COVID-19 Scientific Advisory Group Rapid Response Report

Key Research Questions:

1. **What are the risks of infection transmission related to aerosol generation from use of dental handpieces and other instruments in dental clinics?**
2. **Is there any evidence that SARS (CoV-1 or -2) or MERS-CoV have been transmitted through dental procedures?**
3. **What recommendations can be provided to minimize risk of COVID-19 transmission within dental clinics?**

Context

- Dentistry involves use of dental handpieces and other instruments such as turbine burs, air-water-syringes, drills, ultrasonic scalers, air polishers, and abrasion units *(Abramovitz et al. 2020; Adhikari et al. 2017)* that operate at high speeds and produce aerosols. (Ahmed et al. 2018, Liu et al 2019).
- Grinding, polishing and cutting of dental tissues in the presence of saliva can lead to dispersion of droplets and other particles of various sizes in the surrounding air.
- This review collates literature around bioaerosols, and summarizes existing recommendations around COVID-19 risk reduction for the dental health professional community and patients attending dental clinics.
- There are some areas where existing guidance documents differ in their recommendations, particularly in the setting of AGP (aerosol generating procedures) and the use of N95 masks in the absence of suspect or confirmed COVID-19 infection.
- It is noted that there are AHS hospital dental clinics in Calgary and Edmonton which often handle more complex patients, as well as Oral and Maxillofacial surgeons who work in contracted surgical facilities and hospital OR's to whom both dental facility and AHS IPC guidance apply, given that they may be referred emergency patients with COVID19 who require urgent therapies.
- We acknowledge that we did not seek formal input from all dental health professional groups in Alberta and this should be done as part of any required updates of this initial report.

Key Messages from the Evidence Summary

- Using dental instruments can lead to dispersion of droplets and particles of various sizes in the surrounding air. These particles can include:
    - Aerosols - The dental literature commonly refers to aerosols as particles less than 50 µm in diameter, the smallest of which (0.5 to 10 µm) can be inhaled and therefore reach the lungs (Micik et al. 1969). Aerosols containing microorganisms will be referred to as "bioaerosols"
    - Larger particles (> 50 µm; referred to as "splatter") are ejected from the oral cavity and stop on contact with hard surfaces (inertial impaction) or fall to the ground (gravity sedimentation) (Tellier et al., 2019).Airborne transmission is distinguished by evaporation of droplets to droplet nuclei that are <5µm in diameter, which can stay airborne for significant lengths of time *(Setti et al. 2020).* Aerosol generating medical procedures can creater a circumstance of opportunistic airborne transmission of pathogens which are not otherwise spread by the airborne route.
    - Infectious agents/microorganisms - The oral cavity is a site of colonization for a wide spectrum of infectious agents (e.g., bacteria, viruses and fungi), and there is risk that these microorganisms can become aerosolized during dental procedures and potentially infect dental professionals and patients. With high concentrations of bacteria in the oral cavity (nearly 1.0×10^{7}– 1.0×10^{8} (CFU)/mL of saliva), oral bacteria have been identified as components of dental bioaerosols *(Duthil et al 2004).* There is currently no data on the presence of respiratory viruses in dental aerosols.
- A variety of common dental procedures including use of high speed handpieces, ultrasonic devices and air water syringes have the potential to produce bioaerosols.

- Aerosolized droplets are not necessarily equivalent to airborne transmission of viruses via droplet nuclei, (Tellier et al., 2019) which may have implications in determining the degree of infection control practice required, with truly airborne transmission requiring additional considerations such as settling time, air exchanges and N95 mask use.
- Recent primary evidence has shown that first available saliva specimens of COVID-19 positive patients have a median viral load of 3.3 x 10^6 copies /mL (range, 9.9 x 10^2 to 1.2 x 10^8 copies/mL) *(To et al. 2020).* Another study (under review) has documented presence of SARS-CoV-2 in saliva samples of asymptomatic individuals*. (Wyllie et al. 2020).* It is thus plausible that SARS-CoV-2 may be present in aerosols generated during dental procedures on patients who do not have current symptoms, although the likelihood would be dependent both on the viral load in saliva, and the likelihood a currently asymptomatic individual is infected would be related to the intensity of community spread of COVID-19 in a given area and their exposure history.
- The degree to which transmission of viral pathogens may be reduced by oral rinses with demonstrated virucidal properties (Eggers et al., 2015) or aerosol and splatter transmission reduction by High Volume Evacuation/suction (HVE) is unclear.
- With respect to the second question, there is no published evidence in the academic literature demonstrating highly pathogenic coronavirus (i.e., SARS-CoV-1, MERS, SARS-CoV-2) transmission within a dental practice setting. Nonetheless, transmission of a coronavirus, including COVID-19, [from patient to dental professional, from dental professional to patient and from patient to patient] is biologically possible due to demonstrated high salivary titres of SARS-CoV-2 (Wyllie et al. 2020, To et al. 2020), and the production of bioaerosols during common dental procedures.
- In light of the above, although the literature is not extensive or of very high quality, it is reasonable to conclude that dental health professionals may encounter occupational risk of COVID-19 exposure, and that patients also may be at risk for COVID-19 infection as a result of exposure during aerosol producing dental procedures performed on other patients, particularly if precautions are not observed.
- The third question was addressed by collating some of the extensive relevant guidance documents for review. A recent Cochrane review "*Recommendations for the re-opening of dental services: a rapid review of international sources"* (COVID-19 Dental Services Evidence Review (CoDER) Working Group, published on May 7, 2020), summarizes guidelines from international and professional organizations that are published in the grey literature. Recommendations from this review are provided in this document, as are the Canadian Dental Association recommendations, and recent CDC recommendations for review.
- The current Alberta Dental Association and College approach is already congruent with many of these recommendations.
- A key issue between these documents remains defining the "low risk" patient in whom possible AGP may be carried out in a dental office with usual precautions, versus taking extra precautions or referral to a specialized facility. Community based transmission risk is important in this assessment given the possibility of presymptomatic/asymptomatic spread. The CDC document is the only guideline to address this, and stratifies the community risk as follows:

    - ***No to minimal*** *community transmission is defined as evidence of isolated cases or limited community transmission, case investigations underway; no evidence of exposure in large communal setting.*
    - ***Minimal to moderate*** *community transmission is defined as sustained transmission with high likelihood or confirmed exposure within communal settings and potential for rapid increase in cases.*
    - ***Substantial*** *community transmission is defined as large scale community transmission, including communal settings (e.g., schools, workplaces).*

This classification is used to suggest consideration of a tiered approach to universal PPE based on the level of transmission in the community. In areas where there is moderate to substantial community transmission, DHCP should consider wearing a fit tested N95 or higher-level respirator for patients undergoing procedures that might pose higher risk (e.g., those generating potentially infectious aerosols or involving anatomic regions where viral loads might be higher). However, symptom or exposure risks are evaluated separately in determining the approach to each case (if a patient is not "low risk" additional precautions are required).

Two Scientific Advisory group documents are also linked in this summary section, with information deemed important in discussing the questions and literature associated with this review.

