

RAPID REVIEW

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Open operatory dental setting infection control practices and risk of transmission during aerosol-generating dental procedures

Key Findings

- Few pre-operative mouth rinses have in vivo data available on their virucidal effectiveness versus SARS-CoV-2; and hydrogen peroxide should no longer be recommended as a pre-operative mouth rinse due to lack of efficacy versus SARS-CoV-2.
- No direct evidence has been published on the use of dental dams and various types of suction to prevent SARS-CoV-2 aerosol spread. Pathogen non-specific contamination studies indicate an important role for dental dams and suction in reducing aerosol spread during aerosol-generating dental procedures.
- No direct evidence has been published on aerosol transmission of SARS-CoV-2 in open versus closed dental operatories. The limited evidence available indicates that spread can be diffuse affecting adjacent bays in an open operatory set-up. Spread may be impacted by factors such as air flow conditions and work practice controls, but this requires further investigation.

Background and Scope

The Provincial Infectious Diseases Advisory Committee – Infection Prevention and Control (PIDAC-IPC) has recommended that all aerosol-generating dental procedures (AGDPs) be performed in individual rooms due to risk of SARS-CoV-2 transmission from aerosolized saliva.¹ Open dental operatories may encounter challenges or an inability to improve ventilation or construct enclosed operatories in accordance with this recommendation.

Globally, many dental guidance documents exist and yet many do not cite evidence to support the guidance provided.² This review aims to summarize available evidence for work practice controls to reduce infectious aerosol production during dental procedures with no restriction on type of dental procedure, but with specific reference to reduction of SARS-CoV-2 transmission risk. Reduction of aerosols containing bacteria and viruses other than SARS-CoV-2 were out of scope due to time constraints and to ensure the data were directly applicable. A single exception was made to include a recent rapid review published in the Cochrane Database of Systematic Reviews that covers data from trials related to the topics of interest, but not specific to SARS-CoV-2.³ Except for general studies on open *versus* closed operatory aerosol transmission, the broader engineering controls (e.g., HVAC assessments, portable filtration), personal protective equipment, administrative controls (e.g., triage and screening), and antimicrobial coolants were out of scope for this review.

Methods

A literature search of MEDLINE, SCOPUS and preprint databases for relevant primary articles and reviews published January 1 to November 3, 2020 was performed. Due to time constraints, only English articles were included. Reference lists were screened to obtain additional relevant studies. Articles were included if experimental or clinical evidence was provided, or a review contained unpublished SARS-CoV-2 transmission data from dental settings. Publications only providing expert opinion or making inferences from data of related viruses or bacteria-only data were excluded. Results from a rapid jurisdictional scan of Canadian dental practice guidance and inclusion of outbreak reports known by experts was also conducted. As a result of scarcity of data, preprints were included and summarized, but should not be used to inform decision-making because they are not peer-reviewed. Data summarized from preprints has explicitly been identified as such.

Results

This rapid review is separated into the following categories: outbreak reports in dental settings, jurisdictional review of select Canadian provinces, effectiveness of pre-operative mouth rinses, effectiveness of barrier devices and suction, open versus closed operatory, and a summary of the Cochrane review.

Outbreak Reports

Three COVID-19 outbreaks, all in the month of October, were reported in dental settings in Canada, two in Ontario and one in a dental clinic in British Columbia.

The first outbreak in Ontario reported a possibility of exposure to COVID-19 at a dentist's office with two individuals testing positive and reporting a link to the dental clinic.⁴ The public health unit assessed the risk of exposure as low.

The second outbreak reported in Ontario had three cases linked to a dental service. The public health unit assessed the risk of exposure as low.⁵

The British Columbia outbreak was announced publicly, but further details were not available at time of writing.⁶

In all three cases, it was infection exposure among staff and no outbreak was associated with patients or dental procedures.

