

# **Understanding the Basics of the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS- CoV-2) Infection from a Dentist's Perspective: A Review**

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## **Abstract**

Coronavirus disease (COVID-19) pandemic is still on rise and is affecting the most of the world population. It is causing a widespread public health concerns, thus making it necessary to take proper infection control measure. The transmission risk of COVID -19 infections is higher amongst the healthcare professionals including dentists, dental hygienists and dental assistants. Dental professionals are at high risk due to face to face communication and getting exposed to saliva, blood and other body fluids and can be potential carrier of COVID-19. Undoubtedly COVID-19 has affected the dentistry like never before and directing dentistry in a whole new direction. Though the dental professionals are at high risk, their role is vital for the screening and also in controlling the spread of infection through their clinical set up. The dental professionals need to have a basic understanding of the corona virus and also on COVID 19 infection. The importance of saliva in both the transmission and in diagnostic perspective need to be elaborated to the dental professionals. Also the dental professionals may be involved in studying the disease specific oral manifestations of this newly emerged disease. This article is designed in order to provide information regarding COVID-19, possible methods of diagnosing COVID-19 through oral manifestations and also specific recommendations for dental practice.

**Keywords-** *COVID-19, dentistry, saliva, oral manifestations, prevention, pandemic, SARS CoV2, aerosol.*

## **Background**

Since the first reported case in Wuhan, China, in December 2019, Coronavirus disease (COVID 19) has widely spread to several countries. In March 2020, The World Health Organization (WHO) declared COVID 19, a pandemic.<sup>1</sup> As saliva is a main tool of spread of the virus, dental professionals are at increased risk of contracting the infection and becoming potential carriers of the disease.<sup>2</sup> According to Occupational Safety and Health Administration (OSHA), dental health care personnel (DHCP) are placed in very high exposure risk category as they work in close proximity to the patient's oral cavity.<sup>3</sup> The purpose of this manuscript is to provide a basic understanding of the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS- CoV-2) and COVID19 from dental professionals' perspective and the measures to overcome the challenges.

## **History of the outbreak**

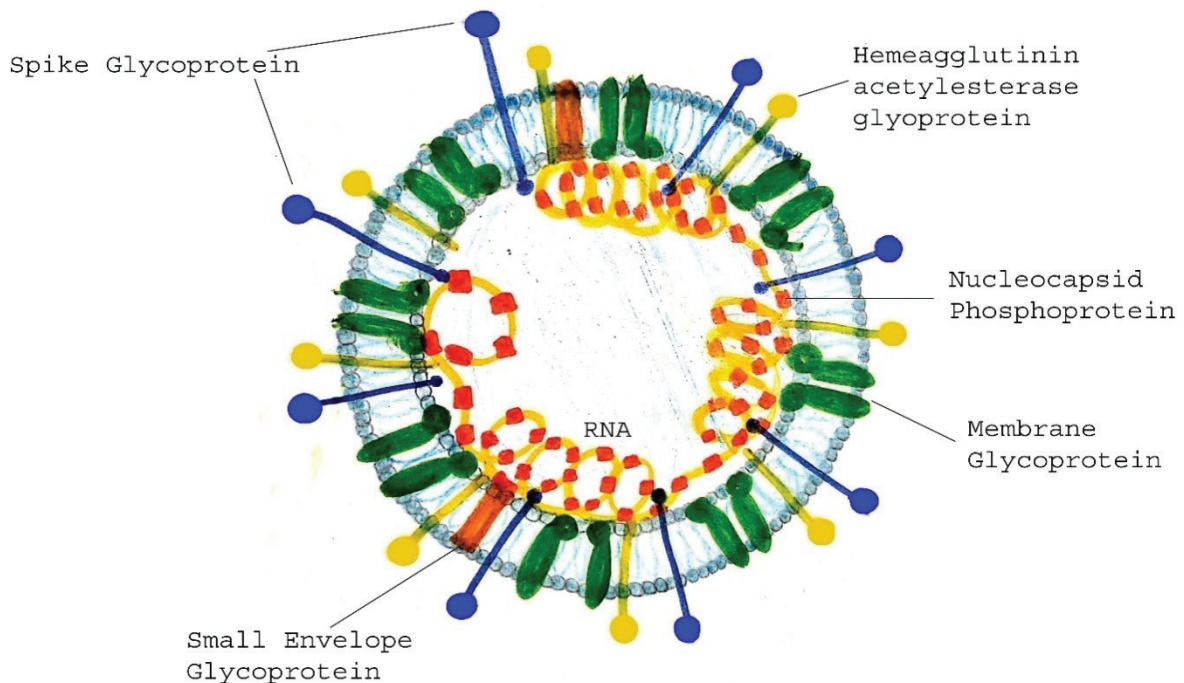
On 31st December 2019, Wuhan health commission in the Hubei province of the Republic of China notified the National Health Commission, China CDC and WHO of a cluster of 27 cases of pneumonia of unknown etiology. These patients presented with a constellation of symptoms such as fever, dyspnea, dry cough, and radiological findings showed bilateral lung glassy opacities. In January 2020, a novel  $\beta$ -CoV was identified as the causative agent.<sup>4</sup> When the virus was first isolated from pneumonia cases in Wuhan, China, in December 2019, it was named as 2019 novel Coronavirus (2019-nCoV). As more information and genetic analyses became available, the virus was given the official name of SARS-CoV-2 by the International Committee for Taxonomy of Viruses. The genome of the new Coronavirus shows similarities to other  $\beta$ -CoV, which

