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Research paper

Transmission risk and protective protocols for COVID-19 in dentistry: systematic review

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Abstract

Background: According to WHO, the new COVID-19 cases are rising with 4.5 million new cases in the first week of April 2021 and over 76000 new deaths globally. The risk of COVID-19 transmission in dental settings has been a concern. Therefore, this study aims to assess the transmission risk in dentistry and review the infection-control measures followed in different dental clinics worldwide and their compliance with the standard country-based or international guidelines.
Methods: This study reviewed the published literature regarding the COVID-19 transmission-control guidelines followed by different dental care centers worldwide. We performed a comprehensive literature search in PubMed and Embase databases. The key guidelines were listed study-wise, divided into three parts: before entering the dental treatment, during the dental procedure, and after the dental procedure. A comparison study was conducted to assess the compliance with the country-based or internationally accepted recommendations given by WHO, ADA, CDC, etc., for dental practices in the COVID-19 pandemic.
Results: During the dental procedure, a rubber dam and high volume saliva ejectors are recommended to minimize aerosol diffusion; mouth rinsing with 1% hydrogen peroxide or 0.2% povidone-iodine is recommended for patients. After the treatment, proper disinfection of the surfaces and instruments must be followed; the reusable dental instruments should be sterilized. Different guidelines were followed in different dental settings depended on the geographical locations; however, the most commonly followed guidelines were provided by WHO, ADA, CDC, and NHS.
Conclusions: The available guidelines will contribute to the prevention of COVID-19 in dental settings. Although the dental clinics are adopting standard guidelines to prevent COVID-19 transmission, the joint efforts and cooperation of both patients and dental practitioners are needed to make it successful. Therefore, both parties should strictly adhere to their respective recommended guidelines and hand hygiene practice in dental settings.

Keywords: *COVID-19; Dental Clinics; Dental Practice Management; Dental Procedure; Infection Control.*

1. Introduction

Coronavirus disease 2019 (COVID-19) is a virulent disease that is spreading throughout the global population day by day. The causative agent for the same is severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) originated from Wuhan, China. The disease was declared a pandemic on 11th March 2020 by WHO, considering its mortality and morbidity rate. [1] The transmission of the disease from airborne transmission dynamics from infected people is of particular concern.
The virus spreads in the form of droplets (5-12 micrometers) and aerosols (5 mm). When an infected person breathes, speaks, or coughs, this virus infects a healthy person. If a susceptible person touches any contaminated surface like a table, doorknobs, etc, SARS-CoV-2 can transfer to a healthy person through their mucus membranes. [2]
The major symptoms are fever, cough, and fatigue. Most of the infected patients have also shown symptoms of anosmia (impairment in smell) and ageusia (impairment in taste). [3] Other symptoms that are less common and may affect some patients like loss of taste, headache, muscle, and joint pain, diarrhea, etc. Symptoms of severe COVID-19 diseases are shortness of breath, loss of appetite, confusion, and high temperature.
WHO states that "Among those who develop symptoms, most (about 80%) recover from the disease without needing hospital treatment. About 15% become seriously ill and require oxygen, and 5% become critically ill and need intensive care. Complications leading to death may include respiratory failure, acute respiratory distress syndrome (ARDS), sepsis and septic shock, thromboembolism, and/or multiorgan failure, including injury of the heart, liver, or kidneys. In rare situations, children can develop a severe inflammatory syndrome a few weeks after infection." [3]
As per WHO, globally, by 17 April 2021, there have been 139,501,934 confirmed cases of COVID-19, including 2,992,193 deaths. As of 14 April 2021, a total of 751,452,536 vaccine doses have been administered. [4]
However, the chances of infection due to the transfer of the SARS-CoV-2 virus in dental settings are even bigger because of aerosol-generating dental procedures (AGDP). The AGDP can result in the patient-to-patient transfer, dentist-to-patient transfer, or patient to dentist transfer as the aerosol produced in those procedures may contain the COVID-19 virus [5]. There are also certain procedures that

provoke gag reflex and coughing [6]. Understanding the risk factors of infection to patients and practitioners during oral healthcare delivery and assessing preventive strategies within the dental premises are key components of improving patient safety and accessing dental healthcare in this pandemic environment.

According to WHO, "The best way to prevent and slow down transmission is to be well informed about the COVID-19 virus, the disease it causes and how it spreads. Protect yourself and others from infection by washing your hands or using an alcohol-based rub frequently and not touching your face." [7]

Numerous country-based and worldly renowned organizations released their recommendations regarding preventive strategies for COVID-19 transmission in dental settings. This systemic review focuses on the transmission risks of COVID-19 in the dental environment and aims at compiling the preventive strategies of different organizations.

