ECRONICON OPEN ACCESS

EC MICROBIOLOGY
Review Article

Aerosols and its Prevention in Orthodontics: A Narrative Review

Sameer Patil[1]*, Ranjit Kamble[2], Vineet Vinay[3] and Sharayu Dhande[4]

[1]Principal, Professor and Head of the Department, Department of Orthodontics and Dentofacial Orthopaedics, Sinhagad Dental College and Hospital, Pune, Maharashtra University of Health Sciences, Nashik, India

[2]Professor, Department of Orthodontics and Dentofacial Orthopaedics, Sharad Pawar Dental College, Wardha, Datta Meghe Institute of Higher Education and Research (Deemed to Be University), India

[3]Associate Professor, Department of Public Health Dentistry, Sinhgad Dental College and Hospital, Pune, Maharashtra University of Health Sciences, Nashik, India

[4]Assistant Professor, Department of Periodontology and Oral Implantology, Sinhgad Dental College and Hospital, Pune, Maharashtra University of Health Sciences, Nashik, India

***Corresponding Author:** Sameer Patil, Principal, Professor and Head of the Department, Department of Orthodontics and Dentofacial Orthopaedics, Sinhagad Dental College and Hospital, Pune, Maharashtra University of Health Sciences, Nashik, India.

Received: March 22, 2023; **Published:** June 16, 2023

DOI: 10.31080/ecmi.2023.19.01329

Abstract

The minute particles of aerosols and splatter possess inherent potential to penetrate and invade respiratory passage of the lungs further proving an abet for transmission of life threatening infections. These particles could often cause threat to orthodontist and other dental professionals along with non-dental staff and the patient. This water and air-borne contamination can be frequently minimized inexpensively by layering certain infection control measures. The objective of this review is to shed light on reinforced infection control protocols and thus prevent cross-transmission of infectious diseases within the orthodontic fraternity.

Keywords: *Aerosol; Splatter; UV Tunnel; HEPA Filter; Infection Control*

Introduction

Micik and colleagues in 1969 were first to use the terms; 'aerosol' and 'splatter' during their pioneering work related to anaerobiology [1]. They defined aerosol as a particle of the diameter of about 50 mm. The minute size of the particles succours to remain free floating in the air prior to settling on the underlying surfaces. This cloud of particulate matter and fluids is often clearly visible in the dental operatory [2].

Micik., *et al*. 1969 later defined splatter as airborne particles greater than 50 microns in diameter. They even concluded that these splatter particles were known to act in an ballistic manner that meant the forcibly ejected particles from the operating site act in a similar way as a bullet until they contact underlying surface. The larger size of these particles prevents them from remaining free floated for a longer period of time and thus aids in settling of these particles [3].

Of which the most common are the micro-organisms found on dental instruments and in DUWLs. Dental plaque is prime source of these micro-organisms since it being primary source of an array of micro-organisms. Regular stringent sterilization and disinfection protocols help eliminate aerobic as well as anaerobic micro-organisms. The ADA recommended protocols have proven to show a marked decline in the total CFU's. The literature published till date provides mixed evidence on aerosol generating procedures in orthodontics [3].

As a result, all the dental specialities are advised to follow universal precautions for each and every patient assuming all the patients to have blood-borne and other hazardous bacterial-viral diseases.

The prime objective of this article is to summarize a variety of disinfectants and other factors that affect standard cleaning and disinfection practices, to put forth certain newer technologies that can supplement manual traditional cleaning and disinfection methods and thus support dental surgeons in their daily practice.

Aerosol and contamination through operative site [3,4]

An aerosol is an ubiquitous combination of aerosolized combination of dental materials, water from dental unit water pipelines (DUWL), respiratory sources, salivary and nasopharyngeal secretions, and free floating airborne particles. Nevertheless, a variety of bacteria, fungi along with viruses have proven their presence in the salivary secretions, few of them could prove more fatal compared to others; most recent being the SARS CoV-2. The lethal nature of aerosols points out their necessity for qualitative and quantitative assessment. One of the stumbling blocks in it could be due to inability to procure aerosols in an appropriate medium.