is found in bats.<sup>4</sup> The genome of SARS-CoV-2 is 96.2% identical to that of bat CoV RaTG13, whereas it shares 79.5% identity to SARS-CoV. Furthermore, the public health office traced all these 27 cases to Human Seafood wholesale market which trades live species of bats, snakes, pangolins, and badgers.<sup>5</sup> On 11th March 2020, due to the global logarithmic expansion of the cases the Coronavirus disease 2019 (COVID-19) was declared as a pandemic by the World Health Organization (WHO).<sup>6</sup> Globally as of 3:52 PM, CEST, 19 August 2020, there have been 21,989,366 confirmed cases of COVID-19, including 7,75,893 deaths, reported to WHO. In India there are 2,767,273 confirmed COVID-19 cases including 52,889 deaths.<sup>7</sup>

### CORONAVIRUS

Coronaviruses are enveloped, single stranded RNA virus belong to the family of Coronaviridae, of the order Nidovirales having diameter of 60-140 nm.<sup>8,9</sup> Currently, there are four genera of coronaviruses:  $\alpha$ -CoV,  $\beta$ -CoV,  $\gamma$ -CoV, and  $\delta$ -CoV.<sup>10,11</sup> The  $\alpha$ -CoV and  $\beta$ -CoV mainly infect the respiratory, gastrointestinal, and central nervous system of humans and mammals, while  $\gamma$ -CoV

and  $\delta$ -CoV mainly infect the birds.<sup>8,12-14</sup> The present SARS-CoV-2 belong to a  $\beta$ -coronavirus genus which infects mammals and humans. SARS-CoV emerged in China in November 2002; the SARS epidemic ended abruptly in July 2003, with no human SARS cases detected since 2004<sup>15</sup>. Although similar to MERS-CoV (Middle East Respiratory Syndrome- CoV) both SARS-CoV and SARS-CoV2 originated from, and are closely related with bat coronavirus, whether the SARS-CoV-2 has an intermediate host remains unknown. Additional sequencing data from other wild animals and mammals are required to confirm the source and origin of SARS-CoV-2.<sup>16</sup> According to the cryogenic electron microscopy (TEM) images, the SARS-CoV-2 virion is crown-shaped having four structural proteins: spike (S), envelope (E), membrane (M), and nucleocapsid (N) (illustrated in Figure 1). The S, E, and M proteins are responsible for viral envelope generation and the N protein carries the RNA genome. Of note, the spike protein is the glycoprotein that facilitates SARS-CoV-2 attachment, fusion, entry, and transmission into host cells by binding with human angiotensin converting enzyme 2 (hACE2) receptors,<sup>17</sup> which are expressed by epithelial cells of the lung, intestine, kidney, blood vessels, and oral mucosa.<sup>18</sup>



### Routes of transmission

SARS-CoV-2 infection mainly spread by respiratory droplets, or by contact. Coughing and sneezing by the affected person renders the COVID-19 airborne, affecting the individuals within the limit of 6 feet. This led to the concept of social distancing to prevent the community spread. Another source of transmission is respiratory droplets of COVID-19 land on objects present nearby the infected individual which is subsequently touched by another individual. Another way of transmission is the direct contact with a handshake and then touching the mucous membranes of the mouth, nose and eyes with contaminated hands. In addition, studies have shown the presence of SARS-CoV-2 in both saliva and faeces of the affected patients.<sup>19</sup> Respiratory and salivary droplets appear to be the main transmission routes of COVID-19 disease through inhalation, ingestion, and/or direct mucous contact.<sup>20</sup> The potential for transmission via salivary bioaerosols poses a particularly significant danger to healthcare workers that operate in close proximity to the face and oral cavities, especially the dental practitioners; oral-maxillofacial surgeons; ear, nose, and throat (ENT) surgeons; and ophthalmologists.<sup>21,22</sup>

#### **Incubation period:**

The incubation period is 1-14 days with the average of approximately 5 days.<sup>23</sup> The evidence on this matter is very limited but virus is viable for up to 72 hours on plastics, 48 hours on stainless steel and 24 hours on cardboard. Copper surfaces tend to kill the virus in about 4 hours. Research further revealed that the virus could survive in droplets for up to 3 hours after being coughed out into the air.<sup>24</sup>

#### **Symptoms**

Common symptoms are fever, breathlessness, tiredness, sore throat and dry cough. Some other symptoms like bodyache, nasal congestion, nasal discharge, hyposmia, dysguesia, hemoptysis and diarrhoea are also found. Most people (80%) have only mild symptoms. Such persons, can act as “carriers” and also serve as reservoir for re-emergence of infection. Although SARS-CoV-2 is known to be highly transmissible when patients are most symptomatic. Severe forms occur in 1 out of 6 who got diseased.<sup>25</sup> In addition to that abnormal chest X-ray and computed tomography findings such as ground-glass opacities and

bilateral patch shadows are found.<sup>26</sup> The disease can lead to major and serious symptoms in to old age people (above 65 years of age), having systemic conditions such as diabetes mellitus, hypertension, chronic liver disease, chronic kidney and heart diseases and pregnant females as well. Complications of COVID-19 include respiratory distress syndrome, arrhythmia, and shock which are more commonly associated with older age and the presence of comorbidities.<sup>27</sup>

