Hilla University College Journal For Medical Science

Volume 1
Issue 1 *Zero Issue*

Article 4

2023

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How to Cite This Article

Sarhan, Abdulridha Taha and Alyassiri, Ali Mihsen (2023) "Prevention of COVID-19 Transmission in Dental Healthcare Settings: A review," *Hilla University College Journal For Medical Science*: Vol. 1: Iss. 1, Article 4.
DOI: https://doi.org/10.62445/2958-4515.1003

ORIGINAL ARTICLE

Hilla Univ Coll J Med Sci

Prevention of COVID-19 Transmission in Dental Healthcare Settings: A review

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Abstract

Dentistry is one of the most exposed professions to respiratory diseases e.g. covid-19 and due to its airborne transmission, aerosols created by dental treatment of infected individuals have become a potential chance of transmission. The aim of this review was to assess the existing infection control measures taken in dental healthcare settings, minimizing treatment mistakes and improving the measures of infection transmission. Literature addressing about the prevention of COVID-19 infection transmission in dental healthcare settings, personal safety and hygiene measures, personal protection equipment, surface asepsis, instrument processing, patient treatment with proper disinfection of the working place and the dental instruments are required against communicable infections, in addition to the management of clinical dental waste. This review article presents various aspects of cross-infection control in dental environment. The dental health care settings are not free from risk. Cross-infection during clinical practice can occur with transmission of infectious agents between patients and health workers in a clinical environment through infected air droplets, blood, saliva and instruments contaminated with secretions. The main concepts and methods have been selected to be considered for the prevention of COVID-19 transmission in dental healthcare settings. Infections could be transmitted in the dental operatory through several routes. A good attitude towards infection control in dentistry was prevailed among patients attending dental healthcare settings. Knowledge and the self-reported practice in dentistry need some improvement about cross-infection.

Keywords: Dental infection prevention, COVID-19 trans

1. Introduction

Cross-infection can be defined as the transmission of infectious agents between patients and staff within a clinical environment [1]. Infection control, which is one of the most discussed topics in dentistry, has become such an integral part of the practice to the extent that dental health workers no longer question its necessity [2]. Recently, the spotlight has been on dental clinics for many reasons, including the receiving quite a few number of patients compared to other specialized clinics [3]. In addition, dental treatment interventions are often surgical interventions such as tooth extraction and dental implants or other face and jaw surgery. This may make dental equipment susceptible to contamination by the saliva and blood of those who are infected, which increases the risk of infection transmission within the clinics [4]. Patient infected with COVID-19 is allowed to transmit their own pathogen to the clinic staff, and the risk is not limited to that, the patient may be a source of transmission to other patients due to the tools used, especially if the tools are not properly cleaned and sterilized [5]. Insufficient cross-contamination control, such as improperly sterilized dental instruments, is also a possible device-borne means of virus transmission [6, 7]. Emanation of the pathogens through the spray of the hand-pieces of the dental unit can also be considered an air-borne means of transmission, which may affect both the patient and the dental team [8, 9]. The aim of this article was to view the preventive measures in oral health care settings during

Received 19 March 2022; accepted 20 July 2022.
Available online 1 January 2023

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https://doi.org/10.62445/2958-4515.1003

Covid-19's spread, based on the information available in the current literature, to be followed to prevent the infection in dental.

Clinics, these fall within seven points: patient medical history, personal protection equipment and disinfection of the working place, chain of infection, transmission of infection, processing and preservation of tools, infection prevention, and disposal of medical waste.