Dental handpieces used during restorations, sonic and ultrasonic scalers are the most common dental devices and procedures causing airborne contamination. Ultrasonic scalers have been known to produce maximum aerosol generation amongst all the procedures till date. Pre-orthodontic therapeutic procedures constitute of non-surgical periodontal therapy, surgical periodontal treatment wherever indicated, restorative and endodontic treatments wherever necessary, extractions wherever indicated. Of which the endodontic, restorative procedures, tooth preparations can be carried out using rubber dam that would aid in marked decline in airborne contamination. The British Orthodontic Society (BOS) advises stringent use of slow speed dental handpiece with use of high vacuum evacuation. The use of high vacuum evacuators during ultrasonic scaling could help decrease about 95% of aerosol production.

Effect of pre-procedural rinses on aerosol production [4]

The pre-procedural rinses are an effective way to reduce oral microbial load (Basso., *et al*. 2020, O'Donnell., *et al*. 2020, Moosavi., *et al*. 2020). The mouth rinses currently used are 0.12% chlorhexidine gluconate, povidone iodine with few newer agents like Citrox and β-Cyclodextrin. The SARS-CoV-2 is vulnerable to oxidation, and therefore it is recommended to use a mouth rinse containing oxidizing agents such as Citrox to reduce salivary load of viral oral microbiota. Mouth rinses containing amphiphilic β-Cyclodextrin that act by disrupting the outer shell of virus and block its growth. This property is potentially used for therapeutic oral biofilm rinses and is considered in preventing viral transmission via the oro-pharyngeal route (Carrouel., *et al*. 2021, Hooper., *et al*. 2011). Combination mouth rinses of cyclodextrins and citrox help lower nasopharyngeal microbiota after coughing and sneezing. Furthermore, Flavonoids have proved essential function in decline in corona virus replication with concomitant inhibition of host immune response (Nagwa., *et al*. 2020).

Management of aerosols with HEPA filters [5-9]

HEPA is an acronym for high efficiency particulate air. The most common methods of managing airborne contamination is use of high efficiency particulate air (HEPA) and UV or ultraviolet chambers in the ventilation system. The HEPA filter have efficiency in capturing about 99.97% of infected particulate. They are extremely efficient in capturing nano-sized particles too.

The history of HEPA filters dates back to World War II, when few Scientists in the United States of America were working on The Manhattan Project in 1950. The first HEPA filter was used there to help prevent the spread of airborne radioactive particulates. Furthermore,

the use of HEPA filters in medical fraternity was preferred since the medical grade HEPA filter fibre was thick enough to capture both micro and nano-sized particulates. The most penetrating particle size (MPPS) is 0.3 mm and as a result, filtering efficiency is doubled for particle size smaller and larger than 3 mm.

The HEPA filters have been constructed of borosilicate fibres in the form of pleated sheet. The sheets are pleated in order to increase overall surface area. These pleats are separated by serrated aluminium baffles or with stitched fabric ribbons that help direct the airflow through the filter. This combination of pleated sheets and aluminium baffles further acts as a filtration medium. These filters are classified into multiple categories based on their ability to filter out microscopic particulate matter ranging from 2.5 PM to 10 PM. They exists in a variety of shapes and sizes, with different grades, classes or minimum efficiency reporting values (MERV) ratings. The MERV grade indicates a filter's capacity to target particles ranging from 0.3 to 10 microns. This rating is based on a test technique that was originally devised by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE). The greater the MERV rating, the more effective is the filter to target and destroy the particulate particles.

The HEPA filter follows four basic mechanisms to capture macro to nano-sized particles:

1) **Inertial impaction:** This mechanism targets large and heavy particle size and further guides them to flow with the fluid surrounding them. Due to heavy nature of these particles, even though the fluid changes its direction before entering the fibre space, the particulate continues to follow in the straight line and further collide with fibres in the surrounding media wherein it gets trapped.
2) **Interception:** This mechanism targets medium-range particle size; such particles that lacks enough inertia and not even small to diffuse within the flow stream. These particles follow the flow stream as it follows the fibre spaces. Once every particle comes into contact with fibre they are captured and intercepted.
3) **Diffusion:** This mechanism targets the smallest sized particles. The small size of particles flow diffusely within the flow stream. It means that smaller the size of particles, more likely it is to traverse through the flow stream, making it easier to collide with the fibre and thus trapped.
4) **Sieving:** This is the most common mechanism in the process of filtration. It targets the particles too large to fit within the spaces between adjacent fibres.

