# Transmission routes of SARS-CoV-2 and protective measures in dental clinics during the COVID-19 pandemic

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**Abstract:** The outbreak of coronavirus disease 2019 (COVID-19) has become a primary challenging public health issue for not only China but also the world. On March 11, 2020, the World Health Organization declared that the pandemic of COVID-19 had become a public health emergency of global concern. As of May 12, 2020 COVID-19 has been reported in over 180 countries/regions, with a total of 4,178,156 confirmed cases and over 280,000 deaths. The risk of cross-infection by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) might be elevated between dental specialists and patients due to the peculiarity of dental practice. Therefore, detailed and effective infection control measures are imminently needed to prevent nosocomial coronavirus infection. This paper, based on proven effective experience, relevant guidelines, and research, not only presents the fundamental knowledge about the name, etiologic characteristics, epidemiologic characteristics and clinical manifestations of COVID-19, transmission routes and risk points of SARS-CoV-2 in dental clinics but also provides recommended protective measures for dental professionals to interdict the transmission of SARS-CoV-2 in dental clinics. Classification schemes as well as color identification according to the results of the questionnaire survey and temperature measurement in precheck and triages are innovations proposed in this paper. (*Am J Dent* 2020;33:129-134).

**Clinical significance:** This paper, based on proven effective experience, relevant guidelines, and research, not only presents the fundamental knowledge about the name, etiologic characteristics, epidemiologic characteristics and clinical manifestations of COVID-19, transmission routes and risk points of SARS-CoV-2 in dental clinics but also provides recommended protective measures for dental professionals to interdict the transmission of SARS-CoV-2 in dental clinics.

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## Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), arising from Wuhan, China, isolated from the patient and whose genome (29,903 nucleotides) has been sequenced,[1] was formally publicized as the dangerous pathogen of COVID-19 by the Chinese Center for Disease Control and Prevention on January 8, 2020.[2] COVID-19, which began in December 2019, has rapidly swept the world in just 2 months. The outbreak of COVID-19 has become a primary challenging public health issue for not only China but also the world.[3,4] The World Health Organization (WHO) declared that the pandemic of COVID-19 had become a public health emergency of global concern on March 11, 2020.[5] As of May 12, 2020, COVID-19 has been reported in over 180 countries/regions, with a total of 4,178,156 confirmed cases and over 280,000 deaths.[6]

The risk of cross-infection by SARS-CoV-2 might be elevated between dental personnel and patients due to the peculiarity of the dental practice, for example, the face-to-face communication and the exposure to saliva, other body fluids, and aerosols.[7] Therefore, detailed and effective infection control measures are imperatively needed to prevent nosocomial coronavirus infection. This review, based on proven effective experience, relevant guidelines and studies, not only presents the fundamental knowledge about COVID-19, transmission routes and risk points of SARS-CoV-2 in dental clinics, but also provides recommended protective measures for dental professionals.

### Introduction of COVID-19

#### Name

On February 11, 2020, the WHO identified the novel viral pneumonia originated from Wuhan as "Corona Virus Disease (COVID-19)". The causative pathogen of COVID-19 was initially named as a novel coronavirus (2019-nCoV), the seventh member of the family of human coronaviruses,[8] while the International Committee on Taxonomy of Viruses (ICTV) advised that this novel coronavirus should be named as "severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)" based on the phylogenetic and taxonomic analysis of COVID-19.[9]

#### Etiologic characteristics

SARS-CoV-2 belongs to the β-CoV,[10] and its genetic characteristics are significantly different from those of severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV). SARS-CoV-2 is sensitive to ultraviolet light and heat, and can be inactivated effectively by 56°C for 30 minutes, 75% ethanol, ether, chloroform, chlorine disinfectants, peracetic acid, etc.

### Epidemiologic characteristics

#### Incubation period

The asymptomatic incubation period of COVID-19 has been reported to be 1 to 14 days based on the current epidemiological investigation and research results[11,12] and there is evidence that it could be 5 to 6 days on average.[2,13] Fourteen days was adopted as the universal duration for medical observation and isolation of (potential) contacts to decrease transmission of SARS-CoV-2 by asymptomatic carriers as much as possible.

