172.
31. Araujo MW, Andreana S. Risk and prevention of transmission of infectious diseases in dentistry. Quintessence Int. 2002;33(5):376–382.
32. Harrel SK, Molinari J. Aerosols and splatter in dentistry: a brief review of the literature and infection control implications. J Am Dent Assoc. 2004;135(4):429–437. doi:10.14219/jada.archive.2004.0207.
33. Szymańska J. Dental bioaerosol as an occupational hazard in a dentist's workplace. Ann Agric Environ Med. 2007;14(2):203–207.
34. Leggat PA, Kedjarune U. Bacterial aerosols in the dental clinic: a review. Int Dent J. 2001;51(1):39–44. doi:10.1002/j.1875-595x.2001.tb00816.x.
35. Murdoch-Kinch CA, Andrews NL, Atwan S, Jude R, Gleason MJ, Molinari JA. Comparison of dental water quality management procedures. J Am Dent Assoc. 1997;128(9):1235–1243. doi:10.14219/jada.archive.1997.0400.
36. ADA Center for Professional Success. Summary of ADA Guidance During the SARS-CoV-2 Crisis. ADA. Accessed March 20, 2023
37. Kilian M, Chapple IL, Hannig M, et al. The oral microbiome - an update for oral healthcare professionals. Br Dent J. 2016;221(10):657–666. doi:10.1038/sj.bdj.2016.865.
38. King TB, Muzzin KB, Berry CW, Anders LM. The effectiveness of an aerosol reduction device for ultrasonic scalers. J Periodontol. 1997;68(1):45–49. doi:10.1902/jop.1997.68.1.45.
39. Bennett AM, Fulford MR, Walker JT, Bradshaw DJ, Martin MV, Marsh PD. Microbial aerosols in general dental practice. Br Dent J. 2000;189(12):664–667. doi:10.1038/sj.bdj.4800859.
40. Al Maghlouth A, Al Yousef Y, Al Bagieh N. Qualitative and quantitative analysis of bacterial aerosols. J Contemp Dent Pract. 2004;5(4):91–100. Published 2004 Nov 15.
41. Grenier D. Quantitative analysis of bacterial aerosols in two different dental clinic environments. Appl Environ Microbiol. 1995;61(8):3165–3168.
42. Legnani P, Checchi L, Pelliccioni GA, D'Achille C. Atmospheric contamination during dental procedures. Quintessence Int. 1994;25(6):435–439.
43. Harrel SK, Barnes JB, Rivera-Hidalgo F. Aerosol and splatter contamination from the operative site during ultrasonic scaling. J Am Dent Assoc. 1998;129(9):1241–1249. doi:10.14219/jada.archive.1998.0421.

44. Van Doremalen N, Bushmaker T, Morris DH, et al. Aerosol and surface stability of HCoV-19 (SARS-CoV-2) compared to SARS-CoV-1. N Engl J Med 2020; 382(16): 1564-1567.
45. Meethil AP, Saraswat S, Chaudhary PP, Dabdoub SM, Kumar PS. Sources of SARS-CoV-2 and other microorganisms in dental aerosols. J Dent Res 2021; 100(8): 817-823.
46. Veena HR, Mahantesha S, Joseph PA, Patil SR, Patil SH. Dissemination of aerosol and splatter during ultrasonic scaling: a pilot study. J Infect Public Health. 2015;8(3):260–265. doi:10.1016/j.jiph.2014.11.004.
47. Watanabe A, Tamaki N, Yokota K, Matsuyama M, Kokeguchi S. Use of ATP bioluminescence to survey the spread of aerosol and splatter during dental treatments. J Hosp Infect. 2018;99(3):303–305. doi:10.1016/j.jhin.2018.03.002.
48. Zemouri C, de Soet H, Crielaard W, Laheij A. A scoping review on bio-aerosols in healthcare and the dental environment. PLoS One. 2017;12(5):e0178007. Published 2017 May 22. doi:10.1371/journal.pone.0178007.
