

FOCUS ON

Risk Assessment Approach for COVID-19 Contact Tracing



April, 2021 (Version 2)

Introduction

This document is a resource companion to the [Management of Cases and Contacts of COVID-19 in Ontario](#)¹ in terms of decision-making on whether contacts are “high” or “low” risk of exposure to a case. The purpose of this document is to support Public Health Unit (PHU) staff involved in case investigation with an understanding of background information on assessment of factors that support risk determination.

Summary of Updates

This document was updated from the original September 2020 version to include:

- Updated evidence on risks associated with case/contact interactions;
- Evidence on currently circulating variants of concern (VOCs) and their potential impacts on the risks of transmission;
- Evidence of effectiveness of vaccines and natural immunity, and consideration of vaccination status and prior infection with COVID-19 on the risk assessment for contacts; and

- Updated case scenarios to reflect new considerations in risk assessment of contacts.

Background

Risk assessment of case/contact interactions requires integration of the factors outlined in this document based on the information received from the case (and contact, as applicable), and the judgment of the case investigator. There are some factors or combinations of factors that may receive more weight in terms of decreasing the risk for contacts, but all factors need to be considered together.

There are factors, such as hand hygiene for the case and contact and environmental cleaning, which are important for prevention of infection. However, the extent to which they can be assessed or how much they contribute to the risk assessment of a specific case/contact interaction is uncertain and therefore these are not addressed in this document.

Additionally, there are also factors that may not alter the risk of having been exposed to an infectious case, but impact the risk of the exposed contact becoming a case themselves (i.e., vaccination and prior infection). Consideration of these factors may be important for prioritizing contact follow-up and recommendations for contacts.

It is recognized that risk assessment decisions can be challenging, and each scenario is unique and each investigator may not come to the same conclusion regarding risk of an exposure. This document aims to provide background information on an evidence-informed approach for new investigators learning to apply the risk assessment process.

Methods

Expert consensus among the communicable diseases, infection prevention and control and environmental and occupational health staff at PHO, supplemented with literature searches, was used to develop the framework of relevant factors to assess as part of the risk assessment, as well as develop example scenarios for applying the risk assessment framework.

Existing knowledge products from PHO and evidence summaries from the World Health Organization and Public Health Agency of Canada were used for supporting literature on the risk of each factor.

Results

Approach to Risk Assessment

Once contacts are identified, contacts need to be categorized into two groups based on the [Management of Cases and Contacts of COVID-19 in Ontario](#).¹

- Contacts with high risk of exposure who require [self-isolation](#)² (quarantine).
- Identifiable individuals/groups of contacts with low risk of exposure who require notification of their exposure for [self-monitoring](#).³

Additionally, [supplemental interim guidance](#)⁴ to the [Management of Cases and Contacts of COVID-19 in Ontario](#)¹ must be followed.

Exposures are only considered to have occurred if the contact was with the case during the case's period of communicability which is generally defined as two days (48 hours) before the onset of the case's symptoms (or two days before date of test for those without symptoms) and until the case is cleared from isolation. See [Management of Cases and Contacts of COVID-19 in Ontario](#)¹ for guidance on period of communicability and the [Quick Reference Guidance on Testing and Clearance](#)⁵ for guidance on clearance from isolation.

Self-isolation of contacts with high risk of exposure is an essential part of case and contact management, as individuals can transmit SARS-CoV-2 before they develop symptoms of COVID-19. However, self-isolating for 14 days from last exposure can have significant impacts on someone's life, so it should only be applied to those at high risk of exposure to a case, and at high risk of becoming a case given the exposure.

When assessing the risk of exposure to an infectious case, consider the factors that were in place that lower the risk of exposure (e.g., physical barriers separating the case and contact), as well as measures where the effectiveness may vary by individual compliance (e.g., hand hygiene, correct use of personal protective equipment (PPE)).

PPE can be an important and effective factor, but is highly user dependent.

PPE may be confused with source control and its role in preventing transmission (i.e., the primary mechanism by which masking reduces transmission risk is through the proper use of a mask by the case for source control)

Factors that exist on a continuum (e.g., cumulative duration of exposure) can be more challenging to assess compared to more dichotomous factors (e.g., indoors vs outdoors). Although it is intuitive that the longer the exposure the greater the risk, there is limited evidence to support a minimum duration of exposure under which the risk is negligible.