#### Source of transmission

Although symptomatic patients have been the major source of transmission, recent investigations indicate that asymptomatic patients or patients in their incubation period who are carriers of SARS-CoV-2[14,15] might also be transmitters. It is extraordinarily difficult to separate the asymptomatic (poten-

tial) patients from a large-scale population due to the limitation of manpower, financial and material capabilities, which makes it extremely challenging to control the infectious source in a timely manner.[16] Furthermore, it remains to be demonstrated whether convalescing patients continue to be a potential source of transmission.[15]

**Routes of transmission**

Currently, it is accepted that its person-to-person transmission happens mainly through the respiratory tract of droplets and close contact transmission.[7,16] Moreover, there might be a risk of fecal-oral transmission due to the discovery of SARS-CoV-2 in the feces of some patients.[17] However, it remains to be confirmed whether SARS-CoV-2 can be spread via vertical transmission (from mother to fetus or newborn).[18,19]

**Susceptible population**

Current observations indicate that all ages are generally susceptible to COVID-19. However, the healthcare personnel who are in extensive and close exposure are especially vulnerable to SARS-CoV-2 infection.

## CLINICAL MANIFESTATIONS

The typical clinical symptoms and signs of the patients with COVID-19 were fever (83-99%), cough (59-82%), and fatigue (44-70%),[20] while some also experienced myalgia, headache, sore throat, diarrhea, and other atypical symptoms.[12,22] Most patients who received chest computed tomography (CT) presented bilateral pneumonia, with ground-glass shadows and bilateral patchy opacity.[11,12,22] Critical patients developed dyspnea and hypoxemia in a week after onset and one-fourth to one-third of the hospitalized patients in Wuhan developed serious complications, for example, acute respiratory distress syndrome, arrhythmia, and shock.[11,21,22]

**Possible transmission routes of SARS-CoV-2 in dental clinics**

Dental health professionals and patients may be exposed to viruses, bacteria and other pathogenic microorganisms due to the special setting of dental clinics, integrating examination, diagnosis, and treatment. It could increase the risk of SARS-CoV-2 infection for professionals in contact with patients face-to-face and frequent exposure to particles of saliva, secretions, blood, and other body fluids that are generated when high-speed dental handpieces rotate at high speed and spray water in the treatment.[23] The SARS-CoV-2 could be transmitted in dental clinics through inhalation of aerosols and droplets suspended in the air for a long time,[24] direct contact with blood and other fluids that are contaminated with viruses,[25] close contact with the oral mucosa, nasal secretions or conjunctiva of infected individuals, and indirect contact with the surfaces of infected equipment and materials.[26] The virus could extend its distance by coughing and chatting without a mask.[27,28]

**Airborne spread**

A large number of works of literature have reported that a diverse set of dental operations can produce aerosols and droplets contaminated with viruses.[25] Therefore, droplet and aerosol transmission of SARS-CoV-2 is the most concerning issue in dental settings by virtue of the difficulty of avoiding producing a great deal of aerosol and droplets blended with the patient's saliva and blood during dental operations.[27] The aerosols and droplets come not only from the coughing and breathing of infected patients but also mainly from the use of dental equipment such as high-speed dental handpieces when the high-speed drives the dental burs to rotate at high speed and produces water mist. However, it is impossible to avoid using high-speed dental handpieces in routine oral operations, making it particularly difficult to control the generation of aerosols and droplets. Particles of droplets and aerosols can remain in the atmosphere for a protracted time before settling on environmental surfaces or entering the respiratory tract.[29] Accordingly, the possibility that the SARS-CoV-2 would spread through droplets and aerosols of infected individuals in dental and medical institutions should be evaluated.