- The proportion of people with COVID-19 who remain asymptomatic during their entire course of infection is estimated to be in the range of 5-20% and importantly, presymptomatic spread is well documented and may contribute to transmission given high viral titres prior to onset of symptoms. See the Scientific Advisory Group (2020) rapid review on the possibility of asymptomatic transmission here.
- Recently a pilot was completed at three Alberta hospital Emergency Departments, screening all patients requiring admission who were determined to be "low risk" by symptom and risk screening. None of 1743 patients who screened as low risk were positive, versus 4.5% of patients from the same EDs who were tested due to the presence of symptoms or risk for COVID-19. (Add link to SAG brief on AHS pilot study once posted).

Committee Discussion and Reviewer Comments:

The initial committee review included discussion about scope as dental health professional bodies have issued COVID-19 guidance, but it was also acknowledged that there are dental facilities associated with Alberta Health Services, as well as Public Health relevance to this review. Additional reviewers from AHS OMFS/Dentistry were sought for a second draft, and as the risk assessment process is tied to a Public Health based community epidemiologic risk evaluation, additional Public health stakeholder review was sought.

Some unresolved reviewer comments remained after incorporation of feedback. This included the suggestion that it was a fallacy to think that aerosol-generating procedures are the same between medical procedures and dental procedures, and that the document should apply only to hospital based dental settings. This reviewer suggested that the only available studies were out of date and did not reflect current practices, and that predicating discussion on patients who are positive for COVID-19 was not reflective of the current state of accepted and mandated dental care in Alberta dental practices, and that guidelines are scientifically unnecessary.

Finally, some data from preliminary local studies in a dental office using particulate detectors was offered. Although of interest and relevance, inclusion of preliminary, single site, raw data is not possible in this Rapid Review protocol, although this review can be updated with emerging evidence.

Recommendations

1. Patients should be screened for COVID-19 risk prior to dental care, by a combination of symptom screening and risk exposure screening.
   Rationale: Delineating the "low risk" patient remains crucial prior to any AGP. The results of a screening program for non-COVID hospital admissions from three Alberta Emergency rooms illustrates that a combined risk and symptom based protocol was an effective method in our current epidemiologic circumstances. Therefore, although current ADA&C recommendations incorporate many of the infection control practices identified by guidelines summarized in this review, recommended screening processes should incorporate risk exposure as well as symptom screening. Relevant documents to consider in screening practices review include the following:

   Testing & Isolation Criteria
   Expanded symptom (+RF) assessment
   Respiratory CD Assessment (COVID + others)

2. Reevaluation of standard practices within healthcare and dental health settings is required if there is significant evolution of the degree of community based COVID-19 risk. In addition, in dental care settings specifically reevaluation is required if there is evidence of increased respiratory virus transmission risk related to dental care processes.
   Rationale: This represents a contextualization of the current CDC guidelines. Presently, the risk of COVID-19 transmission related to aerosol generating procedures appears to be low when appropriate screening is carried out, and community transmission and prevalence are low. As formal epidemiologic indicators are evolving, this reassessment will require explicit collaboration between the following three

parties (1) public health officials to determine and communicate the appropriate epidemiologic threshold for reassessment, (2) dental professionals and (3) regulatory body in ensuring that the recommendations for PPE are congruent with the current level of risk assessment

3. Continued strict compliance to recommended practices and PPE usage for dental health professionals when caring for those with suspect or confirmed COVID-19, with consideration for specialized care referral if dental procedures cannot be deferred until the patient is felt to be noninfectious by public health guidelines is recommended in congruence with guidelines from regional, national and international bodies are available.

4. Dental clinics are recommended to develop standard operating procedures that contextualize existing recommendations from the ADA&C, CDA, and public health bodies for local use.
Rationale: Professional organizations and international bodies of government and academic scientists have produced infection prevention and control recommendations for dental health professionals which are intended to reduce the risk for COVID-19 transmission within a dental care setting, and operationalizing such guidelines may differ in a site specific fashion.

Practical Considerations

- Patients and staff should be screened using a current tool for symptoms suggestive of COVID-19, such as fever, a new cough or a chronic cough that is worsening, new or worsening shortness of breath or difficulty breathing, sore throat, runny nose, as well as Risk Factors for COVID-19 exposure, as detailed here.
- Patients who have COVID-19 symptoms should have dental procedures deferred when possible until symptoms have resolved or until 10 days after symptom onset, whichever is longer.
- If patients with suspect or confirmed COVID-19 require dental procedures that cannot be deferred:
    - staff should wear appropriate PPE (N95 respirator, face shield, gown and gloves)
    - the patient should be cared for in a separate, isolated room (with 4 walls and a closed door if the patients head is within 2 m of the door.) Referral to a dental facility that can accommodate this may be required.
    - to mitigate risk to patient safety, authorities should consider implementing the "Return-to-Practice Office Manual Adapting the Dental Office to the COVID-19 Pandemic" recommendations on deferring appointments, and temporally spacing appointments for any patient whose risk is deemed higher than "low".
- An evaluation of indoor air quality should be considered to assess for appropriate air circulation to minimize risk to dental staff and patients. Parameters for evaluation include the air changes per hour (ACH) and the heating, ventilation, and air conditioning (HVAC) system in place (Canadian Dental Association May 2020).
- Systems should be put in place for regular health follow-up of patients and staff for signs and symptoms of COVID-19, and education provided around notification of the dental practice and public health if new COVID-19 symptoms arise within 14 days of the office visit (for patients).

Strength of Evidence

The overall literature quality was low with few publications identified, many of which were older and antedated current practices. Nonetheless, it is supported that certain dental procedures produce aerosols. Some research studies have been published demonstrating the presence of bacterial isolates within aerosols produced during dental procedures. No evidence was identified demonstrating the presence of viral particles within aerosols produced from dental procedures. Likewise, no evidence was identified demonstrating the direct transmission of coronaviruses between patients and dental health professionals in a dental clinic setting.

Further limitations of this review include a lack of peer-reviewed information specific to COVID-19 and a short turnaround time for this report. As such, there is potential that some information may be missed, and the totality of literature is not guaranteed.

Recommendations for dental health professionals collated here regarding risk reduction of COVID-19 infection during dental procedures are based on expert opinion and extrapolated based on biological plausibility for COVID-19 transmission and infection in dental care settings and theoretical inferences from basic science and the epidemiologic characteristics of SARS-CoV-2.

Summary of Evidence

Question 1.What are the risks of infection transmission related to aerosol generation from use of dental handpieces and other instruments in dental clinics?

A search of the academic literature produced 40 abstracts, from which 17 were selected for full paper review. Excluded manuscripts included opinion papers and narrative reviews. The relevant reported findings for the 17 selected papers is summarized in Appendix 2. The quality of papers was low.

The selected papers included studies conducted in Japan, USA, UK, India, Canada, Italy, Saudi Arabia, South Africa, Turkey, Germany, Taiwan and Brazil. Three (3) studies of varying quality identified the presence of blood in aerosols produced during oral surgery and dental procedures *(Al-Eid et al. 2018; Ishihama et al. 2009; Yamada et al. 2011).* However, the relevance of these in the dental context where HVE is used over low volume suction is limited, and blood exposure is not felt to be a major mode of transmission of SARS-CoV-2.