The pre-filters in the HEPA capture large and heavy sized particles and thus prevent lodging of heavy particles within the inner structure of these filters. Lastly, the layer of anti-bacterial filters have been designed with activated carbon filter in which the activated charcoal adsorbs the odours and colourful substances from the liquids and gases.

Touch-less or no-touch infection control systems

Touchless cleaning techniques provide an incremental benefit to manual practices by limiting cross-transmission of pathogens via environmental surfaces, though evidence of prevention of certain pathogens remains limited. These technologies include a variety of products including self-disinfecting surfaces along with few fumigation methods. Newer "no-touch" (automated) decontamination technologies include aerosol and vaporized hydrogen peroxide, mobile de-vices that emit continuous ultraviolet (UV-C) light, a pulsed-xenon UV light system, and use of high-intensity narrow-spectrum (405 nm) light. These "no-touch" technologies have been shown to reduce bacterial contamination of surfaces in less period of time. The recent technologies that are divided into several categories include:

(A) Liquid surface disinfectants

(B) Improved methods for applying disinfectants

(C) Self-disinfecting technologies

(D) Light-activated photosensitizers

(E) Automated or No-touch technologies.

These recently developed disinfectants have Environmental Protection Agency (EPA) safety rating of category IV (housekeepers do not need to wear any personal protective equipment while using these products). Chemical disinfection has always played a crucial role in eradication of micro-organisms. Newer hydrogen peroxide-based liquid surface disinfectants with a combination of peracetic acid and hydrogen peroxide have proved effective alternatives to disinfectants during the COVID-19 pandemic, also use of electrolyzed water (hypochlorous acid) and cold atmospheric pressure plasma have shown antibacterial effect [10,11].

Rutala., *et al*. 2014 carried out a study to assess decontamination of rooms post UV light disinfection. UV-C devices of 64 inches each with 1200W capacity were fitted within the rooms. The cycle time was devised as per the manufacturer's instructions based on the size and configuration of the rooms. The authors concluded a total 3.56-log10 reduction for Methicillin Resistant *Staphylococcus aureus* (MRSA) in 5 minutes and a total 2.78-log10 reduction for *Clostridium difficile* in 10 minutes post exposure to UV-C light exposure. Hence, UV-C technologies have proven to be an effective measure to reduce airborne contamination with minimal human effort [12].

It is essential to place HEPA filters to help decline the total aerosol overload followed by UV-C disinfection of the rooms after every patient in the orthodontic operatories since even though every patient is being treated for a short period of time the orthodontic pliers, orthodontic brackets, arch-wires, elastics, bands used for banding, mini-screws and mini-implants could prove a niche for settling of free floating particulates. Removal of fixed orthodontic appliances, debonding, polishing of tooth surfaces post debonding cause more of aerosol production compared to in between sessions [13-15]. The study carried out by Johnston., *et al*. 2009 stated 44% reduction in total airborne contamination in presence of high evacuation suction [16].

The training of the orthodontists with their team on infection control measures, routes of transmission, hand hygiene measures is essential to combat infectious diseases. Even though aerosol production is restricted, appropriate use of particulate respirators such as N95, EU FFP2 or equivalent in addition to face shield are required [17,18].

Since the patient room turnaround time is critical in orthodontic clinics, UV-C disinfection along with HEPA filters could prove an effective measure to decontaminate dental clinics in lesser period of time.

Personal protective equipments for infection control [19-25]

A comprehensive program for the use of PPE should be enforced with immediate effect. All the healthcare personnels trained to clean, disinfect, store, and inspect their PPE. All staff should be strictly advised to use with the National Institute of Occupational Safety and Health (NIOSH)-certified N95 respirators. Personal goggles should be issued to every member of staff.