Table 1. Time of viable virus particles on different types of surfaces.

| Surface | Virus | Time of viable virus particles | Reference |
|---|---|---|---|
| Metal | SARS-CoV | 5 days | 42 |
| Glass | HCoV | 5 days | 43 |
| | SARS-CoV | 4 days | 42 |
| Plastic | HCoV | 2-6 days | 44 |
| | SARS-CoV | 4 days | 42 |
| | MERS-CoV | 48 hours | 45 |

**Contact spread**

Dental professionals are frequently in contact with body fluids, materials used by patients, contaminated surfaces of tables and chairs, and polluted dental devices by direct or indirect means, which might facilitate the transmission of SARS-CoV-2.[27] Furthermore, dental professionals might come into contact with secretions from the oral mucosa, nasal tissues, or conjunctiva containing viruses engendered from an infected individual and disseminated by coughing, etc. Therefore, it is extremely essential to take effective infection control measures to block contact transmission of SARS-CoV-2.

**Contaminated surfaces spread**

Some studies[25,30] have shown that human coronaviruses such as endemic human coronaviruses (HCoV), MERS-CoV, or SARS-CoV can remain on surfaces of metal, glass, or plastic for up to several days (Table 1). In addition, previous research[31] has shown that HCoV remains infectious at room temperature for 2 hours up to 9 days, and there is an increased persistence of HCoV at 50% relative humidity compared with 30%. Therefore, contaminated surfaces that are habitually touched in dental clinics are a potential source of SARS-CoV-2 transmission and keeping these environments sanitary and dehydrated would be conducive to decreasing the spread of the SARS-CoV-2 virus.

## RISK POINTS IN DENTAL DIAGNOSIS AND TREATMENT PROCESS

Taking China as an example, a combined potential risk of transmission with the dental-medical process has been implemented highlighting the risk points that are likely to spread SARS-CoV-2. (Table 2).

**Effective infection control and protective measures in dental clinics**

Due to the severity of the novel coronavirus outbreak, it is necessary to take more extreme measures to prevent and control novel coronavirus infections in dental clinics. There are different levels of response, corresponding to varying degrees of prevalence in different regions.

For example, the potentially affected areas of COVID-19 in Sichuan Province, China are divided into four categories: no

Table 2. Potential risk points and transmission of SARS-CoV-2.

| Potential risk link | The main route of transmission | Specific approach and media of transmission |
|---|---|---|
| Pre-check and triage | Respiratory droplet transmission, contact spread | Talking (consulting a nurse) without a mask, touching items (medical, identification cards, medical records) |
| Waiting room | Respiratory droplet transmission, contact spread | Chatting, coughing, sneezing without shield, contacting with public objects contaminated with body fluids |
| Doctor-patient communication, Preliminary oral examination, and routine practice | Respiratory droplet transmission, contact spread | Explaining the illness, checking the oral situation closely, contacting with the paper and pen contaminated with body fluids when signing the informed consent, touching the surface of dental treatment chair and other facilities |
| Adoption of the dental high speed system | Aerosol spread | Spillage from turbine-drills and drills, water vapor, saliva and blood during ultrasonic tooth cleaning |
| Disposal of medical pollutants and equipment | Contact spread | Bur, K file, syringe needle, surgical mask, disposable medical cap, disposable isolation suit or surgical clothes |

Table 3. Questionnaire survey of visitors.

| Questions | Yes | No |
|---|---|---|
| 1. Have you had a fever or experienced a fever in the past 14 days? | ☐ | ☐ |
| 2. Have you encountered respiratory discomforts, such as a cough or difficult breathing in the past 14 days? | ☐ | ☐ |
| 3. Is there any nasal obstruction, runny nose, fatigue, sore throat, chest tightness, diarrhea, myalgia, conjunctival congestion, and other symptoms within 14 days? | ☐ | ☐ |
| 4. Have you ever been to the outbreak area of 2019-CoV, such as Wuhan? | ☐ | ☐ |
| 5. Have you been abroad within the past 14 days? If "yes", please mark where you have been? | ☐ | ☐ |
| 6. Have you come into contact with a confirmed COVID-19 patient or been with a confirmed patient in a relatively confined space, such as in the same vehicle? | ☐ | ☐ |
| 7. Have you had any close contact with a suspected COVID-19 patient in the past 14 days? | ☐ | ☐ |
| 8. Is there at least one confirmed case in your neighborhood or community within 14 days? | ☐ | ☐ |
| 9. Have you attended any gathering activities, such as parties, meetings, or had close contact with many unfamiliar people? | ☐ | ☐ |

case area, sporadic case area, community outbreak area, and local epidemic area during the epidemic period.[32] Correspondingly, the dental institutions in the different regions mentioned above should have different coping strategies. The dental clinics in no case areas can make a routine opening to deal with common oral diseases and in sporadic case areas can carry out the strategy of opening part of clinic rooms and departments. But for dental clinics in community outbreak area or local epidemic area, we recommend providing emergency care only or performing a full stop.

