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Routes of Transmission and Control Protocols of COVID-19 in Dental Clinics: An Overview

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Review Article
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ABSTRACT

Objectives: The aim of this overview was to identify the possible routes of transmission of SARS-CoV-2 in dental clinics and the different control protocols proposed to prevent its further spreading.
Methods: We searched for studies on the electronic databases of PubMed (MEDLINE) and Ebscohost (EBSCO) using a combination of selected keywords from February to May 2020. An additional search was made on Google Scholar using the same keywords. Data extraction and quality valuation of articles were performed by two reviewers.
Results: Sixty-three articles were the results of the search and based on the inclusions and exclusions criteria, 15 articles were included in the final review: 13 literature reviews and 2 experimental studies. The main findings from available data concluded that the virus spreads through respiratory droplets and direct or indirect contact, however, airborne transmission in dental offices has been highlighted because of the inevitable generation of tremendous amounts of aerosol and droplet mixed with patient's saliva or other body fluids during dental procedures. Hence, aerosol transmission needs further studies. 2 studies identified SARS-CoV-2 in the saliva of patients suggesting saliva as a route of transmission and diagnosis and they concluded that the presence of COVID-19 in oral fluids and its effect on the transmission of this virus needs further investigation. Moreover, besides standard precautions, special prevention control such as postponing routine appointments and wearing personal protection equipment can prevent the transmission of the disease, especially by asymptomatic carriers.
Conclusion: Dental procedures generate aerosols and droplets that can be highly contaminated with SARS-CoV2 and explain additional preventive measures during the COVID-19 pandemic. Studies investigating aerosol transmission and saliva transmission in dental clinics are highly needed.

Keywords: COVID-19, 2019-nCoV, SARS-CoV2, Dentistry, Transmission, Prevention and Control.

Introduction

The Coronavirus Disease-2019 (COVID-19) is an infectious disease caused by a new type of coronavirus discovered in China (Wuhan) in December 2019. On January 12, 2020, the World Health Organization (WHO) named the virus '2019-nCoV' which stands for novel coronavirus discovered in 2019. On February 11, to avoid

confusion due to the similarity with the SARS-CoV genotype, 2019-n CoV was classified as Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) by The International Virus Classification Commission (ICTV). At the same time, the World Health Organization (WHO) named the disease 'COVID-19' [7]. The disease has rapidly spread worldwide leading to a "Public Health Emergency of International Concern." according to the world health organization. On 11th March 2020, WHO characterized COVID-19 as a pandemic.

The typical reported symptoms of COVID-19 are fever, dry cough, fatigue or myalgia, while the less common symptoms are sputum production, headache, haemoptysis, diarrhea, and vomiting. In severe cases, patients can suffer from pneumonia with alveolar damage, kidney failure leading to death.[11]

Dental professionals are considered at a high risk of contamination with the new corona-virus since they work in close contact with a potentially infected person and can themselves infect other patients if the infection control protocols are not sufficiently respected in the dental clinics the aim of this review was to summarize the different routes of transmission of the new coronavirus for dental professionals as well as the specific protection measures that must be used in dental clinics during the COVID-19 outbreak We searched for studies on the electronic databases of Ebscohost (EBSCO) and PubMed (MEDLINE)using a combination of selected key words: **((((("COVID-19" [Supplementary Concept]) OR "severe acute respiratory syndrome, coronavirus 2" [Supplementary Concept]) AND "Dentistry"[Mesh]) AND "transmission" [Subheading]) AND "prevention and control" [Subheading].**

We anticipated the fact that some studies published in local journals might not be indexed on the MEDLINE or EBSCO, therefore, an additional search was made on Google Scholar using the same keywords.

Risk of Nosocomial Infection in Dental Clinics

It is now proven that COVID-19 is primarily transmitted between humans through respiratory droplets and through contact: When a person is in close contact with the contaminated person, the transmission mainly occurs through coughing, sneezing, and droplets inhalation. In the dental clinics, direct contact of the infected droplets with oral, nasal, and occular mucosa increases the risk of transmission. The virus can also spread through fomite regarding its ability to survive on surfaces and objects[6,12] Giving the fact that dental professionals are exposed to microorganisms such as viruses, due to the nature of their practice which involves direct or indirect contact with body fluids and contaminated instruments, this offers a very potential route transmission of this Coronavirus.[14] So, every patient should be considered as infected with COVID-19 even in the absence of any symptoms.[11,15,16]