The direct presence of bacteria in splatter and/or aerosols during procedures such as scaling, root planning, cleaning using high speed instruments, was noted by culture from various surfaces (including flooring, and dental professional contact lenses in the absence of protective eyewear), *(Adhikari et al. 2017; Afzha et al. 2016; Ahmed et al. 2018; Bentley et al. 1994; Dutil et al. 2009; Guida et al. 2012; Hallier et al. 2010; Harrel and Molinari 2004),* ATP (adenosine triphosphate) detection *(Watanabe et al. 2018),* and endotoxin testing *(Singh et al. 2010).* In some of these papers, the described situations were at variance with current practices in Alberta dental practices and their recommended practices to reduce risk are already recommended practice in Alberta (consistent mask and face shield use, and use of HVE).

One study monitored both bacterial and fungal contamination in aerosols *(Kadaifcifer and Cotuk 2014).* Another tested for the presence of fungus in aerosols *(Vilarinho Oliveira 2014)* and two studies confirmed the presence of non-infectious aerosolized particles (such as tooth debris) *(Day et al. 2008; Vilarinho Oliveira et al. 2018).*

Although the study designs and robustness of data vary, there is evidence that aerosols may be produced during dental interventions, and there is a lack of published data on the degree to which current procedures and equipment may reduce potential transmission although some reduction is plausible. Two studies were identified where researchers investigated the presence of viral particles in bioaerosols created during dental procedures. This is a significant research gap, given the mortality and morbidity associated with respiratory viruses and the theoretical probability that they can be aerosolized given their small particle size.

Two of the 17 studies will be further described. In the only Canadian study *(Dutil et al. 2009),* Dutil and colleagues recruited 52 patients to undergo dental treatment with an ultrasonic scaler and air water syringe without high volume suction in isolated rooms. Culturable bioaerosols generated during 30-minute dental cleaning treatments of 4 different consecutive patients were captured by standard microbial samplers (fitted with 3 different types of culture media) placed approximately 30 cm from the patient's mouth. Appropriate room and environment control samples were taken 2 hours before the first patient and 2 hours after the last patient. In an attempt to measure personal exposure to bioaerosols (for both the patient and the dental professional), personal inhalable air samplers were placed in the immediate breathing zones of the hygienist and the patients. The number of colony forming units during treatment were significantly different ($P<0.01$) when compared before treatment and after treatment. Air samples taken in the breathing zones of patients and hygienists showed media exposures of 2.0×10^4 and 1.2×10^4 bacteria/m^3 respectively, with both being statistically much higher than background levels ($P < 0.001$). This study was criticized for a setup which appeared to omit appropriate PPE and incorrect use of a saliva

ejector by a patient. Although PPE would not affect the measurement of aerosols, the incorrect use of a containment measure may.

In the second study *(Liu et al. 2019),* researchers developed an experimental model to measure concentrations and dispersion of suspended particles when drilling and grinding extracted teeth with high speed instrumentation with water spray. Air was pumped through a closed system at a flow rate to simulate nasal airflow. They determined that the concentration of total particulate matter produced by grinding teeth was one order of magnitude (1.72×10^8 particles/m^3) higher than indoor background concentration (1.49×10^7 particles/m^3). Second, 97% of total suspended particles were about 1 μm in diameter or smaller, with an average aerodynamic particle diameter of 53.68 nm, which is close to the diameter of SARS-CoV-2 (diameter of approximately 60–140 nm). The use of a central vacuum system led to a statistically significant reduction ($P< 0.01$) in the median mass concentration of particulate matter, from 7.87 μg/m^3 to 4.18 μg/m^3. This study was criticized for both the nature of the mock procedure performed and the flow rates used which are felt to exceed physiological flow and predispose to particulate matter. This study raises a concern that aerosolized nanosize particles could be generated and that surgical masks may provide suboptimal protection for the wearer. However, the experimental model parameters around air flow would influence the detectable particulates and how well this mimicked physiologic parameters is unclear.

Overall, analysis of the peer-reviewed literature demonstrates that aerosols can be produced during dental procedures. It is unclear how much these may influence transmission risk of SARS-CoV-2 from an infectious patient. Appropriate precautions should be taken by dental health professionals and patients to mitigate the risk of infectious disease transmission in dental clinics.

Question 2:
Is there any evidence that SARS (CoV-1 or -2) or MERS-CoV have been transmitted through dental procedures?

A search was conducted to identify relevant, published and peer-reviewed papers and grey literature that addressed the transmission of coronaviruses (SARS-CoV-1 or -2 or MERS-CoV) via dental procedures. Sixty-four (64) publications and 13 recommendation documents were identified.

A review of the abstracts and grey literature did not identify any research studies providing direct evidence of coronavirus transmission through dental procedures.

However, based on the epidemiologic behavior and biological characteristics of coronaviruses, several studies point to the theoretical association between the production of aerosols from dental procedures and the risk of (i) SARS CoV-1 infection *(Fang 2003; Li et al. 2004; Oxford et al. 2003; Samaranayake and Commission 2003; Samaranayake and Peiris 2004; Smales and Samaranyake 2003; Testarelli et al. 2004),* (ii) MERS-CoV infection *(Al-Sehaibany 2017; Althomairy et al. 2018; Baseer et al. 2016; Gaffar et al. 2019; Kelsch 2014; Sukumaran and Patil 2014)* and (iii) SARS-CoV-2 infection *(Ather et al. 2020; Baghizadeh Fini 2020; Dave et al. 2020; Fallahi et al. 2020; Ge et al. 2020; Izzetti et al. 2020; Lo Giudice 2020; Meng et al. 2020; Odeh et al. 2020; Peng et al. 2020; Ren et al. 2020; Sabino-Silva et al. 2020; Sana et al. 2020)* among dental health professionals.

Question 3: What recommendations can be provided to minimize risk of COVID-19 transmission within dental clinics?

Given the theoretical risk of COVID-19 infection associated with exposure to bioaerosols in dental settings, several reviews, opinion papers, and recommendations have been published in the past four months. In the absence of a vaccine and proven treatments for COVID-19, recommendations focus on controls and practices that prevent exposure to the virus. These activities include (but are not limited to) (i) Active screening for COVID-19 symptoms and risk exposures in patients attending the dental clinic. (ii) use of appropriate PPE (iii) disinfection of hard surfaces where the virus can remain viable for long periods of time; and (iv) sterilization of all re-usable medical equipment; and interim recommendations from the ADA&C have been in place addressing these aspects in the setting of emergency dental care. These recommendations are similar to IPC recommendations in healthcare settings, which are effective in reducing HCW SARS-CoV-2 risk.

Primary literature and existing guidelines are summarized. In early exponential growth of the pandemic a publication from *Meng et al. (2020)* made recommendations to ensure that (1) patient flow is well organized to avoid close contact among patients and between dental personnel and patients; (2) temperature checks and health status of all patients and staff are monitored on a routine basis; (3) use of alternative, less invasive methods for oral examination be employed; and (4) extra PPE was used when handling urgent cases with respiratory symptoms. Based on the Italian experience, *Izzeti et al. (2020*) suggested using pre-triage and triage questionnaires to evaluate the potential risk for SARS-CoV-2 infection in patients. Furthermore, the authors recommended all staff (clinical and administrative) wear face masks and use face shields as an additional layer of protection. For dental procedures, *Izzeti et al.* suggest that power tools should be limited and encourage the use of manual instruments to avoid aerosolization in patients with influenza like symptoms.