2. Method

This study reviewed the published literature and guidelines of international health care institutions regarding the COVID-19 transmission- control, followed by different dental care centers across the world, and was conducted based on a predesigned PICO parameter and the guidelines implied by the Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. We performed a comprehensive literature search in Pubmed and EMBASE databases. The competency criteria were outlined using the following PICO parameter:

Population: All articles/ Guidelines for Dental practice on transmission risk

Intervention: Knowing and applying special protocols.

Comparator: Comparison of different guidelines adopted in different studies.

Outcome: Effectiveness of the implemented guidelines to reduce transmission risk.

2.1. Eligibility criteria

Studies were selected based on the following criteria:

articles where step-by-step guidelines were mentioned categorizing transmission control procedures before entering the dental procedure, during the dental procedure, and after the dental procedure.

The exclusion criteria were as follows:

a) articles that were opinion-based, b) articles without sufficient references, c) The detail about the adopted measures to control COVID-19 transmission.

2.2. Search strategy

We searched all articles listed in the Pubmed and EMBASE database during the period of the pandemic. The search strategy was based on the following keywords: COVID-19, Dental practice management, Dentistry in COVID–19, Dental public health, COVID-19 Dentistry, and we searched all terms from libraries. For the qualitative analysis, we searched all studies from the pandemic situation with the PICO parameter.

2.3. Study characteristic

All studies were evidence-based, where step-by-step infection control measures adopted by dental practitioners were mentioned starting from patient screening, guidelines to control infection in waiting rooms, operation rooms, and disinfection procedures after the patient visit. All the guidelines proposed in the studies were referred from country-based or internationally renowned organizations, namely the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), National Health Service (NHS), The American Dental Association (ADA), National Health Commission of the People's Republic of China (NHC). The key guidelines proposed in the selected studies were listed study-wise, which were divided into three parts: before entering the dental treatment, during the dental procedure, and after the dental procedure. A comparison study was shown to assess the compliance with the country-based or internationally accepted recommendations given by WHO, ADA, CDC, etc., for dental practices in the COVID-19 pandemic.

3. Result

3.1. Search results

We searched 52 articles from the PUBMED and EMBASE for the systematic review. The first screening was for duplication; after the removal of duplicated articles, only 49 articles were selected based on analysis of their title and abstract. In total, 41 articles were found to be eligible for full-text screening. A total of 25 articles that met inclusion-exclusion criteria were included for systematic review. The flowchart for study selection is shown in Figure 1.

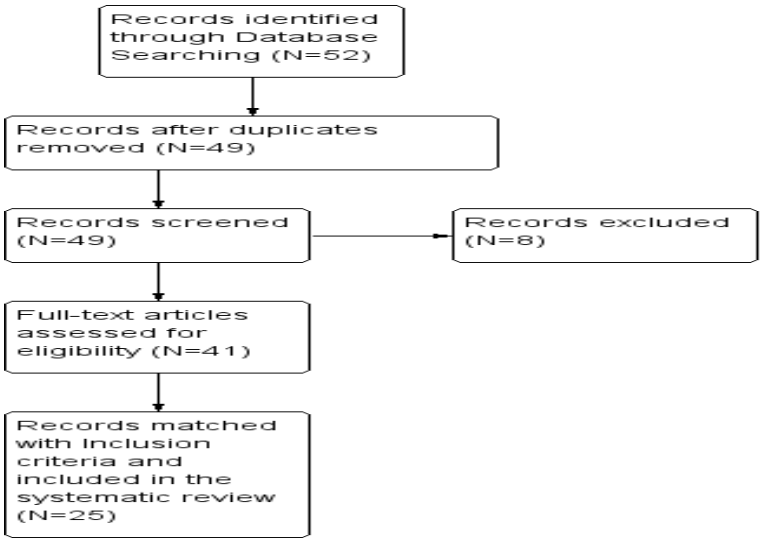

Fig. 1: Flow Chart of Literature Search.

Many key points were common to most of the studies, including screening of the patients by COVID-19 questionnaire to detect any possibility of infection. Most of the studies, including Alessandra Amato et al. 2020, Khalifa S. et al. 2020, Kumar ChandarSrivastava et al. 2020, Mohamed Jamal et al. 2020, Muhammad Adeel Ahmed et al. 2020, Pedro H et al. 2020, R. Izetti et al. 2020 recommended telescreening patients before fixing appointment to detect the urgency of the treatment as well as to detect any chance of COVID-19 transmission from the patient.