49. Volgenant CMC, de Soet JJ. Cross-transmission in the Dental Office: Does This Make You Ill?. Curr Oral Health Rep. 2018;5(4):221–228. doi:10.1007/s40496-018-0201-3.
50. Delamater PL, Street EJ, Leslie TF, Yang YT, Jacobsen KH. Complexity of the Basic Reproduction Number (R0). Emerg Infect Dis. 2019;25(1):1–4. doi:10.3201/eid2501.171901.
51. Grigoriadis A Raisanen IT, Parnanen P, Tervahartiala T, Sorsa T, Sakellari D. Is there a link between COVID-19 and periodontal disease? A narrative review. Eur Dent J. 2022; 16: 514-520.
52. Tamimi F, Altigani S, Sanz M. Periodontitis and coronavirus disease 2019. Periodontol 2000 2022; 89: 207-214.
53. Baima G, Marruganti C, Sanz M, Aimetti M, Romandini M. Periodontitis and COVID-19: Biological mechanisms and meta-analysis or epidemiological evidence. J Dent Res 2022; 101(12): 1430-1440.
54. Chen Y, Li L. SARS-CoV-2: virus dynamics and host response [published online ahead of print, 2020 Mar 23]. Lancet Infect Dis. 2020;S1473-3099(20)30235-8. doi:10.1016/S1473-3099(20)30235-8.
55. Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study [published correction appears in Lancet. 2020 Mar 28;395(10229):1038] [published correction appears in Lancet. 2020 Mar 28;395(10229):1038]. Lancet. 2020;395(10229):1054–1062. doi:10.1016/S0140-6736(20)30566-3.
56. Fehr AR, Perlman S. Coronaviruses: an overview of their replication and pathogenesis. Methods Mol Biol. 2015;1282:1–23. doi:10.1007/978-1-4939-2438-7_1.
57. Gorbalenya AE, Enjuanes L, Ziebuhr J, Snijder EJ. Nidovirales: evolving the largest RNA virus genome. Virus Res. 2006;117(1):17–37. doi:10.1016/j.virusres.2006.01.017.
58. Nakagawa K, Lokugamage KG, Makino S. Viral and Cellular mRNA Translation in Coronavirus-Infected Cells. Adv Virus Res. 2016;96:165–192. doi:10.1016/bs.aivir.2016.08.001.
59. Fan Y, Zhao K, Shi ZL, Zhou P. Bat Coronaviruses in China. Viruses. 2019;11(3):210. Published 2019 Mar 2. doi:10.3390/v11030210.
60. Simasek M., Blandino D. A. (2007). Treatment of the common cold. Am. Fam. Physician 75 (4), 515–520.
61. Weiss SR, Leibowitz JL. Coronavirus pathogenesis. Adv Virus Res. 2011;81:85–164. doi:10.1016/B978-0-12-385885-6.00009-2.
62. Yin Y, Wunderink RG. MERS, SARS and other coronaviruses as causes of pneumonia. Respirology. 2018;23(2):130–137. doi:10.1111/resp.13196.
63. Li F. Structure, Function, and Evolution of Coronavirus Spike Proteins. Annu Rev Virol. 2016;3(1):237–261. doi:10.1146/annurev-virology-110615-042301.
64. Wu F, Zhao S, Yu B, et al. Author Correction: A new coronavirus associated with human respiratory disease in China. Nature. 2020;580(7803):E7. doi:10.1038/s41586-020-2202-3.
65. Hantak MP, Qing E, Earnest JT, Gallagher T. Tetraspanins: Architects of Viral Entry and Exit Platforms. J Virol. 2019;93(6):e01429-17. Published 2019 Mar 5. doi:10.1128/JVI.01429-17.
66. Belouzard S, Millet JK, Licitra BN, Whittaker GR. Mechanisms of coronavirus cell entry mediated by the viral spike protein. Viruses. 2012;4(6):1011–1033. doi:10.3390/v4061011.

67. Wan Y, Shang J, Graham R, Baric RS, Li F. Receptor Recognition by the Novel Coronavirus from Wuhan: an Analysis Based on Decade-Long Structural Studies of SARS Coronavirus. J Virol. 2020;94(7):e00127-20. Published 2020 Mar 17. doi:10.1128/JVI.00127-20.