Peng et al. (2020) describe the three most likely routes of human exposure from infected patients in a dental clinic setting, namely (1) spread through aerosols generated during dental procedures, (2) contact spread with human fluids (3) contaminated surfaces spread when touching surfaces such as metal, glass, or plastic. To mitigate risks in dental settings, the authors made specific recommendations for dental health professionals regarding (1) patient evaluation; (2) hand hygiene; (3) personal protective measures with primary, secondary and tertiary levels of protection; (4) use of rubber dams; (5) use of anti-retraction hand piece; (6) disinfection of dental clinics; and (7) medical waste management.

A review article by *Ather et al. (2020)* provides an algorithm for patient evaluation, suggestions for dental clinic management, instructions for donning and doffing PPE, and makes technical recommendations for handling dental emergencies in the context of COVID-19.

This rapid review did not identify high quality research evidence that supports or refutes the efficacy of recommendations regarding the prevention of COVID-19 transmission in dental clinic settings. However, recommendations can be extrapolated from indirect evidence such as the documented presence of infectious agents and other nanosized particles in dental procedure-produced aerosols, the epidemiologic transmission characteristics of SARS-CoV-2, as well as general infection prevention and control concepts. It is noted that in the Albertan context, standardized practices in Infection Prevention and Control and use of PPE have antedated the COVID-19 pandemic, so many of the international recommendations are possibly redundant to current processes.

To address question #3, therefore, rather than generating recommendations within this rapid review, recommendations have been linked and extracted from various sources:

1. Two recent Cochrane reviews conducted to address concerns regarding risks of COVID-19 transmission in dental clinic settings. (1) *"Recommendations for the re-opening of dental services: a rapid review of international sources"* (COVID-19 Dental Services Evidence Review (**CoDER**) Working Group May 6 2020) and (2) *"Personal Protective equipment for preventing highly infectious diseases due to exposure to contaminated body fluids in healthcare staff* " *(**Verbeek et al. 2020**)*. In addition, the Canadian Dental Association **CDA** (*Canadian Dental Association. 2020)* used expert opinions of international teams of government and academic scientists to generate recommendations which are also represented in the following summary/synthesis of recommendations.
2. We append a precis of the recent CDC Guidance for Dental Settings below as well (note the documented was since updated, June 3, 2020.)
3. The Alberta Dental Association and College recommendations are linked here.

1.Synthesized CDA and CoDER Recommendations

1. Stagger patient entry to ensure physical distancing between patients and between patients and dental clinic staff. Provide all patients (and family members accompanying them) with surgical masks and require these to be worn at all times while on the premises.
   In the Albertan context, it is further noted that the space available for distancing and the entry and exit flow in a clinic may influence the degree to which staggered appointments are required. **(CDA & CoDER)**

2. All patients should be screened for COVID-19 symptoms and if positive, non-urgent appointments should be postponed until symptom resolution **(CDA & CoDER)**
3. All clinical staff coming into contact with patients, in the presence of aerosol generating procedures (AGP), should be trained on appropriate use of the following PPE: (1) Fit tested N95 respirator; (2) face shield; and (3) gown/lab coat (with cuff). Ensure and document staff training on use of PPE. **(CDA, CoDER & Verbeek)**
4. An N95 respirator, eye protection, gown and gloves should be worn when performing an AGMP on any patient with confirmed or suspect COVID-19. This recommendation is in keeping with the AGMP recommendations in AHS medical facilities. **(CDA, CoDER & Verbeek)**
5. Designate dedicated spaces for donning, doffing and disposal of PPE. **(CoDER)**
6. Ensure that enhanced cleaning and management protocols are strictly followed for both AGP and NON-AGP rooms. **(CoDER)**
7. High volume suction should be utilized during dental aerosol producing procedures and where possible a rubber dam (oropharyngeal isolation) should be used **(CDA & CoDER)**
8. Patients should be instructed to contact their dental clinic as well as Public Health regarding first appearance of COVID-19 symptoms post-treatment, to facilitate contact tracing and testing procedures**. (CoDER)**
9. All clinic staff should stay home if ill and follow pertinent Public Health guidelines for symptom assessment. **(CDA & CoDER)**
10. All clinic staff should be screened for COVID-19 symptoms at the beginning of their shift**. (CDA & CoDER)**
11. All clinic staff should be encouraged to mask if proper physical distancing cannot be maintained consistently **(CDA & CoDER)**

II. Summary of CDC Guidance for Dental Settings

Relevant Transmission dynamics

- SARS-Cov-2 is thought to be spread primarily through respiratory droplets. Airborne transmission from person to person over long distances is unlikely. The virus has been shown to persist in aerosols for hours and surfaces for days in laboratory conditions.
- COVID-19 can be spread from asymptomatic individuals

Why is there a risk in Dental settings?

- Use of rotary dental and surgical instruments (Ultrasonic scalers, handpieces and air-water syringes) create visible spray that contain particle droplets of water, saliva, blood, microorganisms and debris.
- Surgical masks offer protection to mucus membranes of nose and mouth but do NOT protect against inhalation of airborne infectious agents.
- There is NO documented evidence that transmission of SARS-Cov-2 occurs in dental settings.

Recommendations

General Recommendations

- Dental care facilities should use guidance found in the Framework for Healthcare Systems Providing Non-COVID-19 Clinical Care During COVID-19 Pandemic
- Standard Precautions for all patients is reasonable if there is no or minimal community transmission, but given the possibility of spread from asymptomatic persons additional considerations should be taken when feasible.
- If there is minimal to moderate or substantial community transmission, dental care to patients without suspect or confirmed COVID-19 can be provided with additional considerations as below.
- *No to minimal community transmission is defined as evidence of isolated cases or limited community transmission, case investigations underway; no evidence of exposure in large communal setting.*
- *Minimal to moderate community transmission is defined as sustained transmission with high likelihood or confirmed exposure within communal settings and potential for rapid increase in cases.*
- *Substantial community transmission is defined as large scale community transmission, including communal settings (e.g., schools, workplaces).*

- Practice Universal source control and actively screen for COVID-19 symptoms
- Ensure regular supply of appropriate PPE

Specific Recommendations

Patient Management

- Call patient prior to treatment and screen for COVID-19
- Avoid non-emergent care if there is more than minimal community transmission.
- Use teledentistry if possible
- Keep visitors accompanying patient to minimum
- Assess patients on arrival and explain protocol. Patients and visitors should be advised to wear a face covering or provided a surgical mask when they arrive if supplies are adequate
- Patients to put on own mask before leaving premises
- Follow-up with patients in case they develop symptoms after visit.

Facility Considerations

- Ensure adherence with respiratory hygiene and cough etiquette. Display visual alerts.
- Provide alcohol based hand sanitizers
- Ensure physical barriers between administrative staff and patients such as plastic/glass windows
- Chairs are to be 2 meters apart in waiting room
- Minimize number of patients in waiting room and remove all toys and magazines.
- Minimize overlapping appointments

Equipment Considerations

- Ensure that dental unit water lines are working properly and that the water microbiological water quality meet EPA standards
- Ensure that autoclaves and other instrument cleaning equipment are working optimally. Use a biological indicator to test the performance of autoclave

Administrative Controls

- Care for only one patient at a time
- Do not expose unnecessary supplies or equipment for a given procedure.
- Limit number of dental care providers present during AGP.
- Avoid AGP as far as possible- Do not use handpieces, air/water syringe and ultrasonic scalers
- If AGP is necessary, use 4-handed dentistry, high evacuation suction and dental dams to minimize splatter and aerosols
- Consider using preprocedural mouthrinses - although there is no evidence regarding its clinical effectiveness against SARS-CoV-2.