To detect any chance of COVID-19 infection, the patients were asked a certain type of questions as described in Figure 2 (Roberto Giudice et al. 2020). When the patient arrives at a dental clinic, the measurement of body temperature, maintaining social distancing, instructions about hand hygiene, and cough etiquette are recommended. Dental staff should be equipped with proper personal protective equipment (PPE). During the dental procedure, a rubber dam and high volume saliva ejectors are recommended to minimize aerosol diffusion; mouth rinsing with 1% hydrogen peroxide or 0.2% povidone-iodine is recommended for patients. After the treatment, proper disinfection of the surfaces and instruments should be followed; the reusable dental instruments should be sterilized. The key guidelines of different organizations are listed in Table 1.

1	Did you travel outside the country?	YES	NO
2	Have you had contact with people who have recently made extranational trips?	YES	NO
	If you answered yes to the previous questions in which countries?		
3	Stayed in one of the municipalities in the Areas defined as Risk of the xxxxx (country) territory?	YES	NO
4	Have you had contact with people residing or coming from municipalities in the Risk Areas of yourTerritory?	YES	NO
5	Over the past 14 days, have you experienced symptoms such as: difficulty breathing, cough, cold, diarrhea, headache, muscle pain, temperature> 37.5 ° C)?C	YES	NO
6	Have you had any recent contact with people who have experienced symptoms such as: difficulty breathing, cough, cold, diarrhea, headache, muscle pain, temperature> 37.5 ° C)?	YES	NO

Fig. 2: Patient Screening Questions for COVID-19

Table 1: The Key Recommendations for COVID-19 Protection in the Dental Environment

Author	Before the dental procedure	During the dental procedure	After the dental procedure
Alessandra Amato et al. 2020 [9]	Use telephone or teleconference for COVID-19 patients and Patients must always wear a surgical mask. Postpone the appointment If the patient's body temperature is over 37.3 ◦C.	Hand washes with hydroalcoholic solution for 60 seconds. Rubber dam should be used.	Treatment room should be disinfected after each dental procedure. All the disposable PPEs should be removed and disposed of using double-layered garbage bags.
Bruno César de Vasconcelos et al. 2020 [10]	The Dental Healthcare Professional (DHCP) must prepare a dental team, which should be vaccinated for influenza, and any staff showing influenza-like symptoms should avoid showing up at the office. The officers must control the PPE. The staff must check patient's temperature and use the patient screening questionnaire as recommended by ADA to determine suspected COVID carriers and isolate them from the rest.	Hand hygiene, using adequate PPE and disposable masks. Dental care should not be too invasive, and procedures that generate aerosol should be avoided. The facilities should include HEPA air purifiers for proper ventilation.	Dental clinics must follow strict measures for cleanliness and disinfection for dental offices and non-disposable instruments. Autoclave should be used for sterilization in case of those instruments which get directly contacted with oral cavity and fluids.