Jurisdictional Review

The jurisdictions are limited to Canadian settings. A large international review of dental guidance documents has been published by Clarkson and colleagues elsewhere.²

QUÉBEC

The Ministère de la Santé et des Services sociaux du Québec (MSSSQ) recommends a pre-operative rinse of the patient's mouth with an antiseptic mouthwash; placement of a dental dam, including disinfection of the isolated area after the placement of the dam and before starting the production of aerosols; and high speed suction with a high volume evacuator.⁷

Guidance from the MSSSQ varies depending on the risk level of the region in which the dental office operates. At risk level 4, all AGDPs must be performed in closed rooms regardless of COVID-19 status of the patient.⁷ Moreover, according to the MSSSQ the treatment of suspected or confirmed COVID-19 patients, if not deferrable, must be performed in an enclosed room if AGDPs will be performed regardless of regional risk level. Québec has specific dental clinics for COVID-19 suspected or confirmed patients who cannot be treated by teledentistry.

ONTARIO

The Royal College of Dental Surgeons of Ontario (RCDSO) recommends either hydrogen peroxide or povidone-iodine (PVP-I) pre-operative mouth rinses for 60 seconds as well as use of a dental dam, if possible, and high volume evacuators (HVE).⁸

Only under urgent circumstances should patients who screen or test positive for COVID-19 be treated. AGDPs must also be avoided unless absolutely necessary for these individuals. These patients, regardless of treatment type, should be placed in an operatory with floor-to-ceiling walls alone with the door closed.

SASKATCHEWAN

College of Dental Surgeons of Saskatchewan (CDSS) guidelines include HVE, dental dam isolation, and mouth rinses with hydrogen peroxide before operation and again of the exposed area after dental dam application.⁹⁻¹¹

Specifically, the guidance dictates that two HVE devices should be used for procedures – one for targeted removal, and a second to run for the whole duration of the procedure. This approach is supported by data reported by Ravenel et al.¹²

All AGDP operatories are expected to be enclosed from floor to ceiling with air changes per hour of at least 6 and an entry or entries that must be closed during AGDPs.^{10,11} The University of Saskatchewan converted their clinic to have enclosed operatories, which included converting some offices into dental operatories, and building walls around chairs in the main clinic. This process reduced the number of chairs in the main bay from 40 open operatory chairs to 14 enclosed operatory chairs.

The CDSS further notes that patients who screen negative for COVID-19 can be treated in an enclosed or open operatory during moderate risk procedures (where a dental dam can be used), and in an open operatory during low risk procedures.^{10,11} However, COVID-19 positive screened or tested patients must be conducted in an enclosed operatory.

MANITOBA

The Manitoba Dental Association (MDA) provides guidance that is noted to change depending on the community risk level.¹³ Specifically, only patients who are COVID-19 non-suspect may be treated in community dental clinics. If a suspected or confirmed COVID-19 patient requires non-deferrable treatment, then it must be performed in a facility that can adhere to their standard airborne transmission-based precautions.

The following techniques are advised for treatment of COVID-19 non-suspect patients to reduce aerosols generated during AGDPs: dental dam isolation; HVE; 4 handed dentistry; limit use of air and water simultaneously with 3-in-1 air/water syringe; hand instrumentation when possible; extra-oral radiography when appropriate; pre-procedural antiviral rinses; and disinfection of dental dam isolated teeth prior to AGDP.

The MDA has advised that they are not imposing changes on current dental practice layouts, but that clinics should consider how the layout affects air changes per hour and make efforts to arrange engineering controls in addition to the aforementioned work practices to reduce aerosols.

Pre-operative Mouth Rinses

Pre-operative mouth rinses have been suggested for use to reduce the SARS-CoV-2 viral load prior to a dental procedure in most guidance documents.^{2,7,10,13-15} In vivo and in vitro data on SARS-CoV-2 susceptibility has been reported for povidone-iodine (PVP-I), chlorhexidine (CHX), and hydrogen peroxide (H₂O₂). Even so, the majority of data is based on in vitro suspension assays. In vitro data only has been reported for benzalkonium chloride, octenidine (OCT), dequalinium chloride, polyaminopropyl biguanide (polyhexanide), and ethanol with essential oils (e.g., as found in Listerine®). A number of clinical trial protocols have been published, but none are complete.^{16,17} Notably, in vitro suspension tests do not account for complexities of the mucosal surfaces which may protect virus from exposure. Other antiseptic rinses have been suggested, but have not been tested such as cetylpyridinium chloride (CPC, N-hexadecyl pyridinium), chlorine dioxide, and cyclic oligosaccharides.¹⁶⁻¹⁸

