Key Messages

- Omicron is rapidly displacing Delta (B.1.617.2, first identified in India) as the dominant variant of concern (VOC) in several jurisdictions (e.g., the United Kingdom [UK]). In Ontario, it is expected that most cases (>80%) infected on December 13, 2021 are likely to be Omicron.

- There is strong evidence that Omicron is much more transmissible than Delta (e.g., higher secondary household attack rate and community transmission). It is estimated that each Omicron case is infecting 7.7 times more individuals than Delta in Ontario.

- More in vitro and modelling studies are reporting significantly reduced ability of convalescent and vaccine-induced plasma to neutralize Omicron. This is supported by a growing number of reports of increased risk of reinfections and breakthrough infections (two-dose mRNA or viral vector vaccines) with Omicron. Evidence is still emerging on the risk of breakthrough infections after an mRNA booster.

- Disease severity is not well-understood for populations comparable to Ontario. While early evidence from South Africa suggests Omicron may cause less severe disease in adults, data from South Africa is not generalizable to the Ontario context due to differences in previous infection and vaccination status, as well as age distribution of the population. Even if Omicron does cause less severe disease in adults, the number of cases caused by increased transmissibility is sufficient to overwhelm health systems.

- The current risk of increased Omicron transmission in Ontario is high, with a moderate degree of uncertainty. The risk of reinfection and breakthrough infection in Ontario is high with a moderate degree of uncertainty, while the risk of increased disease severity is moderate with a high degree of uncertainty. The overall risk assessment may change as new evidence emerges.

- Based on what is known so far about Omicron globally and its rapid growth in Ontario with the potential for exponential case growth, swift implementation of community-based public health measures accompanied by accelerated vaccination efforts (e.g., third doses) is needed to protect Ontarians, health system capacity (including public health capacity), and limit the impact to key societal functions such as in-person learning.
Issue and Research Question

Since its identification on November 8, 2021 in South Africa, Omicron is rapidly becoming the dominant severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) variant in several jurisdictions. Since the last report on December 7, more evidence has emerged of Omicron’s transmissibility and potential immune evasion, and early evidence regarding disease severity. This evidence brief updates the Public Health Ontario (PHO) reports from December 1, 2021 and December 7, 2021, and summarizes available information and evidence on the Omicron VOC relevant to the risk of importation and transmission in Ontario up to December 13, 2021.

Methods

PHO Library Services conducted daily searches of primary and preprint literature using the MEDLINE database (search strategies available upon request). In addition, PHO performed grey literature searches daily using various news feeds and custom search engines. English-language peer-reviewed and non-peer-reviewed (preprint) records that described COVID-19 variants were included.

Epidemiology

- In Canada, 87 confirmed Omicron cases had been reported in seven jurisdictions (Yukon, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario and Quebec) as of December 9, 2021.

- The Ontario 7-day average COVID-19 incidence surged 41% from December 6, 2021 to December 13, 2021. By whole genome sequencing (WGS, ~1-2 weeks turnaround time), as of December 12, 2021, 80 confirmed cases of Omicron had been detected in Ontario. Ontario’s SARS-CoV-2 reproduction number was below 1.1 for much of fall 2021; however, it has increased from 1.12 on December 1, 2021 to 1.26 on December 13, 2021. The data reflect all SARS-CoV-2 cases (including Delta and Omicron), and parts of the province where Delta is still dominant.

- S-gene target failure (SGTF) is a genetic marker seen in the Omicron variant that can be used as a sensitive variant screening method for identifying the Omicron SARS-CoV-2 lineage. In Ontario, based on SGTF, the modelled proportion of samples screening positive for Omicron increased from <1% prior to November 28th, to 33% of specimens collected on December 9th, 2021.

- It is noteworthy that a lineage of Omicron (BA.2) without the Δ69/70 (S-gene drop out) has been reported in Queensland, Australia. This lineage would therefore not be identified using SGTF as a proxy for Omicron. In Queensland, BA.2 accounts for approximately 70% of the Omicron cases there.