2. Methods

A systematic review was undertaken for global literature addressing about the infection control and prevention of COVID-19 transmission in dental healthcare settings. The search points included: prevention of infection, chain of infection, infection transmission, cross-infection, infection control mechanisms, anti-contamination methods, means of processing treatment tools, storage and preservation of instruments processing, and disposal of medical waste. The review covers researches and studies published about this project in the specialized scientific journals and guidelines from 2019 to 2020. Also, several government agencies and professional organizations have a direct influence on dentistry, infection transmission and control or other health care safety issues. In addition to issuing recommendations and regulations some have regulatory roles and others are advisory. The following agencies and organizations] i.e., Centers for Disease Control and Prevention (CDC) [10], International Association of Dental Research (IADR) [11], Agency for Healthcare Research and Quality (AHRQ) [12], British Dental Association (BDA) [13], World Health Organization (WHO) [14], American Dental Association (ADA) [15], Occupational Safety and Health Administration (OSHA) [16], European Federation of Periodontology (EFP) [17], Australian Department of Health (ADH) [18], Environmental Protection Agency (EPA) [19], Infection Prevention and Control (IPC) [20], European Center for Disease Prevention and Control (ECDC) [21], and health professionals [22], can serve as excellent resources for information on cross-infection, infection transmission, infection prevention, occupational health issues and educational materials. This information is particularly focused on the infection transmission in oral health care settings during Covid-19's spread and on the infection prevention practices.

3. Results and Discussion

All selected publications were further scrutinized for adherence to the following topics: Challenges in dental health care settings during Covid-19's spread, modes of transmission of infection in dental healthcare settings, prevention of Covid-19 infection in dental settings, environmental cleaning and disinfection procedures, waste management in dental healthcare settings, perspectives on procedures for dental practice following crisis of COVID-19, and recommendations for dental care workers to prevent COVID-19 transmission.

4. Topic 1: Challenges in dental health care settings during Covid-19's spread

Dental professionals are not only at high risk for infection but also can become potential carriers of the disease. Hence, it is very important to help dental professionals to minimize the spread of COVID-19. Routine dental procedures are important to overall health especially with the continued spread of the COVID-19 virus [23].

4.1. Procedures and preventative measures

Dental care settings invariably carry the risk of COVID-19 infection due to the specificity of its procedures, which involves face-to-face communication with patients, frequent exposure to saliva, blood, other body fluids, and the handling of sharp instruments [24]. The various strategies and procedures for the prevention of infection of this respiratory pathogen are shown in the following points which must be in place for safe treatment in dental health care settings:

1. Follow standard, contact, and airborne precautions including hand hygiene practice (interim guidance from the ADA and CDC).
2. Consider taking extra-oral radiographs instead of intraoral (e.g. panoramic radiography) to avoid infection.
3. Limit the number of dental healthcare providers (DHCP) present during the procedure to only those essential for patient care and procedure support, also the visitors should be limited to those who are necessary.
4. Use a dental hand-piece with anti-retraction function, four-handed dentistry, high evacuation suction and rubber dams to minimize droplet splatter and aerosol generation.
5. Minimize the use of ultrasonic instruments, high-speed hand pieces, and 3-ways syringes.
6. Perform endodontic procedures with dilute (1%) solutions of sodium hypochlorite to extend supplies without adverse effects on outcomes.

7. Use restorable sutures (i.e. sutures that last 3 to 5 days in the oral cavity) to eliminate the need for a follow up appointment.
8. Disinfect surfaces with approved chemicals and maintain a dry environment.
9. Wear an N95 or equivalent or higher-level respirator such as a disposable filtering face piece respirator, a powered air-purifying respirator, or an elastomeric respirator, protection (e.g. goggles, reusable face shields), gloves and gown.

5. Topic 2: Modes of COVID-19 transmission in dental care settings

Transmission of COVID-19 occurs through the immediate environment around the infected person. The typical routes of transmission include direct transmission (transmission of cough, sneeze, and droplet inhalation) and contact transmission (communication with oral, nasal, ande ye mucous membranes [25]. In addition, studies have shown that potential routes of virus transmission can be happened from person to person through direct or indirect contact, or through coarse or small droplets and can also be transmitted directly or indirectly through saliva [26]. Certain conditions must be met in order for a microbe or infectious disease to be spread from person to person. This process, called the chain of infection [27].

