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Review Article

Changing Trends in Dentistry amidst COVID-19: A Review Article

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***ABSTRACT*:**
Human history is observing a very strange time fighting an invisible enemy in the form of COVID-19. As Dentists, we face the challenge of working in and around the oral cavity which is one of the ports of entry for the virus. The unique nature of Dentistry, involves aerosol particles which augments the risk of disease transmission by many folds. Therefore, it is important to take necessary measures to avoid cross-contamination. This review tries to provide an overview of harmful effects of aerosols and also enlists some of the standard precautions which include: pre-procedural mouth rinse, use of High Vacuum Evacuators for all procedures, and use of rubber dam wherever possible. Apart from these precautions, it is also very important to maintain the hygiene levels of the clinic. These precautions will possibly reduce the viral load in a dental setting and prevent aerosolized infections.

Keywords: Novel Coronavirus, Dentistry, Aerosol Disinfection, Triage, Cross Contamination, Infection Control, COVID-19.

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INTRODUCTION:

In the last decade, the World Health Organization (WHO) has declared four diseases as Public Health Emergency of International Concern (PHEIC) namely: H1N1 Swine flu (2009), Polio virus (2014), Ebola virus (2014 and 2019) and Zika virus (2016).

The WHO declares a Public Health Emergency of International Concern when there is "an extraordinary event which is determined to constitute a public health risk to other states through the international spread of disease." [1].

This year on 30th January, novel Coronavirus was declared as a Public Health Emergency of International Concern. It was initially named as 2019 novel Coronavirus (2019-nCoV) however; on 11th February the WHO announced a new name for the disease: Coronavirus Disease (COVID-19).

The first case of Coronavirus was identified in the late December 2019 in Wuhan City, China. Since then, it has widely spread to India, and to almost every part of the world. On 11th March 2020, the WHO declared it as a global pandemic [4].

COVID-19 is an infectious disease caused by Severe Acute Respiratory Syndrome Coronavirus 2(SARS-CoV-2). These are a group of viruses that belong to a family of single-stranded RNA viruses known as *Corona viridae*. These viruses are known to be zoonotic i.e. they are transmitted from animals to humans. In this case, Chinese horseshoe bats (*Rhinolophus affinis*) are the most probable origin. [2]

The average diameter of the virus particle is around 125 nm (0.125 microns) and has distinctive spikes of nine to 12 nanometers (Figure 1). These spike projections from the virus membrane give the resemblance of a crown, or

corona (Latin) hence, the term "Coronavirus" is used. [3]

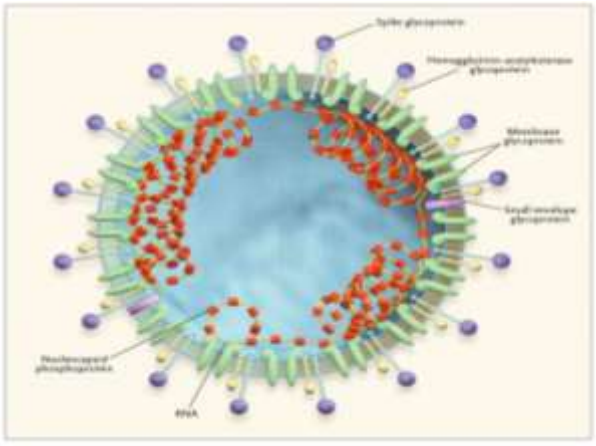

Figure 1: Structure of Coronavirus

SYMPTOMS:

Clinical symptoms of coronavirus infections can range from relatively mild, similar to the common cold to severe (bronchitis, pneumonia, and renal involvement). Currently, there are six coronavirus species that can cause human disease. Four of them are 229E, OC43, NL63, and HKU1—often result in symptoms of the common cold. The other two strains are Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) and Middle East Respiratory Syndrome Coronavirus (MERS-CoV). [3]

ORAL MANIFESTATIONS OF COVID-19:

