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Strategies to prevent transmission of infection in dental setting in lieu of current covid-19 pandemic: A Review

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Abstract

The advent of Covid-19 pandemic has ignited momentum in the already ongoing discussions on hideous aftermaths of the spread of infectious microorganisms in the dental fraternity. It's not a hidden statistic that along with the patients, the dental health care professionals(DHCP) serving are at unending risk of getting exposed to vicious disease inflicting pathogens like Hepatitis B Virus and Herpes Simplex Virus, to name a few, in spite of being equipped with modern prevention methods and isolation techniques like high volume evacuation with rubber dam, IsoVac, ReLeaf and so on, that are supposed to regulate the aerosol formation, moisture and spatter in the field, therefore moderating the peril. The various methodologies that are proven to be the reason for why such infectious spreads have become relatively infrequent also have different results when compared to each other in terms of acting as a defensive wall against these occupational hazards.

The article aims to highlights and determine what meld of equipment and methods are most apt and suitable when it comes to curtailing the exposure to pathogens and diseases in the contemporary dental science scenario thereby protecting the DHCP and the patients alike.

Keywords: Pathogen, Aerosol, Spatter, Isolation Techniques, Effectiveness.

Introduction

Our bodies are constantly in contact with various microorganisms. Some of them may even be infectious in nature. In spite of the exposure, infectious diseases are fortunately quite rare. This is because the epithelial surfaces of the body serve as a physical barrier against most microorganisms. Furthermore, if the infectious agents do succeed in crossing the epithelial surfaces, they are efficiently eliminated by the innate immune system of the body. A number of these organisms are present in the oral cavity and nasopharynx. Both patients and dental health care professionals (DHCP) can serve as a reservoir for pathogenic micro-organisms and can become infected because of their involvement in dental treatments. Most dental procedures involve the use of one or more devices that generate spatter and aerosol, which if contaminated amplify the potential risk of disease transmission to both the dental healthcare professionals (DHCP) and patients. In the current era of the pandemic it is crucial that the dental community must be well aware of the fundamentals of infection prevention, and control to ensure preparedness and safe dental practice.

Transmission of diseases

Corona Virus (MERS-CoV), Severe Acute Respiratory Syndrome Corona Virus-2 (SARS-CoV-2, COVID-19), H1N1 and Cross-infection in dentistry can occur through many pathogenic organisms found in oral cavity and respiratory tract. Example of these organisms are cytomegalovirus (CMV), Hepatitis C Virus (HCV), herpes simplex virus (HSV types 1 and 2), HIV/AIDS, Hepatitis B Virus (HBV),streptococci, Mycobacterium tuberculosis, staphylococci and other viruses and bacteria[1].Emerging agents such as Ebola, Middle East Respiratory SyndromeH5N1 and others can be also transmitted during dental practice[2]. The transmission of the diseases can occur through various routes. (Table 1)

Routes	Organism/ Disease transmitted	Causes
Direct contact	• MRSA-Methicillin resistant staphylococcus aureus[3] (common in DHCPs including students[4]) • Hepatitis C virus	• Contaminated hands, improper sterilized instruments • Reusage of contaminated vials[5]
Blood-blood contact	Hepatitis B virus	Blood exposure accidents (BEAs)- However there prevalence has decreased due to mandatory vaccinations of DHCPs[6].
Dental units and aerosols	Various pathogens from the mouth of the patient or microorganisms from the water source	• Contaminated water from dental unit water line • Aerosols produced from dental hand pieces.

Table 1: Routes of transmission of diseases

Aerosols are small liquid droplets which float in the air. They contain particle size ranging from 0.001 to over 100 μm. These droplets can be classified based on particle size (i) large droplets (>20 μm) that follow a more ballistic trajectory, as they are too large to follow inhalation airflow streamlines and usually associated with short-range transmission (1 m),(ii) small droplets. Of particular interest are aerosol particles in the 0.5–10 μm diameter range. It is important to understand the role of the droplet

size in disease transmission, particles of <5 μm can readily penetrate the airway down to the alveolar space and are highly capable of initiating a lower respiratory tract (LRT) infection. Particles of diameter around 10 μm can penetrate up to the glottis, beyond which the penetrability diminishes; particles >20 μm will probably impact respiratory epithelial mucosal surfaces or be trapped by cilia before reaching the LRT[7]. During the ongoing pandemic, all the dental health care professionals have a high tendency to get exposed to the 2019-nCorona virus, this increases their risk of infection. Due to its airborne nature the virus can be easily transmitted via direct contact, blood exposure, use of dental instruments which create spatter, exposure to blood etc.

