COVID Model Projections

February 17, 2022

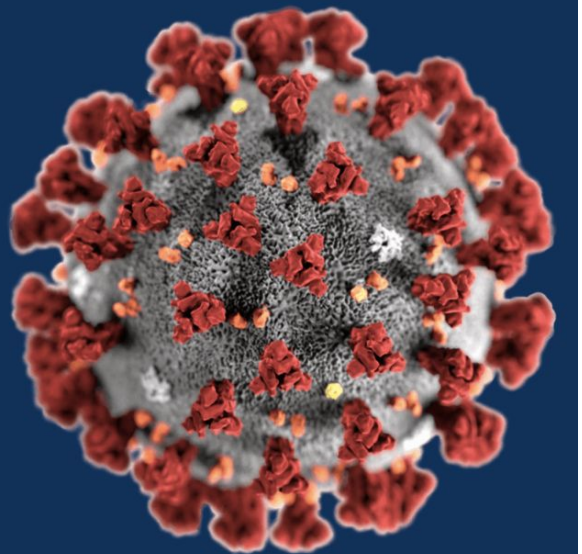
BC COVID-19 Modelling Group

@bcCOVID19group

About BC COVID-19 Modelling Group

The BC COVID-19 Modelling Group works on rapid response modelling of the COVID-19 pandemic, with a special focus on British Columbia and Canada.

The interdisciplinary group, working independently from Government, includes experts in epidemiology, mathematics, and data analysis from UBC, SFU, UVic, and the private sector, with support from the Pacific Institute for the Mathematical Sciences.



https://bccovid-19group.ca

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Independent and freely offered advice, using a diversity of modelling approaches.

Overview

Omicron on the decline

- Declining numbers of cases among those aged 70+ and of COVID patients in hospital provide evidence that the Omicron wave is subsiding in BC, except in Northern Health.
- BC's booster program has been highly successful (53% of eligible people over 12 have now been boosted) and is likely a strong contributor to taming the Omicron wave.

A cautious approach to reopening would help avoid a surge over the next month

- Omicron sub-variant BA.2 is spreading in Canada, with selection favouring BA.2 by a selection coefficient of 6% in BC per day relative to BA.1.
    - The impact of BA.2 depends strongly on when it arrives in the Omicron wave. In BC, the current frequency of BA.2 remains low, suggesting that it will extend the peak but not cause a major rise in Omicron infections.
- Even while Omicron is declining, many infections – more than half – typically happen on the way down from an epidemic peak, so measures such as masking, getting boosted, and avoiding poorly ventilated crowded places will continue to be important over the next month.

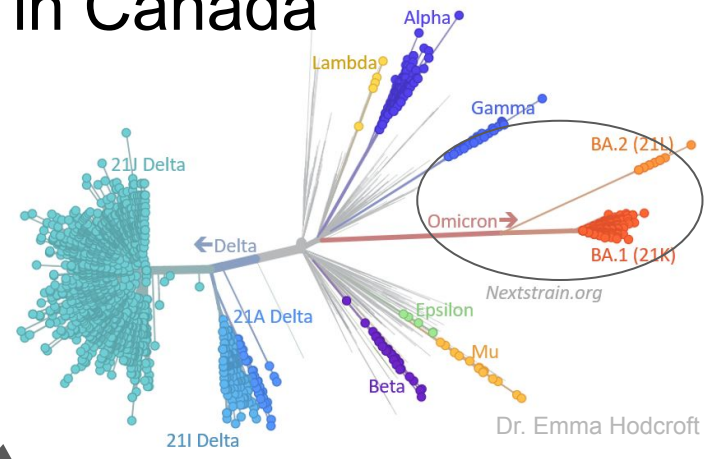
Omicron sub-lineage BA.2 is spreading in Canada