Cameron Estrich et al. 2020 [11]	Screen or interview suspected COVID patients before Dental appointment or treatment. Check patient temperatures before dental treatment Check temperature of DHCP and staffs before the shift Disinfect frequently touched surfaces, materials The non-disposable instruments should be sterilized after use PPE usage guidelines should be implemented There should be a distance between patients in the waiting room	Pre-procedural mouth rinse Extra-oral Suction device	Disinfecting all operatory instruments, frequently touched surfaces, and other materials
Elmeng et al. 2020 [12]	Screen or interview suspected COVID patients before Dental appointment or treatment. Check patient and their accompanying person's temperatures before dental treatment and masks should be provided to them. If the patient showed symptoms of COVID-19 within past 14 days, then quarantine for additional 14 days is recommended.	Procedure that induces coughing need to be avoided. "Extraoral Dental Radiographies" should be implemented Rubber dams are recommended for aerosol. Avoid all system that generates aerosols as much as possible.	Overall cleaning and disinfecting all operatory instruments, frequently touched surfaces, and other materials.
GulsumDuruk et al. 2020 [13]	Use of PPEs, disposables, and hand hygiene guidelines for the dental staff. Patients were asked to rinse their mouth with chlorhexidine or 1% hydrogen peroxide or 0.2 % povidone. Screen or interview suspected COVID patients before Dental appointment or treatment. If the patient showed symptoms of COVID-19 within past 14 days, then quarantine for additional 14 days is recommended. Tele-screening should be done on patients before a visit.	Use of strong absorbent system. Extraoral dental radiographies. To reduce the spatter or aerosol Rubber dams and high volume saliva ejectors are recommended.	Overall cleaning, disinfection, and hand hygiene was recommended in the study
Khalifa S et al. 2020 [14]	Screen or interview suspected COVID patients before Dental appointment or treatment. Isolation room should be used for suspected COVID-19 patients. If a patient stayed in any epidemic region within past 14 days, then quarantine for additional 14 days is recommended. Provision of an airborne infection isolation room and practice of extra-oral suction in dental clinic is recommended. Patients should hand sanitize before entering the waiting area. Patients should be wearing a mask in the waiting area maintaining social distancing. Booked appointments should be implemented.	Extraoral dental radiographies Rubber dams are recommended Use of anti-retraction handpiece Avoiding aerosol producing dental procedures	Frequent disinfection of clinical settings Double-layered yellow color medical waste bags Should be used.
KhawerAyub et al. 2020 [16]	Surgery rooms should be allowed to be vacant after a procedure for 20 minutes in case of negative pressure rooms and an hour for neutral pressure rooms. Waiting rooms should be sufficiently arranged to provide appropriate spacing between seats Appropriate PPE should be donned by the staff at a separate area before a dental procedure.	Use povidone-iodine (PVP-I) or chlorhexidine for scrubbing lips Hydrogen peroxide (1.5-9%) mouthwash. Disposable instruments should be used more To reduce the spatter or aerosol Rubber dams and high volume saliva ejectors are recommended.	Patients should be guided for further visits and analgesics should be prescribed depending on the patient's condition.
Kumar ChandarSrivastava et al. 2020 [17]	Use of PPEs, disposables, and hand hygiene guidelines for the dental staff. Tele-screening or interview suspected COVID-19 patients before Dental appointment or treatment. Patients with fever should be avoided and referred to COVID hospital.	COVID-19 patients can be treated in well ventilated or a negatively pressured room. DHCPs are encouraged to use only those procedures which involve minimal aerosol productions Extraoral dental radiographies.	Sanitize reusable items. Manage laundry and medical waste according to the routine procedure
MatteoPeditto et al. 2020 [18]	Every patient should be screened. Clinicians should follow the protocol. Masks and shoe covers should be offered to them and temperature should be checked using infrared thermometers.	Rinsing the oral cavity with 1.0 % hydrogen peroxide or 1.0 % povidone iodine, after that 0.2-0.3% chlorhexidine for a minute is recommended to minimize bacterial contamination in aerosol.	Patient should be asked to remove the disposable protective items. Patient should be in the standby area.

			The disposable items should be worn by the patient.
Mohamed Jamal et al. 2020 [19]	Tele-screen patients. Triage room for consultation. DHCP should follow the PPE guidelines of the American Dental Association, Scottish Dental Association.	Rinse mouth with 1.0 % hydrogen peroxide or 1.0 % povidone iodine.	Environmental disinfection should be carried out by following a well-supervised protocol.
Monika Tysiąc-Miśta et al. 2020 [20]	Tele-screen patients. Patients should be provided face masks and they should be asked to disinfect their hands. Non-contact body temperature measurements should be taken from the patients. DHCP should be provided with adequate PPE	Rinse mouth with 1.0 % hydrogen peroxide or 1.0 % povidone iodine.	Environmental disinfection should be carried out in the following order: a) cleaning with disposable wipes, moistening with disinfectant, and b) spraying the surface and wiping it again.
Muhammad Adeel Ahmed et al. 2020 [21]	Tele-screen patients. Use of face mask. Non-contact body temperature measurements should be taken from the patients. DHCP should be provided with adequate PPE.	Rinsing mouth with 1.0 % hydrogen peroxide or 1.0 % povidone iodine is recommended.	Environmental disinfection.
Pedro H. et al. 2020 [22]	Tele-screen patients with a questionnaire to detect possible covid-19 carrier. Patients should get the provision of handwashing and gloves. The dental clinic staff should be provided with PPEs. The body temperature measurement should be taken from the patients and should be referred to the medical evaluation immediately in case of fever	Rinse mouth with 1% hydrogen peroxide or 1% povidone-iodine. Use of high and low-speed instruments should be avoided, if it is needed, it should be used with dykes or rubber sheets. Dental surgeons should perform four-hand procedures with the help of an assistant.	• Disinfection of surfaces before and after dental care.
R. Izetti et al. 2020 [23]	Tele-screen patients with a questionnaire to detect possible COVID-19 carriers. Patients should be suggested to sanitize hands. Regular disinfection of ventilation system and frequent opening of windows are recommended. The dental clinic staffs should be provided with PPEs The body temperature measurement should be taken from the patients by contactless thermometer and treatment should be postponed in case of fever	The dentist should perform hand-washing for at least a minute using 60-85% hydroalcoholic solution before wearing gloves.	All disposable protection should be removed from the patient and a disinfection procedure should be performed. 5 min air change is recommended
Roberto Lo Giudice et al. 2020 [24]	The common room, operational area, non medical furnishings and surfaces accessible to patients should be sanitized regularly. The dental clinic staffs should be provided with PPEs Two meter distance should be maintained between patients in the waiting room. Patient should leave all potentially contaminate objects in the waiting room.	Intra-oral radiological examination should be preferred. The high and low-speed hand pieces should be replaced after each use. The use of 3-way-turbines, dental units are recommended.	Disinfection procedure should be performed A Hydroalcoholic disinfectant with a concentration above 60% is recommended.
SanjeevKhangar et al. 2020 [25]	Patients should be provided with an antimicrobial mouth rinse. Patients with respiratory illness should be isolated in a well-ventilated room. Patients should be suggested to sanitize hands and face masks should be provided to them.	Proper air filters should be there. HEPA filter should be in clinic, fiber glass filters etc. Intra-oral radiological examination should be preferred. The high and low speed handpieces should be replaced after each use	All dental instruments and high-frequency contact surfaces should be disinfected by chlorine. The surfaces which were more prone to get contacted by patients should be disinfected after every 2 hours.
Amber Ather et al. 2020 [26]	Noncontact forehead thermometer should be used to detect temperature. With suspected COVID, must be placed in a well-ventilated room which must be 6 feet away from other patients	Patient should be rinsing mouth with 0.2 % Povidone Iodine or 0.5-1.0 % hydrogen peroxide. Suspected Patients should be treated in Airborne Infection Isolation Rooms.	Disinfection of inanimate surfaces and maintain a dry environment.
C. Prati et al. 2020	Every Patient should wear surgical mask. Triaging patients to detect any history of respiratory or cardio-	Patient's nose should be covered	Equipment should be