PVP-I IN VITRO

PVP-I is effective to inactivate SARS-CoV-2 virus in vitro. Bidra and colleagues reported two separate in vitro suspension test studies using PVP-I at concentrations (post-dilution) of 1.5%, 1.25%, 0.75%, and 0.5% at 15 and 30 second exposures.^{19,20} In both studies PVP-I reduced viral titre to below the limit of detection of 0.67 CCID₅₀/0.1 mL (≥ 3.33 and ≥ 4.33 log₁₀ reduction). Two studies performed the same suspension tests except dirty conditions were simulated by the addition of erythrocytes.^{21,22} In Shin et al. under either clean or dirty conditions the PVP-I throat spray product (0.45%) used demonstrated a 99.999% viral titer reduction and a 99.99% viral titer reduction, respectively, after 60 seconds exposure. In Hassandarvish et al. the PVP-I product (0.5%, 1.0%) used demonstrated at least ≥ 4 log₁₀ reduction in either clean or dirty conditions after 15, 30 and 60 seconds of exposure. Additional studies using similar concentrations and conditions have reported similar virucidal efficacy of PVP-I.²³⁻²⁵ Chin et al. and Anderson et al. reported use of PVP-I 7.5% and 10.0% that are concentrations used as a surface disinfectant; while it was effective at reducing virus titre to undetectable levels by culture, this concentration would not be used in practice as a mouth rinse.^{25,26}

PVP-I IN VIVO

One study has been published showing variable effect of PVP-I provided to four SARS-CoV-2 positive patients as a 15 mL, 1.0% rinse used for 60 seconds.²⁷ These data need to be interpreted carefully as prior reviews have failed to consider the lag time between use and effect.²⁸ Following the one minute rinse, saliva samples were taken at 5 minutes, 1 hour, 2 hours and 3 hours.²⁷ No significant change was seen in the first 5 minutes for any patient, and no significant changes after 1, 2 and 3 hours were seen for two of the four patients who had high baseline cycle thresholds (Ct > 35; E, RdRP, and N genes). For the other two patients with baseline Ct of 22.02-27.70 and 27.84-31.40, after 1 hour Ct raised to 33.32-37.68 and 30.51-34.37. After 2 and 3 hours Ct were >38 for the patient with the lowest initial Ct and >35 for the other. Ultimately, these data do not suggest whether or not AGDPs would be any safer to perform. The effects of PVP-I can be estimated from authors' figure as log₁₀ reductions ranging from 0 to 6 in the four patients from baseline compared to 3 hours. No controls were included in this study to account for sampling variability that may occur due to time of collection.

H₂O₂ IN VITRO

H₂O₂ does not have a meaningful effect on SARS-CoV-2 in vitro. Bidra and colleague report 1.5% and 3.0% H₂O₂ (post-dilution) at 15 and 30 second exposures in a suspension assay.²⁰ Compared to PVP-I, which inactivated virus below detectable levels, H₂O₂ only reduced virus titre by 1.33 and 1.00 log₁₀ at 15 seconds, and 1.0 and 1.8 log₁₀ at 30 seconds, respectively for 1.5% and 3.0%. Similar ineffective virucidal activity was reported by Meister et al for a commercial hydrogen peroxide-based mouth rinse product.²⁴ Further, a review noted that there is no scientific evidence demonstrating that H₂O₂ mouth rinse can inactivate SARS-CoV-2 or any other virus in saliva.²⁹

H₂O₂ IN VIVO

H₂O₂ does not have a meaningful effect on SARS-CoV-2 in vivo. From 10 patients with rRT-PCR positive oropharyngeal specimens, 1 of 5 patients with at least 10³ copies/mL was culture positive.³⁰ Thirty minutes after a 30 second mouth rinse of 20 mL 1% H₂O₂, oropharyngeal specimens were again tested, and culture conducted. There was no significant difference between baseline viral load and viral load 30 minutes after mouth rinse. Zero of 5 patients that had initially had their oropharyngeal specimen cultured were culture positive after mouth rinse. No controls were included in this study to account for sampling variability that may occur due to time of collection.

