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Decoding Aerosols Transmission: Its Implications and Precautions in Dentistry

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ABSTRACT

Background: Corona virus disease 2019 (COVID-19) emerged in December 2019, according to official reports, several countries have been crippled across globe affecting more than 100.7 million patients and making it a global public threat. Transmission generally occurs through aerosols, direct contact, and droplet. Dental treatment all over the world are significantly impacted due to this pandemic as dental procedure generates aerosol. The Occupational Safety and Health Administration (OSHA) consider dental work place as highly infectious place due to its aerosol generating procedure. Above conditions, lead to stress to all health care system in the world until a herd immunity or vaccine develops. In most developing countries, only emergency dental treatment is advised. Global and Standard Operating Procedures are accepted with personal protective equipment (PPE) and hand hygiene. Additional measures include use of high-volume suction devices, chemotherapeutic agents such as mouth rinse with 0.2% povidone-iodine or 0.5-1% hydrogen peroxide and rubber dam isolation. Regarding dental aerosol, only few reviews are available. This review explains about dental aerosol, its implications and how dental professionals should adapt the preventive measures for protection against infection caused by aerosols.

Keywords: Dental aerosol, Covid-19, Dental Unit Waterlines (DUWLs), Personal Protective equipment (PPE), High Volume Evacuation (HVE).

INTRODUCTION

Aerosols are the particles with the diameter size less than 50µm whereas splatters are the particles with the diameter size larger than 50µm. Micik et all used the word aerosols and splatter first time in dentistry[1-5]. Aerosol can stay in air for longer period before they settle on surface or cause infection. These pathogens can be transmitted to nose, eyes and mouth through hand contamination[6]. By the end of 2019 a new pathogen was identified which causes pneumonia in Wuhan city of China. The pathogen was named as 2019 novel coronavirus and the disease as coronavirus disease 2019[7].

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Aerosol is one of the most common routes of transmission along with droplet and direct contact. Recent studies quote that virulent pathogens like coronavirus can travel up-to six feet into enter respiratory tract or to contaminate surfaces[8]. Dental procedure in routine, generate a lot of aerosol which is responsible for potential risk of infection to dental care personnel and patients. Therefore, it is necessary to understand aerosol transmission and its effect in dentistry. The American dental association (ADA), and Centres for Disease Control and Prevention (CDC), have recommended that in patients with active SARS aerosol producing procedures should be avoided[9]. With this pandemic COVID-19 dental professionals have to face new challenges and responsibilities. Standard precautions could prevent transmission of disease and help to control the spread of Covid-19 and other respiratory diseases from asymptomatic carriers.

Virus Transmission Vs Disease Infection

Corona is a "street" name, SARS-CoV-2 is the virus, COVID-19 is the disease. Generally, these terms are interchanged. Infection with the disease is not only caused by transmission of a virus but they can cause disease with minimal infectious dose which means minimum dose of viral particles that can initiate viral disease[10,11].

Each virus has different infective dose limit depending on immune response and host susceptibility. Severity of disease and the probability of getting infected are dose-dependent[55,56]. Therefore it is mandatory protect mucus membranes: the nose, the mouth and the eyes: the susceptible portals of entry: the SARS-CoV-2 virus[12,13].

Significance of Aerosol in Dental Setting

Airborne transmission possibility of SARS-CoV-2 remains debatable? Few recent studies have shown that they remain in surrounding environment as aerosols for several hours[14,15]. According to World Health Organisation special precautions should be taken for preventing its transmission through aerosols[16].

The three main sources of airborne contamination in dental settings are[17]:

1. Respiratory sources and the operative site
2. Dental instrumentation
3. Saliva

Zemouri et al. 2020 stated that the largest microbiological contamination, via splashes and aerosols occurs within 1m from the oral cavity, in the dental healthcare clinics[18]. It has been found that different types of coronaviruses can be present in aerosols during exhalation[19]. Viral load in saliva and dorsum of the tongue[20] is more in SARS-CoV- 2-positive patient . Aerosols remain in the air after completion of treatment and serves as a medium for transmission of virus through indirect contact[21].Figure 1

Composition of Dental Aerosols

Aerosols contain microorganisms residing in patient's oral cavity and from dental unit waterlines (DUWLs)[22]. Most common species of micro-organism present are Pseudomonas spp. and Legionella pneumophila[22-25] whereas DUWL water harbour high load of Gram-negative bacteria harbours, which may cause respiratory infections when inhaled[23,25,27]. Other microorganisms, such as Micrococcus spp. and Coryne-bacteria, are also present in the form of droplets and droplet nuclei[25,27]. Staphylococcus spp are the most common species present in aerosols around the patient along with 19 bacterial species[27].

M. tuberculosis, can also be present in aerosol which may lead to tuberculosis[28,29].

Zemouri et al. 2020 indicated that if there is good air ventilation and control of microbial contamination of the DUWL are optimal, then transmission of bacteria through aerosols is low[18].