On April 8, 2020, the Centers for Disease Control and Prevention (CDC) recommended that dental clinics postpone elective surgeries, and non-urgent dental visits, and prioritize emergency visits and procedures.[33]

The World Health Organization published online the Guideline for the Diagnosis and Treatment of Novel Coronavirus Pneumonia,[34] with proven effective experience, relevant guidelines, and research on the important and universally applicable prevention and control procedures against SARS-CoV-2.

The present review proposes the use of triaging patients with color coding to classify and isolate patients according to the results of the questionnaire survey and temperature measurement in precheck and triages which could prove helpful to dental staff, and for organizing isolation of patients within medical and dental institutions.

## Recommendations for management

### The formulation of contingency plans and work procedures

Dental institutions should promptly set up a management group for epidemic prevention and control, formulate emergency plans, make protection standards, determine the prevention and control procedures, and complete personnel assignment of duties.

### The preparation of sufficient protective equipment

Dental institutions should prepare adequate protective equipment for health care workers to protect them from virus infection.

### The training of staff

Personnel training should be carried out in a targeted manner, with an emphasis on strengthening the training of personnel for pre-examination and screening.[35] Depending on the different responsibilities, staff should be trained in prevention and control of the SARS-CoV-2 infection.

### The care for the mental health of staff

What cannot be underestimated is the concern for the mental health of staff. Confronting a considerable outbreak of infectious diseases, some medical workers will inevitably experience anxiety, fear, and other negative emotions. For this reason, in addition to providing adequate epidemic prevention materials and information, dental and medical institutions should also give attention to mental health measures. Staff should be encouraged to work with a positive attitude.

### Pre-check and triages of patients

During the SARS-CoV-2 epidemic prevention and control period, a triage system should be established according to the characteristics of the infection. Medical and dental institutions in non-epidemic areas can maintain normal clinical practice, after formulating emergency plans and pre-examination and triage preparations.[32] The infectious risk of patients can be determined by the results of the questionnaire (Table 3), and temperature measurement, and then categorized by color. Table

Table 4. Classification and treatment plans according to the results of the questionnaire.

| The number of "yes" answers to the questions in Table 2 | Have a fever? | Classification of color markers | Treatment |
|---|---|---|---|
| ≥1 | Yes | Red | The patient should be immediately quarantined, and the staff should report to the hospital infection control administration or local health authorities. |
| 0 | Yes | Red | The patient should be directed to the fever screening clinics or special clinics for COVID-19 for additional medical observation and care. |
| Unlimited (as long as the answer is "yes" to any or both of question 1 and question 2 in Table 2) | No | Red | The patient should be directed to the appropriate specialist clinics, such as fever screening clinics, respiratory clinics or special clinics for COVID-19 for additional examination and medical observation. |
| ≥3 (the number of questions answered "yes" and the answers must be "no" to question 1 and question 2) | No | Yellow | The patient can be treated for dental emergency in an isolated room and the dentists should adopt tertiary protection, trying to avoid procedures that produce a large amount of liquid spills (droplets and aerosols). |
| ≥1 and ＜3 (the number of questions answered "yes" and the answers must be "no" to questions 1 and 2) | No | Purple | The patient can be given some treatment of part of common dental diseases and the dentists should adopt tertiary protection, trying to avoid treatments that produce a large amount of liquid spills (droplets and aerosols). |
| 0 | No | Green | The patients can be given the conventional treatment of almost all dental diseases and the dentist should adopt secondary protection, trying to decrease spills (droplets and aerosols). |