CHX IN VITRO

CHX has an unclear efficacy in vitro. CHX 0.05% reduced virus to undetectable levels by culture when used as a surface disinfectant at sampling timepoints 5, 15 and 30 minutes.²⁶ A 0.2% CHX commercial mouth rinse product as well as another commercial CHX mouth rinse product without an indicated concentration of active ingredient did not show significant virucidal activity following 30 second exposure.²⁴ In a preprint article by Steinhauer et al., a similar poor effect of CHX (0.1% and 0.2%) was reported wherein there was <1 log₁₀ even up to 5 and 10 minutes.³¹ The difference in reported effect between studies may be due to the difference in sampling timepoints or the testing methods (surface disinfection versus suspension test).

CHX IN VIVO

CHX may have a variable effect in vivo. Two patients underwent a 0.12%, 15 mL CHX mouth rinse on hospital day three and hospital day six.¹ At baseline and 1, 2 and 4 hours following the mouth rinse viral RNA load was determined. On hospital day 3 initial patient samples of approximately 5 and 6 log₁₀ copies/mL were reduced to below the 3 log₁₀ copies/mL lower limit of quantification. This effect was still present at two hours, but not at four hours where viral loads approximately returned to their baseline measures. On hospital day six in the same patients with an initial viral load between 4 and 5 log₁₀ copies/mL there was no reduction at any timepoint below the lower limit of quantification except at four hours for one patient. It is not clear why the effect differed between hospital days in the same patients. No controls were included in this study to account for sampling variability that may occur due to time of collection.

OTHER RINSES IN VITRO

Benzalkonium chloride 0.1% reduced virus to undetectable levels by culture when used as a surface disinfectant at sampling timepoints 5, 15 and 30 minutes.²⁶ While a 70% ethanol inactivated SARS-CoV-2 at 30 seconds but not 15 seconds, it is not clear what effect a safe, lower concentration would have.¹⁷ Albeit, Listerine (ethanol and essential oils) had been reported to have virucidal effects similar to PVP-I after 30 seconds exposure.²⁴ An octenidine-based commercial product tested by Meister et al. did not have significant virucidal activity after 30 second exposure.²⁴ A different study using a 0.1% octenidine

and 2% phenoxyethanol-based product showed $\geq 4.38 \log_{10}$ reduction at 15 seconds and up to 1 minute sampling timepoints.³¹ The authors note that this product also contained phenoxyethanol and is not directly comparable to the octenidine-only product tested by Meister et al.^{24,31} A polyaminopropyl biguanide (polyhexanide) product had variable virucidal activity depending on the strain of SARS-CoV-2 that it was tested against.²⁴ Given the relatively poor lower limit of quantification for testing the polyhexanide product and variability of efficacy based on the strain of SARS-CoV-2, this virucide requires further testing. Lastly, a combination dequalinium chloride and benzalkonium chloride commercial product had significant virucidal effect on SARS-CoV-2 following 30 second exposure.²⁴

Mouth rinses are generally safe for routine use with few instances of thyroid dysregulation, contact dermatitis and anaphylaxis related to PVP-I use; teeth and mucosa staining, and stomatitis in rare occasions with use of CHX and CPC.^{16,28}

A review by Chitguppi discusses the likely benefit of mouth rinses for general use in healthcare. In this review the author classifies CHX as the only substantive mouth rinse and likely best choice. Specifically, the author contends that even though data supports virucidal effect of PVP-I, that it is not long-lasting.³² With the limited data published so far and described above, it is not clear whether or not CHX has a substantive effect greater than PVP-I as a mouth rinse.

Considering the data above, and that most guidance documents suggest either H₂O₂ and/or PVP-I, and few recommending CPC, data should be monitored on this topic and guidance updated with appropriate references as it relates to pre-operative mouth rinses.² Particularly H₂O₂ should no longer be recommended at this time as a mouth rinse for SARS-CoV-2.^{15,17,29}

No data were found related to the added effect of targeted sterilization of exposed sites after application of dental dams with or without a pre-operative mouth rinse having already been performed.

No direct data were found related to the effect of mouth rinses, pre-operative or targeted to exposed sites, on reduction of SARS-CoV-2 detected in air.

