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A Review on the Current Trends to Reduce Exposure to Bioaerosols in Operative Dentistry

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ABSTRACT

Aerosols and dentistry always go hand in hand. Aerosols are particles less than 50 μm in diameter and dentists are at high risk of infectious airborne diseases due to these aerosols. They are produced as a result of dental procedures using high speed handpiece, ultrasonic units, three way syringes etc. Covid -19 pandemic has fabricated new challenges to health care providers and increased their responsibilities towards society. During this time of crisis it is necessary for the dental professionals to safeguard themselves and also offer timely treatment to their patients. The current pandemic has opened a wide arena for additions and changes in the way dentists previously worked. Physical barriers such rubber dams, specially designed chambers and protective acrylic screens are used to avoid direct contact with aerosols. Air purification, filtration units along with fumigation and ventilation can be used to reduce the microbial load in air circulating within the operatories. This article reviews the current trends that are available to reduce bio aerosols in dental operatories that can be practically employed in day to day practice.

Keywords : Aerosols, COVID -19, rubber dam, physical barriers, filtration, treatment protocol

Introduction

Dentistry and aerosols are indivisible from each other. Aerosols are small particles of liquid or solid produced by animals or machines that are suspended in the air(Ahmad 2009). The frequent generation of aerosols in dental operatories has the potential of infection transmission to dental personnel(Belting, Haberfelde, and Juhl 1964; Harrel and Molinari 2004). Patients may harbour pathogenic microorganisms such as viruses or bacteria in their blood or air way. While treating such patients , aerosol generation could be a significant health hazard to the dentists and dental assistants since it may lead to causation of infectious disease such as influenza, tuberculosis, meningitis or severe acute respiratory syndromes(Feres et al. 2010),(Bennett et al. 2000). A study showed that during dental procedures, the inner portion of the eye and regions around the nose were the severely contaminated areas of the face among the dentists and these could be a potential route of cross- infection(Nejatidanesh et al. 2013). According to the World Health Organisation (WHO) healthcare professionals have been strongly impacted by the COVID-19 pandemic, a disease caused by the coronavirus(Ashrae 2013). Majority of dental procedures require the use of a high speed handpiece or ultrasonics with water sprays. Exposure to blood and saliva along with aerosols produced during usage of high speed air turbines renders the dental professionals at higher risk to contract SARS-CoV-2 (Bentley, Burkhart, and Crawford 1994),(Rivera-Hidalgo, Barnes, and Harrel 1999),(Toroğlu, Haytaç, and Köksal 2001). With the release of bio aerosols the microbial load of air increases leading to contamination of all surfaces in the dental operatory (Zemouri et al. 2020) (Figure 1). According to a recent study, despite having high knowledge, dentists worldwide are in a state of anxiety to work during the COVID-19 pandemic (Ahmed et al. 2020). There is a need to employ additional infection control methods to prevent the disease spread during this time of

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pandemic(Bescos et al. 2020; Meng, Hua, and Bian 2020). Our team has a copious experience in working on various research projects across multiple disciplines (Govindaraju and Gurunathan 2017; A. Christabel et al. 2016; Soh and Narayanan 2013; Mehta et al. 2019; Ezhilarasan, Apoorva, and Ashok Vardhan 2019a; Campeau et al. 2014; Kumar and S 2016; S. L. Christabel 2015; Kumar and Rahman 2017; Sridharan, Ramani, and Patankar 2017; Ramesh et al. 2016; Thamaraiselvan et al. 2015; Thangaraj et al. 2016; Ponnulakshmi et al. 2019; "Fluoride, Fluoridated Toothpaste Efficacy and Its Safety in Children - Review" 2018) Now the growing trend in this area motivated us to pursue this project. Our institution is passionate about high quality evidence based research and has excelled in various fields (JayaseelanVijayashreePriyadharsini 2019; Pc, Marimuthu, and Devadoss 2018; Ramesh et al. 2018; Ramadurai et al. 2019; Sridharan et al. 2019; Ezhilarasan, Apoorva, and Ashok Vardhan 2019b; Mathew et al. 2020; Samuel 2021; R et al. 2020; Chandrasekar et al. 2020; J. VijayashreePriyadharsini, SmilineGirija, and Paramasivam 2018). The aim of this article is to review the current trends used to reduce bio- aerosols in operative dentistry.