SALIVARY GLAND INFECTION: The genome of COVID-19 virus has been detected in saliva in the majority of patients with this disease, indicating the potential infection of salivary glands. Positive salivary tests indicate possibility of transmission through the spread of saliva as respiratory viruses usually spread via direct contact or splatter and aerosol production from mouth and nose i.e., sneezing or coughing [5,6]

TASTE ABNORMALITIES: Loss of taste and smell has been recognized lately as one of the symptoms of COVID-19. This disorder could be explained by the fact that SARS-CoV-2 has been known for its interaction with angiotensin converting enzyme 2 (ACE2) receptor, to facilitate its penetration into the cell, and this receptor is widely expressed on the epithelial cells of oral mucosa and the brain. In fact, expression of ACE2 was found to be higher in tongue, where the taste buds are most abundant, than gingiva or buccal mucosa [7, 8].

MOUTH RASHES: Rashes inside the body – specifically on the mucus membranes are called "Enanthem" or "Enanthema"('En' means 'in,' as in 'inside the body). These rashes have been recognized lately as one of the latest symptoms of COVID-19. The rashes are like a spot inside the mouth that look like tiny grains of white sand surrounded by a red ring. These rashes are typically found in viral infections [9].

MODES OF TRANSMISSION:

SARS-CoV-2 can pass from one individual to another through exhaled droplets or saliva associated respiratory droplets, aerosol or fomite transmission in dental clinics and possibly through fecal-oral route [10].

SOURCES OF TRANSMISSION IN A DENTAL SETTING:

Oral healthcare procedures are performed using a variety of devices. These devices produce large amount of particles (aerosols) and splattering which contain infectious microorganisms from the oral cavity of patients. These aerosols and splattering are a risk factor for cross contamination in a dental setting [13].

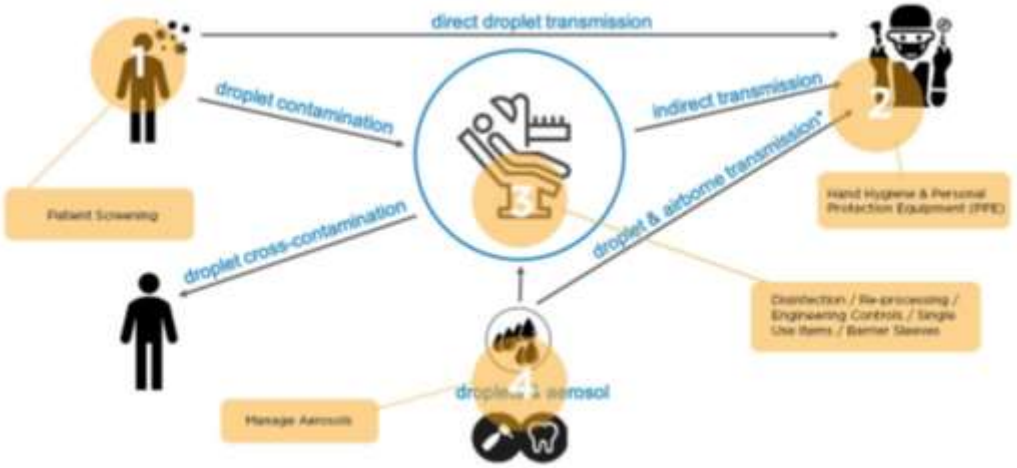

Figure 2: Different routes of transmission in a dental setting: droplets, aerosols and fomite.

WHAT ARE AEROSOLS?

Bio aerosols can be defined as airborne particles of liquid or volatile compounds that contain living organisms or have been released from living organisms. They are about 50 microns or less in diameter. Splatter is usually described as a mixture of air, water and/or solid substances; water droplets in splatter are from 50 micron to several millimeters in diameter and are visible to the naked eye.

Both aerosol and splatter are created when high-powered devices need compressed air and water to work effectively. They are produced with the use of dental hand devices and are commonly contaminated with bacteria, viruses, fungi, often also with blood. These are recognized consequences of certain types of dental procedures and represent a potential mechanism for the spread of infection.