#### **Diagnosis:**

The diagnosis of COVID-19 can be based on a combination of epidemiologic information, clinical symptoms, CT imaging findings, and laboratory tests (e.g., reverse transcriptase polymerase chain reaction [RT-PCR]) according to standards of either the WHO (2020) or the National Health Commission of China (2020).<sup>28</sup> It should be mentioned that a single negative RT-PCR test result from suspected patients does not exclude infection. Clinically, we should be alert of patients with an epidemiologic history, COVID-19-related symptoms, and/or positive CT imaging results.<sup>29</sup>

#### **COVID-19 Transmission Routes in Dental Clinics**

It is known that SARS-CoV-2 can bind to human angiotensin- converting enzyme 2 receptors, which are highly concentrated in salivary glands; this may be a possible explanation for the presence of SARS-CoV-2 in secretory saliva. Therefore there is potential for transmission of COVID-19 via aerosol and splatter in dentistry and also leads to nosocomial spread in the dental office setting. Dental care settings invariably carry the risk of 2019-nCoV infection due to the specificity of its procedures, which involves face-to-face communication with patients, and frequent exposure to saliva, blood, and other body fluids, and the handling of sharp instruments.<sup>30</sup> The pathogenic microorganisms can be transmitted in dental settings through following ways:

**Airborne Spread:** When dental devices work in the patient’s oral cavity, a large amount of aerosol and droplets mixed with the patient’s saliva or even blood will be generated. Particles of droplets and aerosols are small enough to stay airborne for an extended period before they settle on environmental surfaces or enter the

respiratory tract.<sup>31</sup> The chances of transmission through aerosol depends on the particle size. The large particle size (>60µm) tends to settle quickly and they are not much airborne for a longer period. The small-sized droplets (<60µm) spread through the air to somewhat longer distance range and pose a transmission risk to the dental auxiliaries and subsequent patients to the dental operator.<sup>32</sup>

**Contact spread:** A dental professional's frequent direct or indirect contact with human fluids, patient materials, and contaminated dental instruments or environmental surfaces makes a possible route to the spread of viruses.<sup>31</sup> According to the studies published in New York Times, dentists have 98% of risk of getting contaminated by covid-19 as they have to work in close proximity of the patients.<sup>33</sup>

**Contaminated surfaces spread:** Human coronaviruses (HCoV) can persist on surfaces like metal, glass, or plastic for up to a couple of days.<sup>34</sup> Therefore, contaminated surfaces that are frequently contacted in healthcare settings are a potential source of coronavirus transmission.<sup>34</sup>

### Saliva as a diagnostic tool in COVID-19

The salivary gland can be infected by SARS-CoV-2 virus resulting in the subsequent release of viral particles or antibodies into saliva, as evidenced in Rhesus macaque primates where salivary gland epithelial cells were the first target cells for SARS-CoV infection.<sup>35</sup> This is likely to be facilitated by the high expression of hACE2 (SARS-CoV-2 receptor) on the epithelial cells of the oral mucosa, as demonstrated using single-cell RNA sequencing.<sup>36</sup> Saliva can be collected by Saliva and throat wash (by gargling 10 ml saline) samples from 17 SARS-CoV patients were found to be SARS-CoV RNA positive, with the highest detection rate a median of four days after disease onset and during lung lesion development. Saliva samples from 75 patients successfully validated saliva as a viable biosample source for COVID-19 detection when compared to nasopharyngeal or oropharyngeal swabs.<sup>37</sup> In summary, the current gold standard diagnostic test is RT-qPCR to detect SARS-CoV-2 RNA which takes approximately 48 h to obtain the test results. More new tests with higher sensitivity and specificity need to be appropriately validated before being implemented into the current

routine diagnosis.<sup>15</sup>

### At home diagnosis of COVID-19

Recently, the Food and Drug Administration (FDA) has approved a few home sample collection kits by using the gene-editing technique known as clustered regularly interspaced short palindromic repeats (CRISPR) to make home tests.<sup>37</sup> If it works, these tests could be very accurate and give people an answer in about an hour. CRISPR gene editing technique is used to create a rapid test for SARS-CoV-2 RNA. It shows two purple colored lines if the sample is positive. With this technology, developing a test kit that would allow rapid detection of SARS-CoV-2 RNA in saliva within 45-60 minutes at home without expensive equipment.<sup>16</sup>

Collecting saliva is not only less invasive than the nasal swabs but also contains more virus, which makes it easier to detect with RT-PCR. In fact, an at-home saliva collection kit just received a green light by the FDA on May 8, 2020.

They were developing a six-step procedure for home-based testing for saliva along with the nasal swabs.

- Spit into a sample collection tube that contains dry chemical reagents that will begin to react with your saliva when you drop the closed tube into the warm water for 30 minutes.
- The heat helps the chemicals break up the virus particle and expose the virus's genetic material – RNA. The RT-PCR reagents basically multiply the viral RNA creating billions of copies.
- After 30 minutes, transfer the contents of the collection tube to a second tube containing dried CRISPR components and leave it at room temperature for 10-15 minutes.
- Only if CRISPR/Cas finds the specific Coronavirus RNA, will it become active and chop up the synthetic reporter molecules that are engineered and added to this second tube. This part happens in just six minutes. Then drop a paper strip into the second tube. Within 30 seconds one or two purple bands reveal the results.
- The health care provider can then direct the individual to quarantine or recommend further testing

such as antibody-based tests.<sup>38</sup>

### Oral manifestations of covid-19

Taste abnormalities: Loss of taste and smell have been recognized lately as one of the symptoms of COVID-19. An Italian team reported that 20 out of 59 COVID-19 patients who were interviewed (33.9%) had at least one taste or olfactory disorder and 11 (18.6%) had both.<sup>39</sup> Taste and smell disorder in this case could be explained by the fact that SARS-CoV-2 has been known for its interaction with angiotensin converting enzyme 2 (ACE2) receptor, to facilitate its penetration into the cell, and this receptor is widely expressed on the epithelial cells of oral mucosa and the brain. In fact, expression of ACE2 was found to be higher in tongue, where the taste buds are most abundant, than gingiva or buccal mucosa.<sup>40</sup> In summary, dentists should be aware of this symptom since they may encounter patients with taste abnormalities in the form of dysgeusia or burning mouth syndrome.<sup>41</sup>