- The number of countries reporting Omicron cases continues to increase globally. As of December 13, 2021 Omicron cases have been reported in 70 countries from all six World Health Organization (WHO) regions. 6,430 confirmed Omicron cases have been reported by 70 countries around the world as of December 13, 2021. This does not include SGTF with WGS pending, so likely underrepresents Omicron infections.

- In South Africa, Omicron is now the dominant strain and accounted for 78% (493/630) and 100% (n=61) of genomes sequenced in November and December 1 to 10, 2021 respectively. In Gauteng Province, the proportion of pediatric (< 5 years of age) admissions for COVID-19 was observed to be declining from 14% (November 14 to 20, 2021) to 11% (November 21 to 27, 2021) to 8% (November 28 to December 4, 2021).
High community and/or household transmission has been reported by multiple countries, including Canada, the United Kingdom (UK) and the United States (US).13-17

A preliminary analysis of data acquired from the European Surveillance System demonstrated that 121 (70%) of the cases were acquired locally, including 78 (45%) cases sampled as part of local outbreak investigations.18

Transmissibility

Preliminary epidemiological data from South Africa and the UK8,19-23 as well as data from modelling and in-silico analysis, continue to suggest that Omicron is more transmissible than the Delta variant. The UK Health Security Agency assesses that Omicron is at least as transmissible as Delta, with a secondary household attack rate estimate much higher for Omicron than Delta.24 The Public Health Agency of Canada has stated Omicron has the potential to spread faster than Delta.5

In-Silico and Modelling Evidence

Four in silico analyses reported higher binding affinity to human ACE2 (hACE2) receptors by Omicron compared to the Wuhan wild-type or other VOCs.25-28 The hACE2 receptor is used by SARS-CoV-2 to enter host cells; therefore, higher binding affinity would likely lead to increased infectivity and transmission.

Epidemiological Evidence

In England, a logistic growth model using community-based adjusted SGTF counts from non-travellers estimated a growth rate of 0.35 per day as of December 6, 2021, after adjusting for the true positive rate of SGTF for Omicron. The effective reproduction number (Re) (95% confidence interval) was estimated at 3.7 (3.3–4.2) based on generation times of 5.2 days and a coefficient of variation of 2/3. Omicron is projected to be co-dominant with Delta by mid-December at this rate of growth.8

- The adjusted odds ratio (aOR) of household transmission of Omicron vs. Delta is 3.2 (2.0–5.0; P < 0.001). Adjustment was made for age, sex, ethnicity, index of multiple deprivation, type of residence, specimen date, number of household contacts, region and vaccination status of the index case, or prior COVID-19.8

- The aOR of a close contact becoming a case from confirmed Omicron vs Delta index cases is 2.09 (1.54–2.79). Close contacts included household members, face-to-face contacts, people within one meter of the case for ≥1 minute or within two meters for 15 minutes. Enhanced contact tracing may have contributed to higher observed secondary attack rates.8

- In South Africa, on December 2, 2021, the national daily Re was estimated at 2.56 (2.23–2.96), ranging from 1.95 to 3.17 at the provincial level (with Re’s above 2 for 8/9 provinces).19 Using data on the percentage of Omicron out of all genomes sequenced in Gauteng from November 8 to November 28, 2021 to estimate the number of Omicron cases up to December 5, 2021, Grabowski et al. estimated a doubling time of 3.38 days (3.18–3.61) for Omicron.20

- In Oslo, Norway, widespread transmission at a party in a restaurant resulted in at least 17 confirmed Omicron cases among 111 participants, aged 30–50 years, and fully vaccinated between May and November 2021. All participants reported a negative PCR or rapid antigen test result for COVID-19 within 3 days prior to the party, and some reported foreign travel during the two weeks prior to the party.29
Meanwhile, a rapid surge in Omicron cases has been reported in many countries, including England and the US.\textsuperscript{8,16} Denmark reported 1,280 Omicron cases in two weeks after the first case was identified in a sample from November 22, 2021.\textsuperscript{30}

**Disease Severity**

- Severity data has several limitations at the early phase of a wave because numbers are small, mild patients are more likely to be admitted as a precaution, and there has not been sufficient follow-up time for severity and outcomes to have accumulated. Longer follow-up duration is required to more accurately assess the severity of Omicron infection in Ontario.