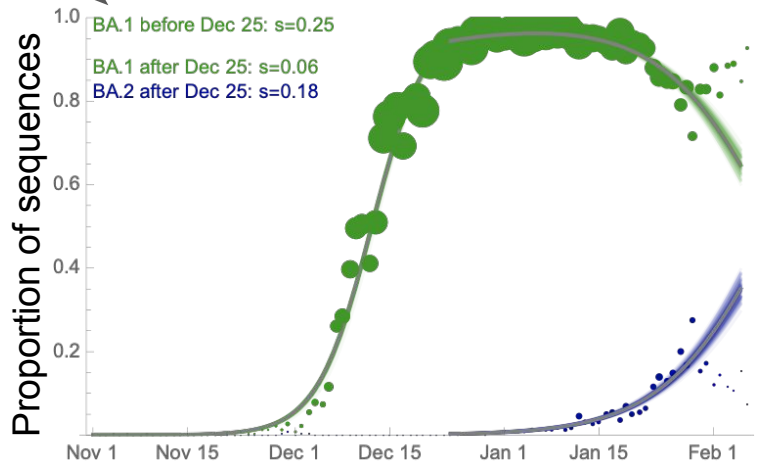
Omicron describes two major lineages, BA.1 and BA.2, which differ at many sites but share 21 changes in the spike protein.

BA.1 (green) spread rapidly In December in Canada but has recently been declining in frequency due to the spread of BA.2 (blue; dot area is proportional to number of sequences).

→ In Canada, BA.2 is spreading faster than BA.1 at a rate of *s* = 12% per day, similar to rates seen in Denmark and UK in our previous report.

Data suggests that the advantage of BA.2 over BA.1 comes from a higher inherent transmissibility (UK Report), not an ability to escape immunity following BA.1 infection. A study of neutralizing antibodies produced by individuals infected with BA.1 indicates that these antibodies neutralize BA.1 and BA.2 at nearly equal rates. A UK study of BA.2 cases with recent COVID found all were previously infected with Delta, not BA.1.





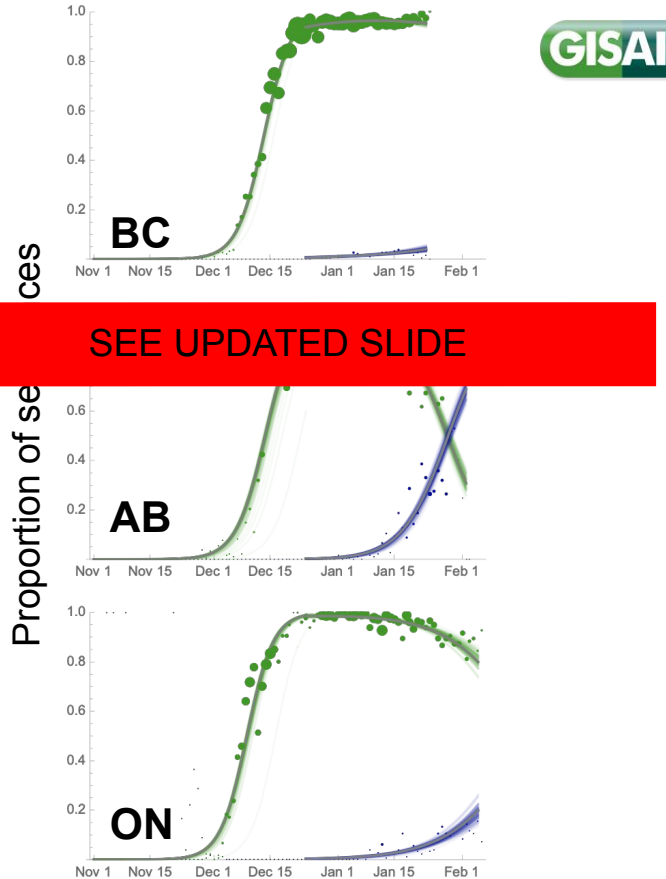
Selection on BA.1 and BA.2 by province

These plots show the proportion of BA.1 (green), BA.2 (blue), and non-Omicron (remainder) for three provinces with sufficient data about BA.2. See Appendix for details.

→ BA.2 is spreading with a selective advantage per day relative to BA.1 of 6.1% in BC [95%CI: 4-8%], 17.5% in AB [16-19%], and 10.3% in ON [9-12%].

BA.2 established earlier in Alberta, where it is now prevalent.

The estimated proportion of COVID-19 cases due to BA.2 on February 17, 2022 is 15% in BC, 96% AB, 44% ON.



SEE UPDATED SLIDE

Source (S. Otto; BC COVID-19 Modelling Group) Parameters estimated by maximum likelihood based on a trinomial distribution given the expected frequencies under selection acting upon BA.1 (including BA.1.1) and BA.2, relative to non-Omicron (AY.25, AY.25.1, AY.103). Selection for BA.2 vs BA.1 can be found by subtracting BA.1's advantage over non-Omicron from BA.2's advantage over non-Omicron; Hessian matrix used to obtain confidence intervals.

