Research

Aerosol Generating Procedures and Associated Control/Mitigation Measures: A position paper from the Canadian Dental Hygienists Association and the American Dental Hygienists' Association

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ABSTRACT

Background Since the outbreak of COVID-19, how to reduce the risk of spreading viruses and other microorganisms while performing aerosol generating procedures (AGPs) has become a challenging question within the dental and dental hygiene communities. The purpose of this position paper is to summarize the existing evidence about the effectiveness of various mitigation methods used to reduce the risk of infection transmission during AGPs in dentistry.

Methods The authors searched six databases, MEDLINE, EMBASE, Scopus, Web of Science, Cochrane Library, and Google Scholar, for relevant scientific evidence published in the last ten years (January 2012 to December 2022) to answer six research questions about the the aspects of risk of transmission, methods, devices, and personal protective equipment (PPE) used to reduce contact with microbial pathogens and limit the spread of aerosols.

Results A total of 78 studies fulfilled the eligibility criteria. There was limited literature to indicate the risk of infection transmission of SARS-CoV-2 between dental hygienists and their patients. A number of mouthrinses are effective in reducing bacterial contaminations in aerosols; however, their effectiveness against SARS-CoV-2 was limited. The combined use of eyewear, masks, and face shields are effective for the prevention of contamination of the facial and nasal region, while performing AGPs. High volume evacuation with or without an intraoral suction, low volume evacuation, saliva ejector, and rubber dam (when appropriate) have shown effectiveness in reducing aerosol transmission beyond the generation site. Finally, the appropriate combination of ventilation and filtration in dental operatories are effective in limiting the spread of aerosols.

Conclusion Aerosols produced during clinical procedures can potentially pose a risk of infection transmission between dental hygienists and their patients. The implementation of practices supported by available evidence are best practices to ensure patient and provider safety in oral health settings. More studies in dental clinical environment would shape future practices and protocols, ultimately to ensure safe clinical care delivery.

Keywords aerosol generating procedures, infectious disease transmission, respiratory aerosols and droplets, personal protective equipment, mouthrinses, SARS-CoV-2, COVID-19

NDHRA priority area **Professional development: Occupational health** (determination and assessment of risks).

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Position Statement of the American and Canadian Dental Hygienists' Associations

No outbreaks of SARS-CoV-2 have been reported in dental practices or within their patient population during the pandemic. Nonetheless, despite the low risk of transmission of SARS-CoV-2 in dental settings, the possibility still exists, until proven otherwise. In light of the available evidence, the following recommendations are made to lower the risk of cross-contamination between dental hygienist and their patients while performing AGPs. Preprocedural mouthrinses are recommended to reduce the level of bacterial and viral contamination in aerosols generated albeit with very limited trial evidence after the use of AGPs for the latter. It is also recommended to use high volume evacuation with or without an intraoral suction, low volume evacuation, saliva ejector, and rubber dam (when appropriate) to reduce the aerosols generated. The combined use of protective eyewear and face shields as well as the use of ventilation and filtration systems in conjunction with aerosol scavenging systems are recommended to prevent the contamination of the facial and nasal regions when performing AGPs. Finally, in case of enclosed spaces, and with sufficient air ventilation, a fallow time of 10 minutes or less can be enough for aerosols to completely settle.

INTRODUCTION

Aerosols can be defined as the suspension of solid or liquid particles in the air, which can be generated by either natural or anthropogenic phenomena, and may be present in different forms, such as fumes, mist, or dust.[1-3] Within healthcare settings, aerosol-generating procedures (AGPs) are described as any clinical procedures that lead to the production of respiratory aerosols or liquid particles of different sizes. These respiratory aerosols or liquid particles, depending on their size, may remain airborne for long periods of time.[4,5] In the wake of the Severe Acute Respiratory Syndrome (SARS) pandemic in 2003, health organizations used the term 'AGPs' to describe procedures that demonstrated a higher rate of infection among healthcare workers performing them.[6,7] As such, for medical practices, aerosol-generating medical procedures (AGMPs) was the initial common terminology.[1] Similarly, when applied to procedures specific to dental practices, the term became aerosol-generating dental procedures (AGDPs).[1,4] However, AGPs is the term commonly used today in the healthcare literature, including oral healthcare.

Owing to the nature of the dental practice, the generation of spray in the form of aerosols, droplets, droplet nuclei, spatter or splatter is common during various procedures.[8,9] When contaminated with saliva, these airborne particles may transmit pathogens from one individual to another through direct contact with uncovered skin or mucosa, or indirect contact via first settling on inanimate areas.[10,11] Therefore, the proximity of the oral health provider and patient during routine dental and dental hygiene procedures is a concern for infection transmission.[12,13] Usage of dental equipment such as handpieces (low or high speed), sonic and ultrasonic scalers, air polishers, electro-surgery units, and air/water syringes during routine procedures has been associated with significant aerosol generation, and in turn with the potential of infection transmission.[5,14]

There are no generally accepted terms and definitions of various forms of airborne matter and no clear delineations between terms frequently used in the field. One of the distinguishing criteria is the size of the matter particle; the smaller the size, the lighter it is, and more potential to stay airborne for a longer duration. Using the definitions developed by Micik and colleagues through their pioneering work in aerobiology in 1960s, the Centers for Disease Control and Prevention (CDC), and the World Health Organization (WHO), the various forms have been differentiated as follows:

- *Splatter:* Mixtures of airborne particles (air, water and/or solid) greater than 50 microns (μm) in diameter, which is visible to the naked eye. These

particles are often projectile in nature, and usually remain airborne for brief periods only.[8,15]

- *Spatter:* Mists that contains droplets that are up to 50 µm in diameter and are usually quick to settle.[4]
- *Aerosols:* Particles smaller than 50 µm in diameter.[16] These are often small enough to remain suspended in the air for longer before they enter the respiratory tract or settle on environmental surfaces.[8,16]
- *Droplets:* Inspirable particles larger than 5 µm in diameter.[8,15]
- *Droplet nuclei:* Residue of dried aerosols ≤ 5 µm in diameter that results from evaporation of droplets.[15,17] Droplet nuclei of 0.5 to 1µm in diameter are known to possess a higher risk of infection transmission in dental settings.[11,16]

Research in the past suggests that some diseases are known to spread via aerosols containing a variety of respiratory pathogens[8,9,18], including measles, influenza, and mycobacterium tuberculosis.[18–20] With the advent of COVID-19 pandemic, its spread through aerosols was a big question and dentistry being recognized as an aerosol generating profession, the importance of infection control and aerosol reduction in dental settings had become a crucial concern.[11,14] It is important to note that evidence demonstrating the risk of transmission of COVID-19 in dental settings remains limited and is still being explored.[14,18] A recent study by Rafiee et al. found that majority of operators' aerosol exposure came from other sources than the patients' saliva and nasal fluids suggesting a low risk of cross-contamination between operators and their patients in dental settings.[21] It is also worth noting that while sneezing, coughing, and even talking can generate respiratory droplets of various sizes, and can cause the spread of viral infections[22], this paper only focuses on the evidence of disease transmission via aerosol generating clinical procedures in dental settings.

The need for better understanding of Coronavirus transmission via AGPs in dental settings has been continuously recognized over the last three years, as dental hygiene care has experienced major disturbances in North America due to provincial and state restrictions placed on AGPs in oral healthcare settings. This prompted the exploration of the effectiveness of various methods of aerosol mitigation to control and minimize the risk of disease transmission when performing AGPs. As a result, there has been an influx of evidence advising on this topic with varying degrees of quality, contextual setting, study design, and methodological limitations. This outpour of knowledge has outpaced clinicians' ability to keep up with the current evidence on how to conduct AGPs in the safest manner possible. Finally, with most regulatory bodies lifting the COVID-19 mandated restrictions, many dental hygienists are still uncertain about the best practices that support safe care delivery.

This position paper aims to provide dental hygienists with timely, high-quality evidence based on scientific literature about infection control and disease transmission related to AGPs. The target audience will include but not just limited to dental hygienists practicing in clinical, public health, and educational settings. In addition, the information presented in this position paper will be essential for policymakers, regulators, healthcare provider organizations, clinicians, and the public to understand the considerations for AGPs in dental hygiene practice in accordance with infection prevention and control practices.

METHODS

Through a collaborative partnership with the Canadian Dental Hygienists Association (CDHA), the American Dental Hygienists' Association (ADHA), an ad-hoc AGPs Steering Committee, and the consulting team, the objectives of the research project were developed to synthesize information on AGPs that will inform dental hygiene practices. The research questions that dental hygienists would potentially be interested in knowing the answers to include the following questions: the risk of infection transmission associated with conducting AGPs, types and effectiveness of

preprocedural mouthrinses to reduce the microbial load of aerosols generated through AGPs, the effectiveness of dental evacuation systems, personal protective equipment (PPE) considerations for AGPs, operatory setups to control the spread of aerosols, and the fallow period following AGPs.

Therefore, the scope of this position paper was to address the aspects of risk of transmission, methods used to minimize the microbial count in aerosols, devices and PPE used to reduce contact with microbial pathogens, and operatory structures used to limit the spread of aerosols. Specifically, to provide information pertinent to the following research question(s) relevant to dental and dental hygiene practices with the aid of a PICO framework (Population, Intervention, Comparison, Outcome):

1. What is the risk of transmission of microbial pathogens between clinical dental hygienists performing AGPs and their patients?
2. Does the use of preprocedural mouthrinses reduce the count of microbial pathogens and/or the risk of infection transmission between dental hygienists performing AGPs and their patients?
3. Does the use of aerosol scavenging systems (e.g., intra and extraoral evacuation systems, high and low volume suction systems) limit the spread of aerosols and reduce the risk of infection transmission between dental hygienists performing AGPs and their patients?
4. What are the types and effectiveness of the personal protective equipment (PPE) used to reduce contact with aerosols and the risk of infection transmission between dental hygienists performing AGPs and their patients?
5. What should be the operatory setup criteria to limit the spread of aerosols in dental and dental hygiene settings?
6. What is the appropriate fallow time that allows aerosols to completely settle and reduce the risk of infection transmission between dental hygienists and their patients after performing AGPs?

Inclusion criteria

Six databases, MEDLINE, EMBASE, Scopus, Web of Science, Cochrane Library, and Google Scholar, were searched for relevant scientific evidence published in the last ten years (January 2012 to December 2022) using the search strategy outlined in Appendix 1. Due to the fast-evolving nature of science and technology, it was decided to limit the search to this 10-year period to ensure the suitability of evidence to current practices. Literature search for the 6 predefined PICO questions was conducted between October 15 and November 15, 2022. On December 20, the search was re-run for all the questions to ensure the inclusion of any new literature. The search was limited to studies published in English. Commentaries and expert opinions were only included if no other studies of higher quality were identified according to the hierarchy of evidence. Finally, the reference lists of identified studies were also reviewed as a snowball mechanism to capture any study not identified through the original search terms.

Exclusion criteria

Grey literature including governmental and organizational guidelines and recommendations were excluded as they may be based on jurisdictional, political, and regulatory approaches rather than scientific. Conference abstracts, and media articles were also excluded.

Identification, screening, and inclusion of studies

Search results were imported into Covidence software and de-duplicated prior to review.[23] Three reviewers, Abdulrahman Ghoneim, Diego Proaño, and Harpinder Kaur independently reviewed titles and abstracts using a screening form developed by the consulting team and approved by the AGPs Steering Committee. If the abstract was not available, the source was included for full-text review. The full texts of the remaining publications were retrieved and screened by the three reviewers using a standardized screening checklist. Any uncertainties related to study selection were resolved through discussion with the research supervisor (Sonica Singhal).

For each question, the research output was reviewed by the assigned reviewer along with the research supervisor. All reviewers and the research supervisor underwent a calibration exercise using 5% of articles from the initial search, and again after the final search using Cohen's kappa coefficient. The average interrater reliability score was 0.73 indicating a substantial level of agreement between reviewers.

Data extraction, quality appraisal, and synthesis plan

A data extraction form was used to populate pertinent information from each data source (i.e., article). Information was categorized to answer questions relevant to any dental setting. Since the scope of this position paper is to explore the breadth of the evidence related to the proposed questions, a quality appraisal of the full-text articles was not conducted. Finally, the consulting team utilized the Covidence software, which is recommended by the Cochrane network, to organize sources and synthesize data.[23]

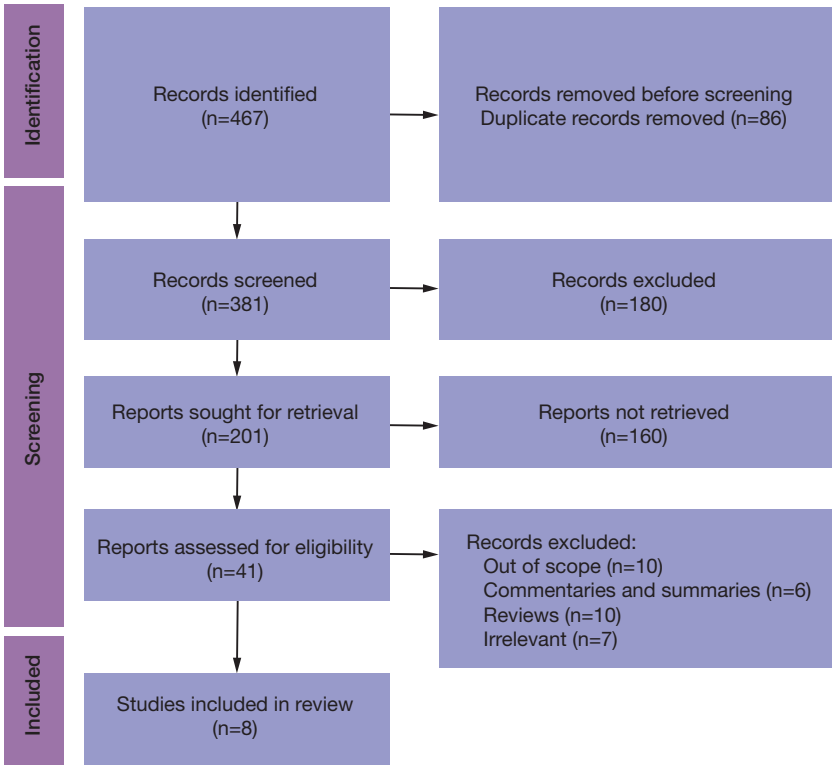
RESULTS

Q1: What is the risk of transmission of microbial pathogens between clinical dental hygienists performing AGPs and their patients?