Dental Dams and Suction

Dental dams have been recommended in most guidance documents, but few have provided evidence for their use and where evidence is provided it relates to bacterial contamination studies.^{2,18,33} A well-known limitation of dental dams is that these devices cannot be used for procedures on subgingival margins.¹⁸

Suction was reported to be recommended in 73% of guidance documents reviewed by Clarkson et al.² No distinction between intraoral and extraoral suction was reported by authors and whether the type of suction recommended pertains to low, medium or high volume evacuators. To date, no SARS-CoV-2-specific data has been reported related to suction use.^{15,18}

Four-handed operation, also termed four-handed dentistry, which is the inclusion of a dental assistant to operate additional devices such as suction is recommended to improve control and application of high volume evacuators.¹⁵ In two studies, four-handed operation reduced spatter (small droplets) and splatter (large droplets) compared to without a dental assistant.^{34,35}

In lieu of direct data on dental dams and suction, experimental studies using fluorescent dyes, citric acid and universal indicator paper, or laser particle counters in dental settings since the COVID-19 pandemic began were reviewed. Four studies have been used to demonstrate control of spread of aerosols during

various AGDPs while using various types of suction (low, medium and high volume evacuators) and dental dams and dental dam accessories.^{12,34-36}

Ravenel et al. compared eight different dry-field isolation techniques during the use of a high speed device simulating an AGDP.¹² The devices used in these techniques are a HVE, an intraoral evacuator (IsoVac product), a 3D printed rubber dam (3D RD) frame that has a mounted HVE with funnel and a connection for a saliva ejector and is used in conjunction with a rubber dam, and a rubber dam. The eight techniques using these devices were: HVE, IsoVac, 3D RD, IsoVac + additional HVE, 3D RD + additional HVE, rubber dam + HVE, HVE with funnel + additional HVE, and HVE with funnel + IsoVac. A control test where no devices were used was the maximum contamination scenario. The ambient room measures acted as the minimum contamination scenario. Spatter was measured by counting contaminated squares arranged in a grid around the manikin head. Detection of a single droplet on a square was considered positive contamination. Aerosols were measured using a laser particle counter 4 cm away from the orifice of the mouth. Results are summarized in Table 1. While the IsoVac + HVE was the best at reducing spatter, it was the worst in terms of reducing aerosols. And while a rubber dam + HVE performed well to reduce aerosols, it did not perform well to reduce spatter. Three techniques appeared to be the ideal combination of reducing spatter and aerosols: 3D RD + HVE, HVE with funnel + additional HVE, and HVE with funnel + IsoVac. Interestingly, two of three of the best results were techniques that did not use a rubber dam.

Table 1. Spatter and aerosol contamination using eight dry-field techniques. (Adapted from Ravenel et al.¹²)

Test Group (n = 8 each)	Spatter (contaminated squares mean, standard deviation)	Aerosols (µg/m3 mean, standard deviation)
Control (high speed device without suction)	50.13, 12.89	319.75, 179.40
Ambient room	N/A	1.00, 0
HVE	14.75, 3.24	1.63, 0.52
IsoVac	23.13, 4.09	1.50, 0.53
3D RD	15.75, 4.37	1.63, 0.52
IsoVac + additional HVE	1.38, 3.11	2.00, 0
3D RD + additional HVE	3.75, 4.20	1.25, 0.46
Rubber dam + HVE	14.25, 1.83	1.38, 0.52
HVE with funnel + additional HVE	3.13, 1.25	1.00, 0
HVE with funnel + IsoVac	3.75, 1.49	1.25, 0.46

HVE: high volume evacuator; 3D RD: 3D printed rubber dam frame.