Airborne and Droplets Spread

The airborne spread of SARS-Coronavirus is well documented in the literature.[20] Studies confirmed that aerosols and droplets produced during the dental procedures were contaminated with the virus. All studies agreed that dental practitioners are exposed very often to the bioaerosols produced during dental procedures. In fact, dental devices such as high-speed handpieces and ultrasonic scalers are used with water running to prevent heat gain. When the turbine rotates at a high speed in the oral cavity, droplets, and aerosols mixed with saliva, water and blood are created. Such bioaerosols are generally infected with bacteria, fungi, and viruses which are small enough to be able to float in the air for an extended period of time until they settle on surfaces or enter the respiratory tract.[13,21,20,22,23]

Direct Contact spreading

Dental professionals are exposed to microorganisms such as viruses due to the nature of dental practice involving direct or indirect contact with body fluids and contaminated instruments. The person to person transmission of the COVID-19 includes direct contact with the infected person such as handshaking as well as by contact with the oral, nasal, or eye mucosa. According to Peng and al[21], dentists as well as patients are exposed in the dental office, to oral, nasal, or conjunctival contact with droplets and aerosols contaminated with SARS-CoV2 generated by sneezing, coughing, or talking without a mask. Furthermore, the regular direct or indirect interaction of dental professionals with human fluids, patient's material, and contaminated dental instruments or environmental surfaces makes it possible for the virus to spread further.[21]

Salivary Transmission of SARS-CoV2

To and al reported that SARS-CoV2 was detected in the initial saliva specimen of 91.7% of the infected patients.[26] However, saliva specimens not only contain saliva secreted from major or minor salivary glands but also contain secretions coming down from the nasopharynx or coming up from the lung through the action of cilia lining the airway. Therefore, additional studies are required to delineate the possible sources of 2019-nCoV in saliva.

Sabino-Silva and al proposed that there were at least three separate pathways for the presence of SARS-CoV2 in saliva: first, from the lower and upper respiratory tract[29, 30] the virus reaches the oral cavity along with the liquid droplets often shared by these organs. Second, the blood-containing COVID-19 can enter the mouth through crevicular fluid, an oral cavity-specific exudates containing local proteins derived from extracellular matrixes and serum-derived proteins.[31] Finally, another way for COVID-19 to occur in the oral cavity is through major and minor salivary contamination of the gland, with subsequent release of the particles into the saliva via salivary ducts.[32]

Furthermore, it has been proven that SARS-CoV 2 uses angiotensin-converting enzyme II receptors (ACE2+) to invade the cell, which is the same receptor used by SARS Coronavirus.[12,33] Xu and al reported that these receptors are abundantly expressed in the mucosa of the oral cavity especially in the epithelium of the tongue. Such results clarified that the oral cavity is a potential source of infection of the novel Coronavirus and provided evidence for the future prevention strategy in dental practice.[34]

Studies concluded that Saliva is a promising non-invasive diagnosis method since saliva may be provided from patients without invasive procedures, the use of saliva specimens decreases the risk of nosocomial transmission of COVID-19 because it is provided without a close contact between the patient and the healthcare worker and it is suitable for circumstances in which the collection of nasopharyngeal specimens may be contraindicated. Also, saliva is technically easier to collect than the respiratory specimens, comfortable for patients and health workers as well as being cheap with minimal equipment required. [26, 32, 35]

Environmental Spread

Contaminated surfaces have been identified as a transmission route for many nosocomial infections.[36] Human coronaviruses such as SARS-CoV and MERS-CoV are proven to be able to survive for several days on surfaces like plastic and metal.[37, 38]

Dental procedures can aerosolize the respiratory splatter, saliva, or blood of the patient and contaminate the environmental surfaces and when transferred from settings to the hands of patients and practitioners, contaminated hands can then cause self-inoculation of mucous membranes of the nose, mouth, or eyes.[21] A

study evaluated the stability of the virus on different types of surfaces within a controlled laboratory setting. Results revealed that SARS-CoV2 remained viable in aerosols for approximately 3 hours, it also showed that SARS-COV-2 was detectable on copper for up to 4 hours, on cardboard for up to 24 hours, and on plastic and steel for up to 72 hours.[24] Moreover, human coronaviruses can remain viable for up to 9 days on plastic and steel.[12] Therefore, maintaining a clean and dry environment in the dental office will also help to minimize the persistence of the virus.