Xerostomia: Taste is the main stimulant for saliva formation. In the study<sup>4</sup>, more than 50% of patients reported dysgeusia and xerostomia. Previous studies showed that xerostomia is secondary to nasal congestion and rhinorrhea due to mouth breathing.<sup>42</sup> This condition may be explained by olfactory dysfunction or may suggest neurological involvement that may lead to dysgeusia and xerostomia. Interestingly, there is no significant difference found in xerostomia between men and women.<sup>43,44</sup> A common manifestation of xerostomia is a burning sensation, which was demonstrated in the particular study.<sup>45</sup>

Oral Mucosal Lesions: According to study conducted by Carreras-Presas et al, there were three COVID-19 positive or suspected to be positive patients developed vesiculobullous lesion on oral mucosa. If future studies confirm this hypothesis, the dental practitioners would be the first to identify suspect COVID-19 positive cases.<sup>46</sup>

Masticatory muscle pain: There is significant relation found between masticatory muscle pain & COVID 19 according to study. Out of 100%, there were 11% of patients having complaint of pain in masticatory muscles.<sup>47</sup>

## RECOMMENDATIONS ON PATIENT MANAGEMENT AND PREVENTION OF NOSOCOMIAL INFECTION IN DENTAL SETTINGS:

Several *guidelines* have been issued earlier by DCI, IDA and mICMR and regarding dental practice in COVID-19 phase. These *guidelines* address dental services in the India, and cover health care workers who are required to attend dental practices and dental ailments in remote locations in the government sector.<sup>48</sup>

### Telescreening /Traiging

Telephonic screening can be done at the initial level as precautionary step to know if the individual is infected or not, before scheduling the appointment. The questions or inquiry should include the information about getting in contact with COVID -19 infected individual in recent times, past foreign travel history and presence of symptoms like mild fever, cough or sore throat.<sup>23</sup> Epicenter areas of COVID-19 can be tracked by dashboard made accessible by the center of systems science and engineering at John Hopkins university globally.<sup>49</sup> Positive answer of any of three questions should remark the cancellation of the appointment and patient should be asked to get self- quarantined and contact the physician.<sup>50</sup>

### Managing waiting room area

Avoid waiting rooms with many people and, make sure that there is more than 6 feet of distance between two individuals.<sup>51</sup> Organise the agenda by keeping 30-minutes of break between two consecutive patients, which allows the correct sanitation of the environment. The accompanying persons should be advised to temporarily leave the practice and return after the scheduled time.<sup>51</sup>

Installation of physical barriers (e.g., glass or plastic windows) at reception areas should be done to limit close contact with potentially infectious patients.<sup>52</sup>

### On arrival patient evaluation

- Patients should be asked to wear masks covering the mouth and nose when they arrive and sanitizer should be provided to them first.
- Patients should be asked to fill up the complete

medical history form, covid-19 screening and emergency questionnaire.<sup>23</sup>

- Body temperature of patient should be measured using non-contact forehead thermometer or with cameras having infrared thermal sensors.<sup>53</sup>

- Individuals having temperature higher than 38 degree Celsius or flue like symptoms should have elective dental care deferred for at least 2 weeks.<sup>54</sup> According to CDC( center of disease control & prevention) suspected individual should be advised to sit separately, atleast at a distance of 6 feet from non affected area.<sup>41</sup>

- Suspected patient should be advised to contact physician to rule out the possibility of COVID-19.

### **Pharmacologic management**

Suspected individual with urgent required dental care with tooth pain and/or swelling should be given antibiotics and/or analgesics as a form of pharmacologic management.<sup>55</sup> According to the British Medical Journal, the use of Ibuprofen is prohibited due to its interference with immune function. Therefore Acetaminophen should be used as substitute drug in treating COVID- 19 infected patients.<sup>56</sup> World Health Organization (WHO) endorsed this recommendation on March 18, 2020

### **Infection control by using PPEs**

Dental professionals should be following standard airborne precautions by using personal protective equipment appropriately. Because of uncertainty of the outbreak there was a shortage of PPEs, but increased production was able to cover up the demand.