The search retrieved 467 studies related to this question. After removing duplicates and irrelevant studies, eight were included in the final analysis. Three were systematic reviews[24–26] and the remaining five[27–31] were experimental in nature. Figure 1 outlines the PRISMA flowchart and Table I (Appendix) outlines the characteristics of the articles identified to answer this question. The main modes of transmission of SARS-CoV-2 in dental settings are aerosols, respiratory droplets, and close interpersonal contact (<1m).[24,29,30] In fact, airborne transmission is the dominant route of transmission for SARS-CoV-2.[29] The common AGPs include prophylaxis with ultrasonic scaler and polishing; periodontal treatment with ultrasonic scaler; any tooth preparation with high or low speed handpieces; direct and indirect restoration and polishing; cementation of crown or bridge; mechanical endodontic treatment and surgical implant placement.[24,30] An experimental study by Baldion et al.[30] developed a risk prediction model by assessing the settlement of particulate matter generated during dental procedures performed on manikins. The factors associated with greater risk of particle settlement were: a distance of less than 78 cm from the manikin head, inadequate ventilation, and use of high speed handpieces.[30] In terms of particle size, it was found that most settled particles produced during AGPs ranged from 1-5µm. However, it is important to keep in mind that authors limited their analysis to settled particles in 30 minutes setting time. Therefore, smaller particles that require more time to settle, and likely to settle farther, were not considered in this analysis.

Next, a systematic review[24] conducted in 2020 attempted to look at documented cases of transmission within different dental

Figure 1. PRISMA flowchart for Q1



settings worldwide. It demonstrated that there was not adequate evidence regarding the actual cases of infection transmission among both patients and dental care providers while delivering care. Similarly, another systematic review from 2021 corroborated the lack of sufficient evidence relating to transmission rates of SARS-CoV-2 in dental settings.[25] Additionally, a cross-sectional survey conducted among 51 hospitals in Japan in 2022 suggested that COVID-19 clusters were unlikely in both dental and oral surgical care settings especially when appropriate protective protocols were implemented. [29] Also, a yearlong retrospective cohort study showed that the risk of contracting SARS-CoV-2 among dentalcare providers was considerably low.[31] It was also implied that this lower number can be attributed to the intensive precautions and preventive measures taken before and during patient care.

A study from 2021 indicated that even in the absence of evidence of direct SARS-CoV-2 transmission through AGPs in dental environment, the possibility still exists; therefore, oral healthcare providers should not consider any in-office procedure risk-free.[28] More recently, a systematic review conducted by Al-Moraissi et al. found that dental, maxillofacial, and orthopedic surgical procedures produce significant number of aerosols. However, the evidence suggesting their infectivity to transmit diseases like SARS-CoV-2 remain very weak.[26] Finally, other research shows that the relative risk of infection transmission of an in-office visit can be dependent on several aspects such as the epidemiological context; geographical region; patient characteristics; and the kind of procedure being performed.[24,30]

Therefore, based on the infection risk prediction model for COVID-19 developed by Baldion et al., the authors classified the procedures undertaken in a dental office according to the settlement of the aerosolized particles generated during AGPs as the following:[30]

- Low risk: Procedures limited to the common areas (outside the operatory) with proper social distancing (e.g., administrative tasks)
- Moderate risk: Procedures related to cleaning, disinfection, and sterilization; and procedures conducted in a clinical environment (inside the operatory) without AGP - no use of ultrasonic or rotation instruments, or 3-way air or water spray
- High risk: Clinical procedures conducted using aerosol generating equipment.

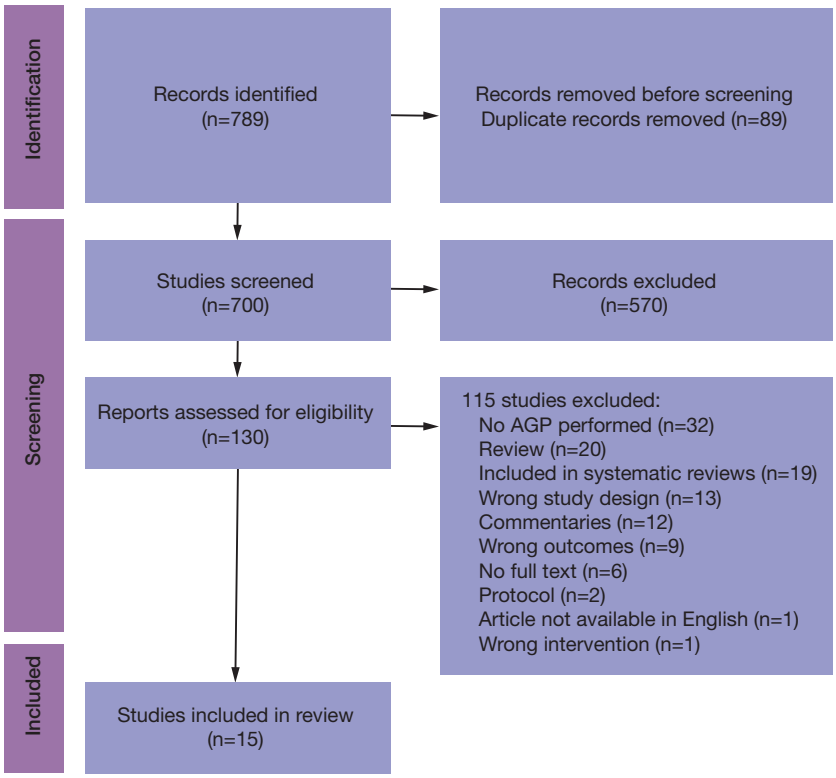
To summarize, oral healthcare provider should be aware of the risk of infection transmission and practice adequate preventive measures while rendering care to patients. The literature search revealed that there is limited literature to indicate the risk of infection transmission including SARS-CoV-2 among oral healthcare providers and their patients. While most studies retrieved in the search were related to modes or routes of aerosol transmission, assessment and distribution of aerosols or splatter, only a few assessed the possible risk. It should be noted that further research is therefore required to estimate the rates of infection transmission among oral healthcare providers including dental hygiene practitioners and their patients related to AGPs.

Q2: Does the use of preprocedural mouthrinses reduce the count of microbial pathogens and/or the risk of infection transmission between dental hygienists performing AGPs and their patients?

The search strategy yielded 789 articles for this question; after removing duplicates and irrelevant studies, fifteen suited the eligibility criteria. Figure 2 outlines the PRISMA flowchart and Table II (Appendix) outlines the characteristics of the articles identified to answer this question. Three of the studies were systematic reviews[32–34] and twelve were experimental trials.[35–46] The studies tested an array of antimicrobial mouthrinses including but not limited to Cetylpyridinium Chloride (CPC), Chlorhexidine (CHX), Essential Oils (EO), Hydrogen Peroxide (HP), and Povidone Iodine (PI). The AGPs tested were ultrasonic scaling, polishing, high speed handpiece for restorative preparations and debonding of orthodontic braces—the duration of the procedures ranged from 3 minutes to 90 minutes.

The included studies were homogenous both in their methodologies and results. The majority of studies

Figure 2. PRISMA flowchart for Q2



(86.7%, n=13/15) assessed the effectiveness of various types of preprocedural mouthrinses on the bacterial loads found in the generated aerosols via measuring colony-forming units (CFUs) at various locations (e.g., the chest of the patient and the operators, the face shield of the operator) in the setting in which AGPs were performed.[33–35,37–46] The authors compared the CFUs formed before and after performing the AGP to test the effectiveness of the tested mouthrinse. Almost all primary studies that tested the effectiveness of CHX (77.8%, n=7/9) found that rinsing with 10-15 mL of 0.12% or 0.2% CHX for 30 seconds to 1 minute before treatment significantly reduced the amount of CFUs compared to water or other rinses.[35,37–41,46] Interestingly, two studies found that the use of 0.1% Octenidine and *Neem*, a novel antiseptic mouthrinse, were more effective than 0.2% chlorhexidine in reducing the bacterial load in the aerosol produced during ultrasonic scaling.[44,45] Neem *(Azadirachta indica)* is a tree that grows in tropical regions such as India and is researched in the dental field for its various therapeutic effects including its anticariogenic, anti-inflammatory, and antimicrobial properties.[47]

Systematic reviews conducted by Marui et al. and Mohd-Said et al. corroborated those findings and suggest that the use of preprocedural mouthrinses prior to performing AGPs can effectively reduce the level of bacterial contamination of aerosols.[33,34] However, Marui and colleagues reported that the included studies had high or unclear risk of selection bias, blinding, and detection bias hence they stated that the results must be interpreted with caution.[33]

Despite that many of the studies were published after 2019 (66.7%, n=10/15),[32,34,36,38–40,42–45] only two studies assessed the impact of using preprocedural mouthrinses on viral loads, especially coronavirus, after using AGPs. First, Burgos-Ramos et al. compared the viral loads captured by portable air cleaners (PAC) with high-efficiency particulate air (HEPA) filters over 3 months in the waiting room (where patients wore face masks but did not undergo mouth rinsing), and 3 treatment rooms (where patients wore no masks but carried out 1 minute mouth rinsing with 1% H_2O_2) of a dental clinic in Spain.[36] The authors found viral load in filters from the waiting room; however, not from the treatment rooms, where patients rinsed with 1% HP as soon as they removed the facemask and had undergone AGPs.

Similarly, Nagraj et al. conducted a systematic review with the primary objective to assess the evidence on the incidence of infection among oral healthcare providers and secondary outcome was reduction in the contamination level of the dental operatory environment.[32] The authors did not come across any study to address their primary objective. In terms of the reduction in the contamination level, they could only find a few studies which assessed reduction in bacterial

contamination level in aerosols, but none evaluated viral or fungal contamination.

Alternatively, several studies including systematic reviews and randomized controlled trials explored the virucidal effect of mouthrinses on the viral load, specifically, SARS-COV-2 in saliva. However, these were mere repeated measures studies that did not utilize AGPs. The explored mouthrinses had mixed results on the viral loads post use. For example, a systematic review conducted by Mohebbi et al. found that 1% PI, Listerine (EO), and CHX reduced the viral load in the saliva samples after rinsing compared to baseline, albeit with various effect rates and substantivities.[48] This corroborated the findings from an earlier review conducted by Silva et al. that also demonstrated significant reductions in the salivary viral load after rinsing with PI and CPC.[49] Alternatively, a systematic review conducted by Ortega et al. did not find evidence to support the use of HP to reduce the viral load of SARS-CoV-2 or any other viruses in saliva.[50]

However, the limitation of this body of evidence is twofold. First, they do not assess the viral load produced by AGPs, and therefore might not be informative for clinicians looking for evidence to support their practices. Second, they did not assess clinical end point outcome (i.e., cross infection between clinicians and patients, etc.) and subsequently might not translate to clinical recommendations. In other words, despite their proven effectiveness in reducing the viral load in saliva, they cannot assume the reduction of the risk of cross contamination. Therefore, to better inform the dental hygiene community about the effectiveness of tested preprocedural mouthrinses, more experimental studies need to be conducted to assess the change in viral load in the aerosol generated during procedure and more importantly, if it changes the possibility of infection transmission.

To summarize, there is substantial evidence to suggest that the use of preprocedural mouthrinses reduce the level of bacterial contamination in aerosols generated by procedures commonly performed by dental hygienists. While there is some evidence to suggest the virucidal effect of preprocedural mouthrinses, the findings are limited to studies that did not perform AGPs.

Q3: Does the use of aerosol scavenging systems (e.g., intra and extraoral evacuation systems, high and low suction systems) limit the spread of aerosols and reduce the risk of infection transmission between dental hygienists performing AGPs and their patients?

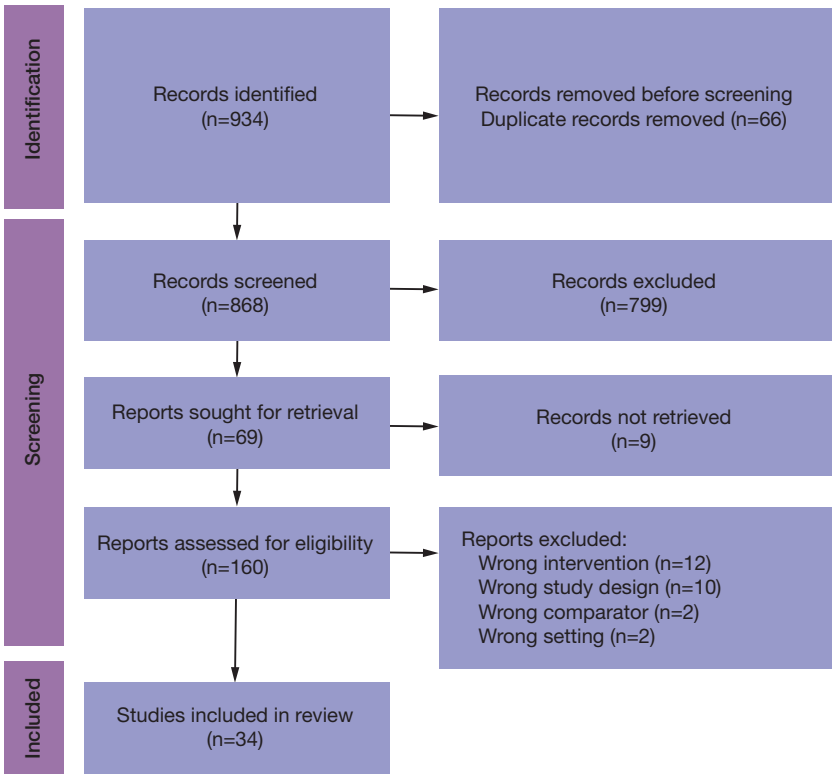
The search strategy yielded 934 articles. After removing duplicates and irrelevant studies, thirty-four met the eligibility criteria and were included in the analysis. Figure 3 outlines the PRISMA flowchart and Table III (Appendix) outlines the characteristics of the articles identified to answer this question.

Studies found were conducted in quite varied clinical settings; the most common was a single-chair dental operatory. More than half of the studies reviewed (n=19) were done on manikins, two without manikins but in vitro, nine observational studies using live participants, and four studies were systematic reviews, including one Cochrane review from 2020. In addition, 18 studies examined aerosol-reducing methods using intraoral devices (i.e., low-and high-volume evacuators), three compared high-volume evacuators intra-orally and extra-orally, and 13 studies examined other extraoral devices (i.e., 10 assessed extraoral suction systems, two dental chambers, and one a dental barrier).

It is relevant to note the high number of studies using manikins in the studies reviewed. The use of manikins instead of human participants could limit the extrapolation of results, however, the use of human participants could raise ethical concerns in experimental studies because of the risk of infection to the health provider, or vice-versa, performing dental AGPs.

The dental AGPs tested were commonly ultrasonic scaling or procedures using high speed handpiece as these are considered to generate the largest amount of aerosols.[51–66] The duration of the AGPs mostly ranged between 5 to 10 minutes and most commonly, studies used bacterial contamination or particle counts to test aerosol mitigation effectiveness.

Figure 3. PRISMA flowchart for Q3



The studies on intraoral aerosol reducing methods almost entirely focused on assessing high-volume evacuators (HVE), which showed greater effectiveness when ultrasonic scalers were used.[51,63] One study, conducted in dental offices in Italy, evaluated only low-volume evacuators (LVE),[67] and found LVE to be effective in reducing the number of particles during AGPs.[67] Other studies suggest that using intraoral HVE compared to LVE is more beneficial in reducing aerosol particles.[56,58] In addition, if the HVE is dynamic (i.e., follows the path of the dental AGP), it is more effective in mitigating aerosol generation than static intraoral devices (i.e., that don't follow the path of the AGP, whether HVE or LVE).[63] The HVE and LVE, however, can be used in combination to yield positive results.[9,21,65] As Rafiee et al. highlight, the addition of HVE to the saliva ejector produces a low number of particles during ultrasonic scaling and is, therefore, not seen as a high-risk exposure.[21] Moreover, the effectiveness of HVE can be improved by using isolation adapters (i.e., with soft tissue retractors),[58,66,68] or a rubber dam (when appropriate),[61,65] compared to HVE alone.