[27]	vascular abnormalities Suspected COVID patients should be separated to limit their contact with others Patients should be requested for respiratory hygiene/cough etiquette. Suspected COVID patients should only come to the clinic in case of emergency.	during the procedure Rubber dam should be used to prevent aerosol and droplets.	decontaminated after each procedure.
Catherine MC Volgenant et al. 2020 [28]	Patients should be requested for hand hygiene Dental workers should be provided with adequate PPE. Negative pressured rooms are more preferred to do the dental procedure, if that kind of room is not available, then also a sufficiently ventilated room can dilute the virus load There should be only one patient in the waiting room, if the presence of multiple patients is necessary, then 6 feet distance should be maintained.	Leak-proof rubber dam should be used. Gag reflex procedure of coughing should be avoided.	Decontamination of surfaces by alcohol, hydrogen peroxide, or sodium hypochlorite. Instruments should be sterilized and disinfected.
FlavioFreitas et al. 2020[29]	Air conditioning system should be sanitized frequently. Patients should be reinforced for hand hygiene Dental workers should be provided with adequate PPE. Antimicrobial mouth rinses using 1% hydrogen peroxide and 0.2% depovidone solution.	Rubber dam should be used to prevent aerosol and droplets. High volume saliva ejectors should be used	After the procedure involving the COVID-19 patient, time for air changing in the room should be given. Cleaning and disinfecting the environment should happen after 15 mins of a patient exit the clinic.
Khadijah et al. 2020 [30]	Screening patients for COVID and recording body temperature is recommended. Mouth rinse using 0.12%- 0.2% chlorhexidine gluconate is recommended before the procedure	Rubber dam should be used to prevent aerosol and droplets. Face shield should be used Hand washing according to WHO guidelines (washing hands for 20 secs) is recommended.	Strict surface disinfection procedure should be implicated after each procedure. Medical waste should be disposed of using Double-layer yellow anti-leakage medical waste marked with special tags.
Maryam Bagizadeh Et Al. 2020 [31]	Attempt should be made to allow only one person in the waiting area, if multiple patients arrive, then at least 6 feet distance should be maintained. Air conditioning system should be sanitized frequently. Patients should be reinforced for hand hygiene	Rubber dam should be used to prevent aerosol and droplets. High volume saliva ejectors should be used	After the procedure involving the COVID-19 patient, time for air changing in the room should be given. Cleaning and disinfecting the environment should happen after 15 mins of a patient exit the clinic.
MehranFalahchai et al. 2020 [32]	The waiting rooms for the confirmed or suspected COVID cases should have negative pressure. For multiple patients, at least 6 feet distance should be maintained from each other.	As per WHO, operatory rooms should be negatively pressured with minimum 12 air changes per hour. Hand washing is recommended before a patient examination	Surfaces of the hospital should be disinfected with disinfectants such as sodium hypochlorite. Sterilization of the operating instruments
Zi Yu Ge et al. 2020 [33	Suspected/ confirmed cases should be in the negative pressure room as per WHO. Waiting room should be adequately ventilated. Patients should be guided and instructed to follow hand hygiene and cough etiquette.	Rotary instruments should be avoided during cavity preparation In case of contacting patients' saliva, touching other instruments in the dental office should be avoided.	Patient visit areas should be disinfected.
Xian Peng et al. 2020 [34]	Patients should get the provision of handwashing and gloves The dental clinic staffs should be provided with PPEs The body temperature measurement should be taken from the patients by contact-free forehead thermometer and should be referred to the medical evaluation immediately in case of fever.	Use of high and low-speed instruments should be avoided, if it is needed, it should be used with dykes or rubber sheets. Use of an anti-retraction handpiece is recommended Dental surgeon should perform four hands procedure with the help of assistant	Disinfection of items should be mandatory.