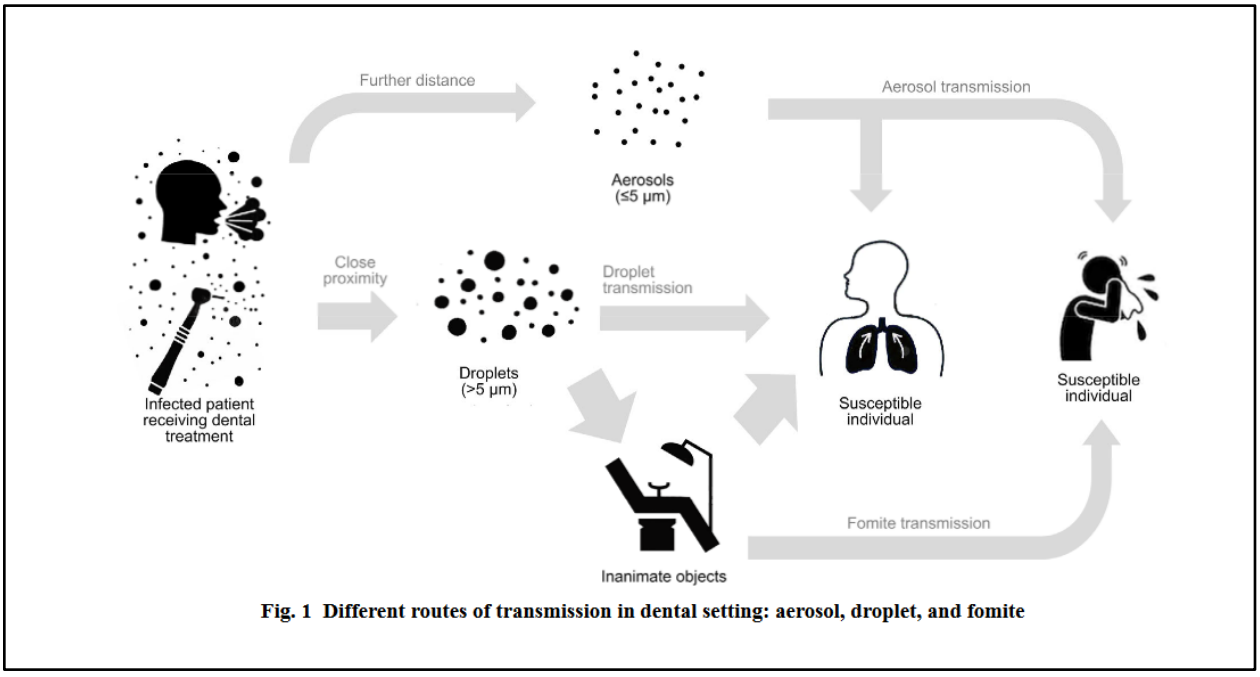

Fig. 1 Different routes of transmission in dental setting: aerosol, droplet, and fomite

Figure 1: Different routes of transmission in dental setting (Ge et al. 2020)

Physical Barriers To Reduce Splatter of Bio-Aerosols

The center for Disease Control and Prevention (CDC) recommends all the dental health care providers to use Personal Protective Equipment (PPE) such as masks, gloves, goggles and gowns to cover their skin and mucous membrane of nose, mouth and eye and also use physical barriers to cover the clinical surfaces to reduce the exposure to pathological microorganisms("The Effect of Rubber Dam on Atmospheric Bacterial Aerosols during Restorative Dentistry" 2017).

Rubber Dam

In 1864, Dr Sanford C. Barnum introduced rubber dams to the dentistry(Elderton 1971). The rubber dam is made of stretchable latex material and used to isolate the tooth or teeth from the other oral tissues and saliva. Rubber dam usage is considered as a standard practice in operative dentistry and endodontics world wide. The three main advantages of using rubber dams during endodontic treatment are control in cross infection, protection and better treatment efficiency and success rates(Ahmad 2009). Use of rubber dams has shown to reduce the bioaerosols and also microbial contamination of the PPE of the dentists and the assistants such as gloves by 98.5% (Samaranayake, Reid, and Evans 1989; Marshall 2017). There was a significant reduction in microbial load in aerosols generated during dental procedures with the usage of rubber dams (Cochran, Miller, and Sheldrake 1989),(Samaranayake, Reid, and Evans 1989).To reduce the bio aerosols in dental operatories The Center for Disease Control and

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Prevention also recommends the use of rubber dams ("Guidelines for Infection Control in Dental Health-Care Settings - 2003" 2003).

The device with the aspiration and filtering system

The main aim of this system is to attenuate the aerosol emission in dental operatories, by isolating the patient in an 'internal environment' and the operator in an 'external environment'. The operator can perform the procedures by accessing the oral cavity of the patient through three holes whereas the chamber made of translucent acrylic material acts as a barrier between the operator and the patient. Translucent flexible polyvinyl chloride (PVC) films are used to cover the orifices of the three holes and also the back of the device instead of rigid acrylic so that the patient can lean comfortably on the chair and at the same time the chair is being protected from contamination(Figure 2). This device contains an aspiration system in which the air from the chamber passes through an antiseptic solution (2% NaOCl) placed in a box externally to reduce the viable microorganisms and toxic particles prior to the return of the air to the external environment (Figure 2). While testing the device it was found that the contamination was restricted to surgical gloves, aprons, interior of the pipe system and internal walls of the acrylic chamber. The contamination was less compared to the treatment done without this device. The disadvantage of using this system was that the movements were confined and the visualization by the dentists were limited during the operative procedures (Teichert-Filho et al. 2020).

Figure 2: Device with the Aspiration and Filtering System

Microscope with Shield

In this setting, a clear polycarbonate disk with two holes, one for the DOM objective lens of microscope and one for the exhaust hose, is used as a barrier between the operator and the patient. There was increased exhaust of air through the vacuum hose inlet hence reducing the dispersion of the contaminated air. This device along with PPE can offer increased protection from the aerosols (Russell 2020).