Recommended Control Protocols During the COVID-19 Outbreak

Dental practitioners should be aware of the routes of transmission of the novel coronavirus in dental clinics and should be able to detect patients with COVID-19 potential infection.[21]

Worldwide, routine dental practices were immediately postponed and only emergencies such as acute pain, trauma, and hemorrhages were treated in response to the pandemic situation.[19, 39]

Early Patient's Evaluation and Triaging

The clinical sorting of patients is mandatory in order to identify COVID-19 suspected cases. Hence, dental workers should have a high level of knowledge concerning the early recognition of suspected cases. The screening is best performed at the entrance of dental clinics. Izetti and al recommended a telephonic pre-triage to identify real emergencies as well as patients with a potential risk of COVID-19 exposure.[12, 40] Once in the dental clinic, the patient's body temperature should be measured using an infrared forehead thermometer which doesn't require any physical contact. [12, 19, 20, 21, 22, 40, 41]

Hand Washing

The importance of handwashing in the prevention of acute respiratory infections is increasingly recognized. Since fomite transmission is already plausible for SARS-CoV2 and fecal-oral transmission has been reported, practicing appropriate hand hygiene becomes crucial in dental practice.[21, 20, 22, 39, 40, 41, 42] A two-before-and-three-after guideline for hand-hygiene is recommended to improve professionals' compliance.[21] The world health organization recommends 5 moments for hand-washing as following: before and after touching a patient, before practicing any clean or aseptic procedure, after body fluid exposure, and after touching a patient's surroundings.[43] According to Mathur and al (CDC) and WHO, dental professionals should wash their hands before and after contact with patients or with contaminated surfaces, before putting on PPE, after taking it off, and when changing gloves.[43, 44] The WHO (2020c) stated that hand hygiene includes either cleaning hands with soap and water for 40-60 seconds or with 70%-90% alcohol-based hand rubs for 20-30 seconds using the appropriate technique. Washing hands with soap and water are preferred when hands are visibly soiled.[20]

Personal Protective Equipment (PPE)

The effective barrier against most aerosol hazards generated in the dental office can be provided by personal protection equipment (PPE). Dental professionals should use PPE as following: gowns, gloves, medical masks, and protective surgical glasses or face shields for eye protection (figure 2). Since SARS-CoV-2 can be transmitted through the eye membrane it becomes crucial to protect the conjunctival epithelium from contaminated droplets and aerosols during dental procedures. Protective eyewear and face shield are strongly recommended to prevent further spread and personal eyeglasses or contact lenses are not appropriate for eye protection because of their lack of sideward protection.[19, 20, 22, 40] Based on the WHO, when working at a distance of less than 1 meter from the patient, a medical mask should be used. However, such a mask is not able to offer adequate protection against aerosols which are particles smaller than 5 micrometers. Hence, when performing aerosol-generating procedures such as using high-speed handpieces, ultrasonic scalers, or

air-water syringe, N-95 masks authenticated by the National Institute for Occupational Safety and Health or FFP2-standard masks or FFP3 set by the European Union should be worn with performing seal-check.[19, 20, 22, 45] Before leaving the dental office, all of the PPE must be taken off safely to avoid self-contamination (skin, clothes, and mucosal membranes) as well as of other coworkers and the environment.[41, 46] In this regard, several ways of taking off PPE were described. According to the WHO and CDC, it should start with taking off the most contaminated items including gowns and gloves, followed by performing hand hygiene. Then, if the face shield is worn, it should be removed from behind. In case goggles and masks are worn, both of them are removed in the same way. On the other hand, CDC suggested another approach affirming that health-workers should take off their PPE starting by removing gloves followed by goggles or face shields. After that, they should remove gowns followed by the mask or respirator, by grasping elastics and avoiding touching the front. Hand washing or using an alcohol-based hand sanitizer is immediately performed after removing all PPE or whenever hands get contaminated during any item's removal.[46, 47]

Mouth Rinsing prior to Dental Procedures

A preoperative antimicrobial mouth rinse can reduce the number of oral cavity microbes.[48, 49] However, most common mouth rinses used in dentistry are not effective to prevent coronavirus' transmission. Instead, 1% hydrogen peroxide or 0.2% povidone-iodine mouth rinse is potentially efficient on SARS-COV-2 as the virus is vulnerable to oxidation.[12,13,20,21,40,41] Overall, these mouth rinses are highly recommended whenever the rubber dam cannot be used.