Engineering Considerations

Ventilation

- Ensure ventilation systems is up to date with standards
- Use the expertise of HVAC professional to ensure maximum air filtration efficiency and increase percentage of outdoor air supplied through HVAC
- Limit the use of demand-controlled ventilation (triggered by temperature or occupancy) during working hours. Ensure that ventilation continue to work post-occupancy. Keep bathroom exhaust fans on during business hours.
- Consider the use of a portable HEPA air filtration unit during an AGP.
- Consider the use of an upper-room UV germicidal irradiation system

Patient placement

- As far as possible, have only one patient per room

- In open floor plan: (1) make sure that patient chairs are 2 meters apart (2) set up easy to clean floor-to-ceiling barriers between patient chairs (3) Operatories should be oriented parallel to direction of air flow
- Orient patients carefully – (1) patients' head near return air vent away from pedestrian corridors

Patient Volume

- Limit number of patients based on number of rooms , layout and time need to clean and disinfect

Hygiene

- Comply with standard hand hygiene – Wash with soap and water and use alcohol based hand sanitizers

Universal Source Control

- Use surgical masks. Use respirator or facemask if more protection is needed
- Administrative staff to use cloth masks as a minimum
- Dental care workers should change facemasks if they become damp, soiled or hard to breathe.
- Training to be provided to dental care workers on when, how and how cloth masks are to be used.

Personal Protective Equipment

- Dental care worker should wear (1) Surgical Mask (2) Eye Protection (goggles with side shields or full face shield (3) gown or protective clothing
- During AGP on patients assumed to be noninfectious, consider the use of an N95 respirators, or if not available use a surgical mask AND a full face shield as a minimum. Ensure the right protocol for donning and doffing is in place and is adhered to.
- Ensure continuous supply for high quality PPE

Environmental Infection Control

- Ensure compliance with environmental cleaning and disinfection procedures after each patient.
- Wait 15 minutes after patient leave treatment space for droplets to settle and then clean.
- There is no evidence on the performance of ultrasonic waves, high intensity UV and LED blue light to inactivate SARS-Cov-2.
- Do not use sanitizing tunnels

Precautions or strategies for patients suspected or confirmed COVID-19 I

Non –Emergency dental care required

- Provide patient with a mask
- Non-acutely sick patient – send patient back home and instruct to call family physician
- Acutely sick patient – refer patient immediately to hospital

Emergency dental care required

- Individual treatment in an individual room with a closed door
- Avoid AGP if possible
- If AGP is required – Dental Professionals to use N95 or high level respirator
    - Number of dental care worker to be kept at a minimum in the room
    - AGP to be done in airborne infection isolation room
- Schedule patient at the end of the day
- Do not schedule other patients at that time

Monitor and manage dental care workers

- Stay home if ill with no penalties
- Immediate use of cloth or surgical facemask if symptoms develop – inform supervisor and go home
- Ensure continuous training on safety precautions

Evolving Evidence

This is a field of research which is being actively investigated and it is expected that more robust data will be available in the foreseeable future. It is anticipated that multidisciplinary research will be undertaken involving environmental/indoor air quality engineering for indoor bioaerosols, biomedical engineering to improve instrumentation quality and precision and aerosol control, and microbiological research to investigate the presence of aerosolized viral particles produced in dental settings.

Date question received by advisory group: May 7, 2020

Date report submitted to committee: May 15, 2020

Date of first assessment: June 25, 2020

(If applicable) Date of re-assessment:

Authorship and Committee Members

This review was written by Sanjay Beesoon and assisted by Susan Jelinski. It was scientifically reviewed by Stephanie Smith (external primary reviewer), Lynora Saxinger (co-writer, internal primary reviewer) Richard Reive (external reviewer), Joseph Kim (external reviewer), Uma Chandran (external reviewer), Rafael Figueiredo (external reviewer), Harbuksh Sekhon (external reviewer), Jerald Pruner (external reviewer), and Paul Major (external reviewer). Additional review and comments were sought from representatives of Alberta Health and Alberta Health Services Public Health. The full Scientific Advisory Group was involved in discussion and revision of the document: Lynora Saxinger (co-chair), Braden Manns (co-chair), John Conly, Alexander Doroshenko, Shelley Duggan, Nelson Lee, Andrew McRae, Jeremy Slobodan, James Talbot, Brandie Walker, and Nathan Zelyas.

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Appendix 1

List of Abbreviations

AGP: aerosol-generating procedure

AH: Alberta Health

AHS: Alberta Health Services

ATP: adenosine triphosphate

CFU: colony forming unit

CoDER: COVID-19 Dental Services Evidence Review

COVID-19: Coronavirus Disease-2019

NON-AGP: non-aerosol-generating procedure

PPE: personal protective equipment

SAG: Scientific Advisory Group

Literature Search Details

The literature search was conducted by Lauren Seal from the Knowledge Resource Services team of Knowledge Management, AHS.

Search Strategy for Question 1

Medline/PubMEd

1 exp Aerosols/ (31096)

2 Air Microbiology/ (7584)

3 Inhalation Exposure/ (9215)

4 "aerosol generating medical procedure*".mp. (10)

5 "aerosol generat*".mp. (796)

6 AGMP.mp. (12)

7 1 or 2 or 3 or 4 or 5 or 6 (45966)

8 exp Dental Equipment/ (17612)

9 7 and 8 (169)

10 limit 9 to last 10 years (23)

CINAHL

S1 (MH "Aerosols") 3,141

S2 (MH "Air Microbiology") 565

S3	(MH "Inhalation Exposure")	708
S4	"aerosol generat*" OR "aerosol generat* medical procedure" OR AGMP	152
S5	S1 OR S2 OR S3 OR S4	4,340
S6	(MH "Dental Equipment+")	6,223
S7	S5 AND S6	28

TRIP Pro/Google Scholar/Google Advanced Search

(dental OR dentistry) AND (tool OR equipment OR instrument or drill) AND (aerosol OR "aerosol generating procedure" OR "aerosol generating medical procedure" OR "aerosol generating" OR "air microbiology" OR "inhalation exposure" OR "air exposure") from:2010

Search Strategy to answer Question 2

Medline

1 exp Coronavirus/ or exp Coronavirus Infections/ or coronaviru*.mp. or "corona virus*".mp. or ncov*.mp. or n-cov*.mp. or "novel cov".mp. or COVID-19.mp. or COVID19.mp. or COVID-2019.mp. or COVID2019.mp. or SARS-COV-2.mp. or SARSCOV-2.mp. or SARSCOV2.mp. or SARSCOV19.mp. or Sars-Cov-19.mp. or SarsCov-19.mp. or SARSCOV2019.mp. or Sars-Cov-2019.mp. or SarsCov-2019.mp. or "severe acute respiratory syndrome cov 2".mp. or "2019 ncov".mp. or "2019ncov".mp. (22435)

2 Middle East Respiratory Syndrome Coronavirus/ (1034)

3 "middle east respiratory syndrome".mp. (2058)