6. Challenges in infection transmission

Dental care settings invariably carry the risk of COVID-19 infection due to the specificity of its procedures, which involves face-to-face communication with patients, frequent exposure to saliva, blood, other body fluids, and the handling of sharp instruments. The pathogenic microorganisms can be transmitted in dental settings by inhaling airborne microorganisms, which can remain suspended in the air for long periods of time [28]. High speed dental headpieces without anti-retraction valves may aspirate and expel the debris and fluids during the dental procedures. More importantly, the microbes, including bacteria and virus, may further contaminate the air and water tubes within the dental unit, and thus can potentially cause cross-infection. Therefore, transmission of the COVID-19 virus can occur by direct contact with infected people and indirect contact with contaminated surfaces in the immediate environment or with objects used on the infected person (Table 1). Airborne transmission is different from droplet transmission as it refers to the presence of microbes within droplet nuclei, which are generally considered to be particles <5μm in diameter, can remain in the air for long periods of time and be transmitted to others over distances greater than 1 m. Droplet transmission occurs when a person is in close contact (within 1 m) with someone who has respiratory symptoms (e.g., coughing or sneezing) and is therefore at risk of having his/her mucosa (mouth and nose) exposed to potentially infectious respiratory droplets [29].

7. Topic 3: Prevention of COVID-19 infection in dental healthcare settings

Standard precautions must be followed by all healthcare workers (HCWs), for all patients and at all times. This comprises broadly of hand hygiene practices, proper donning, doffing and disposal of the personal protective equipment (PPE) and maintaining respiratory hygiene and cough etiquettes [30]. Dental professionals are very familiar with occupational health issues and corresponding risk assessments in order to reduce risk and with applying standard precautions for minimizing spread of infection directly or through cross-contamination.

8. Dental team protection protocol and strategies

Preventing the spread of COVID-19 requires new management strategies that may differ from those used to manage other diseases. COVID-19's incubation period can range from 2–14 days (median, 4 days), while the virus is known to be highly transmissible when patients are most symptomatic, transmission can occur before any symptoms are apparent [31]. Additionally, the majority of people infected with COVID-19 may have no symptoms or symptoms that resemble seasonal allergies or influenza, contributing to a significant number of undiagnosed cases. Hence, even asymptomatic dental patients should be considered as potential carriers and therefore it is recommended to implement a routine screening process for both patients and staff, to ensure that both symptomatic and recently exposed individuals stay home for the safety of all patients and dental team members. Current guidelines recommend that elective care for dental patients with confirmed or suspected COVID-19 be deferred until the patient meets criteria for discontinuation of home isolation [32].

9. Personal protective measures for dental staff

Standard precautions must be followed by all healthcare workers (HCWs), for all patients and at all times. This comprises broadly of hand hygiene practices, proper donning, doffing, disposal of the personal protective equipment (PPE), maintaining respiratory hygiene and cough etiquettes [33]. Hand

Table 1. COVID-19 transmission routes and suggested precautions in the dental settings.

Transmis-sion	Representative example	Suggested precautions
Droplets	Coughing, sneezing, or talking at short distance	Distancing measures (e.g., in waiting room), surgical masks for at-risk patients, PPE for staff
Airborne	Inhaling aerosols from rotary dental instruments and suspended in the air	Reduce aerosol-producing procedures, N95 respirator masks or FFP3 respirator, saliva ejectors, room ventilation
Direct contact	Unprotected touching, contact with oral fluids, secretions, or contact with body lesions	Wear standard PPE, including eyewear or face shields
Contaminated surfaces	Contaminated hands, contaminated needle or other sharp objects, instruments and surfaces not properly cleaned or disinfected	Frequent hand hygiene, thorough disinfection of all surfaces, sterilization of non- disposable instruments

