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INFECTION CONTROL IN DENTISTRY

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Infection control in dentistry

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ABSTRACT

In a dental clinic setting, patients' saliva mixed with crevicular fluid, oral deposits, blood, and pus is often splattered and aerosolized. These aerosolized and splattered materials often contain potentially infectious microbes and they cause transmissible diseases. Thus, during dental treatment, both patients and dental health care personnel (DHCP) may be exposed to potentially infectious agents through contact with blood, oral and respiratory secretions, and contaminated instruments and equipment. This paper reviewed some previously published materials and synthesized an up-to-date knowledge status on infection control in dentistry. It also clarified the significance of infection control in the prevention and control of healthcare-associated infections (HAIs) in dental practice. The authors carried out a narrative review of the current status of infection control in dentistry. The process of writing took place over one month, between July 20 and August 20, 2021. During this review, the authors sought relevant works online. They conducted the online literature search using various databases like PubMed, Z-library, Medline, JSTOR, EBSCOhost, and Google scholar and obtained textbooks and articles published in different journals. Google and Edge search engines were used to find the required literature. The authors used keywords such as 'infection control', 'infection control in dentistry', 'infection control measures', 'infection control in dental practice', 'precautionary measures in infection control', etc. The authors extracted and documented vital information from the different original articles, textbooks, and paper reviews based on the objectives of this review. Inclusion criteria in the study were bibliographic reviews, systematic reviews, meta-analyses, randomized controlled trials, cohort studies, case reports, and studies in English on the subject matter. The authors excluded articles that were unrelated to the topic, whose full-texts were not available, and that were not in the English Language. The study showed that infection control increases the incidence of successful dental treatment. Also, following the laid down standard precautions and treating all patients as being potentially infectious are the main infection control practices in dentistry.

Keywords: *Infection control, cross-infection, cross-contamination, standard precaution, dentistry*

INTRODUCTION

The significance of infection prevention and control (IPC) in medical practice was first established around 1847 by a Hungarian physician, Ignaz Semmelweis. He demonstrated that doctors were causing the deaths of patients by not washing their hands before patients' examinations (Yadav et al., 2017; Fulford & Stankiewicz, 2020). However, it was not until the realization of the risks associated with the Hepatitis B Virus (HBV) in the 1970s and the Human Immunodeficiency Virus (HIV) in the 1980s that the dental profession accepted the basics of infection control wholeheartedly (Whitworth & Palmer, 2010). Sunley et al. (2020) opined that consistent and dutiful adherence to the principles and practices of infection control is critical to reducing the transmission of infections

from one person to another, such as from a health worker to a patient or vice versa.

Sharma et al. (2018) and World Health Organization [WHO] (2019) explained that IPC includes the scientific approach besides all the practical steps and measures undertaken to prevent and contain the spread of communicable diseases. Dental Health Care Personnel (DHCP) as well as patients are exposed to a wide range of potentially infectious microorganisms in the clinical working environment and hence are at high risk of acquiring nosocomial infections (better referred to as healthcare-associated infections) via cross-infection (Pankhurst & Coulter, 2017). The Hong Kong Department of Health [HDH] (2021) noted that the unique nature of dental procedures and patient care settings require specific strategies and protocols. These strategies would help prevent the transmission of disease-causing agents (such as bacteria, viruses, protozoans, and fungi) among DHCP and their patients.

Although Volgenant et al. (2021) maintained that it is impossible to eliminate all risks, these strategies and protocols will reduce the risk of cross-infection, thereby ensuring a safe environment for both patients and staff (Pankhurst & Coulter, 2017). Centers for Disease Control and Prevention [CDC] (2016) noted that transmission of infectious agents among patients and DHCP is rare. However, Upendran et al. (2020) cautioned that dental patients are high-risk patients because they can acquire and transmit infectious diseases. Although the basic principles of infection control have remained almost unchanged, the World Dental Federation [FDI] (2020) explained that the advent of new technologies, materials, equipment, and updated data requires a constant appraisal of current infection control practices. Also, continuing education in infection control practices is essential for the oral health team. This appraisal is necessary because of the increased incidence of communicable diseases (Sharma et al., 2018). The recent outbreak of the COVID-19 pandemic is also a new challenge in modern dentistry that requires new guidelines to avoid contagion (Villani et al., 2020).