### **Specific precautionary recommendation**

- Handhygiene: It is considered one of the critical measures to prevent the contamination of COVID-19. It is recommended to avoid touching eyes, mouth, and nose without having hands carefully washed. Particularly, following the protocol involving 5 hand washings (2 before and 3 after treatment) is recommended. WHO defines hand hygiene as the simplest and cheapest procedure to fight infections, including COVID-19.<sup>51</sup>

- Facial Protection: Wearing a surgical or procedure mask and eye protection is advised (face shield, goggles) to protect mucous membranes of

the eyes, nose, and mouth during activities which generates splashes of blood, body fluids, secretions, and excretions.<sup>52</sup>

- Visual alerts icon (e.g., signs, posters): Post it at the entrance and/or in strategic places (e.g., waiting areas, elevators, cafeterias) so that it can provide patients with appropriate instructions about hand and respiratory hygiene. Instructions should include how to use tissues to cover nose and mouth when coughing or sneezing, to dispose of tissues and contaminated items in waste receptacles, and how and when to perform hand hygiene.<sup>52</sup>

- Preprocedural mouthwash: SARS-CoV-19 and MARS-CoV-19 are highly susceptible to povidone mouthrinse according to the study.<sup>57</sup> 0.2% of povidone iodine mouthwash might reduce the amount or load of covid-19 in oral cavity or saliva.<sup>58</sup> 0.5%-1% of hydrogen peroxide<sup>59</sup> mouthwash can be used as an alternative as it is having non-specific virucidal activity against covid-19. Another substitutive mouthwashes are: Cetylpyridinium chloride 0.05-0.1% and Chlorhexidine 0.2%.<sup>50</sup>

- Disposable instruments: to prevent contamination use the disposable mouth mirror , saliva ejectors, handcuffs and syringes.<sup>23</sup>

- Radiographic images: to prevent gag reflex and coughing, extraoral images should be taken like panoramic radiograph or cone beam computed tomography. If intraoral image have to be taken then intraoral sensors should be covered with double barrier to prevent cross contamination and perforation.<sup>60</sup>

- Rubber dam: To minimize the spatter generation rubber dam should be used.<sup>61</sup>

- Minimizing the use of aerosol generating tool: Ultrasonic instruments, high speed handpiece and three way syringes should be used minimally.<sup>59</sup> In as much as is possible manually remove decay and pulp tissue and manage chemically and/or pharmaceutically. Any dental procedure that has the potential to aerosolized saliva will cause airborne contamination should be prevented. Those procedures include ultrasonic scaling, conventional restorative procedures, periodontal surgeries, polishing, and maxillofacial surgery procedures. Therefore, the possible way of spreading of infection via an almost

invisible aerosol must be recognized and eliminated to the greatest possible extent, which can be done by using tertiary PPE, 4- handed technique and high- volume saliva ejectors.<sup>62</sup> For mandatory emergency treatment, anti-retraction handpieces designed with anti-retractive valves are the best option.<sup>63,64</sup>

- After treatment, the operator must not remove the protective barriers, such as the face mask to talk to the patient, as the potential risk of contagion due to contact with contaminated material in the air may remain. airborne infection isolation room: suspected COVID-19 patients should be treated in negative- pressure treatment rooms to prevent the contamination.<sup>65</sup>

- Impressions: It should be thoroughly disinfected before pouring or sending to the laboratory using an appropriate disinfectant.

- Decontamination of object surface: covid-19 virus can remain viable in aerosol and survive up to 3 days at room temperature on object surface.<sup>51</sup> therefore disinfection of the surfaces using chemicals that are approved should be done immediately after the treatment is done. Disinfection of switches, handles, and surfaces of all rooms with 0.1% sodium hypochlorite or 70% ethyl alcohol should be done.<sup>66</sup> Cleaning and sanitizing air conditioning system outlets, split filters or machines should be done.

- Proper disposal of biomedical waste: Most important step to prevent the cross infection by discarding PPEs and disposable used instrument in to double layered yellow plastic bags.<sup>67</sup> Treatment of waste contaminated with blood, body fluids, secretions and excretions as clinical waste, in accordance with local regulations should be done. Human tissues and laboratory waste that is directly associated with specimen processing should also be treated as clinical waste. Discard single use items properly.

- All indoor areas of dental clinic such as entrance lobbies, corridors and staircases, elevators, office rooms, meeting rooms, cafeteria should be mopped with a disinfectant with 1% sodium hypochlorite or phenolic disinfectants.<sup>48</sup>

- Fogging: It is used as 'No-touch surface disinfection' after a large area has been contaminated.

The commercially available hydrogen peroxide is 11% (w/v) solution which is stabilized by 0.01% of silver nitrate is used for this procedure. 20% working solution should be prepared. The volume required for fogging is approximately 1000ml per 1000 cubic feet. After the procedure has been completed in the operatory, exit the room and close the operatory for half hour for droplets to settle down. Perform the 2 Step surface cleaning followed by fogging. The fogging time is usually 45min followed by contact time/dwell time of one hour.<sup>48</sup>

## Conclusion

Dentistry is a profession where the dentist works in close proximity to the patient's mouth and many procedures produce aerosol which is a mixture of water (from a dental instrument like high speed hand piece) and patient's saliva or blood. These aerosols could result in the spread of infection and diseases including COVID-19. The dental practitioners refrain from some elective dental procedures like restoration and extraction of asymptomatic teeth, aesthetic dental procedures, orthodontic adjustments and routine radiographs. By avoiding the aerosol generating procedures, the dental professionals avoid the spread or transmission of the infection. They attend to only the emergency dental procedures to alleviate the pain of their patients. Further studies need to be designed to explore the disease specific oral manifestations in COVID 19 patients.