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Figure 3: Microscope with Polycarbonate Shield and Exhaust

Modifications In Treatment Protocol

Preprocedural Mouthrinses

Several researches suggest that usage of antimicrobial oral rinse by patients before dental treatment decreases microbial aerosols.(Stirrups 1987)(Stirrups 1987; Orton 1987). In terms of pre procedural mouth rinses Chlorhexidine(CHX) is considered the gold standard due to its broad-spectrum antibacterial activity. It was found that 0.05 percent CPC was as effective as CHX in reducing the levels of bio-spatter generated during dental procedures (Feres et al. 2010),(Goyal, n.d.). Povidone-iodine, especially 0.23% for a minimum of 15 seconds is capable of reducing viral load in saliva and is highly recommended in dentistry(Spagnuolo et al. 2020)(Eggers et al. 2018).

Radiographs

Dental professionals can use extraoral dental radiographs namely panoramic radiographs or Cone Beam Computed Tomography(CBCT) during the COVID-19 pandemic instead of intraoral dental radiographs which can stimulate saliva secretion and cough(Parihar et al.2020).

Carious lesions which are asymptomatic without the pulpal involvement can be treated by one of the following ways to reduce aerosols that are produced by the conventional methods.

Chemo Mechanical Caries Removal (CMCR) Agents

Chemico mechanical method of caries removal is considered an effective alternative to conventional caries removal by rotary as it is atraumatic with bactericidal or bacteriostatic properties(Bussadori, Castro, and Galvão 2005) . In previous studies it was shown that Papacarie, a chemical caries removal agent containing papain and chloramine had bactericidal, bacteriostatic and antiinflammatory characteristics and it was also effective in removal of infected dentin while preserving deeper layers of affected dentin (Bussadori et al. 2014), (Hafez et al. 2017). Several clinical trials have been carried out using chemical caries removal agents such as Caridex in all classes of coronal lesions, cervical lesions and root caries in both deciduous and permanent teeth. It has been reported that teeth with complete removal of carious lesions in dentin ranged from 42–100% using chemo mechanical method(Yip, Stevenson, and Beeley 1995).(Figure 4)

Atraumatic Restorative Technique

This method was introduced in mid 1980s to provide dental health care for disadvantaged population in underdeveloped countries(Frencken et al. 1996).This technique utilises spoon excavator to remove the possible soft caries to the required depth for the stable placement of restoration preferably Glass ionomer Cement(GIC) (Lakhani et al. 2020; Bussadori, Castro, and Galvão 2005). ART is a minimally invasive treatment thus producing a minimal amount of aerosol as the use of high speed handpieces are not required (Cagetti and Angelino 2020).

The carious lesion can be arrested preventing further progression of caries with the application of Silver Diamine Fluoride (SDF) without removing any carious tissue owing to its bactericidal and fluoride releasing property (Horst, Ellenikiotis, and Milgrom 2017). No further restoration is usually required after SDF application. If food lodgment occurs then GIC/ Resin Modified GIC restorative material can be placed over the SDF treated carious dentin. This is referred to as Silver Modified Atraumatic Restorative Technique (SMART) (Nuvvula and Mallineni 2019). In case of restoration with composite resins, self-etch bonds are preferred in order to minimize the use of a three way syringe to wash off excess etchant prior to bonding(Kao 1991).

Caries involving the pulp

Slow speed micromotor handpiece without water spray, chemomechanical caries excavation with a spoon excavator or high speed anti retraction handpiece that reduce the back flow of microbes into handpiece and dental unit can be used until pulp is exposed to minimize aerosols and single visit root canal treatment can be done to reduce the appointments (Casamassimo, Townsend, and Litch 2020)(Hu et al. 2007) .

Post Endodontic Restorations

Endodontically treated, non vital teeth are prone to biomechanical failure compared to vital teeth due to loss of tooth structure owing to carious lesions and/or cavity preparation (Sedgley & Messer 1992)(Tamse*et al.* 1999). Composite resin monoblocking and Hall's technique can be used as an alternative to full coverage crowns made of metal-ceramic which will need high speed handpiece causing aerosol production (Lakhani et al. 2020).

Mechanical Aerosol Reduction And Filtration Systems

Increasing ventilation rates, creating negative pressure isolation rooms, and installation of high-efficiency air filters, will minimize aerosols in the dental operatories, thus preventing cross infection("Use of Negative Pressure Isolation in the Provision of Dental Care" 2020).

Negative pressure Isolation

CDC recommends an isolation room with negative pressure to perform dental treatments(Brian et al.2020). In a negative pressure room the exhausted air must exceed the supplied air with a least pressure difference of 0.01 inch water gauge to sustain a negative pressure room. In this setting the air flow should be channeled from cleaner non operative areas to operative, isolation areas to prevent cross-contamination. Several previous studies have shown airflow directed through a negative pressure isolation room is a preferred model to protect dental professionals from being exposed to infectious respiratory diseases (Chen et al. 2010; Cheong and Phua 2006; Brian et al.2020)(Zhao, Liu, and Chen 2020; Chartier and Pessoa-Silva 2009). The exhausted air is funneled to the outside of the building or the exhaust is driven through HEPA filters before recirculation(Lee 2016).

High Volume Evacuators (HVE)

Suction system with a large opening is attached to an evacuation system that removes a large volume of air around 100 cubic feet of air per minute and reduces the operative site contamination by more than 90% (Kobza, Pastuszka, and Brągoszewska 2018). Currently in dental practice, Extra-Oral Vacuum Aspirator (EOVA) are used for protection against air contaminants splattered from the oral cavity without being dispersed into the environment (Suyama et al. 1995)**.**

Air filtration and purification

Indoor air purification units are used to remove all water mist and splatter from the mouth and to filter and disinfect the aerosols thereby protecting the environment and dental professionals (Zhao, Liu, and Chen 2020).