Table 2: The List of Organizations from Where the Guidelines Were Referred in the Selected Studies. [36-44]

Guidelines	ADA	CDC	WHO	NHS	MOH	NHC	CSA	PDA

	Studies										
1	Alessandra Amato et al. 2020	x	x	x			x				
2	Bruno César de Vasconcelos et al. 2020	x		x							
3	Cameron Estrichet al. 2020	x	x								
4	Elmeng et al. 2020		x	x							
5	Gulsumduruk et al. 2020	x	x	x							
6	Khalifa S et al. 2020					x					
7	KhawerAyub et al. 2020			x	x						
8	Kumar ChandarSrivastava et al. 2020		x	x							
9	MatteoPeditto et al. 2020	x		x							
10	Mohamed Jamal et al. 2020	x	x	x							
11	Monika Tysiąc-Miśta et al. 2020			x							X
12	Muhammad Adeel Ahmed et al. 2020		x	x							
13	Pedro H. et al. 2020						x				
14	R. Izetti et al. 2020			x			x				
15	Roberto Lo Giudice et al. 2020			x							
16	SanjeevKhangar et al. 2020			x							
17	Amber Ather et al. 2020	x	x								
18	C. Prati et al. 2020	x									
19	Catherine MC Volgenant et al. 2020		x	x							
20	FlavioFreitas et al. 2020	x	x		x			x			
21	Khadijah et al. 2020			x							
22	Maryam Bagizadeh Et Al. 2020		x	x							
23	MehranFalahchai et al. 2020		x	x							
24	Zi Yu Ge et al. 2020			x							
25	Xian Peng et al. 2020						x				

3.2. Possible risk and transmission

According to WHO (https://www.who.int/news-room/q-a-detail/coronavirus-disease-covid-19-how-is-it-transmitted), COVID-19 is caused by virus SARS-CoV-2 virus, spread from an infected person to a healthy one. It is spread from mouth and nose through small droplets when an infected person cough, sneeze, speak, sing or breadth heavily. The droplet sizes are categorized as respiratory droplets (>5-10 μm diameter) to smaller aerosols (<5μm diameter). COVID -19 happens to a healthy person when physically they are in close contact with the infected person. The virus gets into their mouth, nose, or eyes in the form of aerosol or respiratory droplets. The risk of aerosol transmission is more in a crowded environment, such as bus, train, crowded waiting areas, etc.

In dental settings, there are many aerosol-generating procedures such as the use of ultrasonic and sonic scalars, high-speed dental hand-pieces, air polishers, and air-water syringes [45]. In the waiting areas of dental clinics, if an infected person sneezes, coughs, or touches surfaces like a table, doorknob, or handrails, other people may get infected by touching these surfaces and then touching their eyes, nose, or mouth without sanitizing their hands. Therefore, in Table 3, the key preventive measures are depicted.

Table 3: Overview of Guidelines on Dentistry in COVID 19 [36-44]