Selection on BA.1 and BA.2 by province

Alberta data analyses had to be removed because the sequences posted to GISAID were chosen **after** first typing Omicron by PCR to determine whether they were BA.1 or BA.2 and then preferentially sequencing BA.2.

These plots show the proportion of BA.1 (green), BA.2 (blue), and non-Omicron (remainder) for two provinces with sufficient data about BA.2. See Appendix for details.

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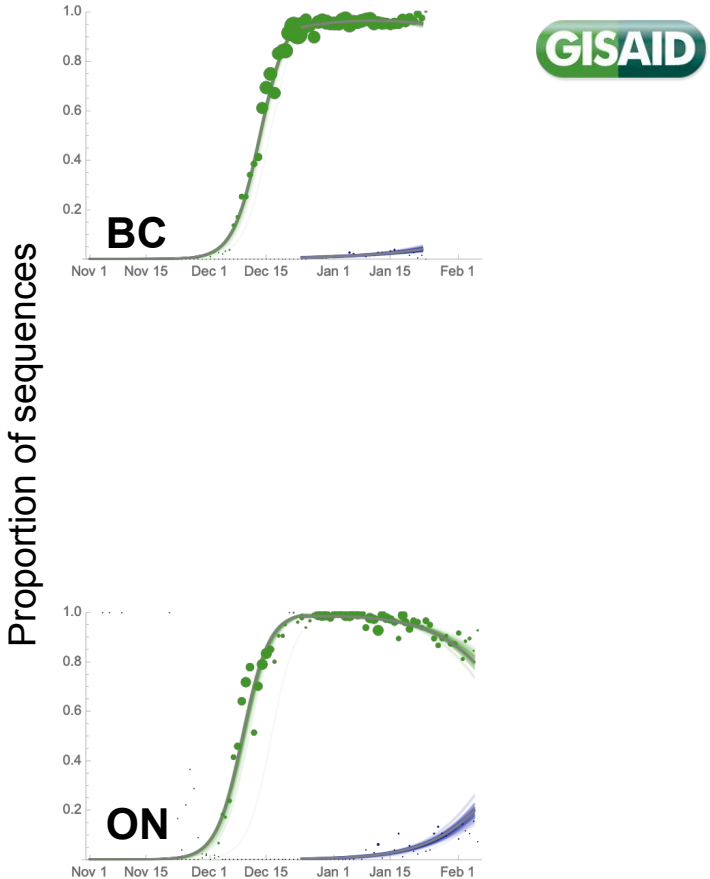

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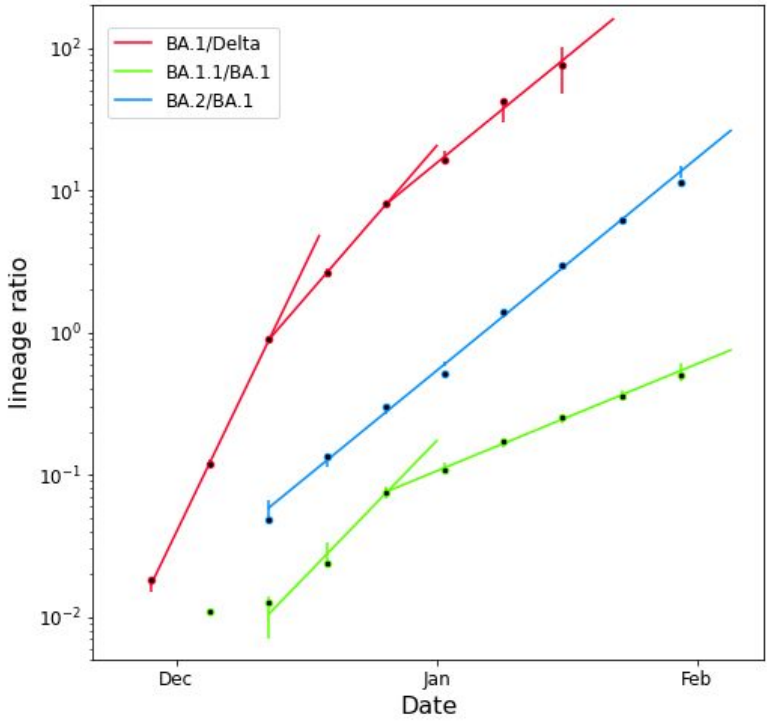
Omicron lineages in Denmark

Denmark was one of the earliest countries to see the rapid growth of Omicron cases.