The application of "cut-off" values for factors that exist on a continuum can help to prioritize contact follow-up for those above the "cut-off" value for the risk factor. For example, "a cumulative duration of 15 minutes" has been used by the Public Health Agency of Canada and others as an example of a time cut-off for the duration of exposure, although there is no specific evidence to support this as a cut-off value.

The three VOCs that have been identified in Ontario have all demonstrated increased transmissibility compared to Wild-Type SARS-CoV-2. The most common VOC in Ontario (B.1.1.7) has approximately 40-50% higher transmission than for non-VOCs.⁶ There is no fundamental change in the modes of transmission for VOCs compared to non-VOCs; however, all interactions should be considered higher risk for contacts, and a lower threshold should be applied to consider a contact at high risk of exposure to a case.

Vaccination and immune response from prior infection change the risk of the contact becoming a case after exposure to an infectious case. While neither vaccination nor recent prior infection completely eliminates the risk of becoming a case after exposure, there is increasing evidence on the effectiveness of available vaccines and the duration of protection from prior immunity. However, there is also emerging evidence on the ability of some VOCs (i.e., B.1.351 and P.1) and other strains with mutations of interest to evade natural and/or vaccine-induced immunity, although the degree to which this occurs is still being elucidated. Exposure to a VOC with escape potential should be considered as part of the

overall risk assessment of the exposed contact becoming a case and transmitting to others if not in quarantine.

There is generally no one specific factor that makes an exposure “high risk” versus “low risk”; the overall exposure scenario needs to be considered to identify the factors present and to assess how each factor and the combination of factors are likely to increase and decrease the risk in each unique situation. How these factors are assessed and integrated will also be influenced by how the information is provided by the case and contact, the risk perceptions and tolerance of the case investigator and the weight they give to the various factors. Updated evidence on the risks associated with specific factors is detailed in the following section.

Information on Elements of the Risk Assessment

CASE

Symptoms of Case at the Time of Interaction

- Respiratory symptoms (coughing and sneezing) increase the risk of respiratory droplet and aerosol spread through the increased production and speed at which respiratory droplets and aerosols are expelled compared to talking.⁷ Respiratory symptoms also increase the risk of contamination of the surrounding environment, increasing the potential risk of spread through virus on surfaces and on the hands of the case.
- Case viral load is highest around the time of symptom onset (any symptoms) and the 1-2 days prior to symptom onset.⁸ Highest risk of transmission occurs very early in the course; 1-2 days before and within the first 5 days from symptom onset.^{9,10}
- Asymptomatic and pre-symptomatic cases have been associated with transmission, likely through talking and/or breathing. Evidence suggests that although they can still be infectious, those who never develop symptoms (always asymptomatic) are less likely to transmit SARS-CoV-2 compared to those who eventually develop symptoms (pre-symptomatic).¹⁰ However, at the time of case follow-up, determination as an asymptomatic or pre-symptomatic case may not be available.

Activities That Increase Risk of Transmission

Singing, yelling and loud talking may generate more respiratory droplets and aerosols and propel droplets further than normal speaking, thereby increasing the risk for others in the vicinity of the case. The absolute distance to which propelled droplets and aerosols may extend from these types of activities will depend on the environment and ventilation of the space.¹¹

Face Coverings for Source Control at Time of Interaction

- Use of a snug-fitting medical (e.g., surgical, procedural) or 2 or 3-layer non-medical mask that covers the nose and mouth as a form of source control may limit the spread of respiratory droplets and aerosols from the case to the contact and into the environment, reducing the risk of transmission.¹²

- Consistent and appropriate use of the mask during the interaction(s) with the contact should be assessed (e.g., was the case wearing their mask over their mouth and nose at all times when with the contact).
- Non-medical masks should be at least two layers and fit snugly to the face.¹³
- Masks with an exhalation valve, single layer fabrics and designs that do not fit tightly around the nose and mouth (e.g. scarves and neck gaitors) do not provide source control.¹⁴
- It is possible that a medical (e.g., surgical/procedure) mask or fit-tested N95 respirator offers improved source control compared to non-medical masks if they fit better and/or have more ability to block droplets and aerosols. Assessment of quality of medical masks (e.g., surgical/procedure masks) or N95 respirators used in the community (non-health care setting) can be difficult to assess through case interview.
- In theory, a face shield alone or in addition to a mask may provide some source control, although no evidence is available to support this and this should not factor into the overall risk assessment from the case.¹⁵