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## References

1. Lai CC, Liu YH, Wang CY, Wang YH, Hsueh SC, Yen MY et al. Asymptomatic carrier state, acute respiratory disease, and pneumonia due to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2): facts and myths. *J Microbiol Immunol Infect.* <https://doi.org/10.1016/j.jmii.2020.02.012>
2. Fallahi, H.R., Keyhan, S.O., Zandian, D. et al. Being a front-line dentist during the Covid-19 pandemic: a literature review. *MaxillofacPlastReconstrSurg* 2020; 42:12. <https://doi.org/10.1186/s40902-020-00256-5>

3. Centers for Disease Control and Prevention, Interim Infection Prevention and Control Guidance for Dental Settings during the COVID-19 Response, Centers for Disease Control and Prevention, Atlanta, GA, USA, 2019. <https://www.cdc.gov/coronavirus/2019-ncov/hcp/dental-settings.html>.
4. Zhu N, Zhang D, Wang W, et al. China Novel Coronavirus Investigating and Research Team. A novel coronavirus from patients with pneumonia in China. *N Engl J Med.* 2020;382:727–733.
5. Lu H, Stratton C, Tang Y. Outbreak of pneumonia of unknown etiology in Wuhan, China: the mystery and the miracle. *J Med Virol.* 2020;92:401-402. doi:10.1002/jmv.25678.
6. Kakodkar P, Kaka N, Baig M. A Comprehensive Literature Review on the Clinical Presentation, and Management of the Pandemic Coronavirus Disease 2019 (COVID-19). *Cureus* 12(4): e7560. DOI 10.7759/cureus.7560
7. WHO Coronavirus Disease[COVID-19] Dashboard:<https://covid19.who.int>
8. Fehr, A. R. & Perlman, S. Coronaviruses: an overview of their replication and pathogenesis. *Methods Mol. Biol.* 2015;1282:1 –23.
9. Gorbalenya, A., Enjuanes, L., Ziebuhr, J. & Snijder, E. Nidovirales: evolving the largest RNA virus genome. *Virus Res.* 2006;117:17 –37
10. Nakagawa, K., Lokugamage, K. G. & Makino, S. in *Advances in Virus Research* (ed John Ziebuhr) Academic Press, 2016;vol. 96:165–192.
11. Fan, Y., Zhao, K., Shi, Z.-L. & Zhou, P. Bat coronaviruses in China. *Viruses* 11, 210.2019.
12. Perlman, S. & Netland, J. Coronaviruses post-SARS: update on replication and pathogenesis. *Nat. Rev. Microbiol.* 2009;7:439–450.
13. Weiss, S. & Leibowitz, J. Coronavirus pathogenesis. *Adv. Virus Res.* 2011;81, 85 –164.
14. Yin, Y. & Wunderink, R. G. MERS, SARS and other coronaviruses as causes of pneumonia. *Respirology* 2018;23:130–137.
15. Ksiazek, T.G., Erdman, D., Goldsmith, C.S., Zaki, S.R., Peret, T., Emery, S., Tong, S., Urbani, C., Comer, J.A., Lim, W., et al. A novel coronavirus associated with severe acute respiratory syndrome. *N. Engl. J. Med.* 2003; 348:1953–1966.
16. . Pingping Han and Sašo Ivanovski. Saliva—Friend and Foe in the COVID-19 Outbreak. *Diagnostics* 2020;10:290. doi: 10.3390/diagnostics10050290.
17. Wrapp, D. Wang, N. Corbett, K.S. Goldsmith, J.A. Hsieh, C.-L. Abiona, O. Graham, B.S. McLellan, J.S. Cryo-EM structure of the 2019-nCoV spike in the prefusion conformation. *Science* 2020;367:1260–1263.
18. Wan, Y. Shang, J. Graham, R. Baric, R.S. 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, 20.
19. Centers of disease control and prevention. Transmission of coronavirus disease 2019(Covid-19). [Available at- <http://www.cdc.gov/coronavirus/2019-ncov/about/transmission.html>].
20. Maren Eggers, Torsten Koburger-Janssen, Markus Eickmann, Juergen Zorn. In Vitro Bactericidal and Virucidal Efficacy of Povidone-Iodine Gargle/Mouthwash Against Respiratory and Oral Tract Pathogens. <https://doi.org/10.1007/s40121-018-0200-7>.
21. Meng L., Hua F., Bian Z. Coronavirus Disease 2019 (COVID-19): Emerging and Future Challenges for Dental and Oral Medicine. *J. Dent. Res.* 2020;22034520914246. doi: 10.1177/0022034520914246. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
22. 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;12:9. doi: 10.1038/s41368-020-0075-9. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
23. Amber Ather, Biraj Patel, Nikita B. Ruparel, Anibal Diogenes, and Kenneth M. Hargreave. Coronavirus Disease 19 (COVID-19): Implications for Clinical Dental Care. *JOE Volume 46, Number 5, May 2020.*
24. VanDoremalen N, Bushmaker T, Morris DH, Holbrook MG, Gamble A, Williamson BN, et al. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. *N Engl J Med.* 2020;382:1564–1567. doi: 10.1056/NEJMc2004973. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
25. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in