- The BA.1 growth advantage over Delta slowed significantly once it became dominant:
  - Shown in red: s = 28%/day, 16%/day, 11%/day
- The BA.2 growth advantage over BA.1 appears to be constant. Shown in blue: s = 11%/day
- BA.1.1 also shows a growth advantage over BA.1 Shown in green: s = 14%/day, 6%/day

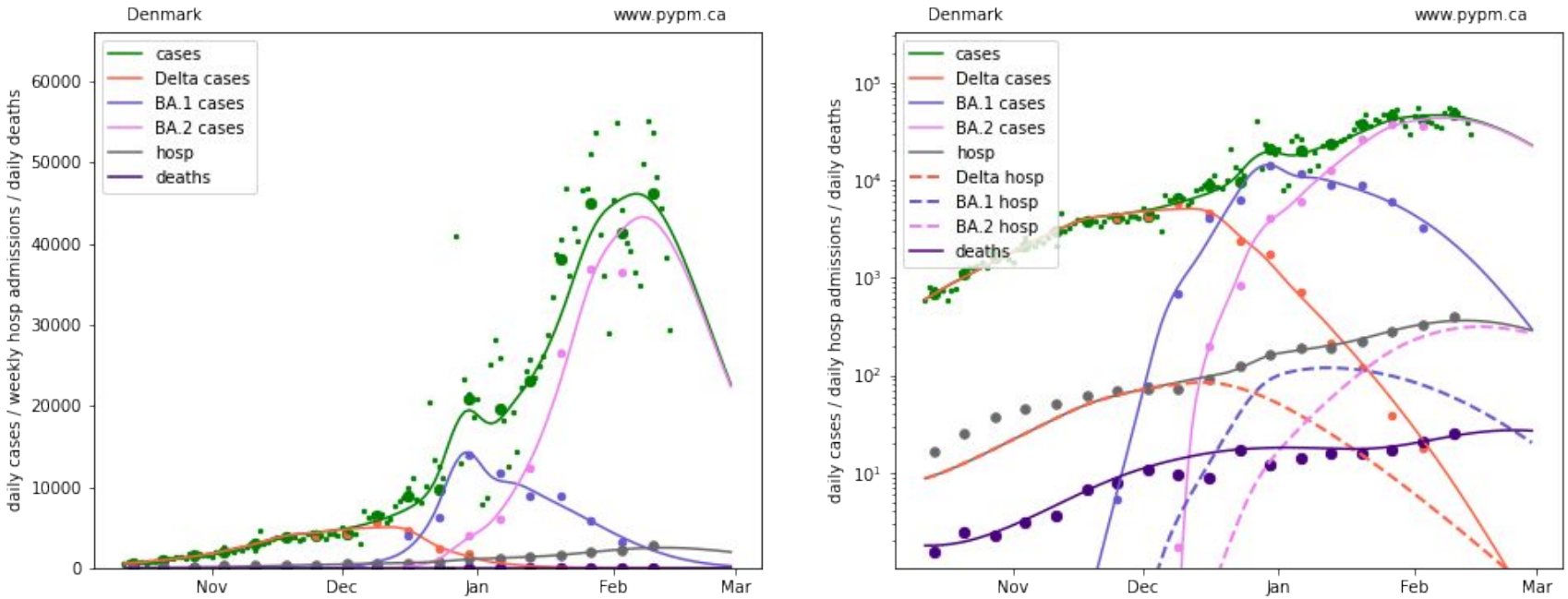
The changes in growth advantage occurred at the same time as a significant drop in growth rates in Denmark (and many other jurisdictions).

The lineage ratios allow hospitalization severity to be estimated for each lineage (next slide).



Source: D. Karlen. Data from Danish Covid-19 Genome Consortium. Maximum likelihood analysis described in Appendix of February 4 report. Bars indicate 95% intervals.