hygiene is recommended with alcohol-based hand rubs (ABHR) or soap and water. Printed posters of both the methods should be pasted near all hand hygiene units. Adequate supply of ABHR (60–80% ethanol is recommended) and antiseptic soap solution (chlorhexidine gluconate 2% and alcohol combination) has been seen to be synergistic [34]. All HCWs involved should have the knowledge of the correct donning and doffing steps, along with appropriate disposal of PPE and be trained in this procedure. Non-powdered latex-free gloves should be used by all HCWs. Eye protection and face shield should be used, gowns should be long sleeved and made of non-absorbable (fluid-resistant) materials. The same gown should not be worn for all patients. In case gowns are not available, waterproof aprons should be used. The WHO recommends the use of medical masks (surgical or procedure masks that may be flat or pleated and are affixed with head straps) and particulate respirators. National Institute for occupational safety and health (NIOSH)-certified N95, for contact and airborne precautions as well as aerosol-generating procedures, respectively [14, 16]. PPEs are protective gears that are designed to safeguard the health of workers by minimizing the exposure to a biological agent. Components of PPE are protective goggles or face shield, mask, gloves, coverall/ gowns (with or without aprons), head cover, and shoe cover.

10. Topic 4: Environmental cleaning and disinfection procedures

Dentists or dental managers should ensure that the dental clinic is a safe environment for patients and workers at all times. COVID-19 can survive on surfaces for up to 3 days, hence, door handles, light switches, and other potentially contaminated surfaces can be the vehicle of indirect contact between patients and dental professionals and should be cleaned frequently. Guidelines have been published and constantly updated by the CDC as well as by local institutions across the world [35]. In general, routine cleaning and disinfection procedures are appropriate for COVID-19 in healthcare settings, including those patient care areas in which aerosol-generating procedures are performed (Table 2). The CDC proposes the use of standard cleaners and water to pre-clean surfaces prior to applying an US Environmental Protection Agency (EPA) - registered, hospital-grade disinfectant to frequently touched surfaces or objects. EPA-registered disinfectants that have qualified under EPA's emerging viral pathogens program for use against COVID-19 has been published [17] and include hydrogen peroxide, quaternary ammonium, sodium hypochlorite, and ethanol at various formulation types and contact times. Infection may also occur through the immediate environment around the infected person. Therefore, infection of the COVID-19 virus can occur by direct contact with infected people and indirect contact with surfaces in the immediate environment or with objects used on the infected person [36].

Table 2. Suggestions for routine environmental cleaning of dental clinic.

Items	Procedure
Door handles tabletops, light switches, chairs	Should be cleaned frequently as much as possible during the day Detergent solution can be used, detergent-impregnated wipes may be used
Floors, ceilings, walls, blinds	Should be cleaned daily. Detergent solution/ wipes are adequate, damp mopping preferable to dry mopping. Window curtains should be regularly changed in addition to being cleaned. Sinks and basins should be cleaned frequently

11. Disinfection of the clinical settings

There are certain environmental cleaning procedures one needs to keep in mind. Dusting should be avoided, floors should not be carpeted and rooms should not have upholstery [37]. For environmental

Table 3. Healthcare waste categories, packaging color code and international hazard labels.

Waste category	Color code	International hazard label
Human anatomical	Red	Infectious hazard label
Infectious human anatomical waste	Red	Infectious hazard label
Infectious animal anatomical waste	Orange	Infectious hazard label
Sharps	Red/Yellow	Infectious hazard label and the words "DANGER - CONTAMI-"NATED SHARPS
Pharmaceutical and chemical waste	Dark green	Appropriate hazard label for toxic substances complying with SANS 10228
Radioactive waste	No color	Appropriate radiation hazard label
Healthcare general waste		No hazard label

cleaning of areas needing airborne precautions, high touch surfaces should be cleaned every day, and as needed, while low touch surfaces can be cleaned as in the following basis:

1. The clinic settings should be cleaned and disinfected in accordance with the standard protocol.
2. To disinfect surfaces use products meeting EPA's criteria for use against SARS-CoV-2, which is are appropriate for the surfaces.
3. Dental OPDs should be cleaned and disinfect according to OSHA guidelines as these procedures are adequate against SARS-CoV-2.
4. Dental operatories and high level isolation rooms where AGPs are performed on COVID or Non-COVID patients can also be cleaned and disinfected using OSHA guidelines [16].