Oral Examination

Procedures generating spatter and aerosols contaminated with saliva and blood such as hand-pieces, ultrasonic devices, and the use of a 3-way syringe should be avoided or minimized as in the most extreme case. An intraoral x-ray can cause cough or gag reflex. Hence, extraoral x-ray such as panoramic and CBCT offer a good alternative during the outbreak of COVID-19.[19] But when intraoral x-rays are practiced, double barriers should be applied to sensors to avoid their perforation.[12] It is recommended to use disposable devices (single use) such as syringes mirror, and blood pressure cuff to avoid nosocomial infections. [12]

The Use of Rubber Dam

A study estimated that airborne particles decreased up to 70 percent in 3-foot diameter in the operative area by using a rubber dam.[50] Therefore, 4 hand operation is necessary to ensure regular aspiration using high-volume suction of droplets and aerosol. If it is not possible to use a rubber dam in some situations, it is advisable to use manual instruments like hand scalers and chemomechanical caries removal in order to minimize aerosol formation.[12,19,21,22,40,41] During dental procedures, high-speed dental devices without anti-retraction valves can aspire and eject the debris containing microorganisms. Peng and al highlighted the importance of the use of anti-retraction handpieces during this pandemic. In fact, this system can notably decrease the return of bacteria and HPV into the tubes of the dental unit.[21,51] Hence, the use of anti-retraction handpieces and autoclaving those between patients are strongly recommended to avoid cross-infection.[39, 41]

Environmental Cleaning and Disinfection Procedures

During dental procedures, air can be filtered either by high volume evacuator (HVE) or by high-efficiency particulate arrestor (HEPA) filter. HVE filter is a single component suction handpiece that aspirates debris. As a consequence, contamination from the operational site will effectively be minimized by 90% with HVE.[20, 52] The device should be maintained at a distance between 6 and 15mm approximately from the aerosol-generating source by a dental assistant. Nevertheless, HEPA can filter the air up to 99.97% of particles with a diameter of 0.3 μm. This expensive filter can form a source of contamination if soiled given that it is hard to

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clean and the invasion of microorganisms' filtered air.[20,53,54] Treating patients with aerosol-generating procedures should be performed in negatively pressured rooms and HEPA (High-Efficiency Particulate Arrestance) filter in preference. Otherwise, dental procedures should be performed in one room with closed doors.[41] The WHO recommended oral health professionals to work in a properly ventilated room with at least 160 l/s/patient airflow for natural ventilation or in rooms negatively pressured with at least 12 air changes per hour (ACH) and controlled direction of airflow in case of mechanical ventilation. At the end of treatment, it is advised to provide at least a 5-minute air change and dental practitioners should never leave the room without taking off PPE.[40] When treatment is over, settings contaminated with droplets and aerosols, surfaces that may be touched by the patient should be immediately disinfected using 0.1% (1g/L) sodium hypochlorite or 0.5% hydrogen peroxide or 62%–71% ethanol without forgetting to clean door hand, desks, chairs, and elevator… Disposable protection if used is removed from the surfaces.[20,40] Given that SARS-CoV-2 can survive up to 9 days on surfaces, strict disinfection protocols must be followed in the dental room and the waiting area.[12,19,21,20,55] A dry environment was suggested in the dental office to monitor diffusion.[40] In addition, healthcare waste should be immediately delivered to the medical institute's temporary storage area, and all used instruments including handpieces should be cleaned and autoclaved. [21,41]

Reducing Aerosol-generating in Emergency Treatments

Dental practitioners should only perform dental emergencies and decrease as much as possible the production of droplets /aerosol during the treatment session.

In this table (tab V), we sum up the precautions that must be applied to avoid droplets and aerosol-generating according to each dental discipline special features.[19, 20, 22, 40]

Dental Specialty	Anticipation measures
Endodontics	Prefer panoramic to retroalveolar x-ray Application of rubber –dam Prepare all instruments and materials in advance and use only the necessary ones. reducing unnecessary hand contact with settings and equipment
Restorative dentistry and pediatric dentistry	Avoid using rotary instruments (if necessary, it must be under rubber-dam, using high-volume saliva ejector and with minimum water flow) Application of chemo-mechanical method/carisolv, laser or atraumatic restorative techniques to eliminate caries and expose pulp Soft toys provided for children should be cleaned as well as restraining devices Promote oral hygiene measures Symptomatic chronic periapical periodontitis: antibiotic therapy and pain killers are recommended Eruptive gingivitis of the permanent first molar: use anti-inflammatory mouth rinse alternating with local chlorhexidine sprays in order to eliminate food debris from the gingival bags between gum and the erupting toothIn case of removable orthodontic appliance, if the hook is entirely broken from the resin, the child can wear the plate as long as it is retaining In case of fixed orthodontic appliances cemented on the palatal arch, it is advisable to suspend the activation to avoid the desinsertion of the device In case of fixed multi-bracket therapy, if the wire slides distally causing gum injury, carer can slide it mesially, using their fingertips. In a case of detachment of a bracket from the dental surface and its rotation by180°, carer can reposition it manually if it stayed attached to the arch. For tooth dislocation, tooth must be repositioned and splinted with the adjacent teeth.