Omicron lineages and modelling Denmark hospitalizations



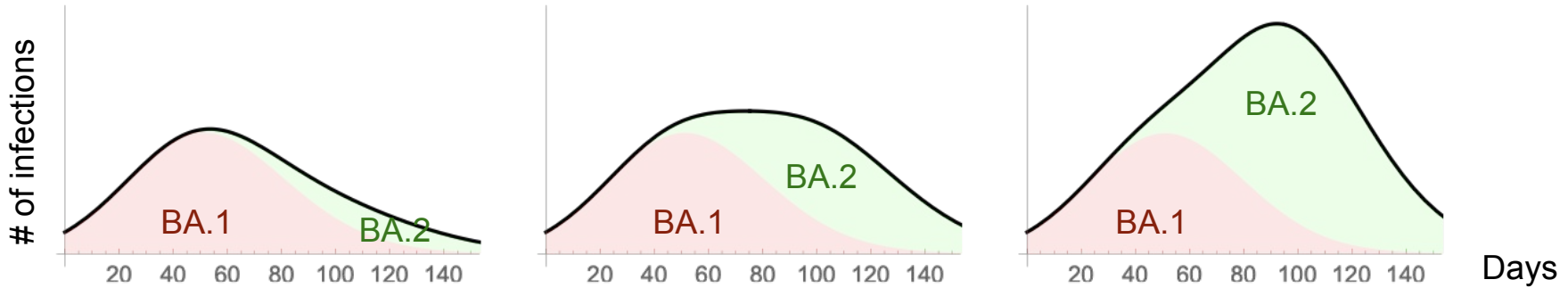
Using the lineage ratios, cases due to each lineage are inferred and fit to define a multiple-strain infection model. By fitting the model to overall hospital admission data, the relative severity of BA.2 to BA.1 infections is estimated to be about 0.7, although this is uncertain and cannot separate impact of BA.2 versus shifts over time in hospital admission rates.

Source (D. Karlen). See www.pypm.ca. The larger dots show weekly averages. The dashed curves show hospital projections scaled to fit overall hospital admission data.

How might BA.2 affect the Omicron wave?

This slide shows a simple epidemic toy model, treating individuals as either susceptible to Omicron, infected with BA.1 (red) or with BA.2 (green). Here, BA.2 spreads 12% faster than BA.1 but arrives later. Immunity provided by BA.1 infection or by boosters* protects against infection by either Omicron variant.

The impact of BA.2 depends on when it becomes common in a region. In areas where BA.2 establishes late (left), the epidemic curve is only extended slightly. In areas where, by chance, it establishes early (right), BA.2 can dominate the Omicron wave, leading to more total cases. The middle panel shows an intermediate outcome where BA.2 creates a “shoulder” in the Omicron wave.



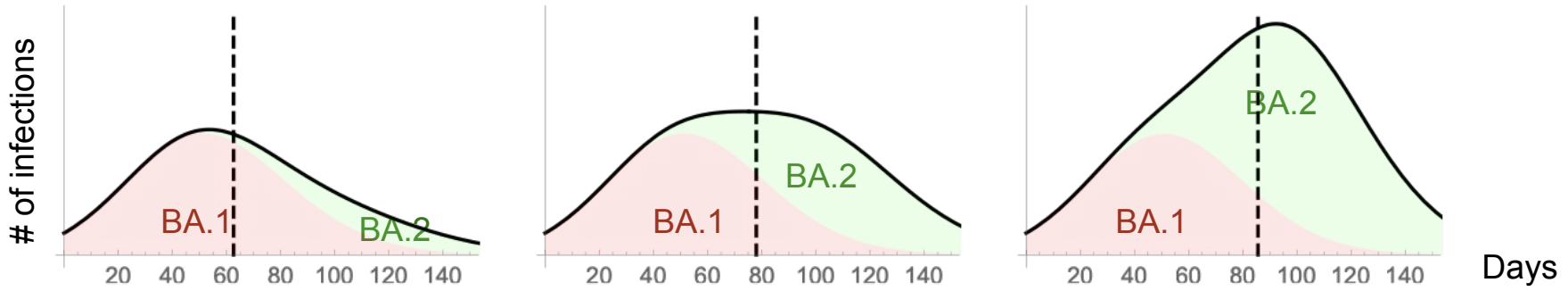
→ The impact of BA.2 depends strongly on the timing of its introduction

Source (S. Otto) Assumes that BA.1 initially spread at a rate of $r = 0.22$ per day, that BA.2 spreads at a rate of $r = 0.34$ per day (a 12% selective advantage of BA.2 over BA.1), infections last on average 7 days, and booster vaccinations proceeded at a rate that 52.7% of the eligible population (12+) would be vaccinated by February 14 2022 (as in BC), with 80% vaccine effectiveness against infection if boosted.