HEPA filter

High-Efficiency Particulate Air (HEPA) filter is used to entrap ultrafine particles including bacteria and viruses. These filters can be integrated with the air conditioning unit and used to filter the air prior to recirculation. Apart from HEPA filters Ultra Low Particulate Air (ULPA) Filters can be used for air purification.
(Lakhani et al. 2020)(Liu et al. 2017) .

Ultraviolet light (UV)
UV light at an intensity of 1210uw/cm2 and wavelength 280 nm is capable of killing viruses by breaking the genome of the virus and inactivating them(Dziedzic, Tanasiewicz, and Tysiąc-Miśta 2020), (Botta et al. 2020). It is recommended to irradiate the treatment chamber and the instruments used using UV for 15 minutes (Parihar et al.2020).

Fumigation
Fumigation is the technique of choice for disinfection of large spaces like dental operatories and in the presence of numerous equipment which are difficult to disinfect individually. Formaldehyde was the most frequently used fumigant for years but recently their use has substantially reduced due to their carcinogenic nature(McDonnell 2006). Recently hydrogen peroxide vapour (HPV) either as vapor or aerosol is used as fumigant to disinfect hospitals and operatories (Beswick et al. 2011)(Kümin et al. 2020). Nebulizer or fogging systems generate fumigant mist which is dispersed through the nozzle.

Ventilation
Indoor ventilation and airflow is of great importance in dental operatories which can be achieved by natural ventilation or a mechanical system. Fresh air continuously supplied to the treatment chamber by opening windows can dilute the virus laden contaminated air. Adequate ventilation in dental clinics especially during the current Covid pandemic plays a very vital role in controlling the spread of infection.

Conclusion

The entire world is coping with the new normal at the present time of Covid pandemic. Dental professionals are at higher risk of air borne infectious diseases due to usage of high speed air turbines and scalers that produce bioaerosols. Hence it is top priority of the dental professionals to safeguard themselves and as well offer uncompromised treatment to their patients. Dentists have to vigorously follow the existing safety measures along with modification in treatment protocols, addition of special filtration and air purification to reduce the aerosols in the dental operatories to face the current challenge and help in preventing the spread of Sars-Cov-2.

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References

[1] Ahmad, I. A. 2009. “Rubber Dam Usage for Endodontic Treatment: A Review.” *International Endodontic Journal* 42 (11): 963–72.
[2] Ahmed, Muhammad Adeel, Rizwan Jouhar, Naseer Ahmed, Samira Adnan, Marziya Aftab, Muhammad Sohail Zafar, and Zohaib Khurshid. 2020. “Fear and Practice Modifications among Dentists to Combat Novel Coronavirus Disease (COVID-19) Outbreak.” *International Journal of Environmental Research and Public Health* 17 (8). https://doi.org/10.3390/ijerph17082821.
[3] Ashrae. 2013. *HVAC Design Manual for Hospitals and Clinics*. Ashrae.
[4] Belting, C. M., G. C. Haberfelde, and L. K. Juhl. 1964. “SPREAD OF ORGANISMS FROM DENTAL AIR ROTOR.” *Journal of the American Dental Association* 68 (May): 648–51.
[5] Bennett, A., M. Fulford, J. Walker, D. Bradshaw, M. Martin, and P. Marsh. 2000. “Microbial Aerosols in General Dental Practice.” *British Dental Journal*. https://doi.org/10.1038/sj.bdj.4800859a.
[6] Bentley, C. D., N. W. Burkhart, and J. J. Crawford. 1994. “Evaluating Spatter and Aerosol Contamination during Dental Procedures.” *Journal of the American Dental Association* 125 (5): 579–84.
[7] Bescos, R., P. Casas-Agustench, L. Belfield, Z. Brookes, and T. Gabaldón. 2020. “Coronavirus Disease 2019 (COVID-19): Emerging and Future Challenges for Dental and Oral Medicine.” *Journal of Dental Research*.
[8] Beswick, Alan J., J. Farrant, C. Makison, J. Gawn, G. Frost, B. Crook, and J. Pride. 2011. “Comparison of Multiple Systems for Laboratory Whole Room Fumigation.” *Applied Biosafety*. https://doi.org/10.1177/153567601101600303.
[9] Botta, Sergio Brossi, Fernanda De Sá Teixeira, Fernando Seishim Hanashiro, Wagner Wlysses Rodrigues

de Araújo, Alessandra Cassoni, and Maria Cecilia Barbosa da Silveira Salvadori. 2020. "Ultraviolet-C Decontamination of a Dental Clinic Setting: Required Amount of UV Light." *Brazilian Dental Science*. https://doi.org/10.14295/bds.2020.v23i2.2275.

[10] Bussadori, Sandra Kalil, Laura Camacho Castro, and Ana Claudia Galvão. 2005. "Papain Gel: A New Chemo-Mechanical Caries Removal Agent." *The Journal of Clinical Pediatric Dentistry* 30 (2): 115–19.