Similarly, the use of rubber dam alone to limit the spread of aerosols was also identified in the literature. In the Cochrane review conducted by Kumbargere Nagraj et al., the authors found three studies that assessed the impact of the use of rubber dam compared to no use at different locations. They found that the use of a rubber dam yielded reduction in aerosol contamination 1 and 2 meters away from the mouth. However, the use of rubber dam also resulted in significantly higher presence of aerosols on the operator's forehead, left ear, submental triangle, and occiput, emphasizing the importance of operator PPE.

In terms of the HVE characteristics, Graetz et al. suggest that the use of a suction cannula of 16 mm in diameter at a high-flow rate of ≥250 l/min provides the lowest splatter contamination values.[55] In addition, Matys and Grzech-Lesniak suggest that the use of a wider customized HVE-tip to be more effective than the standard tip.[58]

In addition, three studies have compared the effectiveness of reducing aerosols in using HVE intra-and-extra-orally.[64,68,69] As such, Ehtezazi et al. report that intraoral HVE is superior to extraoral HVE,[69] while D'Antonio et al. suggest that intraoral HVE, HVE intraoral adapter, or extraoral suction devices are equally effective in preventing respirable aerosol.[64] Furthermore, Choudhary et al. report that the use of an extraoral conical HVE was more effective in reducing aerosol concentration than the standard-tip HVE due to its relatively larger surface area.[68]

Among studies assessing other extraoral aerosol-reducing methods, ten examined extraoral suction systems,[9,51,53,55,60,62,70–73] two assessed innovative chamber devices,[52,74] and one examined an individual dental barrier.[75] Although authors reported positive results for the chamber devices and individual dental barriers, these were isolated studies.

Some studies suggest that extraoral suction systems paired with HVE or LVE showed the greatest reduction in particle concentration, aerosol and droplet level when compared to no extraoral suction systems during dental AGPs.[9,60,73,76] Also, D'Antonio indicates that pairing extraoral suction systems with local ventilation are effective in reducing aerosols in a multi-chair open clinic setting.[64]

In terms of the reviews examined, most were published during the pandemic (2020, 2021). The 2020 Cochrane review considered studies that assessed bacterial contamination and aerosol particle concentration, but not necessarily the risk of infectious disease transmission.[77] In addition, the review reported that the included studies were of low certainty, due to the high heterogeneity in findings, risk of bias, small sample size, wide confidence intervals, and no minimal clinical importance of the difference in CFUs. Furthermore, the studies did not evaluate costs, acceptability, or ease of implementation.[77] The main findings, nevertheless, highlighted the use of HVE and HVE + rubber dam when applicable.[77] This finding coincides with that of Robertson et al., and the Samaranayake et al., and Deana et al. systematic reviews, that all agreed on the effectiveness of HVE on aerosol reduction.[78–80] Moreover, Samaranayake et al. added that this effect depends on the suction strength, proximity to the operating site and number of HVE used as one study demonstrated that two HVEs had a greater aerosol reducing effectiveness than only one.[78]

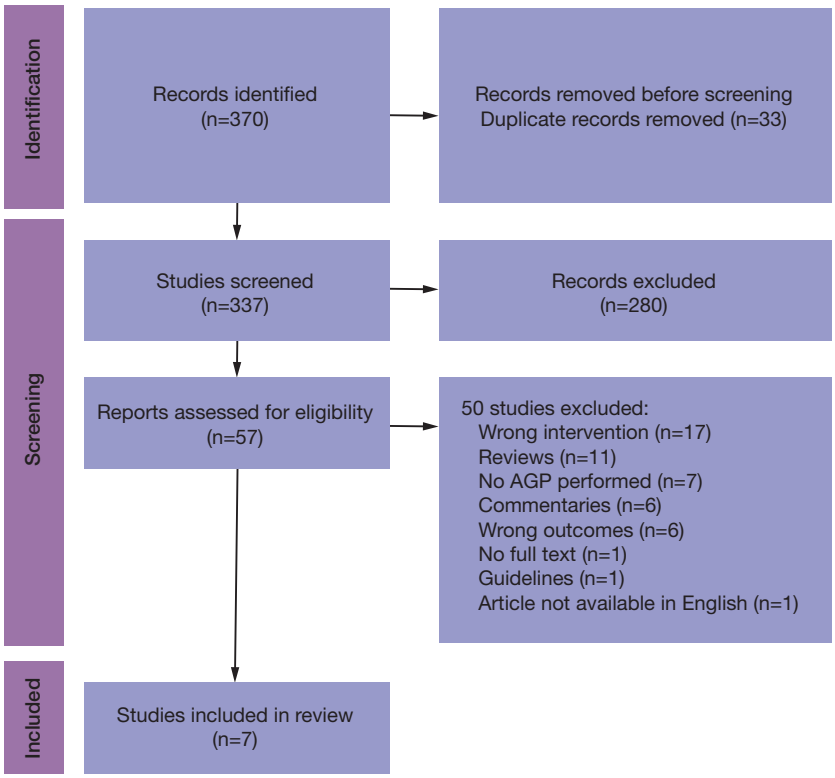
To summarize, the evidence reviewed sheds light on the benefits of the use of HVE either with or without an isolation adapter, LVE saliva ejector, and a rubber dam (when appropriate), for reduced aerosol contamination. In that sense, HVE can be seen as required for oral health practitioners to use during dental AGPs, especially for dental procedures that generate the largest concentration of aerosols, such as ultrasonic scaling and high-speed drilling of anterior teeth.

Q4: What are the types and effectiveness of the personal protective equipment (PPE) used to reduce contact with aerosols and the risk of infection transmission between dental hygienists performing AGPs and their patients?

The search strategy yielded 370 articles. After removing duplicates and irrelevant studies, seven studies were included in the final analysis.[81–87] Figure 4 outlines the PRISMA flowchart and Table IV (Appendix) outlines the characteristics of the articles identified to answer this question. Four of the identified studies were conducted in simulated settings with manikins and structured cubicles that resemble a real dental clinic.[82,84–86] Three studies tested the effectiveness of conventional protective eyewear, masks, and respirators while the rest tested innovative protective devices such as Air-fed masks,[82] Individual Biosafety Capsule Device (IBCD),[85] rigid protective devices,[86] and the Cupola.[87] The outcomes assessed were bacterial contamination on eye lenses,[81] facial contamination,[82], bacterial filtration efficacy (BFE),[83] containment of aerosols,[85–87] and the viral load on the forehead and inside the mouth of an operator manikin.[84]

Afzha et al. found that the use of protective eyewear reduced the bacterial contamination on contact lenses compared to not using eyewear.[81] After 10 minutes of high speed handpiece activity, Bridgman et al. found that 1) the use of N95 masks did not prevent nasal and oral contamination with aerosols; 2) the use of the novel air-fed mask in combination with glasses and N95 resulted in the elimination of all facial contamination; and 3) the use of air-fed mask and a sealed hood resulted in no contamination of the face, head or neck.[82] Donning and doffing instruction of the Air-fed mask system are described elsewhere.[82] However, it is worth noting that the authors did not mention that participants were properly fit-tested for the evaluated N-95 respirators, and only one type of N95 respirator (FFP2) was tested. Therefore, it is important to interpret the findings from this study with caution. All three studies that assessed the aerosol containing devices found reduction in the aerosol dispersion when using compared to no use. Finally, the only study that assessed viral loads found that using a face shield resulted in below-detection levels on the operator manikin's forehead. Similarly, all surgical masks and respirators resulted in undetectable viral loads inside the operator manikin's

Figure 4. PRISMA flowchart for Q4



mouth, with or without the use of a face shield.[84] Therefore, the authors suggested that the combined use of face shields and masks, regardless of the type, can prove effective in reducing the viral load on the operator's forehead and inside their mouth to an insignificant level.

Additionally, three systematic reviews were conducted to test the effectiveness of N95 respirators versus surgical masks in reducing viral illness (e.g., Influenza and COVID-19) without performing AGPs.[88–90] The study by Long et al. did not find the use of N95 respirators superior to surgical masks in terms of reducing the risk of laboratory-confirmed influenza.[88] It is important to note that the ASTM (The American Society for Testing and Materials) level (Level 1, 2 or 3) of surgical masks was not specified in these studies. More recently, the Cochrane review conducted by Jefferson et al. found no evidence to suggest that medical/surgical masks offer any greater protection against viral respiratory illnesses compared to no masks although only two of the ten included studies were conducted in healthcare settings.[89] The authors also did not find any additional protection when using N95/P2 respirators compared to medical/surgical masks on laboratory-confirmed influenza infection.[89] On the contrary, in the systematic review conducted by Collins et al., the authors found that the use of N95 respirators was associated with fewer viral infectious episodes for healthcare workers compared with surgical masks.[90] However, the high-risk biases and the limited number of studies included (n=8) suggests the need for higher quality evidence on this matter. The mixed evidence suggested by the mentioned systematic reviews highlights the uncertainty about the effectiveness of N95 respirators versus surgical masks when it comes to preventing viral infections.

Overall, there are several limitations that hinder the applicability of the findings from this evidence. First, all the studies utilized surrogate outcomes (i.e., the presence of aerosols on the body/masks etc.) rather than the clinical outcomes such as transmission of infection. Second, it is interesting to note that only two studies assessed the effectiveness of these methods for more than 10 minutes which is a closer resemblance of the real-life scenario where dental hygienist might be conducting AGPs for extended periods of time. Finally, the use of simulated settings, while useful, does not provide a similar experience as when experimented on real patients.

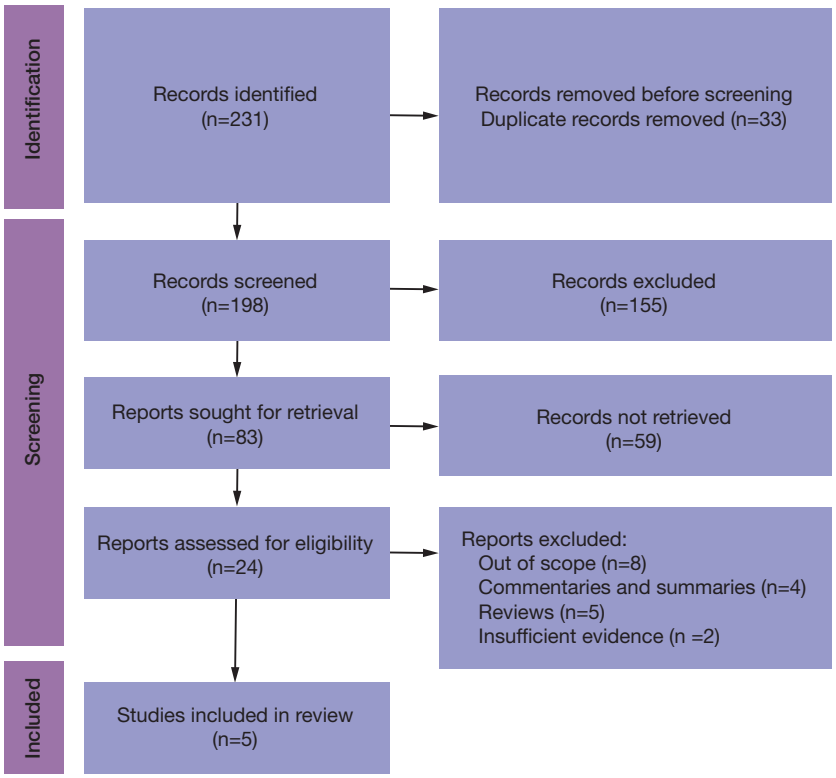
To summarize, despite the paucity of studies addressing this research question, the overall limited evidence suggests that the combined use of protective eyewear, masks (N-95, FFP2, or air-fed), and face shields are effective for the prevention of contamination of the facial and nasal region. Other innovative devices, such as the Individual Biosafety Capsule Device (IBCD), and the Cupola have also shown promising results in limiting aerosol contamination. However, more studies with real patients and while

performing AGPs for prolonged times are necessary to establish their effectiveness.

Q5: What operatory setups limit the spread of aerosols in dental and dental hygiene settings?

The purpose of this research question is to assess the role of architectural or engineering controls within a dental clinic or operatory setup in limiting the spread of aerosols. Air cleaning systems or ventilation systems are considered helpful in reducing airborne transmission in indoor environments. The search strategy yielded 231 articles for this question. After removing duplicates and irrelevant studies, five were included in the analysis. Four studies were experimental in nature[51,91–93] and one was a Cochrane review.[77] Figure 5 outlines the PRISMA flowchart and Table IV (Appendix) outlines the characteristics of the articles identified to answer this question.

Figure 5. PRISMA flowchart for Q5



Ventilation controls can assist in the removal of air contaminants and is usually dependent on the infrastructural configuration.[51,92] Filtration increases the effective air-exchange rate, and the effect of filtration devices usually depends on the distance from the source and airflow in the room.[92] Ren et al. assessed the effectiveness of aerosol removal by mechanical ventilation and a portable air cleaner (PAC) with a high-efficiency particulate air (HEPA) filter in a simulated study at a dental facility.[92] Aerosol accumulation was higher in rooms with poor mechanical ventilation in comparison to rooms with high ventilation, hence an inverse correlation between speed of aerosol removal and mechanical ventilation. The study concluded that using PAC in combination with HEPA filter was highly effective in reducing aerosol accumulation and thereby accelerating aerosol removal. In this case, the authors stated that only rooms with air changes greater than 15 could completely remove the aerosols by mechanical ventilation alone within the 30 min observation period in this study. Given that this might not be achieved in many dental settings, ventilation alone might not achieve aerosol removal in less than 30 minutes. Therefore, the effectiveness for PAC was noteworthy and recommended in rooms with poor mechanical ventilation.

Furthermore, one study looked at the impact of incorporating additional local ventilation systems to the existing operatory setup. Allison et al. looked at local exhaust ventilation (LEV) systems that can capture aerosols at the source and limit their dispersion.[51] They studied the effect of LEV on the distribution of aerosols produced during dental procedures after adding it to the existing suction devices, while using air-turbine handpiece and ultrasonic scaler. The observations included a 90% (within 0.5 m) reduction in aerosol production from the air-turbine handpiece, and 99% for the ultrasonic scaler. Based on their experiment, they inferred that LEV reduces aerosol and droplet contamination by at least 90% in the breathing zone of the operator.

In addition to studying aerosol spread and aerosol settling time after dental procedures in an open plan clinic, Holliday R et al. also looked at impact of cross-ventilation (windows were fully opened).[91] It was found that dental suction and natural ventilation are beneficial in reducing aerosol contamination. As for the layout, the authors found that the risk of aerosol migration from AGPs in an open plan clinic is likely to be minimal when the adjacent dental bays are ≥ 5 m apart.[91] For other aerosol mitigation strategies, Zhu M et al. suggested the implementation of physical barriers between adjacent dental bays in a multi-chair setting (dental school environment in this case).[93] The total partition height between stations was 2.5 meters and transparent plastic sheets (<1 cm in thickness) were used to supplement the original partitions (1.3 meters and made of fabric covered material). They concluded that such barriers reduced transport of aerosols to adjacent dental bays. However, it should be noted that this study did not comment on the spread of aerosol contamination.

