Introduction

Understanding how different countries have responded to mitigate the risk of severe acute respiratory syndrome coronavirus 2 (SARS CoV-2) transmission in dental offices is important. This article describes the different approaches taken towards optimal fallow periods in Canadian jurisdictions. We searched publicly available information from dentist and dental hygiene regulator websites across the 10 provinces and 3 territories in Canada. We also searched for guidance documents on dental associations’ websites or through personal communication with government officials. We extracted and tabulated information on fallow period recommendations or guidance, when available.

Results: Nine jurisdictions (6 provinces and all 3 territories) acknowledge or provide guidance on fallow periods following aerosol-generating procedures. Among those who have provided guidance regarding a fallow period, recommendations follow the Centers for Disease Control and Prevention guidance if the air changes per hour (ACH) in the dental operatory is known.

Conclusion: The evidence for deciding on optimal fallow period is limited and still being explored, resulting in substantial variation across Canadian jurisdictions. A focus on developing scientific evidence relevant to dentistry and assimilating existing science is crucial to establishing consistency and uniformity in information to deliver safe oral health care services.

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mechanically generate aerosols, evidence demonstrating the risk of infection transmission through these procedures is limited and still being explored. The limited evidence in dentistry should not lead to assumptions that there is no risk of infection transmission when conducting AGPs, and therefore, controls to reduce risk are necessary.

Ventilation optimisation in operatories is an important aspect in this regard. For example, the Canadian Standards Association (CSA) develops standards for various health care settings to account for the potential of airborne infection. Ventilation requirements set by the CSA for health care facilities include a minimum number of air changes per hour (ACH). The ACH is a measure that assesses how many times the air within a confined space turns over in an hour. The rate of air change in a room can affect the rate of removal of airborne contaminants.

The National Institute for Occupational Safety and Health (NIOSH) provides a mathematical relationship for the rate of decline in concentration of an airborne contaminant in a situation where there is perfect mixing of room air after the contaminant source is removed. The Centers for Disease Control and Prevention (CDC) has used the NIOSH mathematical model to estimate the percentage removal by ACH (Table 1). These calculations have been used to determine ‘fallow periods,’ or the waiting time after an AGP is conducted before cleaning an operatory and admitting the next patient. The understanding is that the aerosols generated by an AGP will remain suspended in the air for some time and aerosols from a patient positive for COVID-19 may contain virus that could be infectious to others. Thus, the reasoning goes, until the viral particles are removed by ventilation or settle by gravity and are disinfected, the next patient should not enter the room. Therefore, to keep patients, dental staff, and the community safe, it is important to follow an 'optimal fallow period' after dental procedures.

Understanding how the dental care sector in different countries have returned to practice and responded to mitigate the risk of SARS CoV-2 transmission in dental offices is important. This includes a recent rapid review that compares how countries have handled AGPs in dental practice settings. Canadian dental regulators have also been proactive in developing guidance documents to reduce the risk of infection transmission in dental offices. In Canada, there is no federal (or national) institution responsible for regulating the practice of oral health professionals. There are 10 provinces and 3 territories in Canada, each having regulatory bodies responsible for regulating oral health professionals (eg, dentists and dental hygienists). In some cases, the regulatory bodies that govern oral health professionals also act as the professional association for their members.

The guidance developed across Canadian jurisdictions is arguably informed by evidence, but as the availability of robust evidence is lacking in a number of areas (eg, aerosol reduction using rubber dam, effectiveness between intra- or extra-oral high-volume suction), some regulators have taken a precautionary approach in their guidance to keep patients, oral health care workers, and the community safe. The precautionary principle states that, ‘in cases of serious or irreversible threats to the health of humans or ecosystems, acknowledged scientific uncertainty should not be used as a reason to postpone preventive measures.’

To inform current discussions around risk mitigation from AGPs and ACH requirements, this article describes the different approaches taken towards optimal fallow periods in

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### Table 1 – Airborne contaminant removal times (modified from Kohn, 2003).