Aerosol Generating Procedures (AGPS)

An aerosol generating procedure (AGP) is an intervention which result in the production of airborne particles or respiratory droplets, which may be pathogenic and also refer to speaking, sneezing, breathing and coughing produced naturally by patient[12]. It should not be presumed that all medical or dental AGPs have the same risk. Furthermore, it is not concluded that generating aerosols will cause infection. Composition of aerosol

differs even amongst aerosol generating medical procedures (AGMPs). It is noticed that number of droplets while coughing is 1000 times more as compared to normal breathing[30].

Aerosol Generating Medical Procedures (AGMPS)

AGMPs can be subjected into two categories:

1. Patient produce aerosols due to procedures
2. Procedures that mechanically create aerosols[31].

Routine healthcare procedures identified as potentially "aerosol-generating procedure" are airway surgeries, intubation and extubation, chest compression, nebulization, oscillatory ventilation, bronchoscopy, sputum induction. High-risk of SARS-CoV-1 transmission are associated generally with these procedures [11,12].

In contrast, AGMPs may result in dispersing of aerosols through interventions such as nebulizer treatment, ventilation or suctioning. Above mentioned procedures are riskier than these procedures[10,31]. A meta- analysis stated that health-care workers are not at risk with nebulizer treatment in the transmission of SARS-CoV-1[32].

Systemic Symptoms of Covid-19 Patients

Covid-19 patients typically report gastrointestinal symptoms including nausea, vomiting, diarrhoea, and abdominal pain during course of the disease. Liver injury in patients with raised enzymes is also reported in blood tests. Intensity of liver injuries mainly depend on severity of Covid-19 disease[33-35].

Aerosol Generating Dental Procedures (AGDPS)

Since last 40 years dental aerosols have been studied. Bacteria and viruses are present in the tissues and fluids of the oral cavity[36,37]. An aerosol of these microbes is created in the oral cavity when it is exposed to instruments such as high-speed handpiece, ultrasonic scaler, air water syringe[38,39]. According to many studies there is 90% reduction in dental aerosol with use of high-volume evacuation (HVE)[40,41].

Many studies were conducted to examine and analyse the infectivity as well as the risk of cross-contamination of dental aerosol in dental settings.

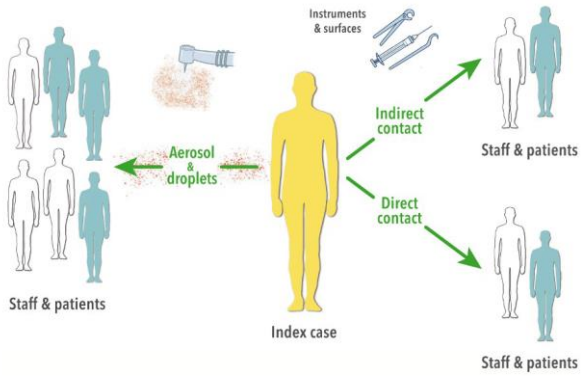

Fig 1: Direct, indirect contact and aerosol leads to transmission of SARS-CoV- 2 virus.

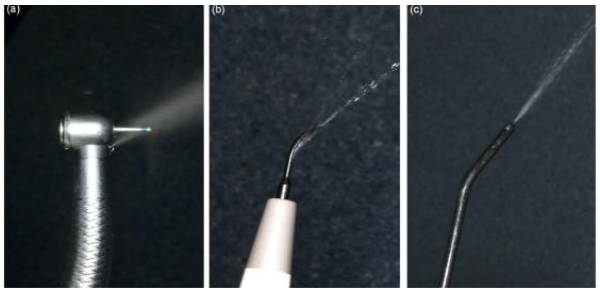

Fig 2: Aerosols generated by dental high-speed handpiece(a), ultrasonic scaler(b), and air water syringes.

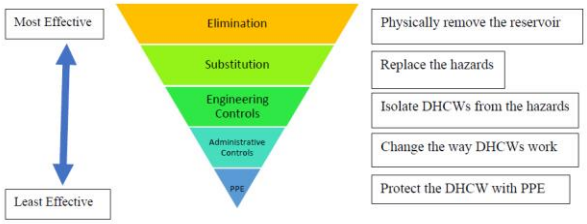

Table 3: Hierarchy of controls in dental health care

Table 4: Components of PPE.

To best of our knowledge if dental health-care workers or patients, follows all standard operating procedures with routine PPE/HVE than there will minimum chance of infection through dental aerosol. Figure 2.