NATURE OF INTERACTION

Distance From Contact

- Maintenance of physical distancing measures (>2 metres) for the entire duration of exposure decreases the risk of transmission.
- Some limited evidence suggests physical distancing between 1-2 metres may also reduce risk of transmission.¹⁶
- Physical distancing of 2 metres does not eliminate the risk of transmission particularly during indoor activities, such as heavy breathing during exercising or if the case was talking loudly, yelling, or singing.^{7,17}
- Maintaining physical distancing (2 metre distance) may be insufficient if the case and contact are within a confined, indoor space for prolonged periods of time without other prevention measures.¹⁸

Barriers Between the Case and Contact

- Barriers, such as plexiglass or plastic sheet barriers, between the case and contact can reduce the risk of transmission by blocking respiratory droplets.¹⁹
- The more complete the barrier (i.e., no openings) and the taller and wider the barrier, the more protection it is likely to offer.

Indoor/Outdoor Environment

- Outdoor environments are lower risk than indoor environments due to plentiful supply of outdoor air resulting in dispersion and dilution of droplets and aerosols, the presence of natural ultraviolet light, and ability to physically distance.^{18,20}

- Smaller, confined indoor environments with inadequate ventilation increase the risk of transmission, compared to larger spaces with adequate ventilation, up to 18.7 times in one preprint estimate.^{21,22} The amount of fresh (outdoor) air intake into the indoor space (e.g., having a window open) and a properly functioning ventilation system will reduce the risk of transmission.²³

Duration of Interaction, Repeated and Cumulative Interactions

- There is insufficient evidence^{1,14} to quantify the risk associated with increasing amounts of time spent at <2 metres distance. Prolonged interactions will increase the risk of exposure compared with transient or brief encounters (few seconds to few minutes). Repeated and cumulative interactions, such as several brief interactions can increase the risk of exposure.²⁴
- A meta-analysis identified transmission rates among household contacts (several hours/ongoing close contact exposure) as 21.1% (95 confidence interval (CI):17.4%-24.8%); from social gatherings with family and friends (e.g. sharing a meal) as 5.9% (95%CI: 3.8%-8.1%), and as 1.2% (95%CI: 0.3%-2.1%) from casual close contacts (i.e., seconds to minutes of contact).²⁵

Physical Interaction (E.g., hug, shaking hands)

- Close physical interactions and physical touching increase the risk the contact is exposed to respiratory droplets from the case.²⁶ Passing of objects between the case and contact may pose a risk to the contact if the case contaminated the object and may also indicate inadequate physical distancing (<2 metres) during the interaction. Few case reports have described transmission of SARS-CoV-2 through contaminated surfaces or objects.
- Wearing a mask for source control will provide less protection in the context of direct or prolonged physical interaction due to viral contamination of the exterior of the mask and hands of the source case.²⁷
- SARS-CoV-2 has been found in semen and feces, and it is not clear yet whether it can be transmitted through sexual activity. Guidance on risk reducing measures to take during sexual activity is available.^{28,29} Consider application of measures that reduce the risk of spread from person-to-person via physical contact and respiratory droplets during sexual encounters.^{28,29}

Superspreading Events

- Some outbreaks can be associated with very high attack rates, likely due to multiple factors. These “superspreading” events reflect the overdispersion observed with COVID-19, whereby a small proportion of people are responsible for a very large proportion of transmission. For SARS-CoV-2, it is estimated that 10% of cases are responsible for about 80% of transmission.³⁰
- For instance, a report of an outbreak in a crowded office setting (call centre) found a 43.5% attack rate amongst those in the same area.³¹⁻³⁵

CONTACT

Use Of Masks, Including the Contact’s Personal Protective Equipment

- PPE (medical mask and eye protection) to cover the mucous membranes of the face (mouth, nose and eyes) will limit droplets landing on the contact’s mucous membranes and may also

limit the inhalation of respiratory droplets and aerosols. PPE has been shown to be effective in protecting workers in health care settings.^{36,37} There is less evidence on the effectiveness of PPE used in the wide range of non-health care community settings where PPE may now be recommended for use.³⁷ The only randomized controlled trial to evaluate wearing a medical mask in the community to prevent COVID-19 could not demonstrate a 50% reduction in risk. A smaller effect size could not be excluded from this trial which estimated a non-statistically significant protective effect of approximately 20%.³⁸