4 mers.mp. (4283)

5 mers-cov.mp. (1630)

6 SARS Virus/ (3029)

7 Severe Acute Respiratory Syndrome/ (4574)

8 SARS.mp. (9973)

9 sars-cov.mp. (3312)

10 "severe acute respiratory syndrome".mp. (8918)

11 Influenza A Virus, H1N1 Subtype/ (15124)

12 H1n1.mp. (20713)

13 Pandemics/ (6868)

14 pandemic*.mp. (27214)

15 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 (52277)

16 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 (63184)

17 exp Disease Transmission, Infectious/ (67642)

18 transmission.mp. (510267)

19 transmit*.mp. (176068)

20 infectiousness.mp. (1385)

21 infectivity.mp. (25995)

22 exp Dentistry/ (402678)

23 exp Dental Facilities/ (8553)

24 17 or 18 or 19 or 20 or 21 (674734)

25 22 or 23 (406986)

26 16 and 24 and 25 (40)

CINAHL

S1 (MH "Coronavirus+")

S2 (MH "Coronavirus Infections+")

S3 coronaviru*

S4 "corona virus"

S5 ncov*

S6 n-cov*

S7 COVID-19 OR COVID19 OR COVID-2019 OR COVID2019

S8 SARS-COV-2 OR SARSCOV-2 OR SARSCOV2 OR SARSCOV19 OR SARS-COV-19 OR SARSCOV-19 OR SARSCOV2019 OR SARS-COV-2019 OR SARSCOV-2019

S9 "severe acute respiratory syndrome cov 2" OR "severe acute respiratory syndrome coronavirus*"

S10 "2019 ncov" OR 2019ncov OR Hcov*

S11 S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10

5,426

S12 (MH "Middle East Respiratory Syndrome Coronavirus")

S13 (MH "Middle East Respiratory Syndrome")

S14 "middle east respiratory syndrome" OR MERS-COV OR MERS

S15 (MH "SARS Virus")

S16 (MH "Severe Acute Respiratory Syndrome")

S17 "severe acute respiratory syndrome" OR SARS OR SARS-COV

S18 (MH "Influenza A Virus, H1N1 Subtype")

S19 (MH "Influenza, Pandemic (H1N1) 2009")

S20 H1N1

S21 (MH "Disease Outbreaks")

S22 pandemic*

S23 S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22

39,111

S24 S11 OR S23 40,423

S25 (MH "Disease Transmission+") 15,355

S26 transmit* OR transmission OR infectiousness OR infectivity 93,551

S27 S25 OR S26 94,505

S28 (MH "Dentistry+") 104,180

S29 (MH "Dental Facilities+") 3,680

S30 S28 OR S29 106,193

S31 S23 AND S24 AND S30 113

PubMed

1 "middle east respiratory syndrome coronavirus"[MeSH Terms] OR "middle east respiratory syndrome"[Title/Abstract] OR "mers"[Title/Abstract] OR "mers-cov"[Title/Abstract] OR "sars virus"[MeSH Terms] OR "severe acute respiratory syndrome"[MeSH Terms] OR "sars"[Title/Abstract] OR "sars-cov"[Title/Abstract] OR "severe acute respiratory syndrome"[Title/Abstract] OR "influenza a virus, h1n1 subtype"[MeSH Terms] OR "h1n1"[Title/Abstract] OR "pandemics"[MeSH Terms] OR "pandemic"[Title/Abstract] OR "coronavirus"[MeSH Terms] OR "coronavirus infections"[MeSH Terms] OR "coronaviru*"[Title/Abstract] OR "corona virus"[Title/Abstract] OR "ncov*"[Title/Abstract] OR "n cov*"[Title/Abstract] OR "novel cov"[Title/Abstract] OR "COVID-19"[Title/Abstract] OR "COVID19"[Title/Abstract] OR "COVID-2019"[Title/Abstract] OR "COVID2019"[Title/Abstract] OR "SARS-COV-2"[Title/Abstract] OR "SARSCOV-2"[Title/Abstract] OR "sarscov2"[Title/Abstract] OR "SARSCOV19"[Title/Abstract] OR "sars cov 19"[Title/Abstract] OR "severe acute respiratory syndrome cov 2"[Title/Abstract] OR "2019 ncov"[Title/Abstract] OR "2019ncov"[Title/Abstract] OR "severe acute respiratory disease"[Title/Abstract] "middle east respiratory syndrome coronavirus"[MeSH Terms] OR "middle east respiratory syndrome"[Title/Abstract] OR "mers"[Title/Abstract] OR "mers-cov"[Title/Abstract] OR "sars virus"[MeSH Terms] OR "severe acute respiratory syndrome"[MeSH Terms] OR "sars"[Title/Abstract] OR "sars-cov"[Title/Abstract] OR "severe acute respiratory syndrome"[Title/Abstract] OR "influenza a virus, h1n1 subtype"[MeSH Terms] OR "h1n1"[Title/Abstract] OR "pandemics"[MeSH Terms] OR "pandemic"[Title/Abstract] OR "coronavirus"[MeSH Terms] OR "coronavirus infections"[MeSH Terms] OR "coronaviru*"[Title/Abstract] OR "corona virus"[Title/Abstract] OR "ncov*"[Title/Abstract] OR "n cov*"[Title/Abstract] OR "novel cov"[Title/Abstract] OR "COVID-19"[Title/Abstract] OR "COVID19"[Title/Abstract] OR "COVID-2019"[Title/Abstract] OR "COVID2019"[Title/Abstract] OR "SARS-COV-2"[Title/Abstract] OR "SARSCOV-2"[Title/Abstract] OR "sarscov2"[Title/Abstract] OR "SARSCOV19"[Title/Abstract] OR "sars cov 19"[Title/Abstract] OR "severe acute respiratory syndrome cov 2"[Title/Abstract] OR "2019 ncov"[Title/Abstract] OR "2019ncov"[Title/Abstract] OR "severe acute respiratory disease"[Title/Abstract] 69,349

2 ((((disease transmission, infectious[MeSH Terms]) OR (transmission[Title/Abstract])) OR (transmit*[Title/Abstract])) OR (infectiousness[Title/Abstract])) OR (infectivity[Title/Abstract]) "disease transmission, infectious"[MeSH Terms] OR "transmission"[Title/Abstract] OR "transmit*"[Title/Abstract] OR "infectiousness"[Title/Abstract] OR "infectivity"[Title/Abstract] 549,768