Infection Control Methods for Reducing Airborne Contamination

There is increased interest in expanding infection control measures to the dental laboratory. Concern over possible cross contamination to dental office personnel by micro-organisms, including 2019-nCoV, hepatitis-B virus and human immunodeficiency virus (HIV), through dental treatment has promoted the study of the effect of disinfecting techniques on dental materials[42]. Monaghan, 2016 et al stated that protocols for infection control are modified with the emergence of new infectious disease[43]. Table 1

Elimination of the Reservoir

Guidelines developed by CDC members on infection control should be followed[44]. In most countries SARS-CoV-2 outbreak, led dental health care to provide only emergency care[45]. Elimination of contact with infectious patient should be the priority. Telephonic conversation, email or video conferences practises must be adapted for treatment[46].

- Dentists should take a medical and travel history from each patient. Temperature and lower respiratory tract symptoms should be closely monitored. Signs and symptoms of fever and coughing should be asked. Symptomatic patients are advised for covid testing and should undergo only emergency treatment in a clinic with protective measures.

- Lot finejad et al. stated that most important measures to prevent the spread of infection are hand and surfaces hygiene in society and clinics; this is also applicable to SARS-CoV-2 as well[47].

- 62% alcohol, 0.5% hydrogen peroxide or 1,000 ppm (0.1%) sodium hypochlorite can be used to disinfect surfaces after treatment of patient infected with Covid 19[48].

Engineering Controls: Isolating DHCWS from the hazards

Air gets contaminated in the workspace after procedure that generates aerosol. Proper precaution should be taken to prevent the dispersion of virus in workspace. Cheong & Phua, 2006[49] stated that it is beneficial to work under negative air pressure. It is important to have effective air ventilation in workspace during pandemic. According to Meng et al[50]. 2020 sufficient ventilation will reduce the viral load. Risk of transmission can be reduced by use of negative-pressure rooms[51].

- It has been suggested that droplet transmission through air-conditioned ventilation result in spread of SARS-CoV-2 virus particles[52].

Administrative Controls: changing the way DHCWS organise their work

Social distancing between patient and DHCWs not wearing PPE kit should be maintained. Routing should be arranged such that there should be adequate distance between patients. Proper attention should be given to prevent contamination between DHCWs.

- Leakproof rubber dam should be applied to reduced viral load during procedures[53]. Proper disinfection should be applied after application of rubber dam. Splash are also minimized after rubber dam application[54].

- It is stated that to minimize aerosol dispersion hand instruments should be used instead of ultrasonic cleaning devices and water cooled instruments[55]. In addition, high volume evacuation is equally important to minimise aerosol production[56].

- Virus particles can be detected in the air of working area even after thirty minutes of aerosol procedure[57]. It is necessary to prevent transmission to unprotected DHCWs in between treatments.

- It has been suggested that to minimize the risk of transmission of SARS-CoV-2 through aerosols in oral cavity, rinse it with hydrogen peroxide (1% H2O2). Re-contamination will soon be

occur in the oral cavity after rinsing as the viral load is high in the nose, throat, tongue and in the saliva. Povidine-iodine and chlorhexidine showed that it reduces and inactivates SARS-CoV-2[53].

Protection of the DHCWs with PPE

- During SARS-CoV-2 pandemic, all patients should be considered asymptomatic carriers. PPE is required for both patients and DHCWs. PPE includes disposable booties, full length gown, head cover, gloves that overlap the sleeves of the gown[56]. Table 2.

- The respiratory tract should be shielded because it is the main portal of entry of the virus. Thus it is recommended is to wear respiratory protection gear during procedures. The filter efficacy of these protective devices are better than regular face mask. A respiratory protection gear with respirator valve should not be used, as it not effective against aerosols, splashes and micro-organisms released from the user. According to various study, N95-mask showed 9% total leakage, whereas for medical masks leakage was 22%–35%[57].

- Goggles or a face shield are also important protective gear to prevent the entry of micro-organism into the mucous membranes of the eyes.

- No touch rule should be followed during treatment as transmission can occur via surfaces like clothing it can be prevented by wearing long sleeved apron which are splash proof. All body parts should be carefully covered.

The CDC provided guidelines for extended use of N95 masks by either treating multiple patients without removing the mask or by reusing the mask once doffed and donned again prior to treating the next.

Future Perspectives for Dental Health Care

In Europe, infection control guidelines have already been applied to the SARS-CoV-2 pandemic. These guidelines include reliable triage which means sorting out and classification of patients or casualties to determine priority of need and proper place of treatment. During infectious disease outbreaks, triage is particularly important to separate patients likely to be infected with the pathogen of concern[58].

Currently, sufficient research is not available on both the virus and the specific risks of aerosol generating dental procedures. In most countries, various protocols have been made in governmental institutions.

Risk, feasibility and additional preventive measures, should be carefully balanced. No one can depict future. The SARS-CoV-2 pandemic, will likely remain present for a prolonged period of time. All protocols should be followed even after restrictions are lifted. Dental health care personnel should keep themselves updated with every new information related to this pandemic. This recent state of environment requires a balance between safety of dental workers and emergency interventions. Social distancing is difficult to follow in dental health care unit, but still it is required to continuously consider which precautions are needed, possibly for the coming years[58].

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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