[11] Bussadori, Sandra Kalil, Camila Haddad Leal de Godoy, Thays Almeida Alfaya, Kristianne Porta Santos Fernandes, Raquel Agnelli Mesquita-Ferrari, and Lara Jansiski Motta. 2014. "Chemo-Mechanical Caries Removal with Papacarie™: Case Series with 84 Reports and 12 Months of Follow-Up." *The Journal of Contemporary Dental Practice* 15 (2): 250–53.

[12] Cagetti, Maria Grazia, and Eleonora Angelino. 2020. "Could SARS‐CoV‐2 Burst the Use of Non‐Invasive and Minimally Invasive Treatments in Paediatric Dentistry?" *International Journal of Paediatric Dentistry*. https://doi.org/10.1111/ipd.12679.

[13] Campeau, Philippe M., Dalia Kasperaviciute, James T. Lu, Lindsay C. Burrage, Choel Kim, Mutsuki Hori, Berkley R. Powell, et al. 2014. "The Genetic Basis of DOORS Syndrome: An Exome-Sequencing Study." *Lancet Neurology* 13 (1): 44–58.

[14] Casamassimo, Paul S., Janice A. Townsend, and C. Scott Litch. 2020. "Pediatric Dentistry During and After COVID-19." *Pediatric Dentistry* 42 (2): 87–90.

[15] Chandrasekar, Raghavan, Shyamala Chandrasekhar, K. K. ShanthaSundari, and Poornima Ravi. 2020. "Development and Validation of a Formula for Objective Assessment of Cervical Vertebral Bone Age." *Progress in Orthodontics* 21 (1): 38.

[16] Chartier, Y., and C. L. Pessoa-Silva. 2009. *Natural Ventilation for Infection Control in Health-Care Settings*. World Health Organization.

[17] Chen, Chun, Bin Zhao, Weilin Cui, Lei Dong, Na An, and Xiangying Ouyang. 2010. "The Effectiveness of an Air Cleaner in Controlling Droplet/aerosol Particle Dispersion Emitted from a Patient's Mouth in the Indoor Environment of Dental Clinics." *Journal of The Royal Society Interface*. https://doi.org/10.1098/rsif.2009.0516.

[18] Cheong, K. W. D., and S. Y. Phua. 2006. "Development of Ventilation Design Strategy for Effective Removal of Pollutant in the Isolation Room of a Hospital." *Building and Environment*. https://doi.org/10.1016/j.buildenv.2005.05.007.

[19] Christabel, A., P. Anantanarayanan, P. Subash, C. L. Soh, M. Ramanathan, M. R. Muthusekhar, and V. Narayanan. 2016. "Comparison of Pterygomaxillary Dysjunction with Tuberosity Separation in Isolated Le Fort I Osteotomies: A Prospective, Multi-Centre, Triple-Blind, Randomized Controlled Trial." *International Journal of Oral and Maxillofacial Surgery* 45 (2): 180–85.

[20] Christabel, S. Linda. 2015. "Prevalence of Type of Frenal Attachment and Morphology of Frenum in Children, Chennai, Tamil Nadu." *World Journal of Dentistry* 6 (4): 203–7.

[21] Cochran, M. A., C. H. Miller, and M. A. Sheldrake. 1989. "The Efficacy of the Rubber Dam as a Barrier to the Spread of Microorganisms during Dental Treatment." *Journal of the American Dental Association* 119 (1): 141–44.

[22] Dziedzic, Arkadiusz, Marta Tanasiewicz, and Monika Tysiąc-Miśta. 2020. "Dental Care Provision during Coronavirus Disease 2019 (COVID-19) Pandemic: The Importance of Continuous Support for Vulnerable Patients." *Medicina* 56 (6). https://doi.org/10.3390/medicina56060294.

[23] Eggers, Maren, TorstenKoburger-Janssen, Markus Eickmann, and Juergen Zorn. 2018. "In Vitro Bactericidal and Virucidal Efficacy of Povidone-Iodine Gargle/Mouthwash Against Respiratory and Oral Tract Pathogens." *Infectious Diseases and Therapy* 7 (2): 249–59.

[24] Elderton, R. J. 1971. "A Modern Approach to the Use of Rubber Dam. 3." *The Dental Practitioner and Dental Record* 21 (8): 267–73.

[25] Ezhilarasan, Devaraj, Velluru S. Apoorva, and Nandhigam Ashok Vardhan. 2019a. "SyzygiumCumini Extract Induced Reactive Oxygen Species-Mediated Apoptosis in Human Oral Squamous Carcinoma Cells." *Journal of Oral Pathology & Medicine: Official Publication of the International Association of Oral Pathologists and the American Academy of Oral Pathology* 48 (2): 115–21.

[26] 2019b. "SyzygiumCumini Extract Induced Reactive Oxygen Species-Mediated Apoptosis in Human Oral Squamous Carcinoma Cells." *Journal of Oral Pathology & Medicine: Official Publication of the International Association of Oral Pathologists and the American Academy of Oral Pathology* 48 (2): 115–21.

[27] Feres, Magda, Luciene Cristina Figueiredo, Marcelo Faveri, Bernal Stewart, and William de Vizio. 2010. "The Effectiveness of a Preprocedural Mouthrinse Containing Cetylpyridinium Chloride in Reducing Bacteria in the Dental Office." *Journal of the American Dental Association* 141 (4): 415–22.