The Cochrane review by Kumbargere Nagraj et al. included studies that previously measured the volume of contaminated aerosols in dental environments.[77] One compared operative settings with air cleaning system (ACS) versus no air cleaning system, and the other compared settings with laminar air on with HEPA versus those with laminar air off to study decontamination of aerosols in air. The results for both studies estimated fewer colony forming units (CFUs) after the procedures, showing a reduction in the aerosol load. Kumbargere Nagraj et al. noted the lack of laboratory studies as one limitation and another was the inclusion of a dated studies in this review.[77]

The search did not yield any studies on other methods such as ionisation, use of UV light and fogging, and few studies assessed operatory design. Future research is required in this area, especially interventional studies that assess architectural or infrastructural as well as engineering controls in practice in dental environments. Some studies have described the mechanism of similar controls (like installing high efficiency air filters, increasing ventilation levels, providing negative ventilation pressure, and incorporating isolation rooms) in dental practices.[93–97] However, due to insufficient evidence in terms of absolute reduction of aerosol contamination in dental operatories, they are not reported here.

To summarize, based on the studies reviewed, it can be inferred that by adopting an appropriate combination of ventilation and filtration approaches, in conjunction with aerosol scavenging systems, dental practices can limit the spread of aerosols generated by AGPs. Future studies to assess the impact of newer technologies and innovations in limiting the spread of aerosols, would be interesting as it may change the landscape of dental operatories setup.

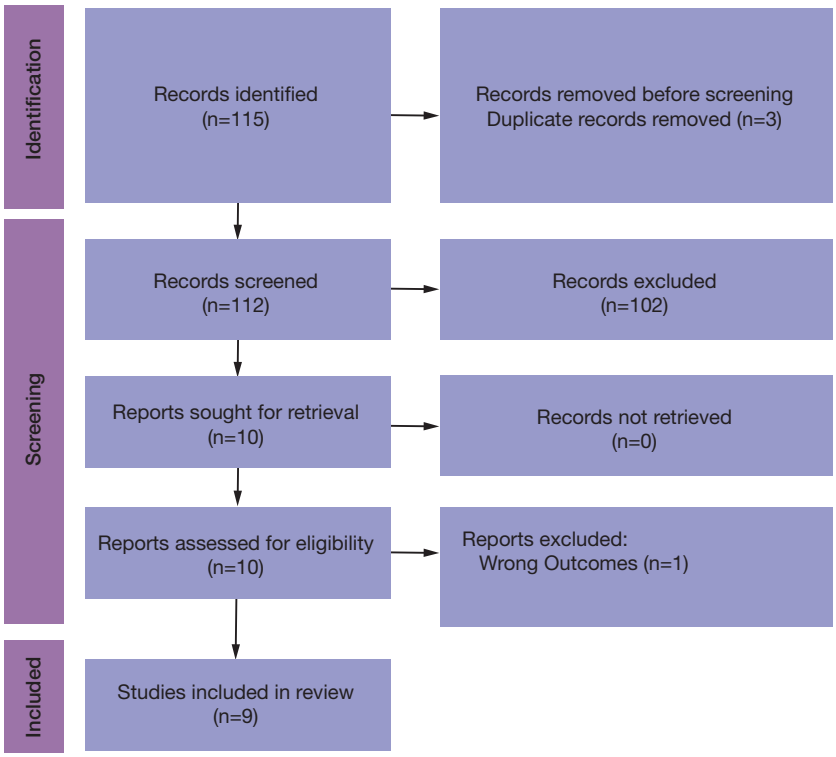
Q6: What is the appropriate fallow time that allows aerosols to completely settle and reduce the risk of infection transmission between dental hygienists and their patients after performing AGPs?

The search strategy yielded 115 articles for this question. After removing duplicates and irrelevant studies, nine studies (3 reviews and 6 experimental studies) were included in the analysis. Figure 6 outlines the PRISMA flowchart and Table VI (Appendix) outlines the characteristics of the articles identified to answer this question.

The appropriate time for particles to settle down (i.e., fallow times) are relevant for dental AGPs, as suspended microorganisms (e.g., bacteria, fungi, viruses) may be found in the contaminated bio-aerosol.[98] This includes the use of 3-way air/water spray, dental cleaning with ultrasonic scaler and polishing, periodontal treatment with ultrasonic scaler, and dental preparation with high and low speed handpiece.[99] Studies concerned with this topic have been conducted keeping the characteristics of the SARS-CoV-2 virus in consideration and are relevant during the COVID-19 pandemic. As such, most of the studies reviewed examined AGPs from ultrasonic scaling, some from high speed and low speed drilling, and a few from crown or root canal preparations, all of which were mainly conducted in enclosed spaces.[62,68,69,99–101]

Mathematical formulas of fallow times have been proposed in the literature and are commonly used

Figure 6. PRISMA flowchart for Q6



in guidelines, although the appropriate level of contaminant removal efficiency threshold (90% vs 99%) has not yet reached a consensus.[18] This mathematical formula has been provided by The National Institute for Occupational Safety and Health (NIOSH) to model the rate of decline in the concentration of an airborne contaminant.[18] It is worth noting, however, that most of the studies reviewed did not provide calculations on how they determined fallow times.[68,79,99,101–103] Few studies described using baseline aerosol concentrations to calculate the time it took to return to those levels.[62,69,100]

From the studies reviewed, it is complex to establish a set fallow time threshold without considering other critical factors. For example, fallow time is highly dependent on the air change per hour (ACH) in the dental clinic setting,[62,102] that is, the higher the change per hour the lower the fallow time. When the ACH is unknown, guidance has been seen to vary from 15 to 180 minutes. Other authors suggest that a minimum of 10 minutes is sufficient when good ventilation (≥10 ACH) is provided.[79,102] Nevertheless, Shahdad et al. suggest that the longest fallow times occur when windows are closed and there is no mechanical ventilation.[62] A more recent study conducted by Longo and colleagues suggested even shorter fallow time intervals. The authors stated that, to restore the baseline aerosol level values after the cessation of AGPs, less than 3 minutes of fallow time is enough when no additional ACH, and no fallow time is required with 20 additional ACH.[104]

The fallow time also depends on the dental equipment (e.g., air-turbine, high speed contra-angle handpiece), length of the dental procedure, the size of the aerosols generated, and other aerosol mitigation strategies, such as the use of rubber dams, high-volume evacuators (HVE) and extraoral suction devices.[68,69,99–102] According to a review done by the College of General Dentistry in the United Knigdom (UK), fallow time is also critically impacted by the absence of HVE and poor ventilation (e.g., 1-2 ACH). Under those circumstances, the fallow period can increase up to 60 minutes.[102]

In addition, one of these studies assessed different clinical setting configuration (single room layout, semiprivate operatory with partial wall, and large multi-operator space), the use of HVE and fallow times.[68] They concluded that dental aerosols were transient when HVE was employed regardless of the setting configuration, and as such the fallow times can be considered to be of 5 minutes under such conditions. Ultimately, it is important to be mindful that fallow time recommendations originated from the tuberculosis literature, and therefore might not be relevant when making recommendations in the context of respiratory viruses such as SARS-CoV-2.[105]

To summarize, ACH level and HVE use are relevant characteristics to factor when estimating fallow times after

performing AGPs. As such, well-ventilated areas, with 10-15 ACHs,[106] and/or the use of HVE can contribute to minimal fallow times (10 minutes or less) after dental AGPs, for example, ultrasonic scaling.

DISCUSSION

With infections like COVID-19 and other communicable diseases that have the potential to spread through aerosols, AGPs will remain a viable risk of infection transmission for dental hygienists working in clinical settings. The purpose of this position paper is to provide dental hygienists and other oral health care providers with guidance when performing AGPs based on the latest scientific evidence. This includes identifying the risk of infection transmission associated with conducting AGPs; effectiveness of different types of preprocedural mouthrinses to reduce the microbial load of aerosols generated through AGPs; dental evacuation systems to reduce the transmission of aerosol far from its origin; appropriate PPE to provide optimal barrier to aerosols that may be contaminated; appropriate operatory setups for proper ventilation; and finally setting optimal fallow periods for aerosol to settle or leave the room. All of these aspects are reviewed to ultimately control the risk of infection transmission via aerosols following AGPs.

While there is a varying degree of robustness in the literature addressing the proposed questions, the following recommendations can be made based on the current evidence to help dental hygienists make informed decisions about their practices and to ensure their patients' and own safety:

1. There is not enough literature to suggest direct evidence of risk of transmission of SARS-CoV-2 between dental hygienists and patients despite AGPs being considered high risk procedures.
2. The review suggests that CHX is effective in reducing bacterial contaminations in aerosols; however, there is limited understanding regarding which preprocedural mouthrinse is effective against SARS-CoV-2.
3. The customized HVE tip with a suction cannula of 16 mm diameter at a high-flow rate offers the lowest splatter contamination.
4. The combined use of protective eyewear, masks, and face shields are effective for the prevention of contamination of the facial and nasal region; however, there is no evidence to suggest their effectiveness against infection transmission.
5. The appropriate combination of ventilation and filtration in dental operatories support the containment of aerosols.
6. In terms of fallow time, a number of factors are accounted for when deciding on the appropriate resting time. When combining the use of HVE with a high ACH, minimal fallow time (10 minutes or less) seems to be enough for aerosols to settle.

The recommendations made by this position paper are based on the most recent scientific evidence rather than the precautionary approach adopted by many guidelines published over the last three years. Moreover, since it provides evidence on AGP related issues, it also serves as a guide for all other members of the oral health care team. A number of limitations should be considered when analyzing the results from this review. First, only studies published in English were included. Therefore, some evidence published in other languages might have been missing. Also, no quality appraisal was conducted for the included studies. As such, no comments on the quality of the evidence presented can be made, and dental hygienists are advised to contextualize the recommendations made to inform their practices. Finally, this review was conducted based on scientific literature and experimental studies, and did not include guidelines and grey literature, as they may be restricted in their approach reflecting only specific jurisdictional, organizational, or regulatory context.

Aerosol Generating Procedures are an integral part of oral healthcare settings, and it is a constant reality that aerosols appear to pose a risk of disease transmission between clinicians and their patients. Therefore,

utilizing the best available scientific evidence, analyzing, and understanding the risk of infection transmission is important to support oral healthcare providers in making safe practice decisions. It is important to remember that recommendations made by this position paper are meant to complement, and not replace, already existing standard infection control protocols, vaccination requirements, and precautions such as pre-screening for illness to mitigate the risk of disease transmission in dental settings.

Key Considerations

- There is a lack of studies that indicate direct evidence of risk of transmission of SARS-CoV-2 among dental hygienists and their patients. However, even in the absence of evidence of direct SARS-CoV-2 transmission through AGPs in dental environment, the possibility still exists, until proved otherwise.
- There is substantial evidence to suggest that the use of preprocedural mouthrinses reduce the level of bacterial contamination in aerosols generated by procedures commonly performed by dental hygienists. To a lesser extent, studies suggest that some mouthrinses have a virucidal effect but with very limited trial evidence after the use of AGPs.
- Evidence suggests that the use of HVE either with or without an intraoral suction reduces aerosol contamination. Combining HVE with saliva ejectors, isolation adapters (i.e., with soft tissue retractors), or a rubber dam (when appropriate) may yield even higher aerosol reducing effectiveness.
- The overall limited evidence suggests that the combined use of protective eyewear, masks (N-95, FFP2, or air-fed), and face shields are effective for the prevention of contamination of the facial and nasal region when performing AGPs.
- The appropriate combination of engineering (ventilation and filtration) systems in conjunction with aerosol scavenging systems, can limit the spread of aerosols when performing AGPs.
- With sufficient air ventilation, a fallow time of as low as 10 minutes or less can be enough for aerosols to completely settle in enclosed spaces. However, factors like the duration of the AGPs, the type of equipment used, and the presence of aerosol mitigating strategies and HVE can alter the time required.

CONCLUSION

Aerosols produced during AGPs can pose a risk of infection transmission between dental hygienists and their patients. In the last three years, there has been an influx of evidence and guidelines about various aspects of AGPs. Therefore, it is important to integrate that knowledge to keep oral healthcare providers, including dental hygienists, updated on the current evidence regarding effective devices, methods, and protocols to mitigate the risk of infection transmission when performing AGPs.

PRACTICE RELEVANCE

The evidence from this position paper will help inform dental hygienists and other oral care providers of the current evidence regarding effective devices, methods, and protocols to mitigate the risk of infection transmission when performing AGPs.

DISCLOSURES

The authors have no conflicts of interest to declare.

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APPENDIX

Table I. Risk of transmission of microbial pathogens†

	Author(s), date Al-Moraissi et al., 2022 [26]	**Study design** Systematic review	**Country** China	**Sample size** NA	**Setting** NA
Intervention	Dental, maxillofacial, and orthopedic surgical procedures (DMOSP).				
Comparator	NA				
Outcome	Transmission of severe acute respiratory syndrome coronavirus (SARS-CoV-2).				
Summary of Findings	One study confirmed that HIV could be transmitted by aerosolized blood generated by an electric saw and bur. There is sufficient evidence that DMOSP generates an ample amount of bioaerosols, but the infectivity of these bioaerosols to transmit diseases like SARS-CoV-2 generates very weak evidence but still, this should be considered.				
Remarks	This study found very weak evidence to suggest the infectivity of aerosols generated by dental, maxillofacial, and orthopedic surgical procedures to transmit diseases like SARS-CoV-2.				
	Author(s), date Amiri et al., 2021 [25]	**Study design** Systematic Review and Meta analysis of observational studies	**Country** Brazil	**Sample size** NA	**Setting** NA
Intervention	Search was conducted using PubMed, Embase, ISI, Scopus, Medicine for articles between September 2019 to December 2020.				
Comparator	NA				
Outcome	Studies that reported effect size of airborne COVID 19 concentrations of hallway air samples (copies/L of air), and personal air samples (copies/L of air).				
Summary of Findings	Two studies were considered, and the effect size of airborne COVID-19 concentrations of the hallway and personal air samples was 64% copies/L of air, and 100% copies/L air, respectively.				
Remarks	This review found insufficient evidence of aerosol transmission. Dentists are more at risk for COVID-19, so related challenges and responsibilities need to be defined for them. Need to understand the risk of aerosol transmission.				
	Author(s), date Baldion et al., 2021 [30]	**Study design** Experimental study	**Country** Colombia	**Sample size** NA	**Setting** Phantom heads with typodont with 28 teeth
Intervention	Settlement of aerosolized particles during AGPs - colored saliva. Gravity-deposited particles - filter paper within the perimeter of the phantom head. Settled particles: recorded with standardized photographs. Analysis of stained area: digital imaging.				
Comparator	Dental units with adequate ventilation vs inadequate ventilation				

Table I. Risk of transmission of microbial pathogens† (continued)