Due to the intricate nature of dental procedures, which includes face-to-face communication with patients, frequent contact with saliva, blood, and other body fluids, and the handling of sharp instruments, dental care settings carry a significant risk of infection transmission (Peng et al., 2020). There are many transmission routes of microorganisms in a dental office. These include via inhalation of airborne microorganisms that can remain suspended in the air for long periods; through direct contact with blood, oral fluids, or other patient materials, contact of oral and nasal mucosa or conjunctiva with aerosols- and droplets-containing microbes generated from an infected individual and moved a short distance by talking or coughing, and indirect contact with contaminated instruments or environmental surfaces. Thus, the universal standard precaution is to assume that all patients are carriers of infectious agents. DHCP also are expected to adhere to all the required precautionary measures (Wei & Li, 2016; Kampf et al., 2020).

Purpose of the Study

Part of the duties of DHCP is to keep their knowledge and skills updated about the diagnosis and management of infectious diseases in the clinical setting. They are required to observe all the laid down standard precautions that are provided by the relevant authorities and thus, take proper measures to ensure the safety of their patients and themselves against infectious diseases (FDI, 2017). This paper was aimed at appraising previously published works on infection control. It synthesized and provided up-to-date knowledge on infection control measures in dentistry. This paper also elucidates the significance of infection control in preventing and containing the spread of HAIs in dental practice.

REVIEW PARAMETERS

The authors carried out a narrative review to study the current status of infection control in dentistry. The process of writing took place over one month, between July 20 and August 20, 2021. During this literature review, the authors sought relevant works online. They conducted the online

literature search using various databases like PubMed, Z-library, Medline, JSTOR, EBSCOhost, and Google scholar. They obtained textbooks and articles published in different journals. The authors used keywords such as *'infection control'*, *'infection control in dentistry'*, *'infection control measures'*, *'infection control in dental practice'*, *'precautionary measures in infection control'*, and so on. The authors extracted and documented vital information from the different original articles, textbooks, and papers reviewed based on the objectives of this work. Inclusion criteria were bibliographic reviews, systematic reviews, meta-analyses, randomized controlled trials, cohort studies, case reports, and studies in English. The authors excluded articles that were unrelated to the topic, whose full-text was not available, and that were not written in the English Language.

CONCEPT OF INFECTION CONTROL IN DENTAL PRACTICE

It is morally obligatory for all health care workers to follow infection control principles and measures. The importance of infection control in dental practice cannot be over-emphasized because DHCP and dental patients are at high risk of exposure to infectious diseases (Patel, 2020). Additionally, Ge et al. (2020) pointed out that the emergence of COVID-19 has brought new challenges and responsibilities to DHCP. Infection control in dental practice is more of a practical approach than an academic analysis aimed at risks assessment and includes the adherence to precautionary measures aimed at preventing and containing the spread of infectious disease agents during dental procedures (Volgenant & de Soet, 2018).

The initial aim of infection control guidelines in dental health care was to prevent the transmission of blood-borne diseases (Kohn et al., 2003). However, the production of aerosols during most treatment procedures has been observed. Aerosols are liquid or suspended solid particles in the air, which have the potential to transmit microbes (Zemouri et al., 2017). Although aerosol production during dental treatments provides a significant risk of infection transmission in dental health care, most patients are considered healthy, so less strict aerosol precautions are taken in comparison with general healthcare settings (Siegel et al., 2007). Consequently, the provision of dental health care has always been in such a way that it has a limited effect on feasibility and costs. Presently, the general guidelines in dental health care strive for optimal and practicable rather than maximal precautions (Volgenant et al., 2021).

DISEASE TRANSMISSION AND INFECTION RISK IN DENTAL HEALTH CARE

For a microorganism to establish itself and cause an infection, it must attach to or penetrate the surfaces of the body. This association between microbes and human cells is specific and has evolved over thousands of years. Hence, many species of bacteria which colonize the mouth and oral tissues are not found anywhere else in the human body or at any other site in the biosphere (Pankhurst & Coulter, 2017).

Most of the microbes do not cause infection in humans. Resident microbes on the skin, in the gastrointestinal tract, or the mouth may be essential for health. These bacteria have a harmonious co-existence with the body. They protect the body by competing with other more harmful bacteria and thus prevent colonization. A typical example of this kind of interaction between the body and microbes is seen in dental plaque. *Streptococcus sanguinis* and the cariogenic mutans streptococci compete for colonization of the infant's mouth. The presence of *S. sanguinis* can delay the colonization of the mouth by mutans streptococci with a subsequent reduction in the rate of dental caries. However, some microbes which do not cause disease in healthy people can cause infection if the host's immune system is compromised. These are known opportunistic pathogens. Dental clinicians must be cautious when clerking patients to obtain information about conditions or drugs which may compromise the patient's immunity. A compromised immunity makes patients more susceptible to infection. Clinicians must take appropriate measures to protect these vulnerable patients (Pankhurst & Coulter, 2017).