The smaller particles of an aerosol (0.5 to 10 μm in diameter) can stay air borne for an extended period before they settle on environmental surfaces or enter the respiratory tract. They have the potential to penetrate and lodge in the smaller passages of the lungs and are thought to carry the greatest potential for transmitting infections [14].

INSTRUMENTS WHICH GENERATE AEROSOLS:

Mechanical instruments such as high-speed dental turbines, micro-motor hand pieces, ultrasonic scalers, air polishers, air abrasion units and air-water syringes produce aerosols (Figure 3). Ultrasonic scalers are considered the greatest source of aerosol contamination, followed by the high-speed micro-motor handpiece, the air polisher, and the air-water syringes (Table 1) [15].

Figure 3: The visible aerosol cloud generated by high-speed hand piece, ultrasonic scalers and air polishing.

Table 1: Dental devices and procedures known to produce airborne contamination.

DENTAL DEVICE	PROCEDURE
Ultrasonic and sonic scalers	➢ Considered the greatest source of aerosol contamination. ➢ Use of high-volume evacuation will reduce contamination by 95%.
Air polishing	➢ Air borne contamination is nearly equal to that of ultrasonic scalers. ➢ Use of suction devices will reduce airborne contamination by more than 95%.
Air-water syringe	➢ Air borne contamination is nearly equal to that of ultrasonic scalers. ➢ High-volume evacuation will reduce airborne contamination by 99%.
Tooth preparation with air turbine handpiece	➢ Minimal contamination if a rubber dam is used.
Local anesthetic spray	➢ Minimal contamination if a salivary suction is used.

DENTISTRY IN THE ERA OF COVID-19:

In the current situation, Dentists as well as patients undergoing dental procedures are at high risk of cross-infection. Most dental procedures require close contact with the patient's oral cavity, saliva, blood and respiratory tract secretions. For this reason, it is suggested that dentists take necessary precautions to protect themselves and make certain important modifications in their clinical setup so as to limit the spread of virus. Also, it is suggested that patients visiting the clinic follow certain instructions for their own safety.

WHAT CAN PATIENTS DO BEFORE ARRIVAL AT THE CLINIC?

- Minimize or eliminate wearing a wrist watch, hand and body jewelry and carrying of additional accessories bags etc.
- Use their own wash rooms at home to avoid the need of using toilets at the dental facility.
- Wear a facemask during transport and before entering the premises.
- Try as far as possible to come alone. If cannot come alone then, person accompanying patient is advised to wait.
- Maintain social distancing on their way to clinic [16].

BASIC INFECTION PREVENTION MEASURES:

- **Promote frequent hand washing**: Rubbing hands for at least 20 seconds, generates foam which will essentially dissolve the fat layer and the remaining protein molecule will dissolve on its own [18].
- **Use of alcohol based sanitizer:** Use hand sanitizers on entry into the office, entry into the operatory, and again after the dental procedure at dismissal.
- Display visual alerts at the entrance of the clinic and in strategic areas about respiratory hygiene, cough etiquette, social distancing and disposal of contaminated items in trash cans [17].
- Temperature should be checked using infra-red thermometers or scanners of every patient and staff.
- Use pulse oximeter, a device used to measure the percentage of blood hemoglobin carrying oxygen on the fingertips of patients and staff.
- Encourage assistants and workers to stay at home if sick.
- **Encourage tele-consultations and tele-screening for patients**: Telephone screening is encouraged as the first point of contact between the patient and the dentist or reception office is encouraged [16] (Figure 4).
- Current medical history and past history particularly pertaining to symptoms of Severe Acute Respiratory illness (fever and cough and/or shortness of breath) or all symptomatic illness (fever, cough, sore throat and runny nose) must be analyzed.
- Any positive responses to either of the questions should raise concern, and treatment should be postponed for 3 weeks except in dental emergencies.