| Air changes per hour | Cumulative % airborne-contaminant removed after 1 h | Time (minutes) for 99.0% reduction* | Time (minutes) for 99.9% reduction* |
|----------------------|---------------------------------------------------|-------------------------------------|-------------------------------------|
| 1                    | 63                                                | 276                                 | 414                                 |
| 2                    | 86.31                                             | 138                                 | 207                                 |
| 3                    | 94.9347                                           | 92                                  | 138                                 |
| 4                    | 98.125839                                         | 69                                  | 104                                 |
| 5                    | 99.30656043                                       | 55                                  | 83                                  |
| 6                    | 99.74342736                                       | 46                                  | 69                                  |
| 7                    | 99.90508612                                       | 39                                  | 59                                  |
| 8                    | 99.96487521                                       | 35                                  | 52                                  |
| 9                    | 99.98700383                                       | 31                                  | 46                                  |
| 10                   | 99.99519142                                       | 28                                  | 41                                  |
| 11                   | 99.99822082                                       | 25                                  | 38                                  |
| 12                   | 99.9993417                                        | 23                                  | 35                                  |
| 13                   | 99.99975643                                       | 21                                  | 32                                  |
| 14                   | 99.99990988                                       | 20                                  | 30                                  |
| 15                   | 99.99998766                                       | 18                                  | 28                                  |
| 16                   | 99.99999831                                       | 17                                  | 26                                  |
| 17                   | 99.99999977                                       | 16                                  | 24                                  |
| 18                   | 99.99999997                                       | 15                                  | 23                                  |
| 19                   | 100                                               | 15                                  | 22                                  |
| 20                   | 100                                               | 14                                  | 21                                  |
| 50                   | 100                                               | 06                                  | 08                                  |

* Values derived from the formula: \( t_2 - t_1 = -\ln (C_2 / C_1) / (Q / V) \times 60 \), with \( t_1 = 0 \), \( t_2 = \text{final timepoint in minutes} \), \( C_1 = \text{initial concentration of contaminant} \), \( C_2 = \text{final concentration of contaminant} \), \( Q \) = air flow rate in cubic feet/hour, \( V \) = room volume in cubic feet, \( Q / V = \text{ACH} \).
Canadian jurisdictions. Further, the implications of these differences on dental practice, dental regulation, and the public are discussed.

**Methods**

We conducted a jurisdictional scan of dental regulators’ guidance documents regarding fallow periods across Canada. We searched publicly available information from dentist and dental hygiene regulator websites across the 10 provinces and 3 territories in Canada. In jurisdictions where information from regulatory bodies was not publicly available, we searched dental association websites for guidance documents (ie, Prince Edward Island) or obtained guidance documents through personal communication with government officials (ie, Nunavut). Since the initial guidance documents on the COVID-19 pandemic and dental practice were developed, several jurisdictions have updated their guidance. Thus, we selected the most recent guidance documents available at the time of search from each jurisdiction, which varied in publication date from May 8, 2020, to September 4, 2020.17,19,23,25,36 From each resource, we extracted the following information, when available: (i) presence of fallow period recommendations or guidance; (ii) information regarding recommended fallow period when ACH is known and not known; (iii) mention or reference to CDC/NIOSH tables; and (iv) any other references noted to support the guidance.

**Results**

A summary of jurisdictional approaches is provided in Table 2. Nine jurisdictions (6 provinces and all 3 territories) acknowledge or provide guidance on fallow periods following AGPs: Saskatchewan (SK), Ontario (ON), Quebec (QC), Prince Edward Island (PE), New Brunswick (NB), Newfoundland and Labrador (NL), Yukon (YT), Nunavut (NU), and Northwest Territories (NT); whereas four provinces, British Columbia (BC), Alberta (AB), Manitoba (MB), and Nova Scotia (NS), do not provide any recommendations in this regard. In these 4 jurisdictions, though, they discuss reducing the risks of AGPs by minimising their use or performing procedural mitigation, such as rubber dam placement or preoperative mouth rinse, but observing a fallow period is not mentioned. Among jurisdictions that acknowledge fallow periods, two provinces (Newfoundland and Labrador and New Brunswick) refer registrants to seek expert advice from heating, ventilating, and air conditioning (HVAC) professionals to determine optimal settings for clearance of aerosols. Where the NIOSH airborne contaminant removal model is used, regulators across the provinces and territories and, in some instances, within provinces (ie, Ontario) make different recommendations for a fallow period, either 99.0% or 99.9% removal prior to re-entering the operatory. Quebec is the only province that has recommended 90.0%.

Among those who have provided guidance regarding a fallow period, recommendations follow the CDC guidance if the ACH information about the dental operatory is known.1 However, if it is unknown, the guidance varies from 15 to 180 minutes. Saskatchewan is the only province that has suggested the fallow period of 15 minutes irrespective of the air exchanges in an operatory. As per the CDC table on airborne contaminant removal times, 15 minutes corresponds to 18 ACH removing 99.9% contaminant, 19 ACH removing 100% contaminant, and 180 minutes does not correspond to any ACH or contaminant removal level.

Two jurisdictions (Saskatchewan and Northwest Territories) appear to recommend the fallow period based on the risk associated with AGPs. Both jurisdictions categorise procedures into low, moderate, or high risk, where low-risk procedures are described as non-AGP procedures, and moderate- and high-risk procedures are defined as AGPs performed with and without the use of a rubber dam, respectively. Despite the similar classification, recommendations for fallow periods according to risk vary between the two. Saskatchewan recommends a 15-minute fallow period for high-risk procedures, whereas Northwest Territories recommends observing fallow periods of 15 minutes for moderate and 120 minutes for high-risk procedures. Another (dental regulator in Ontario) recommends the fallow period based on the COVID-19 status of the patient.