Outcome	Settlement of aerosolized particles in terms of distance from the mouth, the instrument used, area of the mouth treated, and location within the perimeter area.				
Summary of Findings	The greatest risk of particle settlement occurs at a distance up to 78 cm from the phantom mouth, with inadequate ventilation, and when working with a high speed handpiece. Most settled particles generated during the AGPs ranged from 1-5 µm in size.				
Remarks	This study found very weak evidence to suggest the infectivity of aerosols generated by denThis model was useful for predicting the risk of exposure to COVID-19. Distance, ventilation, type of instrument, location within the perimeter to show association with amount of settled particles were the main factors.tal, maxillofacial, and orthopedic surgical procedures to transmit diseases like SARS-CoV-2.				
	Author(s), date Levit and Levit 2020 [24]	**Study design** Systematic review	**Country** Israel	**Sample size** NA	**Setting** NA
Intervention	Searched MEDLINE and Google Scholar for all possible reported cases of COVID-19 transmission in dental practice as of December 1, 2019, until May 13, 2020.				
Comparator	NA				
Outcome	COVID-19 transmission				
Summary of Findings	Out of 78 articles, only 31 articles discussed the risks related to dental practice and recommended infection management protocols. Only 1 had reported data on transmission of COVID-19 in dental practice. In addition, 2 cases of possible transmission to dental provider were reported in China (before its recognition as an epidemic).				
Remarks	It seemed that there are almost no reported cases of infection by SARS-CoV-2 during dental treatments, occupational or nosocomial transmission could not be ruled out. Urgent need to further assess COVID-19 transmission.				
	Author(s), date Manzar et al., 2022 [27]	**Study design** Cross-sectional survey	**Country** Pakistan	**Sample size** 629 general and specialist dentists	**Setting** 12 dental colleges and hospitals
Intervention	Online questionnaire, collected data included the sources of COVID-19 infection, the type of PPE used and the number of AGPs performed each day.				
Comparator	NA				
Outcome	Absolute numbers of responses and their percentages.				
Summary of Findings	Among the total sample, only 18% reportedly contracted COVID-19. The risk of contracting COVID-19 during AGPs was the same as in the case of non-AGPs, and the infection risk was not associated with the number of AGPs performed per day.				
Remarks	None				

Table I. Risk of transmission of microbial pathogens† (continued)

	Author(s), date Mirbod et al., 2021 [28]	**Study design** Experimental study	**Country** United States	**Sample size** NA	**Setting** Simulated conditions (patient's mouth using a mandible set of teeth) and employing a Cavitron Select SPS Ultrasonic Scaler
Intervention	State-of-the-art optical flow tracking velocimetry and shadowgraphy measurements				
Comparator	NA				
Outcome	Flow velocity, trajectories and size distribution of droplets produced during a dental scaling process				
Summary of Findings	First evidence of aerosol droplet formation from an ultrasonic scalar under simulated oral conditions The droplet sizes varied from 5 µm to 300 µm (correspond to droplet nuclei that might carry virus) The droplet velocities vary between 1.3 m/s and 2.6 m/s				
Remarks	Confirms the critical role of aerosols in the transmission of disease during dental procedures Also provides a knowledge base for developing protocols and procedures Indicated that COVID-19 clusters are unlikely to occur in dental as well as oral surgical care settings in presence of appropriate protective measures				
	Author(s), date Tanaka et al., 2022 [29]	**Study design** Cross-sectional survey	**Country** Japan	**Sample size** Staff from 64 hospitals	**Setting** Faculties of the dental and oral/maxillofacial surgical departments of university hospitals
Intervention	Administration of an online survey about clinical activities (administrative control), infection control measures (environmental/engineering control, personal protective equipment, etc.), and confirmed or probable COVID-19 cases among patients and clinical staff.				
Comparator	NA				
Outcome	NA				
Summary of Findings	Staff from fifty-one hospitals (80%) completed the questionnaire. Out of 14 hospitals (27%) who treated patients with COVID-19, no infections were transmitted from the patients to the medical staff. In seven facilities (13%), patients were found to have the infection after treatment (medical staff came in close contact), but there was no transmission from patients to medical staff. Four facilities had medical staff with infections, but none of them exhibited disease transmission from staff to patients. Also, there was no transmission from patients to medical staff, where they came in close contact to patients who reported positive infection after the treatment.				
Remarks	Indicated that COVID-19 clusters are unlikely to occur in dental as well as oral surgical care settings in presence of appropriate protective measures.				

Table I. Risk of transmission of microbial pathogens† (continued)

	Author(s), date Vasan et al., 2022 [31]	**Study design** Retrospective cohort	**Country** India	**Sample size** Study was conducted on healthcare workers who tested positive while rendering treatment to patients	**Setting** Dental hospital
Intervention	Hospital database was used to extract information.				
Comparator	NA				
Outcome	Number of dental care workers with a positive PCR test during the year.				
Summary of Findings	Out of a total of 26 workers responsible for attending and treating the patients, only 9 were found to have contracted the infection during the entire year of study.				
Remarks	Reveals that the risk of COVID-19 infection contraction amongst the dentalcare workers is considerably less.				

PCR, polymerase chain reaction; NA, information not available in articles.

Table II. Preprocedural mouthrinse study characteristics†

	Author(s), date Anjum et al., 2019 [35]	**Study design** Quasi experimental	**Country** Pakistan	**Sample size** 70
Intervention	0.2% CHX; Protocol: NA			
Comparator	5% green tea mouthrinse			
Type and duration of AGP	Ultrasonic scaling for 30 mins			
Outcome	CFU			
Summary of Findings	Significant reduction of CFU occurred with preprocedural rinsing with both mouthrinses as compared to non-rinsing before ultrasonic scaling and 0.2% Chlorhexidine found to be superior to 5% green tea in reducing bacterial load in aerosol samples.			

Table II. Preprocedural mouthrinse study characteristics† (continued)

	Author(s), date Burgos-Ramos et al., 2020 [36]	**Study design** Experimental	**Country** Spain	**Sample size** NA
Intervention	1% Hydrogen Peroxide; Rinse for 1 min, 5-10 mins before the treatment			
Comparator	No rinse			
Type and duration of AGP	NA			
Outcome	Viral loads (COVID-19 detected in exhaled air)			
Summary of Findings	The use of H2O2 solution (1%) for 1 min for mouth rinsing drastically reduced the possibility of coronavirus spread during aerosol-generating dental procedures.			
	Author(s), date Choi et al., 2018 [37]	**Study design** Experimental study	**Country** Korea	**Sample size** 30
Intervention	0.1% CHX solution; Gargle for 30 secs			
Comparator	No gargle			
Type and duration of AGP	Prophylactic scaling; Duration: NA			
Outcome	CFU collected from the operator's face shield.			
Summary of Findings	It was found that there was a significant difference in the number of bacteria between the two experimental groups (with and without chlorhexidine gargling). In the group without any treatment before scaling, the average number of bacteria was 52.5 CFU/ml, but in the group where chlorhexidine gargling was applied, the average number of bacteria was 4.6 CFU/ml, which was remarkably small.			
	Author(s), date Das et al., 2022 [38]	**Study design** Randomized Controlled Trial	**Country** India	**Sample size** 80
Intervention	0.2% CHX, Herbal mouthwash, Water; Rinse 10 ml for 30 secs			
Comparator	No rinse			
Type and duration of AGP	Ultrasonic scaling for 30 min			
Outcome	Mean microbial count in various locations			
Summary of Findings	Regardless of the position of the agar plates, the highest number of microbial colonies were seen in no-rinse group, followed by water, herbal moutrinse, and 0.2% chlorhexidine gluconate. The lowest no of microbial colonies was seen in Group 3, where preprocedural mouthrinse was chlorhexidine gluconate (0.2%).			

Table II. Preprocedural mouthrinse study characteristics† (continued)

	Author(s), date Gund et al., 2022 [39]	**Study design** Prospective randomized clinical trial	**Country** Germany	**Sample size** 306
Intervention	0.1% CHX; Rinse 15 ml for 60 secs			
Comparator	Water; No rinse			
Type and duration of AGP	High speed restorative preparations Supra and subgingival ultrasonic application Duration: 60-90 mins			
Outcome	Bacteria contamination on the operator's face mask			
Summary of Findings	Chlorhexidine led to a statistically significant reduction of bacterial contamination of the surgical mask (mean: 24 CFU) in comparison with water (mean: 47 CFU) and non-rinsing (mean: 80 CFU).			
	Author(s), date Nagraj et al., 2022 [32]	**Study design** Cochrane Systematic review	**Country** NA	**Sample size** NA
Intervention	—			
Comparator	—			
Type and duration of AGP	—			
Outcome	Incidence of infection in dental healthcare providers			
Summary of Findings	None of the studies measured our primary outcome of the incidence of infection in dental healthcare providers.			
	Author(s), date Marui et al., 2019 [33]	**Study design** Systematic review	**Country** NA	**Sample size** 15-60
Intervention	CPC, EO, 0.12% CHX, 0.05% CPC, Tempered and non-tempered 0.2% CHX, Tea tree oil, 0.075% CPC+0.28% zinc lactate+ 0.05% sodium fluoride (NaF)			
Comparator	5% Hydroalcohol, No rinse, Water, Sterile water, Distilled water			
Type and duration of AGP	Prophylactic scaling, air polishing Duration: range 3-10 mins			
Outcome	CFU and anaerobic bacterial cultures.			
Summary of Findings	Pooled estimates suggested that, when compared with a control mouthrinse, there was significant percentage reduction in the number of CFU after the use of CHX, and the use of EO mouthrinse. The use of an herbal mouthrinse did not result in a significant reduction in the number of CFU compared with the control mouthrinse. Overall, a preprocedural mouthrinse significantly reduced the number of CFU, moderate quality of evidence).			

Table II. Preprocedural mouthrinse study characteristics† (continued)

	Author(s), date Mohd-Said et al., 2021 [34]	**Study design** Systematic review	**Country** NA	**Sample size** 18-120
Intervention	0.12% or 0.2% CHX, Herbal EO, CPC, 1% PI, Chlorine dioxide (ClO2), Aloe vera, Herbal extract (HE),Tea tree oil, 94.5% Aloe vera extract, 0.075% CPC+ 0.28% Zn lactate +0.05% NaF, 0.12% CHX+ 10% alcohol Rinse with 10-20 ml for 30sec-2 mins, 2 to 40 mins before procedure, Tempered and non-tempered 0.2% CHX, HE			
Comparator	Saline, Sterile water, distilled water, Hydroalcohol, No rinse			
Type and duration of AGP	Ultrasonic scaling; Polishing; Duration: range 3-30 min			
Outcome	Percentage reduction in CFU.			
Summary of Findings	Among studies comparing CHX with other agents (71.4%, 15/21), the effectiveness of CHX over other agents was evident, with more than half of the studies (7/15) reporting over a 70% reduction in CFU. Preprocedural rinsing for 30s to 2min with selected antimicrobial solutions compared to water or no rinsing were found to effectively reduce aerosol contamination in periodontal prophylaxis on dental patients. There is evidence that chlorhexidine (either 0.12 or 0.2%) is an effective antimicrobial solution for this purpose.			
	Author(s), date Ramya et al., 2022 [40]	**Study design** Clinical trial	**Country** India	**Sample size** 30
Intervention	0.12% CHX; Rinse with 15 ml for 30 secs			
Comparator	PI, No rinse			
Type and duration of AGP	Ultrasonic scaling; Duration for 30 mins			
Outcome	CFU			
Summary of Findings	The preprocedural mouthrinses significantly reduced the bacterial colony forming units in aerosol samples. When utilized pre-procedurally, Chlorhexidine rinses were found to be superior to Povidone iodine in decreasing aerosol bacteria.			
	Author(s), date Rao et al., 2015 [41]	**Study design** Controlled trial	**Country** India	**Sample size** 30
Intervention	Undiluted 0.2% of CHX; Rinse with 10 ml of the rinse, 10 mins before treatment.			
Comparator	No rinse			
Type and duration of AGP	Ultrasonic scaling for 30 mins			
Outcome	CFU			
Summary of Findings	The highest number of colonies was found on blood agar plate positioned at the patient's chest area followed by the doctors. The results showed that CFU in group II were significantly reduced when compared to group I with the p-value<0.001, which was statistically significant.			

Table II. Preprocedural mouthrinse study characteristics† (continued)

	Author(s), date Sadun et al., 2020 [42]	**Study design** Randomized Controlled Trial	**Country** Malaysia	**Sample size** 30
Intervention	EO; Rinse 20 ml for 1 min			
Comparator	Distilled water			
Type and duration of AGP	Ultrasonic scaling; Duration: NA			
Outcome	Microbial load (CFU)			
Summary of Findings	Based on the mean CFU counts, patients pre-rinsed using Listerine showed significantly reduced presence of microbial contaminants compared to those pre-rinsed using the control mouthwash.			
	Author(s), date Takenaka et al., 2022 [43]	**Study design** Crossover randomized clinical trial	**Country** Japan	**Sample size** 10
Intervention	0.5% PI, EO; Rinse for 30 secs			
Comparator	Distilled water, No rinse			
Type and duration of AGP	Provider scaling and polishing for 10 mins			
Outcome	Bacterial count			
Summary of Findings	Combining an eHVE with mouth rinsing (using either 0.5% PI or EO) was found to reduce contamination from aerosols produced by an ultrasonic scaler. Although the eHVE was observed to prevent most bacterial contamination when positioned relatively close to the patient's mouth, preprocedural mouth rinsing provided additional benefits in such situations where the eHVE must be positioned further away, depending on the dental procedure performed.			
	Author(s), date Varghese et al., 2021 [44]	**Study design** Randomized Controlled Trial	**Country** India	**Sample size** 20
Intervention	Neem, 0.2% CHX, Triphala; Rinse 10 ml of the rinse for 30 sec 10 mins before scaling			
Comparator	Water			
Type and duration of AGP	Ultrasonic scaling; Duration for 10 mins			
Outcome	CFU			
Summary of Findings	The effectiveness of preprocedural rinsing with herbal rinse was compared with 0.2% Chlorhexidine which was considered as a gold standard. The outcomes of this study revealed that 10 ml of Neem Mouthrinse when used 10 minutes prior to ultrasonic scaling is more effective in decreasing the aerosol infection as compared to the Triphala mouthrinse and commercially available 0.2% Chlorhexidine mouthrinse.			

Table II. Preprocedural mouthrinse study characteristics† (continued)

	Author(s), date Warad and Bhatagunaki, 2020 [45]	**Study design** Experimental study	**Country** India	**Sample size** 60
Intervention	0.2% CHX, 0.1% Octenidine; Rinse 20 ml for 30 secs			
Comparator	Distilled Water			
Type and duration of AGP	Ultrasonic scaling; Duration: NA			
Outcome	CFU			
Summary of Findings	0.1% Octenidine was found to be most effective preprocedural mouthrinse in reducing the bacterial load in the aerosol produced during ultrasonic scaling followed by 0.2% chlorhexidine and distilled water.			
	Author(s), date Yadav et al., 2018 [46]	**Study design Randomized Controlled Trial**	**Country** India	**Sample size** 40
Intervention	CHX, HE, EO; Rinse with 10 ml of CHX, 15 ml of HR and EO for 60 secs, 10 mins before scaling			
Comparator	Distilled Water			
Type and duration of AGP	Ultrasonic scaling; Duration: not mentioned			
Outcome	CFU			
Summary of Findings	In the study, 0.2% chlorhexidine was found to be most effective preprocedural mouthrinse in reducing the bacterial load in the aerosol produced during ultrasonic scaling followed by essential oil and herbal mouthrinse respectively.			