3	((((dentistry[MeSH Terms]) OR (dental facilities[MeSH Terms])) OR ("dental clinic*"[Title/Abstract])) OR (dental[Title/Abstract])) OR (dentistr*[Title/Abstract])	"dentistry"[MeSH Terms] OR "dental facilities"[MeSH Terms] OR "dental clinic*"[Title/Abstract] OR "dental"[Title/Abstract] OR "dentistr*"[Title/Abstract]	524,445
4	(("dental clinic*"[Title/Abstract]) OR (dentists[MeSH Terms])) OR (dental staff[MeSH Terms])	"dental clinic*"[Title/Abstract] OR "dentists"[MeSH Terms] OR "dental staff"[MeSH Terms]	25,152
5	#3 OR #4	"dentistry"[MeSH Terms] OR "dental facilities"[MeSH Terms] OR "dental clinic*"[Title/Abstract] OR "dental"[Title/Abstract] OR "dentistr*"[Title/Abstract] OR "dental clinic*"[Title/Abstract] OR "dentists"[MeSH Terms] OR "dental staff"[MeSH Terms]	532,316
6	#1 AND #2 AND #5	((((((((((((((((((((((((((((((("middle east respiratory syndrome coronavirus"[MeSH Terms] OR "middle east respiratory syndrome"[Title/Abstract]) OR "mers"[Title/Abstract]) OR "mers-cov"[Title/Abstract]) OR "sars virus"[MeSH Terms]) OR "severe acute respiratory syndrome"[MeSH Terms]) OR "sars"[Title/Abstract]) OR "sars-cov"[Title/Abstract]) OR "severe acute respiratory syndrome"[Title/Abstract]) OR "influenza a virus, h1n1 subtype"[MeSH Terms]) OR "h1n1"[Title/Abstract]) OR "pandemics"[MeSH Terms]) OR "pandemic"[Title/Abstract]) OR "coronavirus"[MeSH Terms]) OR "coronavirus infections"[MeSH Terms]) OR "coronaviru*"[Title/Abstract]) OR "corona virus"[Title/Abstract]) OR "ncov*"[Title/Abstract]) OR "n cov*"[Title/Abstract]) OR "novel cov"[Title/Abstract]) OR "COVID-19"[Title/Abstract]) OR "COVID19"[Title/Abstract]) OR "COVID-2019"[Title/Abstract]) OR "COVID2019"[Title/Abstract]) OR "SARS-COV-2"[Title/Abstract]) OR "SARSCOV-2"[Title/Abstract]) OR "sarscov2"[Title/Abstract]) OR "SARSCOV19"[Title/Abstract]) OR "sars cov 19"[Title/Abstract]) OR "severe acute respiratory syndrome cov 2"[Title/Abstract]) OR "2019 ncov"[Title/Abstract]) OR "2019ncov"[Title/Abstract]) OR "severe acute respiratory disease"[Title/Abstract]) AND ((((("disease transmission, infectious"[MeSH Terms] OR "transmission"[Title/Abstract]) OR "transmit*"[Title/Abstract]) OR "infectiousness"[Title/Abstract]) OR "infectivity"[Title/Abstract])) AND (((((("dentistry"[MeSH Terms] OR "dental facilities"[MeSH Terms]) OR "dental clinic*"[Title/Abstract]) OR "dental"[Title/Abstract]) OR "dentistr*"[Title/Abstract]) OR (("dental clinic*"[Title/Abstract] OR "dentists"[MeSH Terms]) OR "dental staff"[MeSH Terms]))	57

TRIP Pro/Google Scholar/Google

(coronavirus OR “corona virus” OR sars-cov-2 OR COVID-19 OR SARS OR MERS or H1N1 OR “severe acute respiratory” OR “middle east respiratory syndrome”) AND (transmit OR transmission OR infectiousness OR infectivity) AND (dentistry OR dental OR dentist)

Medrxiv preprints/LitCovid/WHO Database/CEBM/Evidence Aid – Covid-19/REACTing/NEJM/Cochrane Library/covid-evidence.org/Canadian Dental Association/Alberta Dental Association and College/Twitter

(transmit OR transmission OR infectiousness OR infectivity) AND (dentistry OR dental OR dentist)

(dentistry OR dental OR dentist)

Covid-19

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Appendix 2: Evaluation of the Evidence for Question 1

				Mixed Methods Appraisal Tool Criteria:	
	Reference	Peer reviewed?	Type of evidence	Are there clear research questions or a clearly identified issue?	Is the collected data or presented evidence appropriate to address the research questions or issue?
1.	Adhikari, A., Kurella, S., Banerjee, P., & Mitra, A. (2017). Aerosolized bacteria and microbial activity in dental clinics during cleaning procedures. Journal of Aerosol Science, 114, 209-218.	☒ Yes	**Primary Evidence** - 45 air samples were collected from 15 cleaning procedures. Controls before and after cleaning **(USA)** No statistically significant increase in air borne **bacteria** during dental cleaning	☒ Yes	☐ Yes
2.	Afzha, R., Chatterjee, A., Subbaiah, S., & Pradeep, A. (2016). Microbial contamination of contact lenses after scaling and root planing using ultrasonic scalers with and without protective eyewear: A clinical and microbiological study. Journal of Indian Society of Periodontology, 20(3), 273-278.	☒ Yes	Primary evidence **(INDIA)** based on rather weak methodology – evaluate **bacterial** contamination on contact lenses of dentists With and without protective eyewear. 50 % contamination for those who wear eyewear and 100% contamination for those who did not. Data presentation is messy. (Bacteria)	☒ Yes	☐ partially
3	Al-Eid, R. A., Ramalingam, S., Sundar, C., Aldawsari, M., & Nooh, N. (2018). **Detection of visually imperceptible blood contamination in the oral surgical clinic using forensic luminol blood detection agent.** *Journal of International Society of Preventive & Community Dentistry, 8*(4), 327.	☒ Yes	Primary evidence **(SAUDI ARABIA)** – PPE of surgeon, assistant and patients were evaluated for traces of visually imperceptible blood contamination using luminol. **Blood** was detected on all PPEs and other hard surfaces	☒ Yes	☐ Yes
4	Bentley, C. D., Burkhart, N. W., & Crawford, J. J. (1994). **Evaluating spatter and aerosol contamination during dental procedures.** *The Journal of the American Dental [Association, 125*(5), 579-584	☒ Yes	**USA** 5 separate procedures were done on different days. Blood agar plates were placed at different distances from patient's mouth and, on the patient, and the HCW. Controls (before treatment)	☐ Yes	☐ YEs OLD and Weak method

			were set up but results NOT Presented. High **Bacteria** counts (Alpha hemolytic streptococci) noted at all spots.		
5	Day, C. J., Price, R., Sandy, J. R., & Ireland, A. J. (2008). **Inhalation of aerosols produced during the removal of fixed orthodontic appliances: A comparison of 4 enamel cleanup methods.** *American Journal of Orthodontics & Dentofacial Orthopedics, 133*(1), 11-17.	☒ Yes	Enamel cleaning in a lab simulated patient – **(UK)** fast hand piece with water irrigation demonstrated the highest air concentration of debris Particle Size range from 0.4 to 15 µm (NON-Infectious particulates)	☒ Yes	☐ Yes
6	Dutil, S., Mériaux, A., de Latrémoille, M., Lazure, L., Barbeau, J., & Duchaine, C. (2009). **Measurement of airborne bacteria and endotoxin generated during dental cleaning.** *Journal of Occupational & Environmental Hygiene, 6*(2), 121-130. doi:10.1080/15459620802633957 Retrieved	☒ Yes	**CANADIAN** Strongest Study design involving 52 patients Statistically significant differences of culturable bioaerosol concentrations before, during, and after dental treatments and determined by (1) culture (2) endotoxin The aerodynamic diameter of dental bioaerosols generated during treatments was between 0.65 µm and 0.84 µm, with a median value of 0.73 µm.	☒ Yes	☒ Yes
7	Guida, M., Galle, F., Di Onofrio, V., Nastro, R. A., Battista, M., Liguori, R., . . . Liguori, G. (2012). **Environmental microbial contamination in dental setting: A local experience.** *Journal of Preventive Medicine & Hygiene, 53*(4), 207-212.	☒ Yes	Air Samples collected by both active and passive sampling to monitor **bacterial** contamination **(ITALY)** T1 Before the working Day T2 During Working Day T3 At the end of the working Day Air contamination did not increase during the day for both for active and passive sampling	☒ Yes	☐ Yes
8	Hallier, C., Williams, D. W., Potts, A. J. C., & Lewis, M. A. O. (2010). **A pilot study of bioaerosol reduction using an air cleaning system**	☒ Yes	The Air Cleaning Systems (UK) resulted in a significant reduction (p = 0.001) in the mean bioaerosols (cfu/m3) of	☒ Yes	☐ Yes