Table 5. Specific contents of classified protection.

| Name of classification/Protection level | Protective equipment | Applicable range |
|---|---|---|
| Primary protection/ General protection | Disposable medical cap, disposable surgical mask, and work clothes (scrubs). Use of protective eyewear or face shield, and disposable medical gloves | Imaging technicians taking the panoramic radiography or cone-beam CT images, or dental staff examining or treating patients |
| Secondary protection/ Advanced protection | Disposable medical cap, disposable surgical mask, work clothes (scrubs), disposable surgical gown, protective eyewear or face shield, disposable medical gloves | Dental staff in contact with low-risk patients and performing procedures with little or no spray (droplets or aerosols) |
| Tertiary protection Strengthened protection | Disposable medical cap, disposable surgical mask, work clothes (scrubs), disposable surgical gown, with extra disposable protective clothing, protective eyewear, face shield, disposable medical gloves, impermeable shoe covers | When dental professionals come into contact with patients at high risk or engage in operations with large amounts of spray (droplets or aerosols) |

4 shows the color coded classifications and treatment plans, based on the patients' questionnaire responses. Red represents an extremely high risk, and the dental treatment should not be performed on such patients or be deferred until 14 days after the exposure event. Yellow represents a high risk; purple represents a medium risk; green represents a low risk.

A color label representing the risk level can be attached to the patient's clothing to help the dentists quickly understand the risk level of patients, make corresponding treatment plans according to the severity of the dental disease and take corresponding protective measures. Furthermore, the waiting area can also be divided according to the label color, and patients can be arranged to wait in the corresponding area consistent with the colors of their labels, which would be conducive to reducing the cross-infection of SARS-CoV-2. When waiting, in addition to separate seats, patients can also be provided with printed brochures or electronic publicity videos to learn basic knowledge about epidemic prevention and control, which would contribute to reducing the risk of nosocomial infection.

## RECOMMENDATIONS FOR THE DENTAL PRACTICE

### Personal protective measures for dental professionals

Currently, there is no accurate and unified standard of preventive measures for dental personnel during the outbreak and epidemic period. Based on the possibility of infection spreading in dental diagnosis and treatment, classified protection is suggested in dental institutions during the epidemic control period, which can be divided into three levels (Table 5).[29]

### Improvement of hand hygiene

Since SARS-CoV-2 can be transmitted by contact and possibly through the fecal-oral pathway, the importance of hand hygiene cannot be overemphasized in dental practice.[17,27] While appropriate hand hygiene is supposed to be the standard routine for dental procedures, proper hand-washing compliance is absolutely imperative for the infection control of SARS-CoV-2. Therefore, strengthening the implementation of good hand hygiene is significant and urgent.[29,35]

### Dental practice

Pre-operative antimicrobial mouthrinsing is commonly considered to reduce the number of oral microorganisms.[36,37] Due to the susceptibility of SARS-CoV-2 to oxidation, it is recommended to use an oxidizable pre-procedural mouthrinse, for instance, 1% hydrogen peroxide or 0.2% povidone to reduce the number of bacteria in saliva, including potential SARS-CoV-2 carriage.

The body position of patients should be adjusted to a relaxed state and the dental procedure causing the pharyngeal reflex and cough should be avoided as much as possible.[38] If intraoral x-ray examination needs to be performed, extraoral panoramic radiography and cone-beam CT are more appropriate than intraoral periapical radiograph and occlusal radiograph which would stimulate saliva secretion and coughing.[39] In addition, procedures involving spraying should be strictly constrained or postponed. Likewise, the combination of a rubber dam