68. Chai X, Hu L, Zhang Y, et al. Specific ACE2 Expression in Cholangiocytes May Cause Liver Damage After 2019-nCoV Infection. bioRxiv 2020 Feb 04. doi:10.1101/2020.02.03.931766. Accessed March 20, 2023
69. Chen Y, Shan K, Qian W. Asians Do Not Exhibit Elevated Expression or Unique Genetic Polymorphisms for ACE2, the Cell-Entry Receptor of SARS-CoV-2. Preprints 2020, 2020020258. doi:10.20944/preprints202002.0258.v2. Accessed April 22, 2020.
70. Peck KM, Lauring AS. Complexities of Viral Mutation Rates. J Virol. 2018;92(14):e01031-17. Published 2018 Jun 29. doi:10.1128/JVI.01031-17.
71. Jeong GU, Yoon GY, Moon HW, Lee W, Hwang I, Kim H, Kim K-D, Kim C, Ahn D-G, Kim B-T, Kim S-J, Kwon Y-C. Comparison of Plaque Size, Thermal Stability, and Replication Rate among SARS-CoV-2 Variants of Concern. Viruses. 2022; 14(1):55.
72. Liu Y, Gayle AA, Wilder-Smith A, Rocklöv J. The reproductive number of COVID-19 is higher compared to SARS coronavirus. J Travel Med. 2020;27(2):taaa021. doi:10.1093/jtm/taaa021.
73. Prada, J.P., Maag, L.E., Siegmund, L. et al. Estimation of R0 for the spread of SARS-CoV-2 in Germany from excess mortality. Sci Rep 2022; 12: 17221.
74. Chowell G, Castillo-Chavez C, Fenimore PW, Kribs-Zaleta CM, Arriola L, Hyman JM. Model parameters and outbreak control for SARS. Emerg Infect Dis. 2004;10(7):1258–1263. doi:10.3201/eid1007.030647.
75. Biggerstaff M, Cauchemez S, Reed C, Gambhir M, Finelli L. Estimates of the reproduction number for seasonal, pandemic, and zoonotic influenza: a systematic review of the literature. BMC Infect Dis. 2014;14:480. Published 2014 Sep 4. doi:10.1186/1471-2334-14-480.
76. Guerra FM, Bolotin S, Lim G, et al. The basic reproduction number (R0) of measles: a systematic review. Lancet Infect Dis. 2017;17(12):e420–e428. doi:10.1016/S1473-3099(17)30307-9.
77. National Institues of Health. News Releases. New coronavirus stable for hours on surfaces. 2020 Mar 17. Accessed March 20, 2023
78. Centers for Disease Control (CDC). Recommendations for preventing transmission of infection with human T-lymphotropic virus type III/lymphadenopathy-associated virus in the workplace. MMWR Morb Mortal Wkly Rep. 1985;34(45):681–695..
79. Johansson MA, Quandelacy TM, Kada S, et al. SARS-CoV-2 Transmission From People Without COVID-19 Symptoms. JAMA Netw Open. 2021;4(1):e2035057.
80. Tang H, Gao L, Wu Z, Meng F, Zhao X, Shao Y, Shi X, Qiao S, An J, Du X, Qin FX. Characterization of SARS-CoV-2 Variants N501Y.V1 and N501Y.V2 Spike on Viral Infectivity. Front Cell Infect Microbiol. 2021 Oct 13;11:720357.
81. COVID-19 Forecasting Team. Past SARS-CoV-2 infection protection against re-infection: A systematic review and meta-analysis. Lancet 2023; 401: 823-841.
82. Todt D, Meister Tl, Tamele B, et al. A realistic transfer method reveals low risk of SARS-CoV-2 transmission via contaminated euro coins and banknotes. iScience 2021; 24(8): 102980.
83. Hakki S, Zhou J, Jonnerby J, et al. Onset and window of SARS-CoV-2 infectiousness and temporal correlation with symptom onset: a prospective, longitudinal, community cohort study. Lancet 2022; 10(11): P1061-1073.