Allison et al. conducted experiments to determine aerosol and splatter following three procedures they have classified as AGDPs of varying duration on a manikin with or without suction.³⁵ Their experiment was conducted in a clinical simulation unit, which does not accurately reflect either an open or closed operatory. The procedures, repeated 3 times each, were: anterior crown preparation with a high-speed air-turbine (10 minutes – with or without suction, and with suction and assistant); full mouth scaling with a magnetostrictive ultrasonic scaler (10 minutes – with suction); 3-in-1 air/water spray use (30 seconds – with suction). Suction was reported as 6.3 L of water per minute (high volume evacuation). Spatter and aerosols were collected on filters placed at various distances from the manikin (limit of detection was 4 m). A 10 minute fallow period allowed settling and drying of aerosols onto filters. Most contamination occurred within 1.5 m, but some was detected up to 4 m in particular during the use of the high-speed air-turbine without suction which was reduced to within 2 m with suction. The 3-in-1 air/water spray device, used only for 30 seconds, had the shortest dispersion with very little beyond 1 m. The ultrasonic scaler, even under suction conditions, still had detectable contamination at 4 m. Note that it is possible very small aerosols that had not settled or settled beyond the 4 m detection zone were missed.

In a follow-up study to Allison et al. by Holliday et al, currently available as a preprint low (40 L/min air) and medium (159 L/min air) volume evacuation were tested in an open operatory with 3.45 air changes per hour.^{35,36} The operatory is a 21 chair clinic with each bay measuring 2.86 m wide by 2.75 m deep with walls that varied from 1.44 to 1.54 m high. The bays across the walkway from one another are open and partially staggered providing direct line of sight to two other bays from a single bay. For this study a crown preparation using a high-speed air-turbine (10 minutes – with or without suction) was the AGDP simulated using a manikin. Two methods for contamination were tested. In the worst case scenario (model 1), the instrument irrigation system contained the fluorescent dye; in the real-world simulation (model 2), the dye was located only in the manikin's mouth. The model 1 scenario was also used to determine where aerosols may travel that would be otherwise undetectable in model 2. Different suction conditions were only tested in model 1, both using four-handed operation approach with no cross-ventilation. Despite the presence of walls 1.44 to 1.54 m high, the manikin's head 0.73 m from the floor, and use of suction in both scenarios that reduced contamination in the bay containing the manikin by 49-53% and adjacent and distant bays by 81-83%, there was still significant contamination detected in both low and medium volume evacuation test conditions over 6 m from the patient. Significantly less contamination was measured in the medium volume evacuation, model 2 condition, yet aerosols still settled on surfaces around 5 m away. Nonetheless, a wide bore aspiration tip was recommended. High volume evacuation was not tested, which may have further reduced spread of aerosols.

A fourth study focused on extraoral scavenging (EOS), HVE, and rubber dam use during two simulated AGDPs: high-speed air-turbine use and supragingival ultrasonic scaler use.³⁴ If a dental assistant was present, the procedures involved the use of HVE throughout the procedure and 20 minutes after. A saliva ejector was also used regardless of the presence of a dental assistant. The EOS device was located 15-20 cm in a 5 o'clock position from the oral cavity and operated at 310 m³/h. The EOS device in this study is similar in concept to Ravenel et al. wherein additional HVE lines with funnel attachments were extraorally located, but in this case the funnel was much larger.¹² Visual contamination of citric acid splatter (50 µm or larger droplets) produced during each procedure was assessed on Universal Indicator Paper. The citric acid was located in the dental chair line. When pooled for all procedures, use of the EOS reduced the mean percentage of intensity of contamination of the operatory, clinician, and assistant by 75%, 33%, and 76%, respectively. Authors also report that HVE and rubber dam use reduced mean percentage of intensity of contamination. In both operatories the furthest contamination detected ranged from 1.33 to 1.34 m, and no higher than 1.33 m. Note that this study does not assess

small aerosols and contamination may have occurred beyond these ranges but was not detectable with the visual inspection methods used.

Each of the four suction experiment data should be interpreted with caution as extrapolation to aerosolized SARS-CoV-2 is not likely to be accurate. In real scenarios the aerosols generated during dental procedures are complex containing saliva, blood, tooth and bone fragments, and other debris. In particular, the settings and conditions of the experiments including data collection methods drastically varied. Nonetheless, it is clear that suction is an integral component to reduce aerosols. No comparisons were available between HVE and low or medium volume evacuators. There appears to be an added benefit to having two forms of HVE in use during four-handed operation to reduce splatter, spatter and aerosols. Dental dams appear in general to be important to reduce contamination and spread of droplets and aerosols, however, based on limited data there may be equivalent reduction of droplets and aerosols by using two HVE devices, one of which used extraorally with a funnel attachment.