- Reports of hospitalization of Omicron patients are emerging from several countries (e.g., Iceland, South Africa, Australia, UK and US), including people from 18 to 85 years of age, as well as fully-vaccinated individuals.\textsuperscript{31-34} In addition, the UK has reported the death of a hospitalized Omicron patient.\textsuperscript{33}

- South Africa’s largest private health insurer released data based on 211,000 COVID-19 test results.\textsuperscript{35} It is important to note that in general, epidemiology and severity data from South Africa is not easily generalizable to the Ontario context due to differences in previous infection (i.e., previous infection expected to result in less severe illness) and vaccination status, as well as age distribution of the population.

  - Data indicates that Omicron severity is 29% lower than the D614G (first) wave of COVID-19.
  - Vaccine effectiveness (VE) against hospitalization has decreased from 93% in Delta wave to 70% in Omicron wave.
  - Children have a low test-positivity rate compared to adults, and low number of COVID-19 admissions, but appear to be at 20% greater risk of hospitalisation during the Omicron wave relative to the D614G wave.
  - Data from Gauteng Province, South Africa noted only 31% of hospitalized patients with COVID-19 had severe illness in the early part of the fourth wave (mid-November up to December 4, 2021), compared to 66% in the second wave and 67% in the third wave.\textsuperscript{12} Severity was defined as patients requiring oxygen or invasive ventilation, managed in high-care or intensive care units, developing acute respiratory distress syndrome, or dying.

**Presenting Symptoms**

- Based on 43 Omicron cases in the US as of December 8, 2021, the most commonly reported symptoms were cough, fatigue, congestion or runny nose.\textsuperscript{16}

- Common symptoms reported by the National Health Information System in South Africa were said to be very similar to other VOCs and include fever, myalgia, cough, and shortness of breath in more severe disease.\textsuperscript{36}
Vaccine Effectiveness (VE)

- The UK Health Security Agency reports that early estimates of VE against symptomatic infection indicate a significantly lower effectiveness against Omicron compared to Delta.\(^8\) Two weeks after a Pfizer (mRNA) booster dose, individuals who received two doses AstraZeneca achieved a VE of 71%, and individuals who received two doses of Pfizer before the booster achieved 76% VE. A VE of 70 to 75% is seen soon after a booster dose, which is considered moderate to high.

- Using data based on 211,000 COVID-19 tests, South Africa’s largest private health insurer reported that VE of two-doses Pfizer-BioNTech has decreased from 80% in the Delta wave to 33% in Omicron wave against COVID-19 infection; and has decreased from 93% in Delta wave to 70% in Omicron wave against hospital admissions for COVID-19.\(^{35}\)

Breakthrough Infections

- Breakthrough infections of Omicron have been reported in many countries, including Botswana, Denmark, Hong Kong, Israel, Japan, South Africa, South Korea, UK, Canada, and the US.\(^{16,23,30,33,37-43}\) A case study from South Africa reported mild severity breakthrough infections with Omicron in seven German visitors who were fully vaccinated and had one booster dose.\(^{43}\) The boosters were administered five to 10 months after the second dose, and one to two months before the breakthrough infection occurred. The data are still emerging to assess the extent to which Omicron can evade protection from mRNA-boosted immunity (two dose mRNA or viral vector regimen and mRNA booster), and whether vaccination protects from long-term sequelae.