Treatment phase	Measures according to renowned organizations	Organization
Prior to dental treatment	Before entering a dental office	
	Delay non-urgent dental and cosmetic services.	ADA, CDC, NHS
	Prevent crowding in a queue by booking appointments.	ADA
	Dental procedures in patients with a history of COVID-19 should be postponed for at least 1 month.	WHO
	High-risk patients like diabetic and immune-compromised patients should be given priority to treat at the early hours of a dental office opening.	NHS
	Use telephone triage, teleconferencing, or Tele-dentistry options is recommended, for non-emergency cases, if possible.	CDC, NHS, ADA
	Ask staff to remain home if they're sick. Actively screen and record the temperature of every staff. Any staff should be sent home if they develop symptoms while at work.	CDC, ADA
	Actively screen and record the temperature of every staff. Any staff should be sent home if they develop symptoms while at work.	CDC, NHS
	At dental office	
	Patients should be actively screened at the time of check-in. Patients with fever should be referred to specific medical centers. If the patient has a fever (temperature < 100.4 °F), but without symptoms of COVID-19, then emergency dental care may be provided.	CDC, MOH
	Body temperature should be recorded by a contact-free thermometer	NHC
	No accompanying individuals should be allowed.	CDC, ADA
	Offer hand washes or hydro-alcoholic solutions (with 60–75% alcohol) for hand disinfection upon entrance to the dental office.	NHS, ADA
	Provide a big room with adequate ventilation in the waiting area. Appropriate zoning and separation measures should be undertaken. Waiting rooms and reception areas should allow for 2-meter separations, ideally marked on chairs and flooring.	NHS
	Remove magazines, reading materials, toys, and other objects that may be touched by others and which are not easily disinfected.	ADA
	Take signature from the patients for instructions on standard recommendations for respiratory hygiene/cough etiquette and social distancing.	ADA
	Provide facemasks or cloth face coverings to everyone entering the dental office	CDC
	Dental professionals should implement PPE (isolated wearing like N-95 masks, Health or FFP2-standard masks, gloves, face shields, goggles, gown, surgical cap, shoe cover)	CDC, NHS, ADA, NHC
	Prepare dental materials and instruments in advance and cover surfaces with disposable protections	NHS
	Materials stored in a refrigerator should be sterilized before and after each treatment	WHO
	Patients should be treated in an isolated and well-ventilated room with negative pressure relative to the surrounding area	CDC

During dental treatment	Hand sanitization should be performed before and after patient's contact, contact with potentially infectious material, before using PPE, and after removing PPE.	CDC
	Alcohol-based hand rub (ABHR) should be used with 60–75% alcohol. If hands are visibly soiled, use soap and water for at least 20 seconds before returning to ABHR.	ADA
	Preoperative antimicrobial mouth rinse like hydrogen peroxide could reduce the number of microbes in the oral cavity. Since SARS-CoV-2 may be sensitive to oxidation, use 1.5% hydrogen peroxide or 0.2% povidone as a pre-procedural mouth rinse.	ADA, NHC
	Rubber dams and high-volume saliva ejectors can help to reduce aerosol or spatter in dental procedures.	NHC, CDC, NHS, ADA
	Use extraoral dental radiographs, such as panoramic radiographs or cone-beam C.T., as required instead of intraoral radiography	ADA, MOH
	If aerosol-generating procedures are needed for emergency care, use 4-handed dentistry; or else avoid the use of aerosol-generating procedures, handpieces/ultrasonic instruments, 3-in-1 syringes, and the air-water syringe whenever possible.	CDC, ADA
	Dental professionals should use resorbable sutures to avoid follow-up appointments.	ADA
	Treatment should be completed in a single visit wherever possible.	NHS
	Environmental cleaning and disinfection procedures should be followed just after completing a session.	CDC
After dental-treatment	Clean reusable PPE with soap and water, or if visibly soiled, clean and disinfect reusable facial protective equipment.	ADA
	All the disposable PPEs should be removed and disposed of using double-layered garbage bags.	MOH
	Manage laundry and medical waste in accordance with routine procedures.	CDC

Abbreviations: World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), National Health Service (NHS), The American Dental Association (ADA), National Health Commission of the People's Republic of China (NHC)
Fig. 1: The text within the figure is Times New Roman, with equivalent height of 10 point, as the caption is. All letters used in the figure are explained in the caption: L = patch length, W = patch width, Cd = cut depth, Cw = cut width, Fl = feed length, Fw = feed width.

4. Discussion

Due to the COVID-19 pandemic, it has been really important for dental professionals to screen the patients prior to treatment telephonically [37] to avoid crowding at the waiting area. There are few more concerns related to the dental procedures which need to be addressed.

4.1. Endodontic and restorative dentistry [46-48]

In case of any emergency treatment, ADA recommends that hand instrumentation and chemo-mechanical caries removal should be used instead of rotary systems whenever possible.
In case of symptomatic irreversible pulpits, pain should be preferably reduced by pulpotomy and pulpectomy or vital pulp therapy instead of conventional root canal therapies. [36]

4.2. Periodontics

Manual scaling and polishing should be preferred over ultrasonic techniques. [49]

4.3. Oral and maxillofacial surgery

For tooth extraction, high-volume salivary ejectors are recommended. In the case of suture, the use of absorbable material is recommended [50]. In case of extensive dental caries and toothache, extraction of pathogenic teeth should be preferred over restorative treatment to reduce treatment time and infection risk [47, 48]. In case of pericoronitis, antibiotic therapy, applying chlorhexidine gel and a mouth wash three times a day are recommended.