**Discussion**

There is variation across Canadian jurisdictions in the range of fallow periods recommended, and whether they are recommended at all. The range of 15 to 180 minutes is substantially large and does not need a statistical test to show that they are significantly different. The origin (from the CDC table) of a fallow period of 15 minutes is understandable, although having such a high number of ACH (18 or 19) is potentially not feasible for many dental offices, especially those existing in old buildings. That said, how organisations came up with 180 minutes is not clear because it does not correspond to any number of ACH or percentage contaminant removal in the CDC table. Doing backwards calculations based on the formula (provided in Table 1), there can be two potential options to arrive at 180 minutes: 99.0% contaminant removal using 1.5 ACH, or 99.9% removal using 2.3 ACH; however, as ventilation systems are designed using whole numbers of ACH, accomplishing such fractional levels of ACH is not feasible. Another important aspect is the optimal level of contaminant removal efficiency; should it be 99.0% or 99.9%? Interestingly, Quebec has recommended 90.0%, the basis of which is again not clear. One may question the rationale of setting this efficiency level; is the 90.0% level of clearance sufficient to reduce the risk of infection transmission compared to 99.9%, or are these levels just arbitrarily picked based on convenience or risk assumptions? Maybe that is the reason that some of the jurisdictions (New Brunswick, Newfoundland and Labrador, and Yukon Territory) have not selected one number over another.

Variations in observance of fallow periods across Canadian jurisdictions is consistent with the findings of the rapid review of international jurisdictions’ guidance on mitigating AGPs in dental offices and as observed across the United Kingdom.14 In the context of Canada, this variation is concerning for two reasons. First, although inconsistency and variable approaches to making decisions might be expected
where there is little evidence to inform policy, from a patient perspective, such variation is arguably untenable and raises questions of safety. Further, at minimum, dental regulators in Canada might benefit from stating what factors were or ought to be considered when arriving at specific guidance (eg, local COVID-19 case numbers, level of community transmission, patient COVID-19 status, etc.).

In general, it appears that some Canadian regulators have developed their guidance in the context of the precautionary principle; however, this principle has been criticised as being both vague and arbitrary to form a basis for rational decision-making. In the professions of dentistry and dental hygiene, with limited evidence in many areas, it unfortunately becomes difficult to fully rationalise precautions, especially given the potential unintended consequences. For example, the variation in fallow period recommendation is one of these precautions that has important implications in terms of policy consistency, access to care, dental practice operations, economic sustainability, evidence-informed practice and, most importantly, safety.

From a policy perspective, again, it seems reasonable to have consistency across and within jurisdictions in such important matters. In Canada, a certified dentist or dental hygienist can practice in any province and is free to practice in more than one province as long as they are registered with each respective provincial or territorial regulator. Thus, following different guidance can be unnecessarily confusing for practitioners. Within one province, having consistency across professions is also important. For example, in Ontario, active

### Table 2 - Overview of fallow period guidance across Canadian dental and dental hygiene regulators.

| Jurisdiction (from west to east) | Profession | Fallow period guidance | If ACH is unknown | If ACH is known | Stated/suggested efficiency |
|----------------------------------|------------|------------------------|-------------------|----------------|-----------------------------|
| British Columbia (BC)            | DDS/DH¹    | No                     | —                 | —              | —                           |
| Alberta (AB)                     | DDS/DH¹    | No                     | —                 | —              | —                           |
| Saskatchewan (SK)                | DDS        | Yes                    | 15 min for high-risk AGP only | 15 min for high-risk AGP only | n/s                          |
|                                  | DH         | Yes                    | Assume 120 min air clearance time, but only require 15 min for high-risk AGP | Assume 120 min air clearance time, but only require 15 min or lower if ACH is known for high-risk AGP | n/s                          |
| Manitoba (MB)                    | DDS        | No                     | —                 | —              | —                           |
|                                  | DH         | No                     | —                 | —              | —                           |
| Ontario (ON)                     | DDS        | Yes                    | 15-30 min (COVID-19 negative) 3 h (COVID-19 positive) 15-30 min | n/s (COVID-19 negative) Follow CDC table (COVID-19 positive) 15-30 min | 99.9%                        |
| Quebec (QC)                      | DDS/DH¹    | Yes                    | n/s               | n/s            | 90.0%                       |
| New Brunswick (NB)               | DDS        | Refer                  | n/s               | n/s            | 99.0% or 99.9%              |
|                                  | DH         | Refer                  | n/s               | n/s            | n/s                         |
| Nova Scotia (NS)                  | DDS        | No                     | —                 | —              | —                           |
|                                  | DH         | No                     | —                 | —              | —                           |
| Prince Edward Island (PE)        | DDS/DH¹    | Yes                    | n/s               | Follow CDC table | n/s                          |
| Newfoundland & Labrador (NL)     | DDS        | Refer                  | n/s               | n/s            | 99.0% or 99.9%              |
| Yukon Territories (YT)           | DDS/DH¹    | Yes                    | <10 min or up to 3 h | <10 min or up to 3 h | n/s                          |
| Northwest Territories (NT)       | DDS/DH¹    | Yes                    | 15 min for moderate-risk AGP 120 min for high-risk AGP | Follow CDC table | 99.9%                        |
| Nunavut (NU)                     | DDS/DH¹    | Yes                    | 3 h (assume ACH rate of 2) | Follow CDC table | 99.9%                        |