84. Huang, N., Pérez, P., Kato, T. et al. SARS-CoV-2 infection of the oral cavity and saliva. Nat Med 2021; 27: 892–903.
85. Iyer P, Chino T, Ojcius D. Infectiou of the oral cavity with SARS-Cov-2 variants: Scope of salivary diagnostics Front Oral Health 2022; https://doi.org/10.3389/froh.2022.1001790
86. Marchesan JT, Warner BM, Byrd KM. The "oral" history of COVID-19: Primary infection, salivary transmission, and post-acute implications. J Periodontol 2021; 92(10): 1357-1367.
87. Kampf G, Todt D, Pfaender S, Steinmann E. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. J Hosp Infect. 2020;104(3):246–251. doi:10.1016/j.jhin.2020.01.022.
88. Chen J. Pathogenicity and transmissibility of 2019-nCoV-A quick overview and comparison with other emerging viruses. Microbes Infect. 2020;22(2):69–71. doi:10.1016/j.micinf.2020.01.004

89. Cleveland JL, Gray SK, Harte JA, Robison VA, Moorman AC, Gooch BF. Transmission of blood-borne pathogens in US dental health care settings: 2016 update. J Am Dent Assoc. 2016;147(9):729–738. doi:10.1016/j.adaj.2016.03.020.
90. van Doremalen N, Bushmaker T, Morris DH, et al. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. N Engl J Med. 2020;382(16):1564–1567. doi:10.1056/NEJMc2004973.
91. Centers for Disease Control (CDC). Recommendations for preventing transmission of infection with human T-lymphotropic virus type III/lymphadenopathy-associated virus in the workplace. MMWR Morb Mortal Wkly Rep. 1985;34(45):681–695.
92. Choudhary S, Bach T, Wallace MA, et al. Assessment of infectious disease risks from dental aerosols in real-world settings. Open Forum Infect Dis 2022; 1-7.
93. Al-Moraissi EA, Kaur A, Gunther f, Neff A, Christidis N. Can aerosols-generating dental, oral and maxillofacial, and orthopedic surgical procedures lead to disease transmission? An implication on the current COVID-19 pandemic. Front Oral Health 2022; 3: 974644.
94. Manzar S, Kazmi F, Bin Shahzad H, Qureshi FA, Shahbaz M, Rashid S. Estimating of the risk of COvID-19 transmission through aerosol-generating procedures. Dent Med Prob 2022; 59(3): 351-356.
95. Epstein JB, Chow K, Mathias R, Dental procedure aerosols and COVID-19. Lancet Infect Dis 2021; 21: e73.
96. Tsuchiya H. The oral cavity potentially serving as a reservoir for SARS-CoV-2 but not necessarily facilitating the spread of COVID-19 in dental practice. Eur Dent J. 2022;
97. Centers for Disease Control (CDC). Recommendations for prevention of HIV transmission in health-care settings. MMWR Suppl. 1987;36(2):1S–18S.
98. Centers for Disease Control (CDC). Update: universal precautions for prevention of transmission of human immunodeficiency virus, hepatitis B virus, and other bloodborne pathogens in health-care settings. MMWR Morb Mortal Wkly Rep. 1988;37(24):377–388.
99. U.S. Department of Labor, Occupational Safety and Health Administration. 29 CFR Part 1910.1030: Occupational exposure to bloodborne pathogens—OSHA, final rule. Fed Regist. 1991;56:64004–64182. Accessed March 20, 2023
100. Garner JS. Guideline for isolation precautions in hospitals. The Hospital Infection Control Practices Advisory Committee [published correction appears in Infect Control Hosp Epidemiol 1996 Apr;17(4):214]. Infect Control Hosp Epidemiol. 1996;17(1):53–80. doi:10.1086/647190.
101. Siegel JD, Rhinehart E, Jackson M, Chiarello L; Health Care Infection Control Practices Advisory Committee. 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Health Care Settings. Am J Infect Control. 2007;35(10 Suppl 2):S65–S164. doi:10.1016/j.ajic.2007.10.007.