Periodontics	Use hand scalers instead of ultrasonic scalers and perform polishing.
Prosthodontics	Use high-volume salivary suction. Choose the right size for impression tray to avoid gagging reflex. If necessary, consider applying oral mucosa anesthesia to the throat. During crown preparation, prefer supra-gingival margins under rubber-dam or split-dam technique. During partial or complete prosthesis try in, avoid touching dental settings with contaminated hands Dental prosthesis, impressions and any other item should be disinfected at the moment of its removal from the patient's mouth.
Oral-maxillofacial surgery	When performing dental extraction, privilege supine position to avoid working face up to the patient's breaths Wash the wound slowly and use salivary suction Prefer absorbable sutures Critical cases: chest CT should be performed to exclude infection with SARS-CoV2

Table V: Approaches to Minimize the Risk of COVID-19 in Different Dental Disciplines.[19,20,22,23,56]

Further Measures

Supplies of alcohol-based hand sanitizers must be available for patients and staff especially in the waiting room.[20,39,41] Instructions for the correct hand and coughing hygiene procedures and personal protective equipment use should be posted.[20,41] Waiting rooms should be well ventilated, with 60L/s per person.[20] Moreover, flyers should remind people to avoid touching their nose, mouth, and eyes. Dental professionals should have their temperature measured twice a day, once before starting to work and the second during work.[41] Sharp instrument manipulation should be done with caution to avoid an infectious accident. It is strongly recommended to remove objects such as magazines and toys from the waiting room to reduce the risk of fomite transmission.[40,41] Also, the number of patients should be limited with at least a 1-meter distance between chairs.[40] The waiting room should be well ventilated and patients should not wait long.[39] Air conditioning should be regularly sanitized in the dental office.[39] the patient's accompanying persons are discouraged to come and if they do, they are suggested to wait outside of the dental clinic. The patient's items should be left in the waiting room.

Conclusion

Dentists are extremely exposed to different infectious diseases and with the COVID-19 outbreak, new challenges facing dentistry are emerging.

This review revealed that in dentistry the virus spreads mainly through respiratory droplets and aerosols mixed with blood, saliva, and other body fluids generated during dental procedures. However, there is definitely much more to know about the virus and further studies of high quality of evidence are needed to detect COVID-19 in oral fluids and its impact on the transmission of this virus. Appropriate Control protocols can play a major role in reducing transmission in dental clinics and therefore further spread of COVID-19.

References

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel coronavirus from patients with pneumonia in China, 2019. https://doi.org/10.1056/nejmoa2001017
2. A.M. Zaki, S. van, Boheemen, T.M. Bestebroer, A.D. Osterhaus, R.A. Fouchier Isolation of a novel coronavirus from a man with pneumonia in Saudi Arabia N Engl J Med, 367 (2012), pp. 1814-1820. https://doi.org/10.1056/nejmoa1211721