	during dental procedures. *British Dental Journal, 209*(8), E14		all three clinics compared with baseline measurements. The mean level of bioaerosols recorded during dental procedures, with or without the ACS activated respectively, was 23.9 cfu/m3 and 105.1 cfu/m3 (p = 0.02) for cavity preparation, 23.9 cfu/m3 and 62.2 cfu/m3 (p = 0.04) for history and oral examination; 41.9 cfu/m3 and 70.9 cfu/m3 (p = 0.01) for ultrasonic scaling and 9.1 cfu/m3 and 66.1 cfu/m3 (p = 0.01) for extraction. The predominant microorganisms isolated were Staphylococcus species and Micrococcus species.		
9	Ishihama, K., Koizumi, H., Wada, T., Iida, S., Tanaka, S., Yamanishi, T., . . . Kogo, M. (2009). Evidence of aerosolised floating blood mist during oral surgery. Journal of Hospital Infection, 71(4), 359-364. doi:10.1016/j.jhin.2008.12.005	☒ Yes	Monitoring of **blood** mist. (JAPAN) At locations 20, 60 and 100cm from the surgical site, 76%, 60 % and 57%, respectively, of the particulates were positive in blood presumptive tests. - contaminated materials have the potential to be suspended in air as blood-contaminated aerosol.	☒ Yes	☐ Yes
10	Jain, M., Mathur, A., Mathur, A., Mukhi, P. U., Ahire, M., & Pingal, C. (2020). **Qualitative and quantitative analysis of bacterial aerosols in dental clinical settings: Risk exposure towards dentist, auxiliary staff, and patients.** *Journal of Family Medicine and Primary Care, 9*(2), 1003-1008.	☒ Yes	Agar plates used to capture aerosolized bacteria particles before, during and after activity in dental science settings. (INDIA) Statistically significant increase of colony counts during dental work, compared with baseline. Statistically significant decrease in colony counts 2 hours after dental work is completed.	☒ Yes	☐ Yes
11	Kadaifciler, D. G., & Cotuk, A. (2014). **Microbial contamination of dental unit waterlines and effect on quality of indoor air.** *Environmental Monitoring & Assessment, 186*(6), 3431-3444		Microbiological air quality in 20 Dental clinics. **TURKEY** Microfungal and bacterial CFUs in indoor and outdoor air in the morning and evening. Weak methodology and data	☒ Yes	☐ Yes

			analysis. In 90 % of DOs, medium (<500 CFU/m3) bacterial contamination levels in the air were observed. In all DOs, low level (<100 CFU/m3) of microfungal air contamination was observed.		
12	Kimmerle, H., Wiedmann-Al-Ahmad, M., Pelz, K., Wittmer, A., Hellwig, E., & Al-Ahmad, A. (2012). **Airborne microbes in different dental environments in comparison to a public area.** *Archives of Oral Biology, 57*(6), 689-696.	☒ Yes	**GERMANY** Bacterial CFUs measured every hour from 7.30 AM to 5.30 PM for 4 different days. High CFUs associated with higher activity during the day. M-shape trend for both normal dental clinic and multichair clinics.	☒ Yes	☐ Yes
13	Liu, M., Chen, C., Chuang, L., Lin, W., & Wan, G. (2019). **Removal efficiency of central vacuum system and protective masks to suspended particles from dental treatment.** *PloS One, 14*(11),	☒ Yes	**TAIWAN** concentration of total PM produced by grinding teeth *(1.72×10^8 particles/m^3)* was significantly higher than the indoor background concentration *(1.49×10^7 particles/m^3).* The aerodynamic diameter of most particles measured by a Nano analyzer was below 70 nm and the average particle diameter was 53.68 nm. Average concentration of **ultrafine particles** was 2.1x10^{11} particles/m^3, while drilling teeth in the absence of a vacuum system. ROBUST STUDY DESIGN. Only study looking at non-infectious PM	☒ Yes	☒ Yes
14	Singh, T. S., Bello, B., Mabe, O. D., Renton, K., & Jeebhay, M. F. (2010). **Workplace determinants of endotoxin exposure in dental healthcare facilities in south africa.** *Annals of Occupational Hygiene, 54*(3), 299-308.		**SOUTH AFRICA** Cross sectional study design N=413 Compared airborne endotoxins levels is spaces for least exposed personnel (2.4) to most exposed personnel (5.6). Age of the dental units explained the most variability observed in the personal air samples	☒ Yes	☐ Yes
15	Vilarinho Oliveira, Aline Maria Alves, de Alencar, R. M., Santos Porto, J. C., Fontenele Ramos, Isla Rita Brito,	☒ Yes	**BRAZIL** Assess air contamination with a variety of fungal species. Clinic 1	☒ Yes	☐ Yes

	Noleto, I. S., Santos, T. C., & Mobin, M. (2018). **Analysis of fungi in aerosols dispersed by high speed pens in dental clinics from teresina, piaui, brazil.** *Environmental Monitoring & Assessment, 190*(2), 56.		contained 15 seats separated by 1.70 m × 6.5 cm dividers, forming boxes. Clinic 2 was composed of 27 chairs and there was no partitions and the space between one chair and another. Results indicate that the minimum safety distance between the dental chairs should be more than 2 meters		
16	Watanabe, A., Tamaki, N., Yokota, K., Matsuyama, M., & Kokeguchi, S. (2018). **Use of ATP bioluminescence to survey the spread of aerosol and splatter during dental treatments.** *Journal of Hospital Infection, 99*(3), 303-305. doi:10.1016/j.jhin.2018.03.002	☒ Yes	**JAPAN** ---Ultrasonic scaling and professional mechanical tooth cleaning were performed as dental treatments on 10 students, with each procedure lasting for 10 min. Bioluminescence used to measure **ATP** as a marker for bacterial activity. ATP after/before ratio on googles ATP after/before ratio on googles 24. Suggesting heavy contamination	☒ Yes	☐ Yes
17	Yamada, H., Ishihama, K., Yasuda, K., Hasumi-Nakayama, Y., Shimoji, S., & Furusawa, K. (2011). **Aerial dispersal of blood-contaminated aerosols during dental procedures.** *Quintessence International, 42*(5), 399-405.	☒ Yes	**JAPAN** 102 samples 50 cm from the mouth and 124 samples 100 cm from mouth. Monitor **blood** containing aerosols using leucomalachite green during 4 different procedures. Blood was detected at both 50 cm and 100 cm for all 4 procedures. As expected positivity rates are lower at 100 cm (further away from the patients mouth)	☒ Yes	☐ Yes

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