† Definitions: eHVE, extraoral high-volume evacuator; CHX, chlorhexidine; CPC, cetylpyridinium chloride; NaF, sodium fluoride; PI, povidone iodine, EO, essential oil; Herbal Extracts, HE; CFU, cultural forming units; NA, information not available in articles.

Table III. Aerosol reduction study characteristics †

	Author(s), date Allison et al., 2022 [51]	**Study design** Non-randomised experimental study	**Country** UK	**Sample size/ observation type** 3 manikins
Type and location of aerosol reduction method	Local Exhaust Ventilation: DentalAIR UVC AGP Filtration system. Location: Extraoral suction system			
Comparison(s)	With suction and without LEV; with suction and LEV; without suction and without LEV; without suction and with LEV			
Dental Setting	Open plan setting: Clinical teaching laboratory. Single-surgery setting: Enclosed dental surgery.			
Size of clinic	Open-plan clinic: 825.4-m3 Single-surgery setting: 49.3-m3			
Type and duration of AGP	Anterior crown preparation of the upper right central incisor for 10min using an air-turbine handpiece. In the single-surgery setting, full-mouth ultrasonic scaling using a magnetostrictive scaler at full power for 10 mins; Duration: 10 mins			
Summary of findings	Local exhaust system reduced aerosols from dental procedures with air-turbine handpiece by at least 90% within 0.5m, and 99% for ultrasonic scaler. OPC particle counts reduced by 95%.			
	Author(s), date Barros et al., 2022 [107]	**Study design** Non-randomised experimental study	**Country** Brazil	**Sample size/ observation type** 120 Bovine maxillary incisors
Type and location of aerosol reduction method	HVE Location: Intraoral			
Comparison(s)	No HVE			
Dental Setting	Dental operatory			
Size of clinic	Not specified			
Type and duration of AGP	Coronal endodontic opening; Duration: 3 mins			
Summary of findings	No differences were detected when using or not the aspiration. Aerosol dispersion was found in all groups (22.56 to 72.30 cm of distance). The longest point was produced without aspiration.			
	Author(s), date Blackley et al., 2022 [54]	**Study design** Non-randomised experimental study	**Country** United States	**Sample size/ observation type** 32 manikins
Type and location of aerosol reduction method	3 different types of HVE systems. Location: Intraoral			
Comparison(s)	Background concentrations with no dental evacuation system			
Dental Setting	Dental operatory bay with five chairs in semi-separated operatories.			
Size of clinic	3.7m x 3.7m			
Type and duration of AGP	Ultrasonic scaling; anterior crown preparation; Duration: 10 mins			
Summary of findings	Respirable and thoracic aeorosols were reduced during ultrasonic scaling and crown preparation using HVE or the other HVE alternatives.			

Table III. Aerosol reduction study characteristics † (continued)

	Author(s), date Chavis et al., 2021 [71]	**Study design** Non-randomised experimental study	**Country** United States	**Sample size/ observation type** manikins Number: NA
Type and location of aerosol reduction method	Extraoral suction system (ADS Dental System) Location: Extraoral suction system			
Comparison(s)	Vacuum airflow level off			
Dental Setting	Dental operatory in dental school			
Size of clinic	Not specified			
Type and duration of AGP	The tooth preparation phase of a standardized restorative treatment; Duration: 4 mins			
Summary of findings	Use of extraoral suction units for dental clinical procedures can help reduce procedural spatter, surface contamination, and potential transmission of the SARS-CoV-2 virus. However, it did not eradicate spatter.			
	Author(s), date Chestsuttayangkul et al., 2022 [74]	**Study design** Non-randomised experimental study	**Country** Thailand	**Sample size/ observation type** manikins Number: NA
Type and location of aerosol reduction method	Metal frame with plastic wrap, plastic shield chamber Location: Extraoral suction system			
Comparison(s)	No barrier but with HVE and intraoral saliva ejector simultaneously.			
Dental Setting	Single-chair operatory room			
Size of clinic	Not specified			
Type and duration of AGP	Scaling procedures; Duration: 5 mins			
Summary of findings	Both types of barriers were able to reduce the surface contamination in most of the areas on dental chair, operator's and assistant's body. No significant difference in surface contamination of splatter reduction was found between the metal frame with plastic wrap and plastic shield chamber.			
	Author(s), date Choi et al., 2022 [56]	**Study design** Non-randomised experimental study	**Country** New Zealand	**Sample size/ observation type** 5 manikins
Type and location of aerosol reduction method	HVE; LVE Location: Intraoral			
Comparison(s)	No suction			
Dental Setting	Enclosed windowless dental surgery			
Size of clinic	3.9 m x 3.5 x 2.7m.			
Type and duration of AGP	Ultrasonic scaling and drilling operative procedures; Duration: 8 mins			
Summary of findings	Drilling and scaling with LVE or HVE reduced aerosol generation significantly. HVE was effective in removing all sizes of aerosol particles measured.			

Table III. Aerosol reduction study characteristics † (continued)

	Author(s), date Choudhary et al., 2022 [65]	**Study design** Non-randomised experimental study	**Country** United States	**Sample size/ observation type** Patients Number: NA
Type and location of aerosol reduction method	HVE; saliva ejector; HEPA filter; rubber dam Location: Intraoral and extraoral			
Comparison(s)	Not specified			
Dental Setting	Operating room (single chair with door closed), two different types of semi-open bay, and large multioperator space			
Size of clinic	Not specified			
Type and duration of AGP	Implant, ultrasonic cleaning, gingival flap with cavitron, root canal procedures with high-speed handpiece, braces debonding, amalgam removal, post and core CEREC crown, composite filling. Duration: range from 30 to 74 mins			
Summary of findings	Few viable bacteria and no viruses in dental aerosols when applying common aerosol mitigation techniques.			
	Author(s), date Choudhary et al., 2022 [65]	**Study design** Non-randomised experimental study	**Country** United States	**Sample size/ observation type** Patients Number: NA
Type and location of aerosol reduction method	Conical or Isovac HVE Location: Intraoral			
Comparison(s)	Standard HVE tip			
Dental Setting	Pediatric and general dental operatories had a single-room layout. Endodontic and periodontic clinics had semiprivate operatories with partial wall barriers between dental chairs.			
Size of clinic	The orthodontic clinic included a large multi operator clinic space (~35 m×20 m×20 m).			
Type and duration of AGP	High speed drilling during debonding of orthodontic brackets; enamel and dentin cutting during cavity and crown preparation; slow speed drilling for finishing cavity preparation, polishing, and trimming during crown preparation; removal of dentin and soft tissues during endodontics; and ultrasonic scaling during teeth cleaning.			
Summary of findings	Conical HVE is likely more efficient in reducing emissions from high-speed drilling than standard-tip HVE.			
	Author(s), date Dahlke et al., 2012 [61]	**Study design** Non-randomised experimental study	**Country** United States	**Sample size/ observation type** manikins Number: NA
Type and location of aerosol reduction method	Dental isolation combination system; HVE and rubber dam Location: Intraoral			
Comparison(s)	HVE			
Dental Setting	Dental operatory			
Size of clinic	Not specified			
Type and duration of AGP	Simulated tooth preparation procedure. Duration: 10 secs			
Summary of findings	The dental isolation combination systems and HVE + rubber dam reduced spatter significantly compared with use of an HVE alone.			

Table III. Aerosol reduction study characteristics † (continued)

	Author(s), date D'Antonio et al., 2022 [64]	**Study design** Non-randomised experimental study	**Country** United States	**Sample size/ observation type** 48 manikins
Type and location of aerosol reduction method	HVE; Isovac; extraoral suction Location: Intraoral and extraoral			
Comparison(s)	No mitigation strategy			
Dental Setting	Dental operatory			
Size of clinic	Not specified			
Type and duration of AGP	High speed handpiece; air-water syringe; ultrasonic scaler; rubber cup prophy Duration: 10 mins			
Summary of findings	All ventilation options used were equally effective at reducing respirable aerosols. Local control options such as HVE, ISO, and EOS units were equally as effective during short-term tests.			
	Author(s), date Deana et al., 2021 [80]	**Study design** Systematic review	**Country** Chile	**Sample size/ observation type** 34 Guidelines or protocols
Type and location of aerosol reduction method	HVE; rubber dam Location: Intraoral			
Comparison(s)	Not specified			
Dental Setting	Not specified			
Size of clinic	Not specified.			
Type and duration of AGP	Not specified. Duration: not specified			
Summary of findings	Procedures such as the use of HVE and the use of a rubber dam were widely recommended in order to reduce the generation of aerosols during dentalcare			
	Author(s), date Ehtezazi et al., 2021 [69]	**Study design** Non-randomised experimental study	**Country** UK	**Sample size/ observation type** 3 manikins
Type and location of aerosol reduction method	HVE with air filtration system; extraoral HVE Location: Intraoral and extraoral			
Comparison(s)	LVE			
Dental Setting	Dental operatory			
Size of clinic	4.4 x 3.1 x 2.6 m			
Type and duration of AGP	Air turbine handpiece; electric contra-angle handpiece; ultrasonic scaler Duration: 3 mins			
Summary of findings	All aerosol-management interventions were relatively effective. Without aerosol-management interventions, particles (0.05–0.236 μm) remained at elevated concentrations for longer than the experimental period.			

Table III. Aerosol reduction study characteristics † (continued)

	Author(s), date Gheorghita et al., 2022 [53]	**Study design** Non-randomised experimental study	**Country** United States	**Sample size/ observation type** 30 manikins
Type and location of aerosol reduction method	EOS type 1: Dental Aerosol System; EOS type 2: Eighteenth Vac Station Location: Extraoral suction system			
Comparison(s)	HVE and a saliva ejector without EOS			
Dental Setting	Dental operatory			
Size of clinic	4.15m x 2.6m with one door and one window			
Type and duration of AGP	Class III cavity preparation in the upper front teeth with palatal access Duration: 5 mins			
Summary of findings	Total number concentrations were 2 times the baseline with both EOS A and EOS B, while without any EOS, approximately 6 times higher.			
	Author(s), date Graetz et al., 2022 [55]	**Study design** Experimental pilot study	**Country** Germany	**Sample size/ observation type** 20 manikins
Type and location of aerosol reduction method	Mobile extraoral scavenger device Location: Extraoral suction system			
Comparison(s)	No EOS but with HVE			
Dental Setting	University dental clinic			
Size of clinic	16.94 m^2			
Type and duration of AGP	High speed tooth preparation and different procedures of provider tooth cleaning Duration: 2 mins			
Summary of findings	No relevant differences between AGPs and the control or among the different AGPs when a high-flow suction system was used. The additional use of a mobile EOS device led to a significantly lower concentration of particles between 0.1 and 0.3 µm in diameter.			
	Author(s), date Graetz et al., 2021 [57]	**Study design** Non-randomised experimental study	**Country** Germany	**Sample size/ observation type** 8 manikins
Type and location of aerosol reduction method	HVE systems with five different intraoral suction cannulas: a 6-mm saliva ejector, a 11-mm suction cannula, and three types of 16-mm suction cannulas Location: Intraoral			
Comparison(s)	No intraoral suction during AGP			
Dental Setting	Dental operatory			
Size of clinic	Not specified			
Type and duration of AGP	High speed tooth preparations; air-polishing. Duration: 6 mins			
Summary of findings	The lowest splatter contamination values resulted when suction cannula of 16 mm of diameter were utilized by a high-flow rate of ≥250 l/min			

Table III. Aerosol reduction study characteristics † (continued)

	Author(s), date He et al., 2022 [59]	**Study design** Non-randomised experimental study	**Country** Canada	**Sample size/ observation type** 180 manikins
Type and location of aerosol reduction method	Plastic and metal HVE Location: Intraoral			
Comparison(s)	Air purifier and no HVE			
Dental Setting	Dental operatory (single chair)			
Size of clinic	3.5 x 3.0 x 2.85 m			
Type and duration of AGP	Drilling and scaling procedure. Location: 15 mins			
Summary of findings	Aerosol reduction measures can effectively remove the aerosol generated by drilling procedures. Air purifiers and HVE used individually reduced aerosol concentration at a rate of 94.8% to 97.6%. Using both measures simultaneously brought the reduction rate to 99.6%.			
	Author(s), date Horsophonphong et al., 2021 [60]	**Study design** Non-randomised experimental study	**Country** Thailand	**Sample size/ observation type** manikins Number: NA
Type and location of aerosol reduction method	HVE; extraoral suction system Location: Extraoral suction system			
Comparison(s)	HVe			
Dental Setting	Dental operatory			
Size of clinic	No specified			
Type and duration of AGP	Ultrasonic scaler. Duration: 10 mins			
Summary of findings	The extraoral suction device effectively reduced the dissemination of the aerosols and splatters generated during ultrasonic scaling.			
	Author(s), date Kumbargere Nagraj et al., 2020 [77]	**Study design** Systematic review	**Country** Not specified	**Sample size/ observation type** 16 Articles
Type and location of aerosol reduction method	HVE; dental isolation combination system; rubber dam Location: Intraoral			
Comparison(s)	No HVE, conventional dental suction, no rubber dam, no rubber dam plus HVE			
Dental Setting	Dental operatory			
Size of clinic	Not specified			
Type and duration of AGP	Ultrasonic scaling and polishing and restorative procedures. Duration: Not specified			
Summary of findings	All included studies measured bacterial contamination and not disease transmission via aerosols or viral contamination in aerosols. Some promising results from HVE and HVE + rubber dam. However, evidence was assessed of very low certainty.			

Table III. Aerosol reduction study characteristics † (continued)

	Author(s), date Lertsooksawat et al., 2022 [52]	**Study design** Non-randomised experimental study	**Country** Thailand	**Sample size/ observation type** manikins Number: NA
Type and location of aerosol reduction method	Negative airflow aerosol chamber Location: Extraoral suction system			
Comparison(s)	No negative airflow aerosol chamber			
Dental Setting	Dental clinic			
Size of clinic	Not specified			
Type and duration of AGP	Dental scaling using ultrasonic scaler. Duration: 10 mins			
Summary of findings	Negative airflow aerosol chamber reduced L. acidophilus colonies at all tested locations by 86.63%.			
	Author(s), date Matys and Grzech-Leśniak, 2020 [58]	**Study design** Non-randomised experimental study	**Country** Poland	**Sample size/ observation type** Manikin Number: NA
Type and location of aerosol reduction method	Saliva ejector; HVE; saliva ejector with an extraoral vacuum; HVE with an extraoral vacuum; zirc evacuator; customized HVE (white)- designed and prepared by the authors; customized HVE (black)- designed and prepared by the authors Location: Intraoral			
Comparison(s)	Saliva ejector and HVE			
Dental Setting	Not specified			
Size of clinic	Not specified			
Type and duration of AGP	Treatment of caries class I with the round diamond bur (#014) with a high speed handpiece, low speed handpiece, with 1 mm diameter sapphire tip with a handpiece H14 of Er:YAG laser. Tooth polishing with silicone rubber dental bur with a low-speed handpiece at 1000 and 10,000 RPM. Dental calculus removal using ultrasound scaler. Duration: 5 mins			
Summary of findings	HVE allowed removing a significant amount of aerosol. The highest efficiency in aerosol reduction was obtained for wider customized HVE. The Er:YAG laser used for caries removal had a low aerosol generation even when working combined with saliva ejector.			
	Author(s), date Montalli et al., 2020 [75]	**Study design** Non-randomised experimental study	**Country** Brazil	**Sample size/ observation type** 3 Screens
Type and location of aerosol reduction method	Individual dental biosafety barrier Location: Extraoral			
Comparison(s)	No individual dental biosafety barrier			
Dental Setting	Postgraduate dental clinic			
Size of clinic	Not specified			
Type and duration of AGP	Drilling. Duration: 1 min			
Summary of findings	This individual dental biosafety barrier was able to reduce contamination by more than 90% over the different distances tested (50, 100, and 150 cm).			