Hair covers or hoods are advised. Longer sleeved gloves should be preferred to prevent exposure of the wrists with glove slippage. Alternately, vertical tape strips should be used to help keep gloves secured to the gown. Eye protection should include protection from side exposure with side shields or goggles. Full face shields advised since they help provide both eye protection and avoid facial and respirator contamination. Some disposable shoe covers may increase the risk of self-contamination during removal of protection clothing. Shoes worn should be impermeable to fluids and possible to be decontaminated. Staff should wear operating room scrub suits or full coveralls under the PPE. Coveralls with an integrated hood may simplify the underlayer worn in conjunction with PPE, however the choice of product is advised to be assessed for ease of handling to refrain contamination during removal. Hand hygiene must be performed after removing PPE, and in the event of inadvertent contamination of the hands by touching infected surfaces during PPE removal.

The Buddy System (two-person assistance system) with mutual supervision is advised to adopt unlike other countries. In addition, the Sky Eye monitoring system should be installed in clinics for dentists and other dental assistants PPE donning areas, and PPE-doffing areas to observe and monitor in real-time during arranging shifts of infection control teams on a 24 hour basis. The dentists should be reminded in a timely manner for the precautions to be taken during donning and doffing of the PPE to ensure their utmost safety. During doffing, the PPE should be gently rolled on the body and any vigorous movements should be avoided, also thus the soiled outside surface of PPE should be rolled inwards. A proper distance should be maintained when spraying the chlorine-based disinfectant to allow for full atomization and to achieve effective sterilization. Moreover, the spraying of disinfectant should avoid the head and face to prevent the disinfectant from irritating the respiratory tract and mucous membranes of the person. Healthcare professionals should avoid touching the side edges or front surfaces of face shield, eye-wear, headcaps, facemasks to prevent contamination. All healthcare professionals should strictly implement the seven-step handwashing technique for a minimum of 15 seconds.

The emergency response plan on exposure to contaminated PPE includes the following steps:

(1) Immediately suspend the doffing procedures once exposure occurs. The exposed area should be immediately disinfected by the buddy in the doffing area.

(2) If exposure occurs to the face or other skin surfaces, immediately apply 75% alcohol or ethanol-containing quick-drying hand sanitizer to wipe the exposed skin on the face or other area for 2 minutes.

Use of powered air purifying respirators (PAPR) vs N95 mask as part of PPE during elective orthodontic cases management [25-28]

Advantages of PAPR	Disadvantages of PAPR
Higher protection factor	May be more complicated than required for mode of transmission, leading to greater risk of contamination when removing PAPR
Full facial and head coverage	Higher cost compared with N95 respirators
More comfortable for prolonged resuscitations or transports and resistance to being accidentally dislodged	Inability to reuse disposable filters between 2 surgeries, need large supply of filters
Eliminates N95 fit testing concerns (especially for those who cannot be successfully fit tested because of facial features)	Need explicit procedures for decontamination and recycling of blower units for next use
No need to maintain supply of variety of N95 respirators to meet fit testing requirements	Potential compromise of disposable components (e.g., hoods, hoses) through inappropriate attempts to sterilize and reuse if supplies run low, leading to infection risk
Can be used with facial hair or for staff who cannot be successfully fit tested	Communication challenges between surgeons due to fan noise
-	Need for recurrent training of staff to maintain competence if not frequently used

Newer protocols for OPD management [29-35]

Only 50% OPD rooms should be utilized in a day. Every day at the end of OPD the hall, clock rooms and other rooms should be sanitized with 1:9 dilution of 5% concentrated liquid bleach solution and should be kept closed for the following day while the nest set of OPD rooms should be utilized for the next day. A thorough cleaning is advised daily twice a day. Fogging is refrained. Gloves and face shields are advised to be disposed of in a red coloured bag and disposable masks, gown, gloves and respirators in a yellow bag after use.