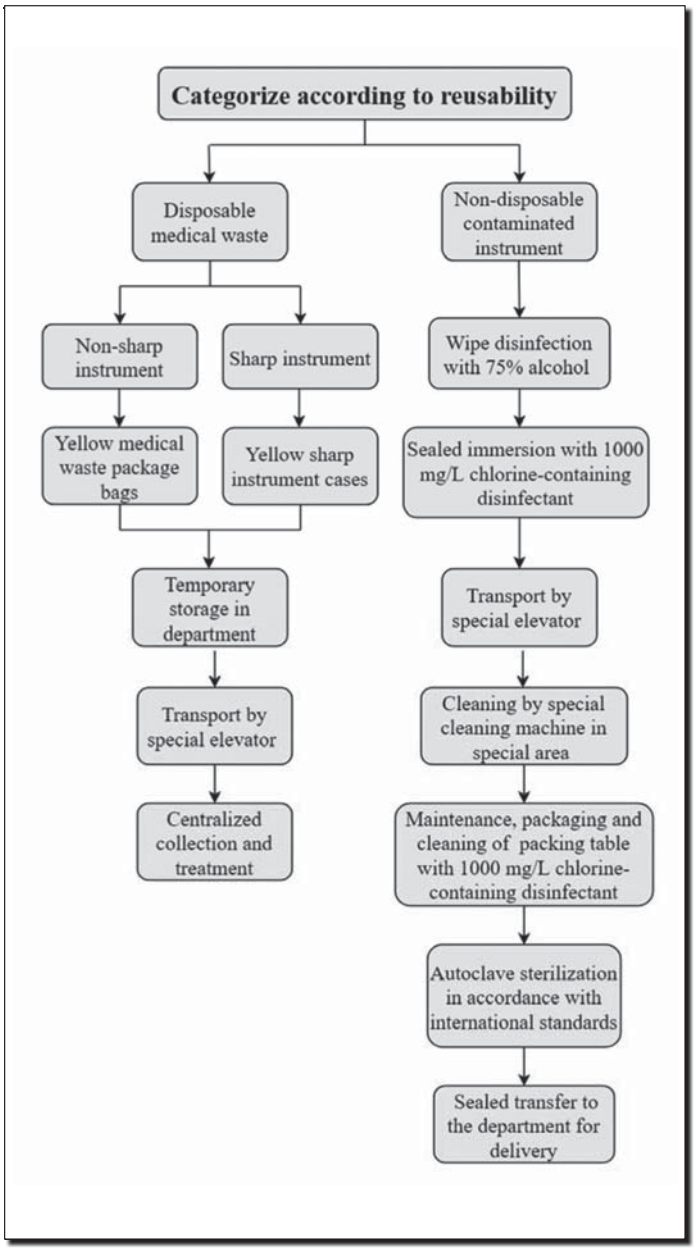


Figure. Treatment process of classified medical pollutants.

and a strong aspirator is more conducive to reducing the dispersion of pollutants than a weak aspirator alone.

### Management of medical waste

Improper or incomplete disposal of contaminated medical substances will not only cause pollution of the surrounding environment, but also produce direct or indirect harm to the human body and may even become a source of a disease epidemic.[40] Therefore, careful management of medical waste should be adopted to manage the medical pollutants, to reduce the potential routes of transmission of SARS-CoV-2 and ensure the safe operation of dental clinics during the epidemic.[41] The detailed treatment process of classified medical pollutants is shown in the Figure.

### Summary

The outbreak of COVID-19 has become a primary challenging public health issue for not only China but also for the world. The risk of cross-infection by SARS-CoV-2 may be elevated between dental personnel and patients due to the peculiarity of the dental practice, for example, the close communication and exposure to saliva, other body fluids, and aerosols. In this review, the fundamental knowledge about the name, etiologic characteristics, epidemiologic characteristics and clinical manifestations of COVID-19 was reviewed. Also, it summarized the possible transmission routes of SARS-CoV-2 in dental clinics, including airborne spread, contact spread, and contaminated surface spread. Besides, the potential risk points in the dental diagnosis and treatment process was highlighted. Furthermore, based on the Guideline for the Diagnosis and Treatment of Novel Coronavirus Pneumonia,[34] proven effective experience, relevant guidelines, and research, we recommend the important and universally applicable prevention and control procedures against SARS-CoV-2 for reference, involving recommendations for management, precheck and triages of patients, the procedure of dental practice and management of medical waste. Color coded classifications according to the results of the precheck/ triage questionnaire and temperature measurement may prove helpful for treatment and isolation of clinical patients.

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