Preventive Methods

The main concerns associated with preventive methods include steps to be taken to prevent cross contamination and know how the dentist and his staff be protected from disease infection. The various methods for reducing the risk of airborne transmission in a dental setting are addressed in table-2.

Preventive measures	**Methods**
1. Use of personal protective equipment	- Use of gloves, surgical masks, protective eyewear, gowns etc. (to protect the skin and mucosa from direct infection) - Use of well fitted masks with high filtration capability like N95 masks(to protect against fine aerosol particles.)
2. Direction of air flow and air cleansing strategies	- The passage of air should be from the corridors → DHCP → patient → outside. (ensured by proper placement of the inlet vent and outlet exhaust).[9]
3. Ventilation	- Dilution and extraction ventilation, pressurization, mechanical filtration, airflow distribution and optimization, ultraviolet germicidal irradiation, and humidity control (reduces the risk of dissemination of infectious aerosols)[10]. - Providing the room with natural windows, (decreases the risk of contamination).
4. Source control	-Use of rubber dams (provides isolation and lowers the spread of contaminated aerosols) - Use of high velocity evacuation (HVE) (eradicates most of the aerosol particles, however it is ineffective in the case of larger droplets and spatters) - Use of antimicrobial oral rinses (decreases the microbial content in the produced aerosol)[11]. - The maintenance of dental unit water line (controls the contamination levels. It should be fitted with microfilters and undergo chemical treatments at regular intervals.)

Table 2: Methods to reduce the risk of airborne transmission in a dental setting

Isolation Techniques

Every operative procedure entails the need for adequate control over the operative field. It is imperative to ensure a proper moisture control, good accessibility and visibility as well as ample room for instrumentation around the working area. Such an environment helps for easy manipulation and insertion of restorative materials. Isolating the working area includes isolation from moisture(saliva, blood, and gingiva crevicular fluid) and from soft tissues (oral mucosa, tongue, lips etc.) Accidental inhalation of aerosol and spatter composed of blood, bacteria, saliva and tissue fluid, which cause exposure to blood-borne pathogens, is accountable for dissemination of pathogenic microorganisms which eventually cause diseases like tuberculosis, hepatitis-B, HIV and Severe Acute Respiratory Syndrome among dentists.

Conventional Methods

i. Rubber dam- It is a thin sheet of latex/non-latex that's held by a clamp and frame which is perforated to sallow tooth to protrude through perforation while other teeth are secured by sheet.

ii. Cellulose wafers- It is absorbent pad made of cellulose. Chiefly used inside cheek covering parotid ducts.

iii. Dri angle- It is an absorbent cellulose triangle whichfacilitates slight retraction of cheek thus aiding in visibility and access. Provides the necessary dry field and restricts the flow of saliva.

iv. Throat shield – Indicated when there is a precariousness of aspirating or swallowing small object.

v. Svedopter- Used in fluid removal and tongue retraction during tooth preparation, mandibular arch band isolation during impression and cementation.

vi. Isolite - Isolation device that provides illumination in addition to suction, retraction of tongue and cheek.

Some advanced dry field techniques

i**.** High Volume Evacuator**:**It is a suction device that draws a sizeable volume of air over a period of time and is fitted on to an evacuation system that eliminates a volume of air up to 100 cubic feet per minute.HVE offers the best solution for controlling aerosolized particles before they leave the mouth[(12)].

ii. Rubber Dam with High Volume Evacuation**:** They shrink the volume fraction of ultrafine dental aerosol particles and also limit the concentration of dental aerosol.

iii. Ivory Releaf**:** It is a hands-free high-volume dental suction device for clinicians and hygienists. It deftly connects to existing HVE systems, and allows for a more congenial, efficient experience for patients and practitioners.

The highlighted features include

• Maintains efficient suction and retraction even while patients are moving.

•The view of the DHCP is not disrupted while a dry field is simultaneously maintained during the course of procedure.