In OPD waiting area hand hygiene station should be installed, television screens should be installed to educate the people regarding signs and symptoms of COVID-19, hand hygiene, how to wear mask, maintaining social distancing, prevention and treatment of coronavirus, do's and don'ts and other health education videos. The OPD waiting area should have minimum furniture and instruments and that too should be adequately spaced. It is necessary to convert OPD air conditioner into a non-circulatory system this can be done by blocking off the return air vents of the air conditioner; and placing HEPA Filters in the OPD section as well as in other operatory. Air conditioners in OPD could result in stagnation of air and therefore should be avoided. Exhaust fans should be used everywhere if possible. Installation of separate ac units (window/split) in each room/chamber if possible. Central air conditioning to be avoided, ensure > 12 air changes per hour if central air conditioning being used. HEPA filters and other stringent infection control protocols to be followed regularly.

Patients are requested to visit with minimum ornaments for their monthly appointments. At the entrance of the operatory, the patient is advised to wear shoe covers, disinfect the hands with hydro-alcoholic solution. Minimum of 2 meters of distance is advocated between each patient. The correct hand disinfection procedure with hydro alcoholic solution is advised: a) Apply a squirt of sanitizer in the palm of hand, b) Rub hands palm against each other, c) Rub the back of each hands with the palm of the other hand, d) Rub palms together with your finger interlaced, e) Rub the back of fingers with the opposite palms, f) Rotate thumbs in the other hand, g) Do a circle on palm with finger clasped, h) Once dry, hands are safe. The same procedure is performed for washing hands with soap and water. The pictorial presentation of hand washing technique should be placed on the walls.

The cloak rooms in the OPD waiting area should be properly sanitized with 1% hypochlorite solution after every patient visit, and so should the drinking water facility by maintaining adequate social distance. The PPE for sanitary cloak room cleaning is disposable rubber boots, gloves (heavy duty), along with a triple layer mask.

Brisking nature of covid-19 and need for rescheduling of aerosol generating procedures [36-42]

COVID-19 is an abbreviation for Corona virus disease-2019 which is an infectious viral disease caused by Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), it was therefore named by WHO and International Committee on Taxonomy of Viruses (Ghebreyesus 2020; Hsu., *et al*. 2020; Kumar., *et al*. 2020; World Health Organization [WHO], 2020). Coronavirus shows striking feature of cross-species transmission through droplet nuclei, and hence proved hazardous to the mankind. It is presumed to spread directly via infectious respiratory droplets of the infected individual or even close contact. Direct or indirect transmission of infected droplet nuclei possess the host to the risk of developing a viral disease.

The current Coronavirus outbreak has refocussed orthodontists to manage many mal-aligned cases more conservatively i.e. with aligners, which would have otherwise be managed with the traditional way. It could be mainly because of the restraints put on by this COVID, limited availability of resources including personnel, rescheduling patient slots and also due to reluctance of undertaking operative intervention in an atmosphere of increased risk of viral transmission, responsibility of protecting staff and 'social distancing' guidelines (Alyami., *et al*. 2020; Di Gennaro., *et al*. 2020; Probert., *et al*. 2021).

Povidone Iodine containing Mouthwashes, Gargle or even Nasal Spray can be a effective alternative to citrox and cetyl-pyridium chloride and also help reduce Nasopharyngeal Viral Load in Patients With COVID-19 (Challacombe., *et al*. 2020; Frank., *et al*. 2020; Guenezan.,

et al. 2021; Kawana., *et al*. 1997; Nagatake., *et al*. 2002; Pattanshetty., *et al*. 2020). Hydrogen peroxide (H_2O_2) did not cause any observable damage on microvilli of oral mucous membranes post gargling with 3% H_2O_2. Another most common route for SARS-CoV-2 is through the nasolacrimal ducts. And as a result, iodopovidone eye drops 0.5% - 0.6% (1 drop 3 times a day on conjunctiva of both the eyes) can be used due to its antiseptic action within a minute against corona viruses. According to Caruso., *et al*. 2020, application of this regimen in our dental practice, will result in to significant reduction of the rate of hospitalization of skeletal orthodontic cases and respiratory complications in patients positive for COVID-19 with or without mild-to-moderate symptoms (Caruso., *et al*. 2020; Cortelyou 1968; Urban., *et al*. 2017).