[28] "Fluoride, Fluoridated Toothpaste Efficacy and Its Safety in Children - Review." 2018. *International Journal of Pharmaceutical Research* 10 (04). https://doi.org/10.31838/ijpr/2018.10.04.017.
[29] Frencken, J. E., T. Pilot, Y. Songpaisan, and P. Phantumvanit. 1996. "Atraumatic Restorative Treatment (ART): Rationale, Technique, and Development." *Journal of Public Health Dentistry* 56 (3 Spec): 135–40; discussion 161–63.
[30] Ge, Zi-Yu, Lu-Ming Yang, Jia-Jia Xia, Xiao-Hui Fu, and Yan-Zhen Zhang. 2020. "Possible Aerosol Transmission of COVID-19 and Special Precautions in Dentistry." *Journal of Zhejiang University-SCIENCE B*. https://doi.org/10.1631/jzus.b2010010.
[31] Govindaraju, Lavanya, and Deepa Gurunathan. 2017. "Effectiveness of Chewable Tooth Brush in Children-A Prospective Clinical Study." *Journal of Clinical and Diagnostic Research: JCDR* 11 (3): ZC31–34.
[32] Goyal, Chhaju Ram. n.d. "A Clinical Study to Assess the Efficacy of a New Oral Hygiene System in the Reduction of Gingivitis and Dental Plaque." *Http://isrctn.com/*. https://doi.org/10.1186/isrctn99297838.
[33] "Guidelines for Infection Control in Dental Health-Care Settings - 2003." 2003. *PsycEXTRA Dataset*. https://doi.org/10.1037/e545872006-001.
[34] Hafez, Marwa Abdel, Mona Elkateb, Sonia El Shabrawy, Amel Mahmoud, and Omar El Meligy. 2017. "Microleakage Evaluation of Composite Restorations Following Papain-Based Chemo-Mechanical Caries Removal in Primary Teeth." *The Journal of Clinical Pediatric Dentistry* 41 (1): 53–61.
[35] Harrel, Stephen K., and John Molinari. 2004. "Aerosols and Splatter in Dentistry." *The Journal of the American Dental Association*. https://doi.org/10.14219/jada.archive.2004.0207.
[36] Horst, Jeremy A., Hellene Ellenikiotis, and Peter M. Milgrom. 2017. "UCSF Protocol for Caries Arrest Using Silver Diamine Fluoride: Rationale, Indications and Consent." *Pennsylvania Dental Journal* 84 (1): 14, 16–26.
[37] Hu, Tao, Gang Li, Yuling Zuo, and Xuedong Zhou. 2007. "Risk of Hepatitis B Virus Transmission via Dental Handpieces and Evaluation of an Anti-Suction Device for Prevention of Transmission." *Infection Control and Hospital Epidemiology: The Official Journal of the Society of Hospital Epidemiologists of America* 28 (1): 80–82.
[38] Kao, Elizabeth C. 1991. "Fracture Resistance of Pin-Retained Amalgam, Composite Resin, and Alloy-Reinforced Glass Ionomer Core Materials." *The Journal of Prosthetic Dentistry*. https://doi.org/10.1016/0022-3913(91)90506-r.
[39] Kobza, J., J. S. Pastuszka, and E. Brągoszewska. 2018. "Do Exposures to Aerosols Pose a Risk to Dental Professionals?" *Occupational Medicine*. https://doi.org/10.1093/occmed/kqy095.
[40] Kumar, Santhosh, and Reshma Rahman. 2017. "Knowledge, Awareness, and Practices Regarding Biomedical Waste Management among Undergraduate Dental Students." *Asian Journal of Pharmaceutical and Clinical Research* 10 (8): 341.
[41] Kumar, Santhosh, and Sneha S. 2016. "Knowledge and Awareness Regarding Antibiotic Prophylaxis for Infective Endocarditis among Undergraduate Dental Students." *Asian Journal of Pharmaceutical and Clinical Research*, September, 154.
[42] Kümin, Daniel, Monika Gsell Albert, Benjamin Weber, and Kathrin Summermatter. 2020. "The Hitchhiker's Guide to Hydrogen Peroxide Fumigation, Part 2: Verifying and Validating Hydrogen Peroxide Fumigation Cycles." *Applied Biosafety*. https://doi.org/10.1177/1535676020921099.
[43] Lakhani, Bhanu P., Apoorva Sharma, Varun Sanwalka, and Pulkit Lakhani. 2020. "Aerosol Reduction In Dentistry: Minimizing Risk Of Covid 19." *European Journal of Medical and Health Sciences*. https://doi.org/10.24018/ejmed.2020.2.3.294.
[44] Lee, Ji Yeon. 2016. "Tuberculosis Infection Control in Health-Care Facilities: Environmental Control and Personal Protection." *Tuberculosis and Respiratory Diseases* 79 (4): 234–40.
[45] Liu, Guoliang, Manxuan Xiao, Xingxing Zhang, Csilla Gal, Xiangjie Chen, Lin Liu, Song Pan, Jinshun Wu, Llewellyn Tang, and Derek Clements-Croome. 2017. "A Review of Air Filtration Technologies for Sustainable and Healthy Building Ventilation." *Sustainable Cities and Society*. https://doi.org/10.1016/j.scs.2017.04.011.
[46] Marshall, K. 2017. "'Dam It – It's Easy!' – or Is It?" *British Dental Journal*. https://doi.org/10.1038/sj.bdj.2017.489.
[47] Mathew, Mebin George, S. R. Samuel, Ashu Jagdish Soni, and Korishettar Basavaraj Roopa. 2020. "Evaluation of Adhesion of Streptococcus Mutans, Plaque Accumulation on Zirconia and Stainless Steel Crowns, and Surrounding Gingival Inflammation in Primary Molars: Randomized Controlled Trial." *Clinical Oral Investigations*, 1–6.