Past the peak does not mean infection risk is over

Simple epidemics (with a single variant) typically cause more infections on the way down from a peak than on the way up, a prediction that has been seen often with COVID (waves rise faster and decline slower).

Here we add dashed lines to the previous graphs to show when 50% of infections would occur, illustrating that many infections are yet to come in the current wave.



→ As long as BC remains near the Omicron peak, measures to reduce risk are important to maintain (masking, booster shots, avoiding crowded poorly ventilated areas)

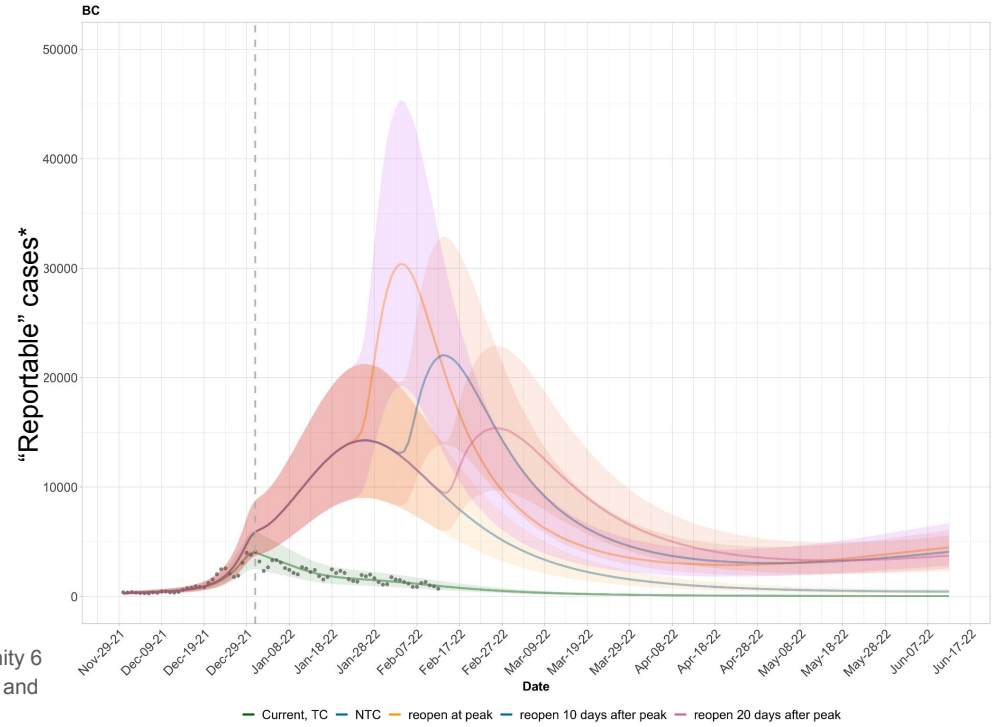
Illustrative comparisons: impact of the timing of reopening

Here we illustrate the impact of full reopening at the peak time vs 10 or 20 days later.

Uses a multi-strain model accounting for reduced testing, boosters, waning immunity and Omicron's advantage over Delta (see model in Appendix).

"Reopening": reverse the decrease in transmission that we estimate for late December 2021.

In all cases, full reopening leads to another surge, but delaying the reopening greatly reduces the peak height.



Parameters: Booster efficacy against infection 70% (Omicron); 2-dose efficacy against infection 15%, immediate protection of recovery against reinfection 90%, waning immunity 6 months, incubation period 3 days. **Estimated parameters:** transmission rates for Delta and Omicron, reduction in transmission late December, dispersion parameter, 2021 ascertainment fraction. **Likelihood:** includes reported cases accounting for testing change; 50% Omicron ~Dec 12, 20% daily growth advantage when Omicron emerged