Respiratory droplets are produced during coughs, sneezes, airway health procedures, laryngeal intubation during surgical orthodontic cases. Droplets carry infectious particles directly from the respiratory tract of the infectious agent to host susceptible mucosal surfaces. The size of the droplet ranges from > 5 μm to 60 and 100 microns.

Therefore, viremia in patients with asymptomatic or confirmed positive COVID-19 patients could pose a risk of transmissibility to the entire team of orthodontists and dentofacial orthopaedic surgeons during aerosol generating procedures.

Conclusion

A plethora of challenges are being encountered on daily basis while striving for and maintaining appropriate sterilization and disinfection protocols in the dental clinics. As a result, there is utmost need to develop modern technologies that will improve disinfection of surfaces in the dental clinics. Both the UV-C light disinfection as well as the HEPA filters have proven efficient enough in dental operatories.

Bibliography

1. Micik RE., *et al*. "Studies on dental aerobiology, I: bacterial aerosols generated during dental procedures". *Journal of Dental Research* 48.1 (1969): 49-56.
2. Hinds WC. "Aerosol technology: Properties, behavior, and measurement of airborne particles". New York: Wiley (1982): 6-8.
3. Miller RL., *et al*. "Studies of dental aerobiology, II: microbial splatter discharged from the oral cavity of dental patients". *Journal of Dental Research* 50 (1971): 621-625.
4. Chaudhari S., *et al*. "Journal of Rheumatology". *Orthopedics and Sports Sciences* (2020).
5. Chaudhari S., *et al*. "Infection Control Measures for Orthopaedic Operatories During Covid-19 Crisis: An Update". *International Journal of Clinical and Medical Case Reports* 17.2 (2021): 36-42.
6. Pirkle S., *et al*. "Evaluating and contextualizing the efficacy of portable HEPA filtration units in small exam rooms". *American Journal of Infection Control* 49.12 (2021): 1506-1510.
7. Noskin GA and Peterson LR. "Engineering infection control through facility design". *Emerging Infectious Diseases* 7.2 (2001): 354.
8. Phu HT., *et al*. "Design and evaluation of a portable negative pressure hood with HEPA filtration to protect health care workers treating patients with transmissible respiratory infections". *American Journal of Infection Control* 48.10 (2020): 1237-1243.
9. Ereth MH., *et al*. "Particle control reduces fine and ultrafine particles greater than HEPA filtration in live operating rooms and kills biologic warfare surrogate". *American Journal of Infection Control* 48.7 (2020): 777-780.
10. Doll M., *et al*. "Touchless technologies for decontamination in the hospital: a review of hydrogen peroxide and UV devices". *Current Infectious Disease Reports* 17 (2015): 1-1.

11. Boyce JM. "Modern technologies for improving cleaning and disinfection of environmental surfaces in hospitals". *Antimicrobial Resistance and Infection Control* 5.1 (2016): 1-0.

12. Rutala WA., *et al*. "Room decontamination using an ultraviolet-C device with short ultraviolet exposure time". *Infection Control and Hospital Epidemiology* 35.8 (2014): 1070-1072.

13. Dhande SR., *et al*. "An Update on Air-Powder Polishing". *Recent Developments in Medicine and Medical Research* 14 (2021): 152-167.

14. Day CJ., *et al*. "Inhalation of aerosols produced during the removal of fixed". *American Journal of Orthodontics and Dentofacial Orthopedics* 11-17.

15. Ireland AJ., *et al*. "Airborne particles". *American Journal of Orthodontics and Dentofacial Orthopedics* 683-686.

16. Johnston NJ., *et al*. "Quantitative and qualitative analysis of particulate production during simulated clinical orthodontic debonds". *Dental Materials* 25.9 (2009): 1155-1162.

17. Kobayashi LM., *et al*. "Extended use or reuse of N95 respirators during COVID-19 pandemic: an overview of national regulatory authority recommendations". *Infection Control and Hospital Epidemiology* 41.11 (2020): 1364-1366.

18. Rodriguez-Martinez CE., *et al*. "Decontamination and reuse of N95 filtering facemask respirators: a systematic review of the literature". *American Journal of Infection Control* 48.12 (2020): 1520-1532.