3. R.J. de Groot, S.C. Baker, R.S. Baric, C.S. Brown, C. Drosten, L. Enjuanes, et al. Middle East respiratory syndrome coronavirus (MERS-CoV): announcement of the Coronavirus Study Group J Virol, 87 (2013), pp. 7790. https://dx.doi.org/10.1128%2FJVI.01244-13
4. Liu J, Liao X, Qian S et al. Community transmission of severe acute respiratory syndrome coronavirus 2, Shenzhen, China, 2020. Emerg Infect Dis 2020 doi. https://dx.doi.org/10.3201/eid2606.200239
5. Modes of Transmission of Virus Causing COVID-19: Implications for IPC Precaution Recommendations." WHO, World Health Organization, 29 Mar. 2020, www.who.int/publications-detail/modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations.
6. Ong SW, Tan YK, Chia PY, Lee TH, Ng OT, Wong MS, et al. Air, surface environmental, and personal protective equipment contamination by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) from a symptomatic patient. JAMA. 2020 Mar 4 [Epub ahead of print]. https://doi.org/10.1001/jama.2020.3227
7. Gorbalenya, A. E. et al. Severe acute respiratory syndrome-related coronavirus: The species and its viruses—a statement of the Coronavirus Study Group. Preprint at https://www.biorxiv.org/content/10.1101/2020.02.07.937862v1 (2020).
8. Zhou, P. et al. A pneumonia outbreak associated with a new coronavirus of probable bat origin. Nature https://doi.org/10.1038/s41586-020-2012-7 (2020).
9. Liu, P., Chen, W. & Chen, J.-P. Viral metagenomics revealed sendai virus and coronavirus infection of malayan pangolins (Manis javanica). Viruses 11, 979 (2019). https://dx.doi.org/10.3390%2Fv11110979
10. Wahba, L. et al. Identification of a pangolin niche for a 2019-nCoV-like Coronavirus through an extensive meta-metagenomic search. Preprint at https://doi.org/10.1101/2020.02.08.939660 (2020).
11. Huang, C., Wang, Y., Li, X., Ren, L., Zhao, J., Hu, Y., .& Cheng, Z. (2020). Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. The Lancet, 395(10223), 497-506. https://doi.org/10.1016/S0140-6736(20)30183-5
12. Ather, A., Patel, B., Ruparel, N. B., Diogenes, A., & Hargreaves, K. M. (2020). Coronavirus disease 19 (COVID-19): implications for clinical dental care. Journal of endodontics. https://doi.org/10.1016/j.joen.2020.03.008
13. Ali, S., Zeb, U., Khan, M., & Muhammad, A. (2020). Transmission Routes and Infection Control of Novel Coronavirus-2019 in Dental Clinics–A Review. Journal of Islamabad Medical & Dental College, 9(1), 65-72. https://doi.org/10.35787/jimdc.v9i1.517
14. Cleveland, J. L. et al. Transmission of blood-borne pathogens in US dental health care settings: 2016 update. J. Am. Dent. Assoc. (1939) 147, 729–738 (2016). https://doi.org/10.1016/j.adaj.2016.03.020
15. Guan, W.-j. et al. Clinical characteristics of 2019 novel coronavirus infection in China. Preprint at https://doi.org/10.1101/2020.02.06.20020974 (2020).
16. Backer, J. A., Klinkenberg, D. & Wallinga, J. Incubation period of 2019 novel coronavirus(2019-nCoV) infections among travellers from Wuhan, China, 20–28 January 2020. Euro. Surveill. https://doi.org/10.2807/1560-7917.Es.2020.25.5.2000062 (2020).