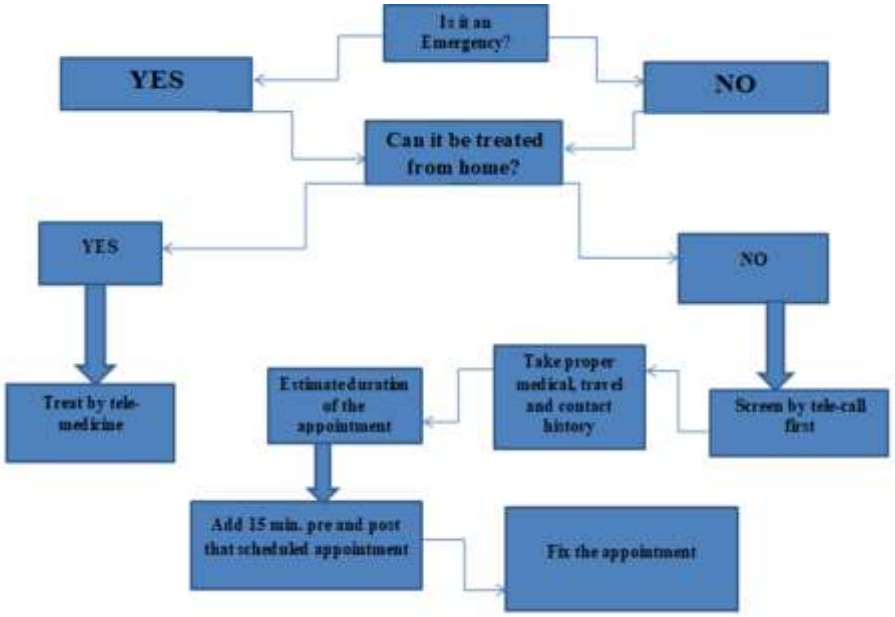

Figure 4: Protocol for Tele-Consultations.

PERSONAL PROTECTIVE EQUIPMENT (PPE):

- PPE includes impervious gown, facemask, eye protection, and disposable cap. These should be donned before entering the room to interact with patients [16].
- It is recommended to wear N95 or KN95 masks for all aerosol generating procedures as they provide more bacterial filtration and are rated higher for particle filtration (Figure 5).
- It is encouraged to wear Level 3 or Level 2 surgical masks during all non-aerosol procedures as they are considered high barrier masks (Figure 6).
- Use of shoe covers and a separate pair of shoes for the clinic are recommended [16].
- All these protective equipment should be doffed off before exiting the clinic. They should be considered placing in a separate laundry bag.

Figure 5: N95 Mask

Figure 6: Type 3 Surgical Mask

MODIFICATIONS REQUIRED IN A CLINICAL SETUP:

- Display visual alerts at the entrance of the clinic and in strategic areas about respiratory hygiene, cough etiquette, social distancing and disposal of contaminated items in trash cans in appropriate languages [18] (Fig. 7).
- Install glass or plastic barrier at the reception desk, preferably with a two-way speaker system (Fig.8).
- Keep the reception non messy free from clutter and extra furniture for ease of cleaning and minimizing contact surfaces.
- Ensure availability of sufficient three-layer masks and sanitizers and paper tissue at the registration desk, as well as nearby hand hygiene stations [16].
- Distant waiting chairs, preferably a meter apart.
- All areas to be free of all fomite such as magazines, toys, TV remotes or similar articles.
- Whatever you cannot remove, yet will not be using, seal it up properly with a final cover of plastic.
- Cashless/contactless payment methods are preferred.
- A bin with lid should be available at triage where patients can discard used paper tissues.

Figure 7: Visual Alerts about Cough Etiquette, Social Distancing, Respiratory Hygiene.

Figure 8: Glass barriers.

- Cover dental chairs with disposable or changeable seat covers or super-wrap (Figure 9).
- Seal the spittoon if possible esp. if you have a wash basin area in the clinic which can be easily cleaned [16].

Figure 9: Super wrapped dental chair.