Table III. Aerosol reduction study characteristics † (continued)

	Author(s), date Narayana et al., 2016 [108]	**Study design** Non-randomised experimental study	**Country** UK	**Sample size/ observation type** 45 Healthy patients
Type and location of aerosol reduction method	HVE Location: Intraoral			
Comparison(s)	No HVE			
Dental Setting	Dental operatory (single chair with ventilation)			
Size of clinic	20 x 15 feet			
Type and duration of AGP	Ultrasonic scaling. Duration: 5 mins			
Summary of findings	CFUs were significantly reduced with the use of HVE. Combination with CHX (0.12%) preprocedural rinse was more effectively than individual methods during ultrasonic scaling procedure.			
	Author(s), date Noordien et al., 2021 [9]	**Study design** Non-randomised experimental study	**Country** South Africa	**Sample size/ observation type** 1 Volunteer
Type and location of aerosol reduction method	Extraoral dental aerosol suction device (DASD) and LVE saliva ejector Location: Extraoral suction system			
Comparison(s)	LVE alone and HVE plus LVE			
Dental Setting	Dental operatory			
Size of clinic	16 m^2			
Type and duration of AGP	High speed air turbine directed 1 mm away from molar. Duration: 5 mins			
Summary of findings	Compared to a LVE, the HVE + LVE showed a 53% and the DASD+ LVE showed a 62% reduction in aerosol, droplet and splatter contamination.			
	Author(s), date Nulty et al., 2020 [70]	**Study design** Non-randomised experimental study	**Country** UK	**Sample size/ observation type** Manikin Number: NA
Type and location of aerosol reduction method	External HVE Location: Extraoral suction system			
Comparison(s)	Without external HVE			
Dental Setting	Dental operatory			
Size of clinic	Not specified			
Type and duration of AGP	Intense (full-blast) three-in-one air-water syringe; micromotor high speed handpiece; air turbine high speed handpiece; low speed handpiece; ultrasonic scaling Duration: 1 min			
Summary of findings	Aerosol particulate was recorded at statistically significantly increased levels during dental procedures without an external HVE device versus with the device.			

Table III. Aerosol reduction study characteristics † (continued)

	Author(s), date Piela et al., 2022 [63]	**Study design** Non-randomised experimental study	**Country** UK	**Sample size/ observation type** Manikin Number: NA
Type and location of aerosol reduction method	Dynamic suction devices: Standard HVE suction, Purevac HVE system, Purevac HVE Mirror Tip connected directly to the suction port Static suction devices: DryShield Isolation System, standard low-volume suction Location: Intraoral			
Comparison(s)	No suction			
Dental Setting	Dental operatory			
Size of clinic	Not specified			
Type and duration of AGP	Ultrasonic scaling and high speed turbine/handpiece treatment			
Summary of findings	Effective mitigation of aerosols generated from ultrasonic scaling and high speed handpiece procedures using high-volume dynamic intraoral suction.			
	Author(s), date Rexhepi et al., 2021 [67]	**Study design** Cohort study	**Country** Italy	**Sample size/ observation type** Patients 15,574 measurements
Type and location of aerosol reduction method	Low-volume suction (40 L/ min air) Intraoral			
Comparison(s)	Measurement of aerosol done at different position			
Dental Setting	A dental unit located in an open plan clinic			
Size of clinic	2.8 m × 2.8 m × 3 m			
Type and duration of AGP	Oral hygiene practices, conservative dental therapy, prosthetic reconstruction, dentoalveolar surgery, and implant surgery. Duration: 40 mins			
Summary of findings	LVE seemed to reduce PM10 and total particles during dental activities (e.g., ultrasonic scaling), while it showed lower effectiveness in reducing ultrafine PM.			
	Author(s), date Robertson et al., 2022 [79]	**Study design** Systematic review	**Country** UK	**Sample size/ observation type** Guidance docments
Type and location of aerosol reduction method	Rubber dam; HVE Intraoral			
Comparison(s)	Not specified			
Dental Setting	Dental operatory			
Size of clinic	Not specified			
Type and duration of AGP	Not specified, Duration: not specified			
Summary of findings	Forty-six documents (73%) recommended use of a rubber dam for patients without COVID-19. The use of HVE was recommended for patients without COVID-19 by 46 (73%) documents.			

Table III. Aerosol reduction study characteristics † (continued)

	Author(s), date Samaranayake et al., 2021 [78]	**Study design** Systematic review	**Country** Not specified	**Sample size/ observation type** 17 Articles
Type and location of aerosol reduction method	HVE; rubber dam Location: Intraoral			
Comparison(s)	Not specified.			
Dental Setting	Dental operatory			
Size of clinic	Not specified.			
Type and duration of AGP	Not specified. Duration: not specified.			
Summary of findings	The use of HVE in reducing bio-aerosols in the clinic environment is effective, which is determined by the suction strength of the appliance, the proximity of the HVE to the operating site, and the number of HVE used.			
	Author(s), date Senpuku et al., 2021 [73]	**Study design** Non-randomised experimental study	**Country** Japan	**Sample size/ observation type** 3 Healthy volunteers
Type and location of aerosol reduction method	Extraoral suction and intraoral suction Location: Extraoral suction system			
Comparison(s)	No extraoral or intraoral suction, and no extraoral but with intraoral suction			
Dental Setting	Dental operatory (single chair) in a university dental hospital.			
Size of clinic	Not specified			
Type and duration of AGP	Simulated scaling. Duration: 10 mins			
Summary of findings	The extraoral suction was effective for reducing droplets and aerosols in the limited area of the left side.			
	Author(s), date Shahdad et al., 2020 [72]	**Study design** Non-randomised experimental study	**Country** UK	**Sample size/ observation type** 23 Manikins
Type and location of aerosol reduction method	External scavenger device Location: Extraoral suction system			
Comparison(s)	No extraoral suction			
Dental Setting	Dental operatory (door closed); some procedures replicated in an open, multi chair clinic single bay floor			
Size of clinic	Dental operatory= 16.8 m^2; Open, multi chair clinic single bay floor surface = 10.0m^2			
Type and duration of AGP	Air turbine procedures were carried out with standard diamond burs and operated at full speed (360,000 rpm). Ultrasonic scaling at a maximum frequency (30KHz). Duration: 5 mins			
Summary of findings	The EOS system reduced the peaks in particle concentration in non-mechanically ventilated and mechanically ventilated environments.			

Table III. Aerosol reduction study characteristics † (continued)

	Author(s), date Suprono et al., 2021 [66]	**Study design** Non-randomised experimental study	**Country** United States	**Sample size/ observation type** 93 students
Type and location of aerosol reduction method	HVE with intraoral suction device Location: Intraoral			
Comparison(s)	HVE			
Dental Setting	Clinic area with multiple open bay cubicles			
Size of clinic	3,118 sq ft, and each cubicle was 78 ft^2.			
Type and duration of AGP	Ultrasonic scalers. Duration: 20 mins			
Summary of findings	The combination of HVE and an intraoral suction device significantly reduced the amount of microbial aerosol during treatment periods.			
	Author(s), date Vernon et al., 2021 [101]	**Study design** Non-randomised experimental study	**Country** UK	**Sample size/ observation type** Manikin Number: NA
Type and location of aerosol reduction method	Rubber dam; HVE Location: Intraoral			
Comparison(s)	No mitigation strategy			
Dental Setting	Dental operatory			
Size of clinic	Not specified			
Type and duration of AGP	Endodontic access procedures on the upper first molar tooth and anterior crown preparation. Duration: 4 min			
Summary of findings	Use of the high-speed contra-angle handpiece with HVE resulted in no detectable bacteriophage, both on non-splatter settle plates and in air samples taken 6 to 10 min post-procedure.			
	Author(s), date Yang et al., 2021 [76]	**Study design** Non-randomised experimental study	**Country** United States	**Sample size/ observation type** Manikin Number: NA
Type and location of aerosol reduction method	Extraoral HVE Location: Extraoral suction system			
Comparison(s)	Saliva ejector plus high-speed suction			
Dental Setting	Dental operatory			
Size of clinic	Not specified			
Type and duration of AGP	High speed handpiece; ultrasonic scaling. Duration: 6 mins			
Summary of findings	The increase of aerosol (size smaller than 10 µm) level was minimal during dental procedures when using saliva ejector and high-speed suction. Use of extraoral HVE further reduced aerosol levels to below baseline level.			

Table III. Aerosol reduction study characteristics † (continued)

	Author(s), date Rafiee et al., 2022 [21]	**Study design** Cross-sectional	**Country** Canada	**Sample size/ observation type** Patients
Type and location of aerosol reduction method	51 samples from 7 dental procedures			
Comparison(s)	No HVE (saliva ejector only); no rubber dam			
Dental Setting	Dental operatory			
Size of clinic	The area has a volume of L (7.87 m) × W (7.59 m) × H (2.66 m) consisting of six dental units.			
Type and duration of AGP	40 minutes			
Summary of findings	Combining HVE + saliva ejector reduces aerosol escape. From the different procedures and aerosol reducing methods used, ultrasonics with HVE + saliva ejector yielded the lowest particle concentration.			

† Definitions: LEV, Local exhaust ventilation; HVE, High volume extraction; EOS, Extraoral scavenger; HEPA, high efficiency particulate air; DASD, dental aerosol suction device; CFU, Colony forming units; CHX, Chlorhexidine; PM, Particulate matter; NA, information not available in articles.

Table IV. PPE study characteristics†

	Author(s), date Afzha et al., 2016 [81]	**Study design** Randomized controlled trial	**Country** India	**Setting** Dental College
Intervention(s)	Protective eyewear			
Comparison(s)	No protective eyewear			
Type and duration of AGP	Scaling and root planning for 30 mins			
Outcome	Aerosol contamination of contact lenses			
Summary of findings	Overall, the results of this study indicate low microbial contamination of contact lens in Group A (contact lens with protective eyewear) when compared to Group B (contact lens without protective eyewear) which is statistically significant ($p < 0.01$)			
Remarks	Scaling and root planning were rendered with piezoelectric ultrasonic scalers in combination with high volume evacuation (HVE)			

Table IV. PPE study characteristics† (continued)

	Author(s), date Bridgman et al., 2021 [82]	**Study design** Experimental study	**Country** New Zealand	**Setting** Simulated setting
Intervention(s)	The air-fed mask under plastic hoods with a low air consumption 20L/min.			
Comparison(s)	N95 mask and goggles, Air-fed mask on 150L/min, Air-fed mask on 300L/min, Air-fed mask on 300L/min combined with an N-95 mask			
Type and duration of AGP	High speed handpiece for 10 mins			
Outcome	Head and neck area contamination			
Summary of findings	The N-95 mask did not prevent nasal and mouth contaminations, but the combination of an air-fed mask with a sealed hood prevented these contaminations. Although goggles worn tightly did prevent contamination, the air-fed mask system was far more comfortable and did not fog up			
Remarks	None			
	Author(s), date Checchi et al., 2021 [83]	**Study design** Experimental study	**Country** Italy	**Setting** Periodontal private clinic
Intervention(s)	Filtering Face Pieces (FFP2) used for 8, 16, 24, 32, 40 h			
Comparison(s)	Unused FFP2 mask			
Type and duration of AGP	Procedures that involved the use of ultrasonic devices and high speed handpieces for 8-40 h			
Outcome	Bacterial filtration efficiency (BFE)			
Summary of findings	Our results based on BFE of five respirators measured at 8, 16, 24, 32, and 40 h of usage indicate no significant difference when tested the respirator and control are compared at each time. Moreover, the non-significant effect of time on BFE of the tested respirators is confirmed by multilevel analysis (GLM). In light of these results, it is clear that this type of FFP2 can be considered probably effective for multiple working hours and days			
Remarks				
	Author(s), date Ionescu et al., 2021 [84]	**Study design** Experimental study	**Country** Italy	**Setting** Simulated setting
Intervention(s)	Surgical mask, no HVE, Surgical mask, HVE, FFP2 respirator, HVE			
Comparison(s)	NA			
Type and duration of AGP	High speed handpiece for 10 secs			
Outcome	Viral load			
Summary of findings	The combination of mask or respirator and face shield reduced viral loads below the detection limit, thus decreasing the risk of the operator's being contaminated. In the experimental setup of our study, surgical masks and N95 (FFP2) or FFP3 respirators were equally effective in protecting the operator, whereas HVE did not seem to decrease the risk of experiencing aerosol contamination.			
Remarks	The PPE were tested adjunctly with HVE			

Table IV. PPE study characteristics† (continued)

	Author(s), date Sabra Rita de Assis et al., 2022 [85]	**Study design** Experimental study	**Country** Brazil	**Setting** Simulated setting
Intervention(s)	Individual Biosafety Capsule Device (IBCD)			
Comparison(s)	No IBCD			
Type and duration of AGP	High speed handpiece for 1 minute			
Outcome	CFU			
Summary of findings	When comparing contamination in two clinics with and without the use of the IBCD, the results showed that the barrier was able to reduce air contamination derived by orthodontic procedures during patient consultation by 97% compared to its non-use ($p<0.05$). The results of this study showed that the use of the biosafety device is an effective means to reduce air contamination by more than 99% of bacterial contamination around the main droplet/aerosol source			
Remarks	Non			
	Author(s), date Teichert-Filho et al., 2020 [86]	**Study design** Experimental study	**Country** Brazil	**Setting** Simulated setting
Intervention(s)	Rigid protective device			
Comparison(s)	No device			
Type and duration of AGP	High speed handpiece for 1 minute			
Outcome	The observation of the dye			
Summary of findings	In the simulated dental procedure without the device, the dye was observed on the face of the manikin, surgical gloves, apron (chest, legs, fists) and face shield, as well as on the dental chair (backrest, light reflector) and floor. The dye was found on the operator's clothes under the apron, revealing the possibility of contamination. In contrast, in the simulated dental procedure using the device, the dye was observed only on the surgical gloves, apron (fists), inside the pipe system and internal walls of the acrylic chamber.			
Remarks	None			

Table IV. PPE study characteristics† (continued)

	Author(s), date Villa and Grenon, 2021 [87]	**Study design** Experimental study	**Country** United States	**Setting** Dental setting
Intervention(s)	Cupola			
Comparison(s)	Without the Cupola, With Cupola and Drape			
Type and duration of AGP	High speed handpiece for 1 minute			
Outcome	Spread of droplets and aerosols			
Summary of findings	The mean number of 0.3 µm particles with no Cupola was 3777 (SD: ± 556), with The Cupola was 2068 (SD: ±1468) and with the Cupola and Drape was 2031 (SD: ± 1108) ($p<0.015$). The mean number of 0.5 µm airborne particles with no Cupola was 65 (SD: ± 7), with The Cupola was 29 (SD: ± 28) and with the Cupola and Drape was 28 (SD: ± 23) ($p<0.05$). We have shown that the Cupola is effective at decreasing aerosols and droplets generated during simulated dental procedures.			
Remarks	None			

HVE, high volume evacuator; FFP, filtering face piece; IBCD, individual biosafety capsule device; CFU, colony forming unit; BFE, bacterial filtration efficiency.