Open versus closed operatory

A closed dental operatory is recommended across most guidelines for treatment of suspected or confirmed SARS-CoV-2 patients. Some do not specify alternative protocols for suspected or confirmed SARS-CoV-2 patients versus screen-negative patients.² Guidance from the CDC provides added detail of suggestions for open operatory layouts such as patient orientation with respect to air flow, use of barriers, and at least 6 feet distance.³⁷ However, their guidance on an open *versus* closed operatory is not firm advising ideally that AGDPs occur in an airborne infection isolation room for suspected or confirmed SARS-CoV-2 patients, but do not specify whether AGDPs are always required to be performed in closed operatories for screen-negative patients or if AGDPs can be managed for screen-negative patients in open operatory environments while applying appropriate aerosol reducing procedures such as those already described in this document. There is a lack of data on aerosol distribution related to treating patients with SARS-CoV-2.

Application of evidence within the Ontario context will be complicated by varied layouts and designs of open operatory environments and the presence or absence of barriers between patients that makes broad generalization difficult, the community prevalence of COVID-19 and likelihood of unknowingly treating asymptomatic patients. In lieu of data related to SARS-CoV-2 aerosol spread in open versus closed operatories, recent studies examining splatter, spatter and aerosols have been included.

Under the conditions reported in the Dental Dams and Suction section for the Allison et al. study that tested three AGDP procedures with suction, they conclude that their data has implications for closed operatories in that surfaces should not be cluttered as environmental contamination is likely.³⁵ For open operatories they note their data are not sufficient as their setup lacked partitions that may impede aerosol and splatter, but consider the risk to likely be lower at 2 m distance than at 0.5 m.

In Holliday et al., the follow-up study to Allison et al. described in the Dental Dams and Suction section currently in preprint, it was cross-ventilation achieved by opening windows in the clinic area that was a significant factor for reducing aerosol contamination of adjacent and distant bays for both models.^{35,36} Yet small sectors of contamination could still be detected in adjacent and distant bays over around 5 m away. Facility design and not using a high volume evacuator may be important limitations in this study to better control aerosol contamination.

A study by Shahdad et al. compared splatter (large droplets) distribution in open and closed operatories.³⁵ Further details are described in the Dental Dams and Suction section. The operatories had a HEPA filtered air exchange system that provides six air changes per hour. Heights of partitions in bays

of open operatory were not provided, however each bay had a floor surface area of 10.0 m². The closed operatory had an area of 16.8 m². With respect to measuring splatter, the authors concluded that open clinics are no worse than closed surgeries in their specific setting. Note that this study does not assess small aerosols and contamination may have occurred beyond these ranges but was not detectable with the visual inspection methods used.

An apparent unresolved issue in these studies is that the greatest risk of open operatories relates to patients who are most exposed by having no respiratory protective equipment and wide open mouths. However, these patients are likely to have suction devices in use near or inside of their mouths creating complicated air currents that may serve to protect exposures of their mucus layers to aerosols originating from people other than themselves. It is not known whether transmission is less likely to occur to dental workers who are wearing PPE compared to patients, however, dental workers will have significantly greater durations of exposures to aerosols from various patients throughout a workday.

Non-SARS-CoV-2 Cochrane Rapid review

A rapid review with data recent to September 17, 2020 by Nagraj et al. synthesized available randomized controlled trials and controlled clinical trials conducted on AGDPs with interventions intended to reduce contaminated aerosols during dental procedures (with the exception of pre-operative mouth rinses).³ This review included efficacy of HVE (7 studies), hands-free suction device (2 studies), saliva ejector (1 study), rubber dam (3 studies), and rubber dam with a high-volume evacuator (1 study) among other outcomes. The evidence did not evaluate risk of infectious disease transmission and authors rated all data as very low certainty suggesting new data could change the findings of the review. No studies investigated viral contamination. The authors stated that studies suggest effectiveness of many of these measures to reduce aerosol production, but due to the data being drawn from studies that were small, indirect and at high risk of bias it is necessary that future studies measure contamination in aerosols, size distribution and infection transmission risk for respiratory diseases.

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