- Use another space for writing prescriptions. E-prescriptions can be used as an alternative.
- In case that is not possible, table top should be clean and empty and wrapped in a disposable cover [16}
  - Fumigation systems.
  - High volume extra oral suction.
  - Indoor air cleaning system.
  - Dental chair water lines equipped with anti-retraction valves.
  - Hand pieces with anti-retraction valves.
  - Chemicals such as sodium hypochlorite solution, chlorhexidine gluconate, povidine iodine, glutaraldehyde, ethanol, hypochlorite and peroxide for disinfection (Figure 10) [16].
  - Appropriate PPE and ensure it is accessible to Health Care Workers.

Figure 10: Chemicals used for disinfection.

HOW TO RENDER DENTAL TREATMENT DURING COVID?

- **Mouth rinse Before Dental Procedure:** Pre procedural mouth rinse containing oxidative agents such as 1% hydrogen peroxide or 0.2% povidone is recommended, for the purpose of reducing the salivary load of oral microbes.
- Distribute throughout the oral cavity for 30 seconds and then, gently gargle at the back of the throat for another 30 seconds before spitting out [18] (Figure 11).
- Patient is requested to brush his or her teeth before appointments.
- 10 or 11 O'Clock operator's sitting position - is mostly recommended during COVID-19 outbreak as it is considered to be a more safe position and prevents direct aerosols exposure. In order to avoid splatter, eight o'clock position should be avoided. [11].
- **Radiographs:** Intraoral X-ray examination can stimulate saliva secretion and coughing. Therefore, extraoral imaging such as computed tomographic imaging; panoramic radiography should be used to as appropriate alternatives during the outbreak of COVID-19 [17].
- Avoid aerosol-generating procedures and prioritize the use of hand instruments such as spoon excavators in combination with chemomechanical caries removal agents.
- Use new set of instruments which are packed carefully (Figure 12).
- Use of disposable (single-use) devices such as mouth mirror, syringes to prevent cross contamination is encouraged (Figure 13).
- **Use of Rubber dam:** However, if aerosol-generating procedure needs to be performed, use of rubber dam could significantly reduce air

borne particles in approximately 3-foot diameter of the operational field by 70% [19].

- The large diameter (> 8mm) of High Volume Evacuation reduces the amount of bio aerosols by up to 90%. Therefore, use of HVE's in procedures involving ultrasonic scalers and high- speed handpieces is encouraged [19].
- **Extraoral Suctions**: Use of high power extraoral suctions can also reduce the cross contamination by aerosols in a clinic, as it is capable of removing up to 80% of total aerosol produced during a procedure.
- Additional measures such as improving the quality of water, flushing of water from dental unit water lines, hand pieces equipped with anti-reflux devices are strongly recommended to prevent cross infection.

Figure 11: Betadine Antiseptic Solution.

Figure 12: Properly packed instruments.

Figure 13: Disposable diagnostic instruments.

POST TREATMENT:

Patient discharge protocol:

- The patient drape will be removed by the assistant, and the patient is asked to perform hand wash and guided out of the clinic towards reception and handed back his foot wears and belongings.
- The procedures and prescription is recorded only after doffing the PPE.
- Patient to perform hand hygiene and to be provided with review or follow up instructions [16].

DISINFECTION OF A DENTAL CLINIC:

- After the patient leaves the treatment room, the assistant will collect all hand instruments immediately; rinse them in running water to remove organic matter and as per standard sterilization protocol.
- All 3 in 1 syringe, water outlets, hand piece water pipelines, etc. should be flushed with the disinfectant solution for 30-40 seconds.
- Remove water containers and wash them thoroughly and disinfect with 1% sodium hypochlorite using clean cotton/ gauge piece and then fill with fresh 0.01% sodium hypochlorite solution and attach back to the dental chair [16].
- Sterilization of electronic equipment using 60-90% alcohol based spirit after every patient is recommended.
- Disinfect inanimate surfaces using1% sodium hypochlorite and disinfecting waterlines with 0.01% sodium hypochlorite can help reduce the risk of cross infection and maintain a dry environment to curb the spread of SARS-CoV-2. (Figure 14).
- The virus can potentially survive in the environment for several hours/days. So, to prevent bio aerosol contamination, the clinics should have a provision of good ventilation and the clinic should be fumigated with formaldehyde on a regular basis.