Lo Giudice (2020) noted that biological risk is an inherent threat in dental practice, to which patients and DHCP may be exposed. Medical activities carried out in dental practice always pose the risks of potential transmission of an infectious biological agent. So, clinicians must refer to procedures for the assessment and prevention of these infectious agents. It is important to note that the routine infection control procedures currently being practiced have not been specifically designed for the prevention of pathogens transmissible by aerosol which is a common means of SARS-CoV-2 transmission. So, there are presently no precise guidelines for the protection of DHCP against the novel coronavirus disease (WHO, 2020). Due to the transmission route of COVID-19, it is worthwhile to include further airborne and contact precautions to the routine standard hygienic procedures to reduce the risk of transmission (Spagnuolo et al., 2020).

ROUTES OF INFECTION TRANSMISSION IN DENTAL PRACTICE

The general routes for transmission of microbial agents in dental practice according to Bednarsh and Molinari (2010), and confirmed by Paramashivaiah et al. (2016), and Upendran et al. (2020), are

a) the direct contact with infectious lesions, or infected saliva, or blood, or other infected materials;

b) the indirect contact with contaminated objects, such as instruments, environmental surfaces, or equipment;

c) inhalation of airborne microorganisms that can remain suspended as aerosols in the air for long periods;

d) and contact of conjunctival, nasal, or oral mucosa with droplets such as spatter of blood, saliva, or nasopharyngeal secretions containing microbes from an infected person spread by coughing, sneezing, or talking.

In dental practice, infection transmission pathways are described as "horizontal". It can be from patient to operator, from operator to patient, and from patient to patient (Smith & Smith, 2014).

BREAKING THE CHAIN OF INFECTION

For pathogens to thrive, they must have a means of transmission from host to host. If they do not find new hosts, they would eventually disappear. If pathogens are uncontrolled, dental clinics present fertile environments for cross-infection (Pankhurst & Coulter, 2017). The HDH (2021) noted that before infections spread, three criteria must be satisfied:

a) the presence of a susceptible host;

b) the presence of pathogenic microorganisms; and

c) an accessible portal of entry via which the organisms invade and colonize the susceptible host.

Elimination of any one of these requisites will prevent the transmission of an infectious disease. Thus, the goal of infection control is to eliminate one, two, or all of these criteria. Although it is difficult to avoid exposure to microorganisms, exposure does not suggest the transmission of infection. Exposure to microbes will not cause disease unless the three hitherto mentioned criteria are present (Pankhurst & Coulter, 2017).

For patient-to-operator and operator-to-patient cross-infection to be prevented, DHCP must utilize physical barriers such as personal protective equipment (PPE; like gloves, masks, safety goggles, gowns, aprons, etc.). Transmission from patients to patients should be prevented through cleaning, disinfection, and sterilization procedures (Verbeek et al., 2020).

COMMON INFECTIOUS DISEASES OF CONCERN TO DENTAL PRACTITIONERS

The main infections that can be contracted in a dental setting are caused by bacteria such as *Staphylococcus aureus, Pseudomonas aeruginosa, Streptococcus pyogenes, Streptococcus pneumoniae, Clostridium tetani, Legionella*, (Laneve et al., 2019). Wood et al. (2015) added that mycobacteria such as *Mycobacterium tuberculosis*; fungi like *Candida albicans*; and viruses such as HIV, hepatitis A, B,

C, D, E, and G virus, (HAV, HBV, HCV, HDV, HEV, and HGV) are of major concern in dental practice. Other important infectious agents are herpes types 1 and 2 (HSV1/2), measles virus, mononucleosis (Epstein-Barr), varicella-zoster, rubella, mumps, influenza, diphtheria, SARS, and prions (Lo Muzio et al., 2013; D'Affronte & Platia, 2020). These microbial infectious agents are domiciled in the oral cavity as well as the respiratory tract. They can gain access to the blood and saliva and can then be transmitted via aerosol generated during dental procedures or via coughing, sneezing, and talking (Leggat & Kedjarune, 2011).

UNIVERSAL PRECAUTIONS VERSUS STANDARD PRECAUTIONS IN INFECTION CONTROL

Universal precautions were a set of practices and procedures based on the concept that all blood and all body fluids might be contaminated and should be treated as infectious (Bednarsh & Molinari, 2010). Because patients with blood-borne infections can be asymptomatic or unaware they are infected, the concept of universal precautions was expanded and the term was changed to standard precautions in 1996 by the CDC (O'Donnell et al., 2006). Anagnostopoulos-King and Rodriguez (2020) explained that standard precautions are basic processes of infection control to minimize the risk of transmission of infection. They are the least infection prevention practices that apply to all patient care, irrespective of the health status of the patient.