17. Chen JL, 2020. Pathogenicity and transmissibility of 2019-nCoV— a quick overview and comparison with other emerging viruses. Microbes Infect, in press. https://doi.org/10.1016/j.micinf.2020.01.004
18. Grenier, 1995; Jones and Brosseau, 2015) Chowell G, Abdirizak F, Lee S, et al., 2015. Transmission characteristics of MERS and SARS in the healthcare setting: a comparative study. BMC Med, 13:210.https://doi.org/10.1186/s12916-015-0450-0
19. Meng, L., Hua, F., & Bian, Z. (2020). Coronavirus disease 2019 (COVID-19): emerging and future challenges for dental and oral medicine. Journal of Dental Research, 99(5), 481-487. https://doi.org/10.1177%2F0022034520914246
20. Ge, Z. Y., Yang, L. M., Xia, J. J., Fu, X. H., & Zhang, Y. Z. (2020). Possible aerosol transmission of COVID-19 and special precautions in dentistry. Journal of Zhejiang University-SCIENCE B, 1-8. https://dx.doi.org/10.1631%2Fjzus.B2010010
21. Peng, X., Xu, X., Li, Y., Cheng, L., Zhou, X., & Ren, B. (2020). Transmission routes of 2019-nCoV and controls in dental practice. International Journal of Oral Science, 12(1), 1-6. https://doi.org/10.1038/s41368-020-0075-9
22. Mathur, N., Tyagi, S., Dwivedi, V., Narang, A., Tyagi, P., & Nath, K. S. (2020). DENTAL CONSIDERATIONS AMIDST COVID-19 SCARE. International Journal of Medical and Biomedical Studies, 4(3). https://doi.org/10.32553/ijmbs.v4i3.1058
23. Krithikadatta, J. Endodontic and Dental Practice during COVID-19 Pandemic: Position Statement from Indian Endodontic Society (Doctoral dissertation, Faculty of Dentistry, Sri Ramachandra University, Chennai, India. Doi; 10.4103/endo.endo_61_20
24. vanDoremalen N, Morris D, Bushmaker T et al. Aerosol and Surface Stability of SARS-CoV-2 as compared with SARS-CoV-1. New Engl J Med 2020 doi: https://doi.org/10.1056/NEJMc2004973
25. Cheng V, Wong S-C, Chen J, Yip C, Chuang V, Tsang O, et al. Escalating infection control response to the rapidly evolving epidemiology of the Coronavirus disease 2019 (COVID-19) due to SARS-CoV-2 in Hong Kong. Infect Control HospEpidemiol. 2020 Mar 5 [Epub ahead of print]. https://doi.org/10.1017/ice.2020.58
26. To, K. K.-W. et al. Consistent detection of 2019 novel coronavirus in saliva. Clin. Infect. Diseases https://doi.org/10.1093/cid/ciaa149 (2020).
27. Yan J, Grantham M, Pantelic J, et al; EMIT Consortium. Infectious virus in exhaled breath of symptomatic seasonal influenza cases from a college community. Proc Natl Acad Sci USA 2018; 115:1081–6. https://doi.org/10.1073/pnas.1716561115
28. Wang, W.K.; Chen, S.Y.; Liu, I.J.; Chen, Y.C.; Chen, H.L.; Yang, C.F.; Chen, P.J.; Yeh, S.H.; Kao, C.L.; Huang, L.M.; et al. Detection of SARS-associated coronavirus in throat wash and saliva in early diagnosis. Emerg. Infect. Dis. 2004, 10, 1213–1219. https://dx.doi.org/10.3201%2Feid1007.031113
29. Zhu N, Zhang D, Wang W et al (2019) China Novel Coronavirus Investigating and Research Team. A novel coronavirus from patients with pneumonia in China. N Engl J Med: 2020. https://doi.org/10.1056/NEJMoa2001017
30. Zhou P, Yang XL, Wang XG et al (2020) A pneumonia outbreak associated with a new coronavirus of probable bat origin. Nature. https://doi.org/10.1038/s41586-020-2012-7

31. Silva-Boghossian CM, Colombo AP, Tanaka M et al (2013) Quantitative proteomic analysis of gingival crevicular fluid in different periodontal conditions. PLoS One 8(10):e75898. https://doi.org/10.1371/journal.pone.0075898
32. Sabino-Silva, Robinson, Ana Carolina Gomes Jardim, and Walter L. Siqueira. "Coronavirus COVID-19 impacts to dentistry and potential salivary diagnosis." Clinical Oral Investigations 24.4 (2020): 1619-1621. https://doi.org/10.1007/s00784-020-03248-x
33. De Wit, E., van Doremalen, N., Falzarano, D. & Munster, V. J. SARS and MERS: recent insights into emerging coronaviruses. Nat. Rev. Microbiol. 14, 523–534 (2016). https://doi.org/10.1038/nrmicro.2016.81
34. Xu H, Zhong L, Deng JX, et al, 2020. High expression of ACE2 receptor of 2019-nCoV on the epithelial cells of oral mucosa. Int J Oral Sci, 12(1):1-5. https://doi.org/10.1038/s41368-020-0074-x
35. Khurshid, Zohaib, FarisYahya Ibrahim Asiri, and Hamed Al Wadaani. "Human saliva: Non-invasive fluid for detecting novel coronavirus (2019-nCoV)." International Journal of Environmental Research and Public Health 17.7 (2020): 2225. https://doi.org/10.3390/ijerph17072225
36. Otter JA, Yezli S, Salkeld JAG, et al., 2013. Evidence that contaminated surfaces contribute to the transmission of hospital pathogens and an overview of strategies to address contaminated surfaces in hospital settings. Am J Infect Control, 41(5):S6-S11. https://doi.org/10.1016/j.ajic.2012.12.004
37. Kramer A, Schwebke I, Kampf G, 2006. How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. BMC Infect Dis, 6:130. https://doi.org/10.1186/1471-2334-6-130
38. Otter, J. A. et al. Transmission of SARS and MERS coronaviruses and influenza virus in healthcare settings: the possible role of dry surface contamination. J. Hosp. Infect. 92, 235–250 (2016). https://doi.org/10.1016/j.jhin.2015.08.027
39. Spagnuolo, G., De Vito, D., Rengo, S., & Tatullo, M. (2020). COVID-19 outbreak: An overview on dentistry. https://doi.org/10.3390/ijerph17062094
40. Izzetti, R., Nisi, M., Gabriele, M., & Graziani, F. (2020). COVID-19 transmission in dental practice: brief review of preventive measures in Italy. Journal of dental research, https://doi.org/10.1177%2F0022034520920580
41. TUÑAS, INGER TEIXEIRA DE CAMPOS. "Coronavirus Disease 2019 (COVID-19): A Preventive Approach to Dentistry." Brazilian Journal of Dentistry, 17 Mar. 2020, doi: http://dx.doi.org/10.18363/rbo.v77.2020.e1766.
42. Infection Prevention and Control during Oral and Dental Healthcare When Coronavirus Disease (COVID-19) Is Suspected." Indian Dental Association, Indian Dental Association, 17 Feb. 2020, https://www.ida.org.in/pdf/20200319_WHO_IDA_IPCguidanceforOHSP.pdf
43. "Hand Hygiene: Why, How & When?" WHO, World Health Organization, 2009, www.who.int/gpsc/5may/Hand_Hygiene_Why_How_and_When_Brochure.pdf?ua=1
44. Mathur, P. (2011). Hand hygiene: back to the basics of infection control. The Indian journal of medical research, 134(5), 611. https://dx.doi.org/10.4103%2F0971-5916.90985
45. "Advice on the Use of Masks the Community, during Home Care and in Health Care Settings in the Context of the Novel Coronavirus (2019-NCoV) Outbreak." WHO, 2020, www.who.int/docs/default-source/documents/advice-on-the-use-of-masks-2019-ncov.pdf.