[48] McDonnell, G. 2006. "Hydrogen Peroxide Fogging/fumigation." *The Journal of Hospital Infection*.
[49] Mehta, Meenu, Deeksha, Devesh Tewari, Gaurav Gupta, Rajendra Awasthi, Harjeet Singh, Parijat Pandey, et al. 2019. "Oligonucleotide Therapy: An Emerging Focus Area for Drug Delivery in Chronic Inflammatory Respiratory Diseases." *Chemico-Biological Interactions* 308 (August): 206–15.
[50] Meng, L., F. Hua, and Z. Bian. 2020. "Coronavirus Disease 2019 (COVID-19): Emerging and Future Challenges for Dental and Oral Medicine." *Journal of Dental Research*. https://doi.org/10.1177/0022034520914246.
[51] Nejatidanesh, Farahnaz, ZeynabKhosravi, Hossein Goroohi, Hamid Badrian, and Omid Savabi. 2013. "Risk of Contamination of Different Areas of Dentist's Face During Dental Practices." *International Journal of Preventive Medicine* 4 (5): 611–15.
[52] https://www.oraljournal.com/pdf/2020/vol6issue2/PartF/6-2-43-203.pdf.
———. n.d. Accessed April 18, 2021b. https://www.oraljournal.com/pdf/2020/vol6issue2/PartF/6-2-43-203.pdf.
[53] Nuvvula, Sivakumar, and Sreekanth Kumar Mallineni. 2019. "Silver Diamine Fluoride in Pediatric Dentistry." *Journal of South Asian Association of Pediatric Dentistry*. https://doi.org/10.5005/jp-journals-10077-3024.
[54] Orton, G. S. 1987. "Clinical Use of an Air-Powder Abrasive System." *Dental Hygiene* 61 (11): 513–18.
[55] Pc, J., T. Marimuthu, and P. Devadoss. 2018. "Prevalence and Measurement of Anterior Loop of the Mandibular Canal Using CBCT: A Cross Sectional Study." *Clinical Implant Dentistry and Related Research*. https://europepmc.org/article/med/29624863.
[56] Ponnulakshmi, R., B. Shyamaladevi, P. Vijayalakshmi, and J. Selvaraj. 2019. "In Silico and in Vivo Analysis to Identify the Antidiabetic Activity of Beta Sitosterol in Adipose Tissue of High Fat Diet and Sucrose Induced Type-2 Diabetic Experimental Rats." *Toxicology Mechanisms and Methods* 29 (4): 276–90.
[57] Ramadurai, Neeraja, Deepa Gurunathan, A. Victor Samuel, Emg Subramanian, and Steven J. L. Rodrigues. 2019. "Effectiveness of 2% Articaine as an Anesthetic Agent in Children: Randomized Controlled Trial." *Clinical Oral Investigations* 23 (9): 3543–50.
[58] Ramesh, Asha, Sheeja Varghese, Nadathur D. Jayakumar, and SankariMalaiappan. 2018. "Comparative Estimation of Sulfiredoxin Levels between Chronic Periodontitis and Healthy Patients - A Case-Control Study." *Journal of Periodontology* 89 (10): 1241–48.
[59] Ramesh, Asha, SheejaSaji Varghese, Jayakumar NadathurDoraiswamy, and SankariMalaiappan. 2016. "Herbs as an Antioxidant Arsenal for Periodontal Diseases." *Journal of Intercultural Ethnopharmacology* 5 (1): 92–96.
[60] R, Hannah, R. Hannah, Pratibha Ramani, Arvind Ramanathan, Jancy Merlin R, S. Gheena, Abilasha Ramasubramanian, and K. Monika. 2020. "CYP2 C9 Polymorphism among Patients with Oral Squamous Cell Carcinoma and Its Role in Altering the Metabolism of Benzo[a]pyrene." *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology*. https://doi.org/10.1016/j.oooo.2020.06.021.
[61] Rivera-Hidalgo, F., J. B. Barnes, and S. K. Harrel. 1999. "Aerosol and Splatter Production by Focused Spray and Standard Ultrasonic Inserts." *Journal of Periodontology* 70 (5): 473–77.
[62] Russell, Cameron. 2020. "Development of a Device to Reduce Oropharyngeal Aerosol Transmission." *Journal of Endodontia* 46 (8): 1144–48.
[63] Samaranayake, L. P., J. Reid, and D. Evans. 1989. "The Efficacy of Rubber Dam Isolation in Reducing Atmospheric Bacterial Contamination." *ASDC Journal of Dentistry for Children* 56 (6): 442–44.
[64] Samuel, Srinivasan Raj. 2021. "Can 5-Year-Olds Sensibly Self-Report the Impact of Developmental Enamel Defects on Their Quality of Life?" *International Journal of Paediatric Dentistry / the British Paedodontic Society [and] the International Association of Dentistry for Children* 31 (2): 285–86.
[65] Soh, C. L., and V. Narayanan. 2013. "Quality of Life Assessment in Patients with Dentofacial Deformity Undergoing Orthognathic Surgery--a Systematic Review." *International Journal of Oral and Maxillofacial Surgery* 42 (8): 974–80.
[66] Spagnuolo, Gianrico, Danila De Vito, Sandro Rengo, and Marco Tatullo. 2020. "COVID-19 Outbreak: An Overview on Dentistry." *International Journal of Environmental Research and Public Health*. https://doi.org/10.3390/ijerph17062094.
[67] Sridharan, Gokul, Pratibha Ramani, and Sangeeta Patankar. 2017. "Serum Metabolomics in Oral Leukoplakia and Oral Squamous Cell Carcinoma." *Journal of Cancer Research and Therapeutics* 13 (3): 556–61.
[68] Sridharan, Gokul, Pratibha Ramani, Sangeeta Patankar, and Rajagopalan Vijayaraghavan. 2019. "Evaluation of Salivary Metabolomics in Oral Leukoplakia and Oral Squamous Cell Carcinoma." *Journal of*