102. Harte JA. Standard and transmission-based precautions: an update for dentistry. J Am Dent Assoc. 2010;141(5):572–581. doi:10.14219/jada.archive.2010.0232.
103. CDC. What healthcare personnel should know about caring for patients with confirmed or possible coronavirus disease 2019 (COVID-19). Accessed March 20, 2023
104. CDC. oral Health. Infection Prevention & Control in Dental Settings. Summary of Infection Prevention Practices in Dental SettingsStandard Precautions. 2018 Jun 18. Accessed March 20, 2023
105. Wikimedia Commons. 3D medical animation corona virus. Accessed March 20, 2023106.
106. Giovanditto F, Soma D, Vaira LA, et al. Recommendations for a safe restart of elective aerosol-generating oral surgery procedures following the COVID-19 pandemic outbreak: An Italian multicenter study. J Cranio-maxillo-facial surgery. 2022; 50: 462-467.
107. EPA. Pesticide Registration. List N: Disinfectants for Use Against SARS-CoV-2. Available at: https://www.epa.gov/coronavirus/about-list-n-disinfectants-coronavirus-covid-19-0
108. United States Department of Labor. Occupational Safety and Health Administration. Dentistry Workers and Employers. Available at: https://www.osha.gov/coronavirus/control-prevention/dentistry
109. Pierre-Bez AC, Agostini-Walesch GM, Smith PB, et al. Ultrasonic scaling in COVID-era dentistry: A quantitative assessment of aerosol spread during simulated and clinical ultrasonic scaling procedures.

110. Seneviratne CJ, Balan P, Karrie Ko KK, et al. Efficacy of commercially available mouthrinses on SARS-CoV-2 viral load in saliva: Randomized controlled trial in Singapore. Infect 2021; 49(2): 305-311.
111. Bernal CGG, Uribe ER, Flores JS, et al. Oral antiseptics against SARS-CoV-2: A Literature review. Int J Environment Res Pub Health 2022; 19: 8768.
112. Gul SNS, Dilsiz A, Saglik I, Aydin NN. Effect of oral antiseptics on the viral load of SARS-CoV-2: A randomized controlled trial. Dent Med Prob 2022; 59(3): 357-363.
113. Demirkol N Karagozoglu I, Kocer IK. Efficiency of HEPA-filtered extra-oral suction unit on aerosols during prosthetic dental preparation: A pilot study. Clin Oral Invest 2022
114. Alvarenga MOP, Dias JMM, Lima BJLA, Gomes ASL, Monteiro GQM. The implementation of portable air-cleaning technologies in healthcare settings—a scoping review J Hosp Infect 2023; 132: 93-103.
115. Watanabe J, Iwamatsu-Kobayashi Y, Kikuchi K, et al. Visualization of droplets and aerosols in simulated dental treatments to clarify the effectiveness of oral suction devices. J Prosthodont Res 2023
116. Barrett B, McGovern J, Catanzaro W, Coble S, Redden D, Fouad AF. Clinical efficacy of an extraoral dental evacuation device in aerosol elimination during endodontic access preparation. JOE 2022; 48(12): 1468-1474.
117. Thorton GM, Fleck BA, Dandanayak D, Kroeker E, Zhong L, Hartling L. The impact of heating, ventilation, and air conditioning (HVAC) design features on the transmission of viruses, including the 2019 novel coronavirus (COVID-19): A systematic review of humidity. PLOS One 2022\
118. Zhu M, Medina M, Nalliah R, et al. Experimental evaluation of aerosol mitigation strategies in large open-plan dental clinics J Am Dent Assoc 2022; 153(3): 208-220.

### Additional Resources

- *JADA. ADA Coronavirus Resource Center for Dentists.* Accessed March 20, 2023.
- *CDC. Coronavirus (COVID-19).* Accessed March 20, 2023.
- *EPA. Pesticide Registration. List N: Disinfectants for Use Against SARS-CoV-2.* Accessed March 20, 2023.
- *ADA. ADA Coronavirus (COVID-19) Center for Dentists.* Accessed March 20, 2023.

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