19. ACS. COVID 19: Consideration for Optimum Surgeon Protection (2020).

20. Ebola PPE Process "Buddy Checklist" per 10/21/14 CDC (10/27/14).

21. Cheng L., *et al*. "Problems and solutions of personal protective equipment doffing in COVID-19". *Open Medicine* 15.1 (2020): 605-612.

22. Centers for Disease Control and Prevention. Recommended guidance for extended use and limited reuse of n95 filtering facepiece respirators in healthcare settings - NIOSH Workplace Safety and Health Topic (2020).

23. Chasib NH., *et al*. "Dentists' practices and attitudes toward using personal protection equipment and associated drawbacks and cost implications during the COVID-19 pandemic". *Frontiers in Public Health* 9 (2021): 770164.

24. Salehiniya H., *et al*. "Mental health status of dentists during COVID-19 pandemic: A systematic review and meta-analysis". *Health Science Reports* 5.3 (2022): e617.

25. Radonovich LJ Jr., *et al*. "Respirator tolerance in health careworkers". *The Journal of the American Medical Association* 301 (2009): 36-38.

26. Rebmann T., *et al*. "Physiologic and other effects and compliance with long-term respirator use among medical intensive care unit nurses". *American Journal of Infection Control* 41 (2013): 1218-1223.

27. Fisher EM and Shaffer RE. "Considerations for recommending extended use and limited reuse of filtering facepiece respirators in health care settings". *Journal of Occupational and Environmental Hygiene* 11 (2014): D115-D128.

28. Umer FA., *et al*. "Role of respirators in controlling the spread of novel coronavirus (COVID-19) amongst dental healthcare providers: a review". *International Endodontic Journal* 53.8 (2020): 1062-1067.

29. Chasib NH., *et al*. "Dentists' practices and attitudes toward using personal protection equipment and associated drawbacks and cost implications during the COVID-19 pandemic". *Frontiers in Public Health* 9 (2021): 770164.

30. Carling PC and Bartley JM. "Evaluating hygienic cleaning in health care settings: what you do not know can harm your patients". *American Journal of Infection Control* 38 (2010): S41-S50.

31. Boyce JM., *et al*. "Variations in hospital daily cleaning practices". *Infection Control and Hospital Epidemiology* 31 (2010): 99-101.

32. Rutala WA and Weber DJ. "Disinfectants used for environmental disinfection and new room decontamination technology". *American Journal of Infection Control* 41 (2013): S36-S41.

33. Donskey CJ. "Does improving surface cleaning and disinfection reduce health care-associated infections?" *American Journal of Infection Control* 41 (2013): S12-S19.

34. Dancer SJ. "Controlling hospital-acquired infection: focus on the role of the environment and new technologies for decontamination". *Clinical Microbiology Reviews* 27 (2014): 665-690.

35. Han JH., *et al*. "Cleaning hospital room surfaces to prevent health care-associated infections. a technical brief". *Annals of Internal Medicine* 163 (2015): 598-607.

36. Aponte Mendez M., *et al*. "Dental care for patients during the Covid-19 outbreak: a literature review". *International Journal of Scientific Research in Dental and Medical Sciences* 2.2 (2020): 42-45.

37. Peng X., *et al*. Transmission routes of 2019-nCoV and controls in dental (2020).

38. Izzetti R., *et al*. "COVID-19 Transmission in Dental Practice: Brief Review of Preventive Measures in Italy". *Journal of Dental Research* (2020).

39. Van Doremalen N., *et al*. "Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1". *The New England Journal of Medicine* 382 (2020): 1564-1567.

40. HC Yeh., *et al*. "Characterization of Aerosols Produced during Surgical Procedures in Hospitals". *Aerosol Science and Technology* 22.2 (1995): 151-161.

41. Banakar M., *et al*. "COVID-19 transmission risk and protective protocols in dentistry: a systematic review". *BMC Oral Health* 20.1 (2020): 1-2.

42. Karia R., *et al*. "COVID-19 and its modes of transmission". *SN Comprehensive Clinical Medicine* 2 (2020): 1798-1801.

Volume 19 Issue 6 June 2023
All rights reserved by Sameer Patil*., et al.*