Table V. Operatory setup study characteristics†

	Author(s), date Allison et al., 2022 [51]	**Study design** Experimental	**Country** UK	**Sample size** Not specified	**Setting** Dental manikins
Intervention	Ten-minute crown preparations with an air-turbine handpiece 10-min full-mouth ultrasonic scaling Fluorescein used as a tracer Optical particle counters: measure aerosol particles between 0.3 and 10.0 µm				
Comparator	Open plan clinic, single surgery unit				
Outcome	Reduction in aerosol after adding LEV to the existing suction devices				
Summary of Findings	LEV reduced aerosol production from the air-turbine handpiece by 90% within 0.5 m, and this was 99% for the ultrasonic scaler. OPC particle counts were substantially reduced for both procedures as well as a reduction of 95% within 0.5 m was seen when air-turbine was used.				
Remarks	The effect of LEV was substantially greater than suction alone for the air-turbine and was similar to the effect of suction for the ultrasonic scaler.				

Table V. Operatory setup study characteristics[†] (continued)

	Author(s), date Holliday et al., 2021 [91]	**Study design** Experimental	**Country** UK	**Sample size** Not specified	**Setting** Dental manikins in simulated setting
Intervention	Filter papers were placed in an open plan clinic to collect fluorescein An 8-metre diameter rig Fluorescence photography and spectrofluorometry for analysis				
Comparator	Not specified				
Outcome	Contamination in terms of distance in clinic setting, Aerosol settling time				
Summary of Findings	Contamination distribution varied across the clinic depending on conditions Unmitigated procedures have the potential to deposit contamination at large distances Distant bays (≥5 m head-to- head chair distance) gave very low or zero readings Almost all (99.99%) of the splatter detected was retained within the procedural bay				
Remarks	Aerosols have the potential to contaminate distant sites, and the majority of settled aerosol is detectable after 10 minutes Cross-ventilation reduced contamination in adjacent and distant areas by 80-89%				
	Author(s), date Kumbargere Nagraj et al., 2020 [77]	**Study design** Cochrane review	**Country** NA	**Sample size** NA	**Setting** Only 2 studies that measured the volume of contaminated aerosols
Intervention	Ventilation (local and general) Decontamination of aerosols in air				
Comparator	Air cleaning systems v/s none				
Outcome	Air cleaning system versus no air cleaning system Laminar air on with HEPA versus laminar air off				
Summary of Findings	Effect estimates showed fewer CFU in ACS group for both the procedures. Lesser CFU during the use of laminar air flow with HEPA filters compared to no laminar air flow or filter at less than 1 metre from the floor.				
Remarks	Showed reduction in volume of contaminated aerosols in operative environments. Evidence that an ACS can significantly reduce the aerosol load during dental procedures. Through laminar airflow in a dental operatory, dental aerosols containing micro-organisms disseminated into the environmental air by an ultrasonic scaling device can be significantly reduced (99.67%.)				

Table V. Operatory setup study characteristics† (continued)

	Author(s), date Ren et al., 2021 [92]	**Study design** Experimental	**Country** United States	**Sample size** NA	**Setting** Dental facility with 52 enclosed dental treatment rooms and 3 open bay clinics each containing 12 dental units spaced 7–8 feet apart
Intervention	Room airflow and mechanical ventilation rates Quantification of aerosol particle generation (Lasair III 310C aerosol particle counter) Effectiveness of aerosol removal by PAC Effectiveness of aerosol removal by mechanical ventilation and PAC				
Comparator	Different treatment rooms 10 dental treatment rooms Baseline, after 5-min of incense burn, and after 30-min of observation with and without the PAC or ventilation system in operation				
Outcome	Air change rate per hour by ventilation (ACHvent) and equivalent ventilation provided by the PAC (ACHpac) Concentrations of 0.3, 0.5 and 1.0 µm aerosol particles Concentration decay constants for the 0.3 µm particles with ventilation alone (Kn) and with ventilation and PAC (Kn+pac), and by times needed to reach 95 % and 100 % removal				
Summary of Findings	The speeds of aerosol removal from the dental treatment rooms were highly correlated with mechanical ventilation rates (mechanical ventilation alone) ACHvent varied from 3 to 45 Kn and Kn+pac were correlated with ACHvent (r = 0.90) and combined ACHtotal (r = 0.81), respectively Accumulated aerosol particles could not be removed by ventilation alone within 30-min in rooms with ACHvent<15				
Remarks	Noted that adding PAC with a HEPA filter improves aerosol removal in rooms with low ventilation rate PAC reduced aerosol accumulation and accelerated aerosol removal, and accumulated aerosols could be completely removed in 4 to 12-min by ventilation combined with PAC Effectiveness of the PAC was especially prominent in rooms with poor ventilation				
	Author(s), date Zhu et al., 2022 [93]	**Study design** Experimental	**Country** United States	**Sample size** NA	**Setting** Simulated with dental manikins
Intervention	Conducted drilling procedures with a high speed handpiece and high-volume evacuator High speed imaging and particle sampling was done				
Comparator	Compared drilling operations with supplemental internal and external suction and evaluated the effects of barriers separating operating spaces				
Outcome	Formation and transport of aerosol clouds Aerosol concentration and size distribution of particulate matter				
Summary of Findings	In the context of dental operatory design, barriers considerably reduce aerosol transport to adjacent dental training stations (higher barriers were better than the short ones)				
Remarks	It was observed that using barriers was the most effective mitigation strategy				

† Definitions: OPC, optical particle counters; CFU, cultural forming units; ACS, air cleaning systems; HEPA, high efficiency particulate air-filter; ACH, air change rate per hour; PAC, portable air cleaner.

Table VI. Fallow time study characteristics†

	Author(s), date College of General Dentistry, 2020 [102]	**Study design** Review	**Country** UK	**Sample size** 83 articles/ documents	**Dental Setting** Not specified
Dental setting characteristics	Not specified				
Type and duration of AGP	Not specified				
Post-procedure duration	Not specified				
Use of aerosol mitigation	Not specified				
Calculation of fallow time	Not specified				
Fallow time	Not specified				
Main finding	ACH is a huge factor in determining fallow time. Fallow time varies according to the procedure, ventilation rate, high volume suction used, rubber dam, and length of procedure. Shortest times (10 min) are recommended for ≥10 ACH, with high volume suction used and with or without rubber dam				
	Author(s), date Choudhary, 2021 [68]	**Study design** Non-randomised experimental study	**Country** United States	**Sample size** Patients Number: Not specified	**Dental Setting** Pediatric + General, Endo + Perio, Orthodontic
Dental setting characteristics	Not specified				
Type and duration of AGP	High-speed drilling, Low-speed drilling, Ultrasonic scaling Duration: Not specified				
Post-procedure duration	Not specified				
Use of aerosol mitigation	Dental suction used = 8.2 mm tip with flow rate 74 standard cubic feet per minute at 7.0Hg (2095.44 LPM; Henry Schein 1400 RAMVAC standard model).				
Calculation of fallow time	Not specified				
Fallow time	Not calculated				
Main finding	When present, appeared transient– regardless of dental clinic configuration. Authors imply this is sufficient evidence to reduce follow time to 5 minutes.				

Table VI. Fallow time study characteristics† (continued)

	Author(s), date Clarkson et al., 2020 [103]	**Study design** Rapid Review	**Country** UK	**Sample size** 30 documents	**Dental Setting** Not specified
Dental setting characteristics	Not specified				
Type and duration of AGP	Not specified				
Post-procedure duration	Not specified				
Use of aerosol mitigation	Not specified				
Calculation of fallow time	Not specified				
Fallow time	2 to 180 minutes				
Main finding	Same fallow time between non-covid and covid patients. Use of aerosol mitigation strategies and increase the number of air changes per hour.				
	Author(s), date Ehtezazi et al., 2021 [69]	**Study design** Non-randomised experimental study	**Country** UK	**Sample size** 3 manikins	**Dental Setting** Typical dental surgery room
Dental setting characteristics	4.4 x 3.1 x 2.6 m. All non-experimental air-conditioning equipment was turned off during the experimental work, and the average room temperature and relative humidity over the study period were 27°C and 67%, respectively.				
Type and duration of AGP	Air turbine handpiece, electric contra-angle handpiece, and ultrasonic scaler Duration: 3 mins				
Post-procedure duration	15 minutes				
Use of aerosol mitigation	Low-volume suction, high-volume suction (intraoral) with air filtration system, high-volume suction (extraoral), and air cleaning system.				
Calculation of fallow time	Estimation of fallow time was performed by linear regression of particle concentrations at each sample location following cessation of AGPs and was calculated as the time at which the extrapolated particle concentration decreased below the upper baseline particle concentration.				
Fallow time	None				
Main finding	All aerosol-management interventions evaluated were relatively effective in controlling aerosols generated by the dental handpieces. The use of high-volume intramural suction HVS(IO) or the HVS(IO) combined with the Air cleaning System (ACS), was enough to reduce the fallow time to zero minutes. In the absence of aerosol-management interventions.				

Table VI. Fallow time study characteristics† (continued)

	Author(s), date Fennelly et al., 2022 [99]	**Study design** Non-randomised experimental study	**Country** UK	**Sample size** 70,524,717 particles recorded Manikin	**Dental Setting** Typical dental surgery room
Dental setting characteristics	Mechanically ventilated clinic at Cork University Dental School and Hospital				
Type and duration of AGP	Ultrasonic scaling, and high-speed drilling; Duration: 6 minutes (1 min intervals)				
Post-procedure duration	Not specified				
Use of aerosol mitigation	High-volume evacuation and High-volume evacuation plus local exhaust ventilation				
Calculation of fallow time	Not specified				
Fallow time	49 to 280 minutes				
Main finding	High-volume evacuation and high-volume evacuation plus local exhaust ventilation eradicated all procedure-related aerosols, and the enclosure stopped procedure-related aerosols escaping. If no mitigation procedures done, then fallow time increases to 71 min or even 126 minutes.				
	Author(s), date Li et al., 2021 [100]	**Study design** Non-randomised experimental study	**Country** China	**Sample size** Manikin Number: Not specified	**Dental Setting** Dental clinic
Dental setting characteristics	36m x 2.7m x 2.3m. Indoor room temperature, and relative humidity (23°C, 52%). Ceiling ventilation with 6 ACH.				
Type and duration of AGP	Ultrasonic scaling; Duration: 2 minutes				
Post-procedure duration	4o minutes				
Use of aerosol mitigation	HVE intraoral (3cm2 aspirator tip and at the high flow rate, 300 l/min of air.)				
Calculation of fallow time	The FT estimation was studied by the linear and exponential regressions of the particle counts in the post-procedure duration. The FT was calculated as the time by the particle counts decreased below the baseline levels.				
Fallow time	27 to 35 minutes				
Main finding	Without any mitigation measures, the estimated fallow time in the single dental surgery environment with 6 ACH is in the range of 27-35 min. High-volume evacuation cannot eliminate the fallow time to zero minutes but can reduce it by 3-11 min. Although the ACH was recommended from 6 to 12 ACH, the relationship between the fallow time and ACH value was not well-investigated. Some other factors of fallow time include duration of dental treatment, dental procedures, ventilation type, and number of dental providers.				

Table VI. Fallow time study characteristics† (continued)

	Author(s), date Robertson et al., 2022 [79]	**Study design** Rapid Review	**Country** UK	**Sample size** 75 articles	**Dental Setting** Not specified
Dental setting characteristics	Not specified				
Type and duration of AGP	Not specified				
Post-procedure duration	Not specified				
Use of aerosol mitigation	Not specified				
Calculation of fallow time	Not specified				
Fallow time	2 to 180 minutes				
Main findging	Fallow time ranged from 2 to 180 minutes in 26 documents. Longer fallow period for patients with COVID-19. Although most documents recommended similar durations. Fallow periods can decrease to a minimum of 10 minutes				
	Author(s), date Shahdad et al., 2021 [62]	**Study design** Non-randomised experimental study	**Country** UK	**Sample size** Manikin Number: Not specified	**Dental Setting** Not specified
Dental setting characteristics	Not specified				
Type and duration of AGP	Cavity and crown preparation; Duration: 20 mins				
Post-procedure duration	30 minutes				
Use of aerosol mitigation	High-volume suction and saliva ejector.				
Calculation of fallow time	Estimated from the aerosol measurements by calculating how long it took from the end of the procedure for the aerosol concentration in each size range to revert to within a threshold of 5% of the mean value before the procedure. A conservative approach was adopted, with the overall fallow time taken as the longest identified for each particle size range.				
Fallow time	None				
Main finding	Largest fallow time was found in the case of the non-mechanically ventilated environment with windows closed throughout. The estimates for the required fallow time were notably smaller for the procedures in the hospital mechanically ventilated closed and open bays. Usually, the aerosol levels were found to return to pre-procedure levels within less than ten minutes (with 6 ACH). Fallow times estimates were larger for the procedures in which the tooth being operated on was alternated every five minutes.				

Table VI. Fallow time study characteristics† (continued)

	Author(s), date Vernon et al., 2021 [101]	**Study design** Non-randomised experimental study	**Country** UK	**Sample size** Manikin Number: Not specified	**Dental Setting** Clinical surgery
Dental setting characteristics	9 ACH				
Type and duration of AGP	Root canal access and full crown preparation; Duration: 20 mins				
Post-procedure duration	20 minutes				
Use of aerosol mitigation	High-volume aspiration (with saliva ejection), rubber dam and aspiration, and an aspiration Jet 25 aerosol extraction device with a flute shaped end piece.				
Calculation of fallow time	Not specified				
Fallow time	Not calculated				
Main findging	The HSCAH eliminated any aerosol within 6 min of procedure completion. This evidence strongly suggests there is no need for a Prolonged fallow period with this handpiece. Where a HSCAH is not available, a rubber dam was equally effective in reducing air contamination shortly after conclusion of an AGP.				

† Definitions: ACH, Air changes per hour, AGP, Aerosol-generating procedures, HVS (IO), High-volume suction intraoral, FT: Fallow time, HSCAH: high-speed contra-angle handpiece.