4.4. Prosthodontics

Greater disinfection measures of prosthetic materials and impressions are especially recommended to reduce contamination in the lab. Salivary suction is recommended to avoid gag stimulation.

4.5. Oral and maxillofacial radiology

For diagnosis, the use of extra-oral radiographs is preferred over intraoral [36]. Regarding the awareness about COVID-19 among the dental staff, alarming results were found in the study by Khalifa S et al. 2020. About one-third of the dentists reported that either there was no preventive plan, or even if it was there, the dentists were unaware of the specific measures for infection control, patient screening, and dental management in the COVID-19 pandemic [14].
In the study by Kumar Chandan Srivastava et al. 2020, the awareness among the dental staff was found to be directly proportional to their experience and qualification. This finding shows that higher experience and qualifications lead practitioners to follow a rational and evidence-based model to tackle the COVID-19 threat for infection. DHCPs strongly agreed that they must update themselves with the latest information about COVID-19[17].
According to the study Cunningham et al., 2020, some reports demonstrate that patients showed signs of improvement by administering serum of COVID-19 patients having antibodies to SARS-CoV2 from recovered [68]. This supports the hypothesis that vaccination is the most practical approach for preventing COVID-19.

4.6. Findings of previous studies in support of guidelines

Droplets, aerosols, and their significance in the infection transmission: In the study Kutter et al., 2018, it was found that SARS-CoV can spread up to six feet of distance [52].
According to Otter et al., 2013 study on transmission of hospital pathogens, the contaminated surfaces were found as a route of transmission of several nosocomial pathogens [53]. There are several studies like Kramer et al., 2006; Otter et al., 2013, which reported the survival of coronavirus on various surfaces for considerable days, especially when suspended in human secretion[54]. According to Otter et al., 2013, hand contact with contaminated surfaces and subsequently touching the eyes, nose, or mouth results in infection [53].
Droplets and aerosols in dental settings: According to the study by Farah et al. 2019, a high-speed hand-piece in a dental procedure like tooth preparation, oral prophylaxis, and oral surgery, friction between the tooth and the rotating bur results in heat, this could damage the dental tissue. Therefore, water coolant is used to prevent heat generation [55]. However, the water coolant also generates aerosols, and after combining with oral fluids, bio-aerosols are generated, which gets contaminated by bacteria, fungi, and viruses. These contaminated aerosols remain in the air for a considerable amount of time and get inhaled by dentists or patients present there [56][57].
The study Chowell et al., 2015 shows that the transmission of most of the SARS-CoV cases was caused by aerosol-generating procedures, undergone in patients with the respiratory disease [58].

4.7. Special precautions in the dental setting

It is reported that angiotensin-converting enzyme II (ACE2), which is the cell receptor for COVID-19 infection, is highly expressed on the oral cavity mucosa and present abundantly in the epithelial cells of the tongue. This implies that the oral cavity is a potentially high-risk transmitter of COVID-19 infection. This can be considered for preparing preventive strategies for dental settings [59]. According to the study, Atkinson et al., 2009, the ventilation of 60L/s/patient in the waiting area is considered adequate for infection control [60].
Studies like Rabenau et al., 2005 and Fung and Cairn cross, 2006 suggested that during the outburst of SARS, hand washing with soap and hand rubs with 70%–90% alcohol was effective in controlling SARS[61][62].
During dental practices, the microorganisms transmit from the oral cavity towards the dentist's face, particularly in the eyes and around the nose, which are common areas for infection transmission [63] [64]. A meta-analysis Marui et al., 2019, showed that the use of pre-procedural mouth rinse, including chlorhexidine (CHX), cetylpyridinium chloride (CPC), and essential oils, resulted in a mean reduction of 68.4% colony-forming units in dental aerosol [66]. According to the study Harrel and Molinari et al., 2004, if a rubber dam is used, the remaining contamination source would only be the tooth under treatment [67].

5. Limitation

As all the studies included in the analysis belong to 2020, in the COVID-19 pandemic, many rapid steps and strict actions have been taken to control the SARS-CoV transmission. Therefore, the practices adopted by the dental practitioners may have been updated by this time. Due to the absence of literature, no study published in 2021 was found relevant to the topic.

6. Conclusion

The review focused on transmission risks and the available protective protocols in dentistry. Through the research and available literature, it is concluded that the available guidelines will contribute to the prevention of COVID-19 in dental settings to a large extent. Although the dental clinics are adopting standard guidelines to prevent COVID-19 transmission, joint efforts and cooperation of both patients and dental practitioners are needed to make it successful. Therefore, both parties should strictly adhere to their respective recommended guidelines and follow hand hygiene in dental settings.

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