Standard precautions integrate and develop the basics of universal precautions into a standard of care to ensure that healthcare professionals and patients are protected from pathogens that are transmissible by blood, and other body fluids, excretions, and all secretions excluding sweat (Schneider & Leventer, 2020). The pathogens include but are not limited to cytomegalovirus (CMV), hepatitis virus, and herpes virus. The expansion of these standards also addressed the spread of diseases via airborne transmission, i.e., tuberculosis, influenza, and varicella (Cleveland et al. 2016).

The major elements of standard precautions according to Bednarsh et al. (2010) include

1. hand washing
2. use of personal protective wears such as hand gloves, face masks, eye shields, and gowns
3. aseptic management of patient-care equipment
4. environmental infection control
5. injury prevention and management
6. respiratory hygiene/cough etiquette
7. safe injection practices.

INFECTION CONTROL MEASURES IN DENTISTRY

Different countries use various terms for dental infection control measures. For instance, in Greece, they are called "Basic Measures", in Canada "Routine Practices" and "Principles of Infection Prevention Control", in India "Standard Precautions in Dental Infection Control and Safety", in Japan "Sterilization Service Guidelines", and in Brazil "Infection Control Recommendations". Nonetheless, these terms generally refer to the same basic protocols (Anagnostopoulos-King & Rodriguez, 2020).

The CDC first published infection control recommendations for dentistry in 1986 which were updated in 2003. Although these recommendations have been widely circulated, compliance with recognized infection control principles is irregular in developed and developing countries (Anders et al., 2016). Scarlett and Grant (2015) noted that untrained practitioners provide oral care healthcare services in facilities that do not meet infection control protocols and these create ethical dilemmas since there is a shortage of dental healthcare professionals worldwide. In dental practice, the prevention, control, and reduction of infection transmission risk commonly take place through:

i. Immunization of health care workers
ii. Evaluation of the patients

iii. Personal protection
iv. Sterilization
v. Disinfection
vi. Laboratory asepsis
vii. Waste management
viii. Spillage management
ix. Precaution in dental radiology

INFECTION CONTROL MEASURES IN THE CONTEXT OF THE COVID-19 PANDEMIC

Dental healthcare workers are among the most exposed professionals to COVID-19 infection. Therefore, to abate COVID-19 transmission, it is essential to establish a clinical procedure in the working environment. The rapid spread of SARS-CoV-2 has shown the need to modify preventive and therapeutic protocols in dental practice (Gamio, 2020). So, where urgent treatment is required on a confirmed or suspected COVID-19 patient, the patient should be treated in a public hospital by suitably trained and equipped healthcare personnel. It is obligatory to schedule the appointment towards the end of the day (Amato et al., 2020).

When visiting the dental clinic, patients should not be accompanied unless it is necessary and they must always wear surgical masks. DHCP must communicate these instructions to the patient via a detailed recommendation provided during the appointment scheduling. Once the patient enters, an operator kitted with gloves, a filtering facepiece particles-2 (FFP2) respirator, visor face shield, and a protective gown will determine the patient's body temperature using an infrared thermometer. The operator should avoid making contact with the patient's body surfaces. If the patient's body temperature is over 37.3^0C, it is advisable to reschedule the appointment, especially in the case of non-urgent care.

The patient should leave any materials brought to the clinic in specifically organized boxes or spaces. The patient must sanitize their hands with a hydroalcoholic solution. The patient is equipped with appropriate PPE such as goggles, disposable shoe covers, a gown, headgear, and a surgical mask which must be worn until the end of the clinical procedure. The patient must then remain seated in the waiting room until they are called to enter the clinical area (Amato et al., 2020).

The primary route of SARS-CoV-2 transmission among people is through respiratory droplets. Thus, it is mandatory to fix appointments in such a way as to ensure that the number of patients in the waiting room allows a social distance of at least 2 meters (Liu et al., 2020). The estimated time of any procedure should exceed at least 30 minutes. This is to avoid a large number of patients sharing the waiting room. Elderly patients and those with multiple chronic systemic diseases are more susceptible to COVID-19 infection. Consequently, it is better to fix their appointment at the beginning of the working day (Cascella et al., 2020). SARS-CoV-2 could survive on paper and cardboard for up to 48 hours. So, ornaments, magazines, newspapers, and posters must be removed from the waiting room to enhance cleanliness. If there are desks at the reception, plexiglass separators should be placed to protect the staff from droplets. The receptionist must wear a surgical mask and disposable gloves, which must be replaced after each patient (van Doremalen et al., 2020).