In-Vitro and Modelling Evidence

- Since the previous Risk Assessment, more evidence has emerged demonstrating reduced ability of existing convalescent or vaccine-induced antibodies to neutralize Omicron, compared to other VOCs.\(^{8,44-51}\) A few reports are highlighted below.

- The UK’s Variant Technical Group reviewed five preliminary live virus studies (three international and two UK) and estimated a 20- to 40-fold reduction in neutralizing activity by the sera of individuals who received two doses of Pfizer, for Omicron compared to early pandemic viruses.\(^8\) They reported at least 10-fold loss of neutralization compared to Delta; in both UK studies this was over 20-fold. The reduction in activity was even greater using sera from individuals who received two doses of AstraZeneca. A high proportion of the AstraZeneca sera actually fell below the quantification limit of the assay. An mRNA booster dose resulted in increased neutralizing activity, regardless of primary vaccination type.

- On December 8, 2021, Pfizer-BioNTech released preliminary VE data for Omicron.\(^{51}\) They reported that three doses of the Pfizer-BioNTech COVID-19 Vaccine neutralizes Omicron, while two doses has significantly reduced neutralization titers. A third dose increases the neutralizing antibody titers by 25-fold compared to two doses, against the Omicron variant. The titers after the booster dose are comparable to titers after two doses against wild-type SARS-CoV-2, which was associated with high levels of protection. They speculate that because 80% of epitopes in the spike protein recognized by CD8+ T cells are not affected by Omicron mutations, two doses may still provide protection against severe disease. Pfizer-BioNTech expect to have a variant-specific vaccine for Omicron available by March if an adaptation is needed to increase the level and duration of protection.
• COVID-19 convalescent plasma collected in April and May 2020 from 30 individuals in the US were examined for their anti-SARS-CoV-2 CD8+ T-cell responses to determine if the previously identified viral epitopes targeted by CD8+ T-cells in these individuals (n=52 distinct epitopes) are mutated in Omicron. Only 1/52 epitopes identified in the plasma corresponds to an amino acid mutation in Omicron. Therefore, Omicron has not evolved extensive T-cell escape mutations at this time, and individuals with infection-induced anti-SARS-CoV-2 CD8+ T-cell responses should recognize Omicron and avoid severe disease. Further study is needed to determine if vaccine-induced CD8+ T-cell-mediated immunity is affected by Omicron mutations.

• Modelling studies based on a ~40-fold reduction in neutralizing antibody titers of Omicron relative to wild type SARS-CoV-2 estimated an increased relative risk of hospitalization four to five-fold and increased risk of symptomatic disease seven to ten-fold for mRNA vaccines for individuals recently vaccinated. In contrast, those vaccinated with mRNA vaccines >4 months ago will have waned ~8-fold translating to ~320-fold lower neutralizing antibody levels compared to recent vaccines against wild type. Based on modelling predictions, the authors suggest substantial reductions in VE for hospitalizations, and nearly zero protection against symptomatic disease and documented infection in individuals with waned immunity (>4 months from second dose). A third dose of mRNA vaccines restored protection, but only to levels equivalent to waned protection against the Delta variant.

Reinfection

• Gauteng Province, South Africa had a high cumulative infection rate and the number of COVID-19 cases declined from July to October without simultaneous reduction in population mobility. The surge of Omicron cases from 0% to 100% within four weeks in November 2021 suggests Omicron can escape immunity from prior COVID-19 infections.

• In England, the relative risk of reinfection by Omicron (25 possible reinfection/361 cases) vs. non-Omicron (336 possible reinfection/85,460 cases) was estimated at 5.2 (3.4–7.6). The estimate was based on cases confirmed by WGS; adjusted for age, public health region, specimen collection routes (pillar). Prioritized testing for Omicron may have contributed to the higher observed rates of reinfection with Omicron.

• As of December 6, 2021, there were 329 Omicron cases (confirmed, highly probable, and probable), of whom 17 (4.9%) were linked to a previous confirmed COVID-19. The median age was 37 years (range = 23–57).