- PPE needs to be worn appropriately and consistently to provide protection from an infectious case. Training of the wearer increases the likelihood of appropriate use. Inappropriate removal of PPE contaminated by the case on the outer surface may result in contaminating oneself when touching PPE for removal. The wearer needs to perform hand hygiene after PPE removal to reduce the risk of self-contamination after removing PPE.
- Use of eye protection (goggles or face shield) in addition to a face mask decreases the risk of acquisition from respiratory viruses, including SARS-CoV-2.
- Medical (e.g., surgical, procedural) masks typically have more consistent construction, and many have fluid resistant outer layers to prevent exposures from droplets.²³ For this reason non-medical masks are generally not considered PPE as they do not have the same performance characteristics.
- Consistent and appropriate use of a medical mask and eye protection by the contact lowers the risk of exposure.
- Non-medical masks are worn for source control. The extent to which non-medical masks protect the wearer is likely small, and influenced by construction, fit, and appropriate use and handling, including while removing the mask.
- The benefit of using a face shield alone by the contact is unknown and expected to be lower than wearing it with a medical mask as the face shield is open on the sides and bottom leaving room for exposure to respiratory droplets or aerosols.
- Use of a face shield in addition to a non-medical mask potentially reduces the risk of exposure to the wearer by blocking respiratory droplets, preventing contamination of the surface of the mask and preventing the wearer from touching the mask and their face.
- Combination use of a case wearing source control and the contact wearing a mask and eye protection as PPE further lowers the risk of exposure.

FACTORS THAT LOWER THE RISK OF AN EXPOSED CONTACT BECOMING A CASE

VACCINATION

- For currently authorized vaccines in Canada and information on their indications, use, efficacy and safety, please refer to the National Advisory Committee on Immunization (NACI) [Recommendations on the use of COVID-19 vaccines](#).³⁹
- After assessment of risk of exposure of a contact to a case, the subsequent risk of becoming a case may also be modified by the contact's COVID-19 vaccination status. A lower risk of

becoming a case after exposure and subsequently transmitting to others impacts the need for post-exposure quarantine and testing.

- Therefore, several considerations may factor into the management decision-making of an exposed contact including:
 - Time from vaccination to exposure. COVID-19 vaccines require a minimum of 14 days to provide substantial protection, with more protection after longer time intervals.⁴⁰ A complete series is more effective than an incomplete vaccine series.
 - Other factors that may reduce their individual vaccine effectiveness, such as immune compromised state of the contact.
 - Whether the exposure was to a case infected with a known variant of concern with potential for lower vaccine effectiveness (e.g., B.1.351 or P.1).

Vaccine Efficacy/Effectiveness by Timing from Initial Dose

- Protection from current COVID-19 vaccines does not start until 14 days after the first dose of the vaccine series. Clinical trial data evaluated vaccine efficacy based on 7-14 days from the second dose. Higher levels of protection from a partial vaccine series has been observed after longer intervals after first dose.
- Data from individuals in Israel receiving the Pfizer vaccine indicate that vaccine effectiveness (VE) for preventing asymptomatic infection 14 to 20 days after the first dose, 21 to 27 days after the first dose, and more than 7 days after the second dose is 29%, 52% and 90%, respectively.⁴¹
- Among long-term care (LTC) residents, Canadian data from Ontario, British Columbia and Quebec demonstrate a VE of 80% for preventing SARS-CoV-2 infections 2-3 weeks following a single dose of either Pfizer or Moderna vaccine.⁴²⁻⁴⁴
 - In Ontario, there was an estimated 89% relative reduction in SARS-CoV-2 incidence for LTC residents eight weeks after the start of vaccination at which point 92% of residents had received one dose and 67% of residents had received their second dose.⁴⁴
- Among healthcare workers (HCW) in Israel, England, US and Canada, there was a 72-80% reduction in COVID-19 infections and symptomatic disease two to three weeks after receiving a single dose of Pfizer or Moderna vaccine.⁴²⁻⁴⁹
- With a single dose of Viral Vector Vaccine:
 - Janssen reported VE against laboratory-confirmed moderate to severe/critical COVID-19 in individuals was 66.9% (95% CI: 59.03; 73.40) as of 14 days after vaccination (one-dose series) and 66.1% (95% CI: 55.01; 74.80) as of 28 days after vaccination.⁵⁰ VE against asymptomatic infection was not provided.
 - Astra Zeneca reported VE against symptomatic laboratory-confirmed infection was 76.0% (95%CI: 59.3;85.9) between day 22 and day 90 after a single dose.⁵¹