Oral Pathology & Medicine: Official Publication of the International Association of Oral Pathologists and the American Academy of Oral Pathology 48 (4): 299–306.
[69] Stirrups, D. R. 1987. "Methods of Reducing Bacterial Contamination of the Atmosphere Arising from Use of an Air-Polisher." *British Dental Journal*163 (7): 215–16.
[70] Suyama, Y., T. Ozaki, S. Takaku, Y. Fukuzawa, H. Mochizuki, T. Ishii, and S. Yoshida. 1995. "Eliminating Effects of an Air Purifier on Infectants during Dental Procedure." *The Bulletin of Tokyo Dental College* 36 (1): 27–31.
[71] Teichert‐ Filho, R., C. N. Baldasso, M. M. Campos, and M. S. Gomes. 2020. "Protective Device to Reduce Aerosol Dispersion in Dental Clinics during the COVID‐ 19 Pandemic." *International Endodontic Journal*. https://doi.org/10.1111/iej.13373.
[72] Thamaraiselvan, Murugan, SugumariElavarasu, SuthanthiranThangakumaran, Jayaprakash SharanabasappaGadagi, and ThangaveluArthie. 2015. "Comparative Clinical Evaluation of Coronally Advanced Flap with or without Platelet Rich Fibrin Membrane in the Treatment of Isolated Gingival Recession." *Journal of Indian Society of Periodontology* 19 (1): 66–71.
[73] Thangaraj, SoundaraViveka, VidyaraniShyamsundar, Arvind Krishnamurthy, Pratibha Ramani, Kumaresan Ganesan, MuthulakshmiMuthuswami, and Vijayalakshmi Ramshankar. 2016. "Molecular Portrait of Oral Tongue Squamous Cell Carcinoma Shown by Integrative Meta-Analysis of Expression Profiles with Validations." *PloS One* 11 (6): e0156582.
[74] "The Effect of Rubber Dam on Atmospheric Bacterial Aerosols during Restorative Dentistry." 2017. *Journal of Infection and Public Health* 10 (2): 195–200.
[75] Toroğlu, M. S., M. C. Haytaç, and F. Köksal. 2001. "Evaluation of Aerosol Contamination during Debonding Procedures." *The Angle Orthodontist* 71 (4): 299–306.
[76] "Use of Negative Pressure Isolation in the Provision of Dental Care." 2020. April 13, 2020. https://dimensionsofdentalhygiene.com/negative-pressure-isolation-provision-dental-care/.
[77] VijayashreePriyadharsini, Jayaseelan. 2019. "In Silico Validation of the Non-Antibiotic Drugs Acetaminophen and Ibuprofen as Antibacterial Agents against Red Complex Pathogens." *Journal of Periodontology* 90 (12): 1441–48.
[78] VijayashreePriyadharsini, J., A. S. SmilineGirija, and A. Paramasivam. 2018. "In Silico Analysis of Virulence Genes in an Emerging Dental Pathogen A. Baumannii and Related Species." *Archives of Oral Biology* 94 (October): 93–98.
[79] "Website." n.d. Accessed September 13, 2020a. https://www.cdc.gov/coronavirus/2019-ncov/hcp/dental-settings.html.
———. n.d. Accessed September 13, 2020b. https://www.cdc.gov/niosh/hhe/reports/pdfs/2010-0092-3188.pdf.
[80] Yip, H. K., A. G. Stevenson, and J. A. Beeley. 1995. "An Improved Reagent forChemomechanical Caries Removal in Permanent and Deciduous Teeth: An in Vitro Study." *Journal of Dentistry* 23 (4): 197–204.
[81] Zemouri, C., C. M. C. Volgenant, M. J. Buijs, W. Crielaard, N. A. M. Rosema, B. W. Brandt, A. M. G. A. Laheij, and J. J. De Soet. 2020. "Dental Aerosols: Microbial Composition and Spatial Distribution." *Journal of Oral Microbiology* 12 (1): 1762040.
[82] Zhao, Bin, Yumeng Liu, and Chen Chen. 2020. "Air Purifiers: A Supplementary Measure to Remove Airborne SARS-CoV-2." *Building and Environment*. https://doi.org/10.1016/j.buildenv.2020.106918.

[83] Parihar A, Saxena A, Rawat A, Jain A. COVID–19: Influenced alteration in dental OPD management. infection. 2020;5:6.