ACH = air changes per hour; AGP = aerosol generating procedure; CDC = Centers for Disease Control and Prevention; COVID-19 = coronavirus disease 2019; DDS = dentists; DH = Dental hygienist; n/s = not stated.

¹ The same guidance document is referenced for both professions.
discussion among practitioners and associations suggest that the difference in guidance between dental and dental hygiene regulators has negatively impacted dental offices in general. Dentists and dental hygienists working within the same office are following different guidance, creating confusion and tension about what comprises safe patient care and a safe workplace. This can lead to unnecessary disharmony among coworkers and, in turn, can affect patient care, which should be of prime importance.49

From the perspective of access to care, the implications of fallow periods ranging from 15 to 180 minutes are substantial. In a typical working day of 8 hours, if 3 hours of fallow period is advised, no more than 2 patients can be treated in an operatory in a day. Even in dental offices that have multiple operatories, the ones that have walls from floor to ceiling can be limited.40 In a number of jurisdictions, AGPs are advised to be conducted in closed rooms and, because most procedures are aerosol generating, implementing a 3-hour fallow period will negatively impact access to dental care. In short, the number of patients that can be treated in any given day is severely limited and results in significant wait times for an appointment.

Another operational issue concerns the implications of fallow periods for the economic sustainability of dental practices in Canada, where almost all oral health professionals work in the private sector.41 Working at lower production levels but incurring more costs because of increased administrative tasks and the need for more personal protective equipment and engineering controls (ventilation upgrades or closing operatories) challenges the economic viability of dental care delivery. As a ripple effect, one might also expect oral health professionals to have higher stress levels and poorer mental health, which may result in a lower quality of patient care.42

Understandably, there has been an ongoing push from oral health professionals in Canada to review the requirements of fallow periods. Meanwhile, based on the existing literature, they are using different measures such as large extractor fans, high efficiency particulate air (HEPA) filters, or ultraviolet germicidal irradiation along with high-volume suction and rubber dams to reduce the waiting period between patients.4 It is important to understand that even after making these efforts, the relative effectiveness of each of these measures remains unclear. This demands the generation of new contextual scientific evidence while assimilating existing science and taking preventive measures into consideration to develop more rigorous guidance.

It is also worth mentioning that the NIOSH model being commonly used as a basis for recommending fallow periods is dated and has limitations. Specifically, no data are available from dental settings; the relevance of the droplets generated in dentistry in terms of the potential for infection transmission and, thus, the extent to which they can be considered airborne contaminants; assumptions of perfect mixing of the air within a space, whereas perfect mixing usually does not occur and removal times will be actually longer in rooms with imperfect mixing or air stagnation; and ACH values assumed to apply to an empty room, which are not necessarily valid if a person or equipment are present.4 To add another level of complexity, the transmission of SARS-CoV-2 is still a focus of intense debate among experts in virology, infectious disease, aerosol science, and epidemiology. Unanswered questions include: What do we know about transmission via speech and exhaled breath? How long do infectious particles linger in the air? How far can they travel? Indeed, the National Academies of Science, Engineering, and Medicine, among other agencies, have provided a forum for dialogue on such questions.43 These and other unknowns substantiate the need to conduct experiments specifically in actual dental settings (not in controlled environments) to arrive at a more realistic understanding about aerosols, their potential for infection transmission, and what is required in terms of air exchanges and fallow periods. This will perhaps facilitate more consistent understanding of the relevant issues among oral health professionals and their institutions and, most importantly, help keep Canadians safe, regardless of the jurisdiction where care is being received.

Conclusion

The evidence for deciding on optimal fallow period after performing AGPs is limited and still being explored, resulting in substantial variation across Canadian jurisdictions. A focus on developing scientific evidence and assimilating existing science (ie, current Canadian standards for ACH rates in dental office settings) can be helpful in establishing consistency and uniformity in information. This approach can support in harmonising safe oral healthcare delivery for all Canadians.

Conflict of interest

None disclosed.

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