Infectiousness in Breakthrough Cases

- Limited evidence is available on the infectiousness of breakthrough cases following vaccination (generally defined as >7 days after second dose in a two dose series or >14 days after a one dose series).
- In an observational study in Israel, infections occurring 12-37 days after receiving the first dose of Pfizer vaccine had significantly reduced viral loads at the time of testing, indicating potential effects on viral shedding and contagiousness.⁵²
- A study of health care workers in Scotland found their household members had a 30% lower risk of infection when the health care worker was vaccinated with one dose, and a 54% lower risk when the health care worker had two doses.⁵³

Individual Level Factors that May Reduce Immune Response to Vaccine

- Individual level immune response to vaccination may vary due to underlying health conditions. Despite overall estimates of vaccine effectiveness in the population, a specific individual may have a lower level of protection.
 - Community dwelling older adults (60 years and older) had similar estimates of vaccine effectiveness to the general population.
 - Fully vaccinated populations who have underlying immunocompromising conditions (e.g., organ transplantation, cancer treatment), may have diminished immune responses and subsequently lower level of protection provided by COVID-19 vaccines.⁵⁴⁻⁵⁶ However, data on which immunocompromising conditions or other conditions that might affect response to the COVID-19 vaccine and the magnitude of risk are not fully elucidated.

Vaccine Effectiveness Against Variants of Concern

- Some variants of SARS-CoV-2 may have sufficient mutations that enable the variant to evade immunity induced by vaccination. Therefore, estimated vaccine effectiveness that were derived for circulating strains at the time, may not be equally valid for new variants.
 - One Israeli study concluded that the reported VE reflects an average effectiveness for multiple VOCs, including B.1.1.7, which became increasingly prevalent (up to 80%) over the study period.⁴¹
 - Two studies (one in older adults vaccinated with Pfizer and Astra Zeneca and one in health care workers vaccinated with Pfizer) from the UK demonstrated high levels of protection against B.1.1.7, the dominant lineage circulating at the time of these studies.^{47,57}
- VE might be compromised against variants with the N501Y and E484K mutations (e.g., B.1.351), but there are very few real-world vaccine efficacy/effectiveness studies against non-B.1.1.7 variants.⁵⁸
- One study with a small sample size observed that a two-dose regimen of the AstraZeneca vaccine did not show significant protection against mild-to-moderate COVID-19 due to the B.1.351 variant in South Africa.⁵⁹

IMMUNITY FOLLOWING PREVIOUS INFECTION

- Individuals that developed an immune response to their SARS-CoV-2 infection are at reduced risk of reinfection in the six months (approximately) following infection.⁶⁰
- One study observed an 89% reduced risk of infection in seropositive, compared to seronegative, healthcare workers over 6 months.⁶¹
- In a large study in Denmark, 80% or more of a naturally infected population (<65 years) in spring 2020 were protected against reinfections in fall 2020. However, individuals aged 65 years and older had less than 50% protection against repeat SARS-CoV-2 infections during the same period.⁶²
- Those with an initial asymptomatic infection appear to have a less robust immune response compared to those with symptomatic infection.⁶⁰
- Some VOCs may also increase susceptibility to reinfection despite prior infection.
 - The E484K mutation (common to the B.1.351 and P.1 VOCs) has resulted in cases of demonstrated reinfection, and models demonstrate potential immune escape.⁶³⁻⁶⁶
 - Current evidence suggests B.1.1.7 is unlikely to be associated with a higher risk of reinfection.⁶

VARIANTS OF CONCERN (VOC)

- All identified VOCs (B.1.1.7, B.1.351, P.1) appear to have higher transmissibility than non-VOCs. The magnitude of the increase in transmissibility varies and the biological mechanism behind the increased transmissibility has not been clearly determined yet.^{6,64,65}
- Based on the increased transmissibility, a lower threshold should be applied for considering a contact at increased risk of exposure to a case infected with a VOC.