• The UK Health Security Agency’s recent VOC and VOI technical briefing reported no evidence of increased reinfection risk at the population level, but preliminary analyses indicate approximately three- to eight-fold increased risk of reinfection with the Omicron variant.

Measures in Response to Omicron

This section was informed by scanning government websites, and searches in the Google search engine for literature related to Omicron, public health measures, and vaccination programming; thus, some relevant articles may not be included. The following jurisdictions were searched December 14, 2021: Denmark, England, Finland, France, Germany, Ireland, Israel, Italy, Netherlands, Norway, and Portugal.
Changes to Public Health Measures

Some of the jurisdictions reviewed here were increasing public health measures due to a Delta surge, even before the emergence of Omicron. As a result, it is not always clear whether changes to public health measures or vaccine programming are specific to Omicron, or Omicron and Delta waves.

- Some jurisdictions implemented mask mandates in indoor settings (e.g., Denmark, England, France, Ireland, Netherlands, Norway, Portugal, California, New York State), on public transport (e.g., Denmark, England, Ireland, Norway), or at outdoor events (e.g., Germany, Italy). 53-66

- In some jurisdictions, immunity certificates are now required in more settings than previously (e.g., Denmark, England Germany, Ireland, Italy, Portugal, California), and eligibility for immunity certificates is more restrictive (e.g., how long a negative test result is valid or the duration of validity of the most recent vaccine dose) in some jurisdictions (e.g., Denmark, France, Italy). 54,56-58,62-64,67-70

- Capacity limits were introduced at hospitality and cultural venues (e.g., Denmark, Germany, Ireland, the Netherlands), or venues are temporarily closed (e.g., Denmark, France, Ireland, Norway), and large events cancelled (e.g., Denmark, Germany). Portugal will close schools and nightclubs the week of January 2 to 9, 2022, with mandatory telework orders as a containment strategy after holidays. 71,72 In some jurisdictions, there is national guidance limiting private gatherings as well (e.g. Germany, Ireland, Norway). 54,58,61,64,67,73-75 Portugal continues to require a negative COVID-19 test to access large events and long-term care homes, in an effort to minimize the risk of large outbreaks. 62,63

- Remote work was recently recommended in some jurisdictions (e.g., Denmark, France), while other jurisdictions mandated it (e.g., England, Finland, Ireland, Norway). 61,69,73-76

Changes to Vaccination Programming

Since the identification of Omicron, some of the jurisdictions reviewed here have updated their COVID-19 vaccination programs. 79

- Several jurisdictions have expanded eligibility for booster doses (e.g., Denmark, England, Finland, France, Germany, Ireland), 56,80-84 and/or shortened the minimum interval between completion of a vaccination series and a booster dose (e.g., three months in England, five to six months in Finland, five months in France and Portugal). 56,81,82,85 Israel is starting to discuss fourth doses of vaccine for at-risk patients. 86

- Some jurisdictions have announced plans for vaccinating vulnerable children and children residing with vulnerable individuals (e.g., Finland, France, Germany, Portugal), 87-90 or children 5 to 11 years old in general (e.g., Denmark, Ireland, Italy). 91-93

- On December 13, 2021, the UK announced more than 750 Armed Forces personnel would be administering COVID-19 vaccines and helping to plan a large-scale booster rollout to maximise effectiveness. 94 The armed forces and pharmacies in Norway have also been called upon to speed up delivery of vaccinations. 75
Ontario Risk Assessment

- The current risk of increased Omicron transmission in Ontario is high, with a moderate degree of uncertainty. The risk of reinfection and breakthrough infection in Ontario is high with a moderate degree of uncertainty, while the risk of increased disease severity is moderate with a high degree of uncertainty.

- Using projections that account for time lags in the incubation period (5 days) and case presentation (2 days), most cases infected on December 13th, 2021 (>80%) are likely to be of the Omicron variant.