All DHCP must measure their body temperature daily, at least in the morning and in the evening. If the body temperature exceeds 37.0^0C, the operator must not go to work, and sanitary observation should be activated. DHCP must enter the dental clinic wearing surgical masks. They must then put on shoe covers and clean their hands with a disinfectant hydroalcoholic solution or use running water and soap for at least 1 minute. Each staff must leave their clothing and other personal items in their lockers (in a personalized locker room) and wear washable clothing and footwear. After the procedure, they must sanitize their hands again with a hydroalcoholic solution. All DHCP must maintain social distancing of at least 1.5 m from one another and always wear a surgical mask. They must avoid staying in common eating and

relaxation areas at the same time unless it is necessary (Amato et al., 2020).

The patient, hitherto donned with appropriate PPE, is seated on the dental chair unit which has been earlier prepared with a detachable or disposable barrier to protect its non-sterilizable parts. Before the commencement of the clinical intervention, patients must remove their surgical masks and wear them again at the end. A clinical study conducted by researchers showed a consistent detection of SARS-Cov-2 in the saliva of 92% (11 of 12) of analyzed patients (To et al., 2020). Therefore, to reduce the presence of the viruses in the saliva, the use of mouthwash with 1% hydrogen peroxide-based solutions to rinse for at least 30 seconds has been advised. Nonetheless, it is important to note that although the SARS-Cov-2 has shown a strong sensitivity to oxidizing agents in vitro, no test has been performed to ascertain their efficacy in vivo. Also, the possible side effects of using these substances as mouthwash have not been established (Lo Giudice, 2020). Oral rinses with mouthwashes containing chlorhexidine are not effective for SARS-CoV-2 (Peng et al., 2020).

During clinical procedures, it is highly recommended that the rubber dam be used to limit the spread of aerosols and potentially infected biological material. A study by Samaranayake et al. (1989) cited by Amato et al. (2020) showed that the use of rubber dams significantly reduces airborne particles by 70% within 1 meter of the operating range. The entrance to the surgery must remain shut throughout the treatment period to avoid the dispersion of aerosol to the environment (Amato et al., 2020). Generally, social distancing, correct behavioral rules, adequate ventilation of all the dental clinic rooms, validated instrument sterilization, and surface sanitizing protocols can reduce the risk of SARS-CoV-2 transmission. Patients should be screened carefully before entering the dental clinic. As knowledge about coronavirus disease continues to improve, more effective and perhaps more simplistic preventive strategies will be developed (Amato et al., 2020).

SIGNIFICANCE OF INFECTION CONTROL IN DENTAL PRACTICE

Apart from the prevention of cross-contamination and cross-infection, infection control increases the incidence of successful dental treatment (Singh, 2020). Thus, the importance of infection control cannot be over-emphasized. Highly resistant organisms are now on the increase and are the cause of HAIs. In the USA, an estimated 1.7 million cases of HAIs occur yearly contributing to the death of almost 100,000 patients. HAIs have become a leading cause of death in the USA and kill more people each year than AIDS, breast cancer, and auto accidents combined. An estimated 5–10% of hospitalized patients in the developed world acquires HAIs. However, the rates of HAIs are much higher in underdeveloped countries. Most of these HAIs are preventable. Irrespective of where dental care is rendered, DHCP is ethically and legally mandated to ensure the safety of staff and patients (DePaola & Grant, 2020).

CONCLUSION

The incidence of health-associated infections (HAIs) is on the rise. Though preventable, HAIs have emerged to become a major cause of death worldwide with an even greater occurrence in developing countries. This could be attributed to the lack of uniform standard infection control measures as well as irregularities in adherence to the already established practices and protocols.

The provision of dental care by untrained practitioners and the use of facilities that do not meet the infection control protocols have worsened the situation. Infection control has become part of medical and dental care. However, in the face of an outbreak of a highly contagious airborne infection, additional precautionary measures are required. Dental treatments involve a proximity range between patients and clinicians. It also involves the use of high-speed handheld tools, sharp surgical and rotary instruments, and air-water syringes. The use of these instruments produces visible aerosol sprays containing droplets laden with virulent transmissible pathogens. These pathogens arise from a mixture of body fluids — saliva, blood,

gingival crevicular fluids, and other tissue exudates derived from oral deposits. Standard precautions, while beneficial, provide insufficient protection against the highly contagious and rapidly transmissible SARS-CoV-2 virus. Thus, in addition to adequate and proper use of PPE, hand hygiene, disinfection, and proper sterilization, it is highly recommended that a clinical protocol be established and implemented in the working environment.

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