- Wuhan, China: a descriptive study. *Lancet*. 2020; 395(10223):507-13.
26. Guan W, Ni z, Hu Y, et al. Clinical characteristics of 2019 novel coronavirus infection in China. medRxiv 2020.02.06.20020974; doi:https://doi.org/10.1101/2020.02.06.20020974.
  27. R. Izzetti, M. Nisi, M. Gabriele, and F. Graziani. COVID-19 Transmission in Dental Practice: Brief Review of Preventive Measures in Italy. *Journal of Dental Research* 1–9.
  28. World Health Organization. 2020a. Clinical management of severe acute respiratory infection when novel coronavirus (2019-nCoV) infection is suspected: interim guidance [accessed 2020 July 18]. [https://www.who.int/publications-detail/clinical-management-of-severe-acute-respiratory-infection-when-novel-coronavirus-\(ncov\)-infection-is-suspected](https://www.who.int/publications-detail/clinical-management-of-severe-acute-respiratory-infection-when-novel-coronavirus-(ncov)-infection-is-suspected).
  29. L. Meng, F. Hua, and Z. Bian. Coronavirus Disease 2019 (COVID-19): Emerging and Future Challenges for Dental and Oral Medicine. *Journal of Dental Research* 2020;Vol. 99(5): 481–487.
  30. Xian Peng, XinXu, Yuqing Li, Lei Cheng, Xuedong Zhou and Biao Ren. Transmission routes of 2019-nCoV and controls in dental practice. *International Journal of Oral Science*. 2020;12:9. <https://doi.org/10.1038/s41368-020-0075-9>.
  31. Cleveland, J. L. et al. Transmission of blood-borne pathogens in US dental health care settings: 2016 update. *J. Am. Dent. Assoc.* (1939) 147. 2016;729–738 .
  32. Tang, J. W., Li, Y., Eames, I., Chan, P. K. & Ridgway, G. L. Factors involved in the aerosol transmission of infection and control of ventilation in healthcare premises. *J. Hosp. Infect.* 2006;64:100–114.
  33. The workers who face the greatest coronavirus risk. By Lazaro Gamio March 15, 2020. [Available at: <https://www.nytimes.com/interactive/2020/03/15/business/economy/coronavirus-worker-risk.html>]
  34. Kampf, G., Todt, D., Pfaender, S. & Steinmann, E. Persistence of coronaviruses on inanimate surfaces and its inactivation with biocidal agents. *J. Hosp. Infect.* <https://doi.org/10.1016/j.jhin.2020.01.022> (2020).
  35. Liu, L. Wei, Q. Alvarez, X. Wang, H. Du, Y. Zhu, H. Jiang, H. Zhou, J. Lam, P. Zhang, L. et al. Epithelial cells lining salivary gland ducts are early target cells of severe acute respiratory syndrome coronavirus infection in the upper respiratory tracts of rhesus macaques. *J. Virol.* 2011;85: 4025–4030.
  36. Xu, H. Zhong, L. Deng, J. Peng, J. Dan, H. Zeng, X. Li, T. Chen, Q. High expression of ACE2 receptor of 2019-nCoV on the epithelial cells of oral mucosa. *Int. J. Oral Sci.* 2020;12: 8.
  37. Researchers Validate Viability of Saliva in COVID-19 Detection. [Available online: [https://www.mpomag.com/contents/view\\_breaking-news/2020-04-03/researchers-discover-that-saliva-can-detect-covid-19/](https://www.mpomag.com/contents/view_breaking-news/2020-04-03/researchers-discover-that-saliva-can-detect-covid-19/)]
  38. The Conversation Media Group Ltd. [Available online: <https://theconversation.com/rapid-home-based-coronavirus-tests-are-coming-together-in-research-labs-were-working-on-analyzing-spit-using-advanced-crispr-gene-editing-techniques-138064>]
  39. Giacomelli, A. Pezzati, L. Conti, F. Bernacchia, D. Siano, M. Oreni, L. Rusconi, S. Gervasoni, C. Ridolfo, A.L. Rizzardini, G. et al. Self-reported olfactory and taste disorders in in patients with severe acute respiratory coronavirus 2 infection: A cross-sectional study. *Clin. Infect. Dis.* 2020. [CrossRef]
  40. Xu, H. Zhong, L. Deng, J. Peng, J. Dan, H. Zeng, X. Li, T. Chen, Q. High expression of ACE2 receptor of 2019-nCoV on the epithelial cells of oral mucosa. *Int. J. Oral Sci.* 2020;12:1–5. [CrossRef] [PubMed]
  41. Najla Dar Odeh , HamzahBabkair , Shaden Abu-Hammad, SaryBorzangy, Abdalla Abu-Hammad and Osama Abu-Hammad. COVID-19: Present and Future Challenges for Dental Practice. *Int. J. Environ. Res. Public Health* 2020;17:3151. doi:10.3390/ijerph17093151.
  42. Knight, A. The differential diagnosis of rhinorrhea. *J Allergy ClinImmunol.* 1995;95(5, pt 2):1080-1083.
  43. Nederfors, T, Isaksson, R, Mörnstad, H, Dahlöf, C. Prevalence of perceived symptoms of dry mouth in an adult Swedish population—relation to age, sex and pharmacotherapy. *Community Dent Oral Epidemiol.* 1997;25(3):211-216.
  44. . Niklander, S, Veas, L, Barrera, C, Fuentes, F, Chiappini, G, Marshall, M. Risk factors, hyposalivation and impact of xerostomia on oral health-related quality of life. *Braz Oral Res.* 2017;31:e14.