46. HOW TO PUT ON AND TAKE OFF PERSONAL PROTECTIVE EQUIPMENT (PPE). World Health Organization, 2020, https://apps.who.int/iris/bitstream/handle/10665/70066/WHO_CDS_EPR_2007.8a_eng.pdf?sequence=1&isAllowed=y
47. HOW TO SAFELY REMOVE PERSONAL PROTECTIVE EQUIPMENT (PPE) . Centers for Disease Control and Prevention, 2020, www.cdc.gov/hai/pdfs/ppe/ppe-sequence.pdf.
48. Kohn WG, Collins AS, Cleveland JL, Harte JA, Eklund KJ, Malvitz DM; Centers for Disease Control and Prevention. 2003. Guidelines for infection control in dental health-care settings—2003. https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5217a1.htm.
49. Marui VC, Souto MLS, Rovai ES, Romito GA, Chambrone L, Pannuti CM. 2019. Efficacy of preprocedural mouth rinses in the reduction of microorganisms in aerosol: a systematic review. J Am Dent Assoc. 150(12):1015–1026. https://doi.org/10.1016/j.adaj.2019.06.024
50. Samaranayake, L. P., Reid, J. & Evans, D. The efficacy of rubber dam isolation in reducing atmospheric bacterial contamination. ASDC J. Dent. Child 56, 442–444 (1989). https://pubmed.ncbi.nlm.nih.gov/2681303/
51. Hu, T., Li, G., Zuo, Y. & Zhou, X. Risk of hepatitis B virus transmission via dental handpieces and evaluation of an anti-suction device for prevention of transmission. Infect. Control Hosp. Epidemiol. 28, 80–82 (2007 https://doi.org/10.1086/510808
52. Narayana TV, Mohanty L, Sreenath G, et al., 2016. Role of preprocedural rinse and high volume evacuator in reducing bacterial contamination in bioaerosols. J Oral Maxillofac Pathol, 20(1):59-65. https://dx.doi.org/10.4103%2F0973-029X.180931
53. Chuaybamroong P, Chotigawin R, Supothina S, et al., 2010. Efficacy of photocatalytic HEPA filter on microorganism removal. Indoor Air, 20(3):246-254. https://doi.org/10.1111/j.1600-0668.2010.00651.x
54. Day DB, Xiang J, Mo J, et al., 2018. Combined use of an electrostatic precipitator and a high-efficiency particulate air filter in building ventilation systems: effects on cardiorespiratory health indicators in healthy adults. Indoor Air, 28(3):360-372. https://doi.org/10.1111/ina.12447
55. Kampf G, Todt D, Pfaender S, et al., 2020. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. J Hosp Infect, online ahead of print. https://doi.org/10.1016/j.jhin.2020.01.022
56. Luzzi, V., Ierardo, G., Bossù, M., & Polimeni, A. (2020). COVID-19: Pediatric Oral Health during and after the Pandemics. https://doi.org/10.1111/ipd.12737

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