Figure 14: Disinfectant solution to clean dental instruments.

MEASURES TO CURB AEROSOL CONTAMINATION IN CLINICS:

To curb aerosol contamination, negative pressure shall be maintained in all rooms or areas. The ventilation rate shall be 12 or more air changes per hour (ACH). ACH is referred to the amount of outside air that needs to be introduced into a building or clinic. The required ventilation rate may be achieved by using in-room air cleaning technologies. In no situation, shall the outdoor air supply ventilation rate be less than 6 ACH [20].

Some important points to be considered while using these air technologies are as follows.

- Airborne infection isolation room or area (AIIRs) must be operated at a negative pressure of at least -0.01 inches of water gauge compared to adjacent areas. Their exhaust ducts must also be under negative pressure for the entire length until the ducts exit for discharge.
- Doors and windows must be closed while the room is in use for airborne infection isolation except when doors and windows are kept open for entering and exiting and when windows are part of the ventilation system being used to achieve the required negative pressure.
- An AIIR may be equipped with an anteroom that serves as a clean buffer area between the AIIR and the hallway. In such setups, the AIIR is usually under negative pressure compared to the anteroom, which is under negative pressure compared to the hallway. Employees are to don PPE, masks in the anteroom before entering an AIIR.
- Negative pressure shall be visually demonstrated by smoke trials or equally effective means daily while a room or area is in use for all.
- Ventilation systems for all rooms or areas shall be constructed, installed, operated and inspected annually.
- When a case or suspected case vacates a room or area, the room or area shall be ventilated for a removal efficiency of 99.9% before letting employees to enter without respiratory protection [20].

The following air cleaning technologies can be used (19).

AIR CLEANING TECHNOLOGY	PROCEDURE
1. FILTRATION	• An air filtration device named High-efficiency particulate arrestor (HEPA) filters are used. • Can remove particles measuring 0.3 μm in diameter. • Can remove up to 99.97% particles (Figure 15).
2. OZONIZATION	• Ozone molecules are highly reactive and when they come in contact with microorganisms they react and render them harmless. • In this process air is subjected to high voltage charges, which results in the separation of oxygen atoms and ozone isotopes. • The amount of ozone required in this process presents a health risk to dental professionals.
3. IONIZATION	• In this process, charged electrodes are used to project negative ions into the air. • Microorganisms get attracted to these ions and become heavier and precipitate onto surfaces. • However, the microorganisms are not destroyed through this process and thus are further treated through some more conventional forms of disinfection.
4. AIR STERILIZATION	• UV radiation of wavelength 100-280nm and the peak of this wavelength being 265nm are used to rupture the DNA of bacteria and viruses thus making them sterile and incapable of reproduction.
5. SURFACE SANITIZATION	• Surface sanitization of the dental offices can be easily achieved by chemical sanitization; as a result it prevents indirect transmission of microbes.

Figure 15: HEPA Filter.

DENTAL UNIT WATER LINES:

The Dental Unit Water Lines (DUWL) presents a potentially large source of infection. The tubes are constructed in such a way that, the center of the lumen has the maximum flow of water and the periphery has the minimal flow. Bore water lines, water stagnation, heating of dental chair unit, anti-retraction valve failure and contamination of reservoir bottles are some of the possible reasons for contamination of DUWL. Due to the intermittent usage of the dental unit, improper cleaning and sterilization of the DUWL bacterial biofilm adheres to the tubes. Another factor which encourages the bacterial adherence to the surface of the tube is the material used to make the tube which is hydrophobic polymeric plastic tubing (e.g.: polyvinyl chloride and polyurethane) [19].