45. Bergdahl, M. Salivary flow and oral complaints in adult dental patients. *Community Dent Oral Epidemiol.* 2000;28(1):59-66.
46. Petrescu, N., Lucaciu, O., & Roman, A. (2020). Oral mucosa lesions in COVID-19. *Oral diseases*, 10.1111/odi.13499. Advance online publication. <https://doi.org/10.1111/odi.13499>
47. AmeenBiadsee, Ameer Biadsee, FirasKassem, ShchadaMasarwa, ZeevOrmianer. Olfactory and Oral Manifestations of COVID-19: Sex-Related Symptoms—APotentialPathwaytoEarlyDiagnosis. <https://doi.org/10.1177/0194599820934380>
48. [Available online: <https://www.mohfw.gov.in/pdf/GuidelinesonDisinfectionofCommonPublicPlacesIncludingOffices.pdf>]
49. Dong E, Du H , Gardner L. An interactive web-based dashboard to track COVID-19 in real time. *Lancet Infect Dis* 2020. <https://linkinghub.elsevier.com/retrieve/pii/S1473309920301201>
50. Yixuan Wang, Yuyi Wang, Yan Chen ,Qingsong Qin. Unique epidemiological and clinical features of the emerging 2019 novel coronavirus pneumonia implicate special control measures. <https://doi.org/10.1002/jmv.25748>
51. COVID-19 guide for dental hygienists: [Available online: [www.ifdh.org%2Fmedia%2FCOVID-19-AIDI-Recommendations-Italy.pdf&usg=AOvVaw0EL4Frtxr-AQh3r9jqr9I](http://www.ifdh.org%2Fmedia%2FCOVID-19-AIDI-Recommendations-Italy.pdf&usg=AOvVaw0EL4Frtxr-AQh3r9jqr9I)]
52. Indian Dental Association's Preventive Guidelines for Dental Professionals on the CoronavirusThreat: [Available online: [www.ida.org.in%2Fpdf%2FIDA\\_Recommendations\\_for\\_Dental\\_Professionals\\_on\\_the\\_Coronavirus\\_Threat.pdf&usg=AOvVaw0RJmG7Kbn\\_2ZoEX6twadPa](http://www.ida.org.in%2Fpdf%2FIDA_Recommendations_for_Dental_Professionals_on_the_Coronavirus_Threat.pdf&usg=AOvVaw0RJmG7Kbn_2ZoEX6twadPa)]
53. YunjiePeng, Xi Chen, Kailong He, Junhao Shi, Kong Zhao, QiukaiYing. A New Kind of Multi-functional Bed Based on Intelligent Control. *International Journal of Engineering Trends and Technology* 10.1 2020: 9-11.
54. Infection Control: Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) | CDC [Internet]. [cited 2020 Mar 9]. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html>
55. Jasmine Marwaha, Kianor Shah2020/04/1114 Safety & Preventive Measures for Dental Health Care Professionals on COVID-19 5 10.4444/ijshr.1003/421
56. Michael Day. Covid-19: ibuprofen should not be used for managing symptoms, say doctors and scientists. 2020:1.
57. Maren Eggers, TorstenKoburger-Janssen, Markus Eickmann, Juergen Zorn: In Vitro Bactericidal and Virucidal Efficacy of Povidone-Iodine Gargle/ Mouthwash Against Respiratory and Oral Tract Pathogens: <https://doi.org/10.1007/s40121-018-0200-7>.
58. Kariwa H, Fuji N, Takashima I. Inactivation of SARS coronavirus by means of povidone- iodine, physical conditions, and chemical reagents. [http://refhub.elsevier.com/S0099-2399\(20\)30159-X/sref25](http://refhub.elsevier.com/S0099-2399(20)30159-X/sref25)
59. Hamid Reza Fallahi, Seied Omid Keyhan, Dana Zandian, Seong-Gon Kim&Behzad Cheshmi. Being a front-line dentist during the Covid-19 pandemic:a literature review. <https://rdcu.be/b5Hsq>
60. Hokett SD, Honey JR, Ruiz F, Baisden MK, Hoen MM. Assessing the effectiveness of direct digital radiography barrier sheaths and finger cots. *J Am Dent Assoc* 2000;131:463-7.
61. Paridhi Gupta1, Bhagyalakshmi A., Pranshu Mehta, COVID-19: a dental perspective. <http://dx.doi.org/10.18203/2394-6040.ijcmph20202020>
62. DENTAL EMERGENCY PROTOCOL DURING COVID-19 PANDEMIC: [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjtiIzpdfqAhXawjgGHcvKBCEQFjAAegQIBBAB&url=https%3A%2F%2Fwww.mohfw.gov.in%2Fpdf%2FDentalAdvisoryF.pdf&usg=AOvVaw1\\_UHPcwi60mO3LCpSDiL0p](https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjtiIzpdfqAhXawjgGHcvKBCEQFjAAegQIBBAB&url=https%3A%2F%2Fwww.mohfw.gov.in%2Fpdf%2FDentalAdvisoryF.pdf&usg=AOvVaw1_UHPcwi60mO3LCpSDiL0p).
63. Samaranyake L, Reid J, Evans D(1989). The efficacy of rubber dam isolation in reducing atmospheric bacterial contamination. *ASDC J Dentistry Children* 56(6):442-444.
64. Samaranyake LP, Peiris M 9(2004). Severe acute respiratory syndrome and dentistry: a retrospective view. *J Am Dent Assoc* 135(9):1292-1302.
65. Centers of disease control and prevention. Infection Control: severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). Available at: <https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html>.
66. Summary of Infection Prevention Practices in Dental Settings. <https://www.cdc.gov/oralhealth/>

infectioncontrol/ summary- infection-prevention-  
practices/index.html.

67. Sanjeev Malhotra and ReenaSirohi. COVID

19 Aftermath - A Oral Health Care Provider  
Prospective. [https://doi.org/10.37191/Mapsci-2582-3736-2\(2\)-029](https://doi.org/10.37191/Mapsci-2582-3736-2(2)-029).