•Prunes the procedure times by up to 15 minutes when compared with other suction systems.

•Augments the comfort and convenience for both patients and clinicians.

•Adds to patient safety by eliminating the risk of back-flow.

iv**.** 3D Cheek Retractor with HVE: Cheek retraction and high-volume evacuation are advantageous for several moisture sensitive tasks such as bracket bonding. The improvised cheek retractor can be coupled with HVE to

corroborate a moisture free field during bonding, with nominal requirement of chairside help.

v. VAC**:** It facilitates the isolation when restoring posterior teeth and provides a bite block, tongue retraction for mandibular areas and high-speed suction equipments.VAC station is an extraoral aerosol suction device which forestalls blood, saliva, dust and other substances from spreading during dental treatments like high-speed drilling, laser and electrosurgery.VAC Station abates the risk of infection from aerosols and purifies the air via a multi-level filtration system and UV C light. It confines germs and viruses ≥0.3 μm with more than 99.97% efficacy, including vapours of mercury.

Vi. Isovac**:** Isovac is a dental isolation adapter that has wide applications in several other operatories in a dental practice. Isovac latches onto the existing HVE coupler whenever required.The resultant dual suction, bite blocking, tongue retraction and throat shielding all lead to a more relaxed, quicker patient experience in the chair.The mouthpiece joint to the Isovac safeguards the patient's airway, tongue and cheek. Uninterrupted suction assists to reduce the amount of contaminated dental aerosols that the team comes in contact with.

The Isovac provides the optimal dental isolation environment for facilitating a wide array of clinical procedures, which includes restorative, cosmetic, paediatric, sedation, periodontal and Extraction. The modern day Isovac adapter enables the standard High Volume Evacuator (HVE) to use Isolite Systems' entire range of Mouthpieces.

Determining the effectiveness of various dry field isolation methods to mitigate aerosol and spatter spread Concern of viral spread in dental setup and need of improved strategies:

It has been observed and submitted that one of the primary mechanisms of various bacterial and viral disease transmission, including SARS-CoV-2 virus, is via aerosols that are known to be generated throughout the dental procedures in a dental setting. The saliva of the affected patients has also been found out to be a major transmission route for several bacterial and viral infections.

For instance, SARS-CoV-2 virus can be detected in the saliva of the patients who are affected. It is found to bind to the human Angiotensin-Converting Enzyme-2 receptors which are highly concentrated in human salivary glands, salivary ducts, and oral cavity, which leads to the postulate that the SARS-CoV-2 virus is transmitted via salivary droplets.

Spatter consists of droplets up to 50 μm in size which sinks quickly, whereas aerosols are defined as droplet particles which are smaller than 5 μm that can remain airborne for extended periods. Spatter droplets are effectively stopped by barriers such as gloves, masks, and gowns. These small particles can reach deep into the bronchioles and have been reported to play a significant role in viral infections. Therefore, these drops might contain infectious particles that pose a health threat to those within the spray's pattern. Thus, it is reasoned that aerosol generation from the use of a dental handpiece or an ultrasonic scaler in a patient's mouth has, the potential of transmitting the virus.

The half-life of SARS-CoV-2 in aerosols is reported to be approximately 1.1 hours–1.2 hours and larger droplets settled on surfaces as spatter have a median half-life of 5.6 hours. Therefore, this issue has raised a concern about the potential spread of the virus in the dental setting and it has also been found out to be contributing to the increasing need for the development of aerosol and spatter mitigation strategies.

Several new devices were introduced into the dental market to mitigate the spread of aerosols and spatter and

therefore, reduce the risk of infections spread by these droplets. Certain studies have been conducted to check the efficacy of conventional evacuation apparatus when used alone or in combination to effectively reduce and eliminate aerosols and spatter in the dental practice and results were found to be overwhelming when used in combinations(13,14).

Conclusion

Spread of diseases and infections in dental settings still remains highly understudied as its extent is unknown but cannot be completely neglected. Infection control should be considered as an integral part of dental practice. A dental setting is equipped with many instruments that can play an incredibly significant role in mitigating the creation of aerosols and spatter .Improved and advanced dry field techniques should be opted to eliminate the potential spread of aerosols and spatter. These simple setups should be incorporated to ensure a safe dental practice with not much of capital investments

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