If proper treatment of DUWLs is followed, major sources of potentially contaminated dental aerosols can be controlled. The following approaches can be followed:

NON-CHEMICAL APPROACH: This includes flushing of DUWL water, improving the quality of water (Figure 16), using anti retraction valves (also known as check valves are the devices which do not allow water to draw back from the oral cavity in to the dental hand piece tubing and water lines and are more efficient when fitted distal to the hand piece) and retrograde aspiration (i.e. it does not allow water to travel backwards into the hand piece). The water line has to be flushed at the start of each clinical day and between patients, for 30 seconds to 1 minute to reduce microbial accumulation due to overnight waterline stagnation. Physical cleaning can be done by using sponges or balls, making them pass through the pipeline in order to remove the biofilm. Use of fumigation techniques and UV light in the workplace are also an option. [19].

Figure 16: Water distiller to improve the quality of water.

CHEMICAL APPROACH: This includes the use of chemical disinfectants which have broad spectrum anti-microbial activity like chlorhexidine gluconate, povidine iodine, glutaraldehyde, ethanol, hypochlorite and peroxide. Besides that, hydrogen peroxide and ozone can be introduced continuously in the DUWL during treatment. However, the efficacy of hydrogen peroxide and ozone regarding purification of DUWL was proven to be limited [19].

Apart from these, the hand piece should be externally sterilized by autoclaving and internally by using chemiclave. This is because the spores inside the high speed hand pieces may survive autoclaving therefore; it has to be treated internally with chemical disinfectant.

The suction pipes should be cleaned with ammonia. Surfaces such as dental unit light handles, electrical and mechanical controls, head and arm rest of the chair, dental unit controls can be wrapped using aluminum foils or thin plastic sheets [19].

All the available methods of reducing aerosol contamination should be followed routinely for adequate protection (Table 2).

Table 2: Methods of reducing airborne contamination.

DEVICE	ADVANTAGES	DISADVANTAGES
Barrier Protection—Masks, Gloves and Eye Protection	Part of "standard precautions," Inexpensive.	Masks will only filter out 60 to 95% of aerosols, subject to leakage if not well-fitted.
Chemical disinfectants like povidine iodine, glutaraldehyde, ethanol, hypochlorite and hydrogen peroxide	Improves the quality of water in DUWL and reduces the microbial count.	The efficacy of hydrogen peroxide was proven to be limited.
Preprocedural rinse with antiseptic mouthwash such as Chlorhexidine	Reduces the bacterial count in the mouth, saliva and air; inexpensive on a per-patient basis.	Tends to be most effective on free floating organisms; it will not affect biofilm organisms such as plaque, subgingival organisms, blood from the operative site or organisms from the nasopharynx.
High-Volume Evacuation (HVE)	Will reduce the number of bacteria in the air and remove most of the material generated at the operative site such as bacteria, blood and viruses; inexpensive on a per-patient basis.	When an assistant is not available, it is necessary to use a high-volume evacuator attached to the instrument or a "dry field" device; a small-bore saliva ejector is not an adequate substitute.
High-Efficiency Particulate Air (HEPA) Room Filters Ultraviolet Treatment of Ventilation System	Effective in reducing numbers of airborne organisms.	Only effective once the organisms are already in the room's air, moderate to expensive, may require engineering changes to the ventilation system.

CONCLUSION:

Dentists are exposed to higher risk of coronavirus infection due to close contact and consistent exposure to body fluids such as blood and saliva. Till now no vaccines and /or antiviral agents have been clinically endorsed for the treatment of the disease. Therefore, prevention of the disease and control of the infection is deemed a top priority. The need for strict and effective infection control protocols in dental practice is of great importance to avoid cross contamination.COVID-19 situation is still evolving and advisories and recommendations by the WHO, IDA, DCI, ICMR and MoHFW keep on evolving. Therefore, Dentists should keep themselves updated with the latest releases.

In the end we would like to conclude by saying that, similar to previous outbreaks, this present outbreak will also be contained shortly. Hopefully, our lives will be back on track and Dentistry and the entire Dental fraternity will emerge out as an advanced and even more stronger unit and will continue to create beautiful smiles.

"For every dark night there's a brighter sky."

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