Primary focus should remain in adherence to required PPE and additional entry/exit procedures. For undertaking droplet and/or contact precautions, cleaning may be done twice a day, or as needed, for high touch surfaces, with a focus on all surfaces within the patient zone, noncritical patient care equipment, and any surface visibly soiled with blood or body fluids [38]. PPEs are protective gears that are designed to safeguard the health of workers by minimizing the exposure to a biological agent. Components of PPE are protective goggles or face shield, mask, gloves, coverall/gowns (with or without aprons), head cover, and shoe cover [39].

12. Topic 5: Waste management in dental healthcare settings

The hazardous dental waste defines by the Waste Act as the materials that contains organic or inorganic elements or compounds that may, owing to their inherent physical, chemical or toxicological characteristics have a detrimental impact on health and the environment. All disposable protective wear as well as the medical wastes like blood / fluids have to be packed into double-layers yellow and redcolored medical waste bags, with "gooseneck" ligation should be used and disposed of and labeled as "COVID-19 Waste" (Table 3) [40].

13. Types of dental wastes

Healthcare waste consists of both health care general waste (HCGW) and healthcare risk waste (HCRW). HCGW is that portion of waste that poses a minimum degree of risk to human health and the environment, i.e. from administrative and housekeeping activities, for example, paper, pens, plastics etc. HCRW is that portion of healthcare waste that is hazardous and which is capable of producing disease or injury and includes the following:

A. Infectious waste that including highly infectious materials.
B. Anatomical with excluding teeth/pathological waste (laboratory waste).
C. Sharps waste.
D. Pharmaceutical waste.
E. Radioactive waste.
F. Cytotoxic/genotoxic waste.
G. Sanitary waste.

Historically, incineration was the only method for treating HCRW. Due to global pressure against incineration it was phased out in 2003 because of the alternative technology and current healthcare waste management (HCWM) includes a system of containers and equipment used for the segregation and containment of HCRW at source until it is finally treated and disposed of.

All disposable protective wear as well as the medical wastes like blood/fluids have to be packed into double-layer yellow colored medical waste bags, with "gooseneck" ligation should be used and disposed of and labeled as "COVID-19 Waste". There is no doubt of the gravity of the horrendous situation arising from the COVID-19 pandemic worldwide, post-pointing elective nonessential procedures are implicated; however, as oral physicians, we still can perform our social and moral responsibility toward our needy patients in these tough times thwarting the newer challenges we face [34].

14. Management of clinical dental waste

Dental clinical waste should be managed according to CDC infection control guidelines along with special precautions for COVID-19 as following:

1. The waste (including disposable protective equipment after use) should be transported to the storage area timely.
2. The reusable instruments and items should be pre-treated, cleaned, sterilized, and properly stored in accordance with the guidelines. Better to be done at central sterilization department.
3. Clinical dental waste generated by the treatment of patients with suspected or confirmed COVID-19 infection and/or contaminated with body secretions and blood are regarded as "infectious medical waste".
4. Double-layer medical waste package bags and "gooseneck" ligation should be used.
5. Package bags should be marked and their disposal should be performed according to the requirement for the management of waste.

15. Topic 6: Perspectives on procedures for dental practice following crisis of COVID-19

It was expected some professional changes in the dental following the epidemic, in particular regarding PPE and dental office set-up in terms of schedule and preparation for treatment [41, 42]. While measures are being put into place by dentists in how they respond to this pandemic, based on ADA and CDC recommendations and those presented by WHO, dental offices are getting creative in how they still see their patients. However, It is very important to adopt the following policies that have being put into place by dental offices which keep patients and dental staff safe, such as:

1. **No waiting rooms.** Your dental office has likely already closed their waiting areas. Instead, when you arrive at the dentist, you are taken straight back to a treatment room.
   This is why it's very important to call ahead before your appointment to understand what protocols they have in place. This means toys and magazines will also be removed and your wait times should be less.
2. **Treatment and checkout take place in the treatment room.** Dental offices are trying to minimize movement and contamination in their office so everything will be brought directly to you at your dental visit.
3. **No-touch door handles.** Some dental offices are even installing foot handles on their front doors so you don't even need to touch the handle to the door when you arrive.
4. **Sanitation teams.** Dental offices are already very sanitary. They consistently wipe down areas and use gloves when they are working on your dental treatment, but they are increasing these efforts even more in light of the COVID-19 outbreak.
5. **Patient screenings.** Your dentist will likely ask you a few questions before your visit about where you have traveled or if you know anyone who has tested positive for COVID-19. If you have been exposed to the virus and have an immediate dental need, don't let that keep you from calling your dental office to find out what you need to do.

16. Topic 7: Recommendations for dental care workers to prevent COVID-19 transmission

Routine dental procedures are important to overall health. But with the continued spread of the COVID-19 virus, the novel coronavirus, the American Dental Association is recommending postponing elective dental procedures.

The CDC also recognizes that existing and future local or state government mandates supersede CDC recommendations [43]. In addition, state dental associations may best understand local challenges being faced and make recommendations appropriate to members in their areas. The PPE required to reduce the risk of transmission during dental treatment to its lowest levels are scarce. Asymptomatic patients cannot be assumed to be COVID-19 free. Unless point of care tests is readily available to the dental practice, no one can be assured that they are treating a non-infected individual [44–46]. The safety of their patients, staff and themselves should be foremost when dentists exercise their professional judgment, and information regarding the relative risks is available, therefore the following recommendations are requested to apply:

1. Consider extending operational hours or reducing the number of appointments to minimize the number of patients in the clinic at the same time.
2. Patients have to limit the number of visitors that accompany them to their dental appointment.
3. Advise patients and anyone accompanying them to wear cloth face coverings when entering the facility and at all times other than when undergoing treatment.
4. Isolate patients with suspected or confirmed COVID-19 to prevent the transmission of disease to other individuals.

5. Restrict the number of personnel entering the patient treatment area.
6. Minimize aerosol-generating procedures and take all appropriate precautions to protect workers. Avoid aerosolgenerating procedures altogether if appropriate precautions are not available.
7. Minimize the number of staff present when performing aerosol-generating procedures. When performing necessary aerosol-generating procedures.
8. Increase the frequency of room and equipment cleaning and disinfection, at a minimum, ensure rooms and equipment are cleaned in between patients.
9. If aerosol-generating procedures are necessary for dental care, use high evacuation suction and dental dams to minimize droplet spatter and aerosols.
10. Workers should avoid touching their faces, including their eyes, noses, and mouths, particularly until after they have thoroughly washed their hands after completing work and/or removing PPE.
11. Train and retrain workers on how to follow established health and safety protocols.
12. Perform as many tasks as possible in areas away from patients and individuals accompanying patients.
13. Minimize using, or do not use, dental hand pieces and air-water syringes. The use of ultrasonic scalers is not recommended during this time. Prioritize minimally invasive/a traumatic restorative techniques (hand instruments only).
14. When performing dental care, workers should follow all appropriate precautions for dentistry and healthcare workers, as well as ensuring appropriate blood-borne pathogen standards are followed when encountering saliva and blood.
15. Dentistry employers and dentistry workers must provide and use proper PPE when exposed to potential sources of in the workplace.

17. Conclusion

As a result, the whole dental teams should be careful and keeping patients and themselves in a safe environment by adopting the information in guidelines mentioned in this study. All members of the dental team have a professional responsibility to keep themselves informed of current guidance and be vigilant in updating themselves as recommendations are changing so quickly. For emergency clinical care of patients with known or suspected COVID-19, dental providers should follow the Interim Infection Prevention and Control Guidance for Dental Settings during the COVID-19 response. Infections could be transmitted in the dental operatory through several routes. Knowledge and the self-reported practice in dentistry need some improvement about cross infection. While, the available evidence, including the recent publications mentioned above, WHO continues to recommend droplet and contact precautions for those people caring for COVID-19 patients.

Acknowledgment

There is no acknowledgment.

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