- It is estimated that each Omicron case is infecting 7.7 times more individuals than Delta in Ontario during the November 28th to December 9th, 2021 period.

- In terms of the risk of importation, federal travel-related restrictions were implemented after Omicron was known to have been circulating in southern Africa, and the list of affected countries has expanded quickly. The overall risk assessment may change as new evidence emerges (see Table 1).

Table 1. Risk Assessment for Omicron B.1.1.529

<table>
<thead>
<tr>
<th>Issue</th>
<th>Risk Level</th>
<th>Degree of Uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Importation in Ontario</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Increased Transmissibility</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Disease Severity</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>COVID-19 Re-infection</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Lowered Vaccine Effectiveness/Breakthrough Infections</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Impacts on Testing/Surveillance</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

Implications for Practice

Although uncertainty remains and evidence is still emerging, particularly in respect of severity, the rapid transition to Omicron dominance in Ontario, coupled with evidence from other jurisdictions that Omicron is more transmissible than Delta and that two-doses of COVID-19 vaccine likely provide much less protection against symptomatic infection, there is a serious risk of increased morbidity and mortality in Ontario, as well as threats to acute health care and public health system capacity. Swift implementation of community-based public health measures is needed, in concert with accelerated vaccination efforts (e.g., third doses), to reduce morbidity and mortality in the population, based on what is currently known about Omicron. A multi-layered public health measures approach continues to be crucial, including masking, physical distancing, ventilation, testing, and decreasing social contacts.

Due to the upcoming holiday season and colder weather, particular consideration is needed to mitigate risks associated with settings where the “3 Cs” are present (closed spaces, crowded places, close contact) and in settings with populations at increased risk of severe COVID-19 disease.
References


22. Moore T. COVID-19: Omicron causing up to 1,000 infections a day in UK - many more than official figure suggest, leading scientist says. Sky News [Internet], 2021 Dec 6 [cited 2021 Dec 7]; UK. Available from: https://news.sky.com/story/covid-19-omicron-causing-up-to-1-000-infections-a-day-many-more-than-official-figures-suggest-leading-scientist-says-12488640


30. Rolander N. Denmark’s Omicron surge is a warning to the rest of the world. BNN Bloomberg [Internet], 2021 Dec 10 [cited 2021 Dec 13]. Available from: https://www.bnnbloomberg.ca/denmark-s-omicron-surge-is-a-warning-to-the-rest-of-world-1.1694153


41. The Canadian Press. Alberta’s chief medical officer says most of 11 Omicron COVID cases were vaccinated. Toronto Star [Internet], 2021 Dec 7 [cited 2021 Dec 9]; Canada. Available from: https://www.thestar.com/news/canada/2021/12/07/albertas-chief-medical-officer-says-most-of-11-omicron-covid-cases-were-vaccinated.html


80. Danish Health Authority. The Danish Health Authority recommends booster vaccination of everyone aged over 18 [Internet]. Copenhagen: Danish Health Authority; 2021 [cited 2021 Dec 7]. Available from: https://www.sst.dk/en/English/News/2021/The-Danish-Healthy-Authority--recommends-booster--vaccination-of-everyone-aged--over-18


84. RTÉ. NPHET meeting over Omicron and 'considering further measures'. RTÉ [Internet], 2021. Available from: https://www.rte.ie/news/coronavirus/2021/1127/1263468-covid-ireland/


89. The Local Europe. Germany to roll out Covid vaccinations for 5-11 year olds. The Local Europe [Internet], 2021 Dec 13 [cited 2021 Dec 16]. Available from: https://www.thelocal.de/20211213/germany-to-start-covid-vaccinations-for-5-11-year-olds/


93. The Local Italy. Italy approves Covid vaccine for 5-11 year olds: what you need to know. The Local Europe [Internet], 2021 Dec 2 [cited 2021 Dec 16]. Available from: https://www.thelocal.it/20211202/italy-approves-vaccines-for-5-11-year-olds-what-you-need-to-know/