Sample Scenarios Applying Risk Assessment

Scenario 1

A 40 year old man had onset of symptoms of sore throat and headache, and tested positive for SARS-CoV-2 the next day, and subsequent variant mutation testing found N501Y detected, E484K not detected (interpretation, likely to represent B.1.1.7). The individual went to a high intensity fitness class for 45 minutes in a gym, two days before the onset of symptoms. The class participants maintained distancing (>2 m apart) and the COVID-19 operational plan of the gym was well adhered to by staff and participants, including non-medical masking by all participants except for when they were in their 2 m by 2 m space during the class.

Assessment of Scenario 1

While there was physical distancing, masking and reasonable protocols in the gym, all class participants and the instructor could be considered at high risk of exposure since this involved high intensity activity (heavy breathing), indoors, and for a prolonged time. Even if the case did not have a variant mutation identified, this risk of exposure for the class participants and instructor could still be considered high.

If a participant/instructor contact was fully immunized, the necessity for quarantine based on this exposure is likely low, given the discrete exposure event, measures in place to reduce risk of exposure, and their expected robust immune response given the exposure setting (i.e., community dwelling adults).

Scenario 2

A 70 year old female case with onset of symptoms three days before the positive specimen collection. A 80 year old neighbour stopped by the case's driveway outdoors for a chat for approximately 10 minutes, one day before symptom onset in the case. The case and contact were more than 2 metres apart, but neither were masked. The contact had their first dose of a two-dose vaccine series three weeks before the exposure.

Assessment of Scenario 2

The maintenance of physical distancing in an outdoor environment for the duration of the contact would generally be considered a low risk of exposure for the contact. However, if there was uncertainty about the maintenance of distancing, or a longer duration of exposure, it may be reasonable to consider as a high risk of exposure particularly as the case did not have source control masking and was presymptomatic and the contact was not masked.

Scenario 3

A 25 year old female case was working as a server for an outdoor patio bar/restaurant in the two days before she tested positive asymptotically as a close contact of her roommate who developed symptoms the day before. She wore a non-medical mask and face shield for the duration of her shift. There were approximately 60 patrons over her two shifts in the outdoor patio, which was covered by a canopy on three sides. The restaurant did not have records of which tables she served. There were 5 other staff she overlapped with on her shifts and talked to in between serving and on breaks indoors in the restaurant. Her variant mutation testing came back as N501Y detected and E484K detected (likely representing either B.1.351 or P.1).

Assessment of Scenario 3

Use of mask and face shield by the case provides some source control for limiting exposure to contacts. However, patrons were unmasked and had repeated short interactions with the case at <2 metres distance over their meal. The outdoor environment would lower risk of exposure. Additionally, she likely only had contact with less than half the patrons in attendance as 1-2 other servers were working over her shifts. The patrons could be considered low risk of exposure given the case was asymptomatic and wore source control as well as the overall short duration of interactions (cumulative <10 minutes for most patrons) in an outdoor environment. However, some patrons could also be considered at high risk of exposure given the close contact, no masking of the contacts, and that the server reported having longer chats (cumulative >15 minutes) with some tables. Without additional information on which tables were served, all patrons would have to be advised of their potential exposure, and managed the same way.

The five co-workers would be considered at higher risk of exposure given the duration of shift(s), the indoor interactions, and interactions during breaks when PPE may be removed for eating/drinking.

Results of the variant mutation testing may not be available at the time when decision-making on contacts is required. However, in this situation, subsequent information on mutations detected may

prompt more stringent contact measures given increased transmissibility and potential for lower vaccine effectiveness (if any of the contacts were vaccinated).

Limitations

Evidence on risk reduction or increase associated with each factor is still emerging and there is insufficient evidence at this time to provide a weighting to each one or combinations of factors.

Conclusion

An approach to risk assessment framework should be applied to systematically assess the relevant case, contact and nature of interaction factors to determine the overall risk of an exposure.

While some factors may more definitively decrease or increase the risk of exposure, there is limited information to guide the relative contributions of combinations of factors on the overall risk of an exposure.

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