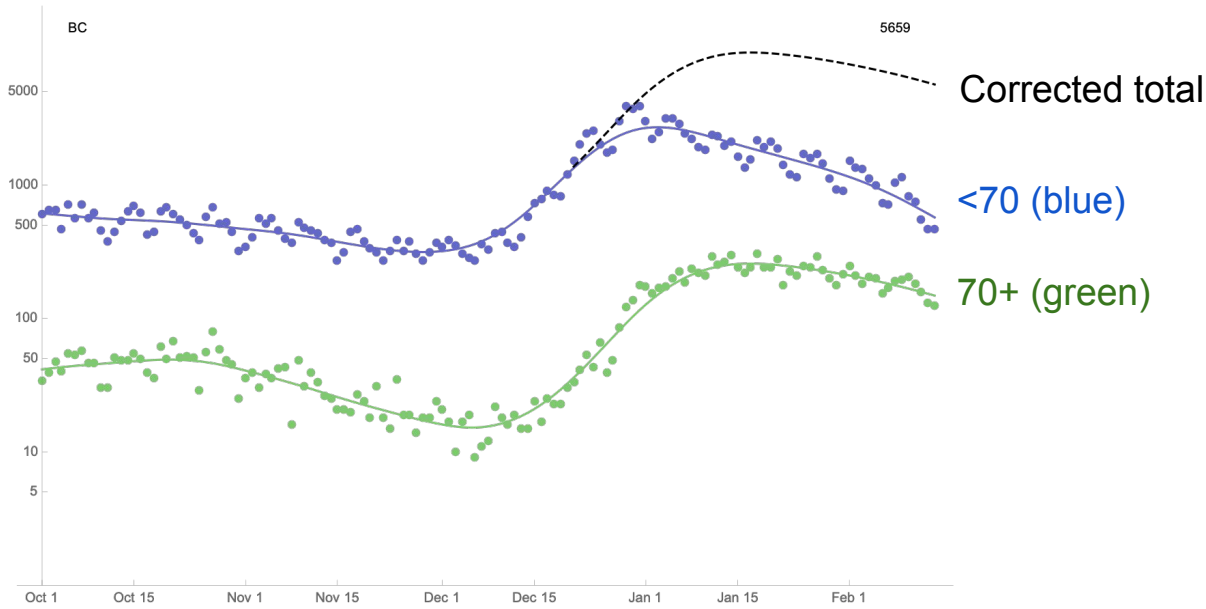
* Reportable case: would have been reported, under pre-Dec 2021 testing

Age-corrected case counts: British Columbia

The black dashed curve estimates the total number of “reportable” cases, applying growth in older age cohorts (green) to correct for limited testing in younger groups (blue).

This correction suggests ~5700 reportable cases on February 14 compared to the 519* reported.

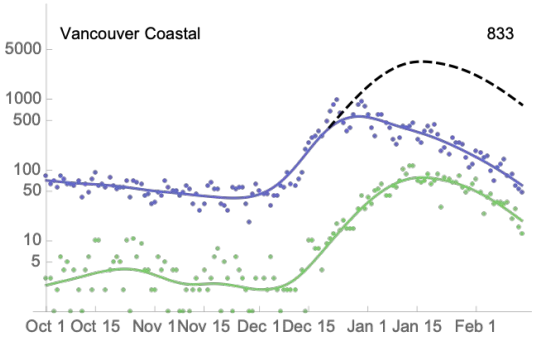
The age distribution is, however, likely to have shifted over the last month, so this total is increasingly unreliable.

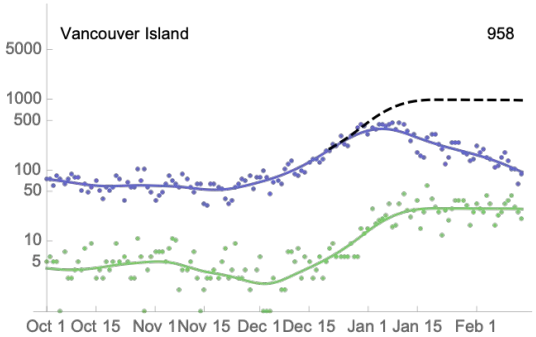


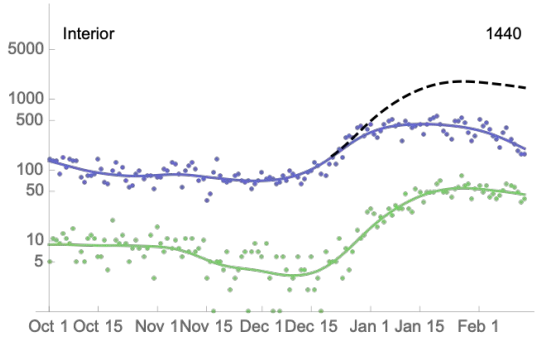
→ Cases among the 70+ age group, who have been more consistently tested, are now **declining significantly in BC****, although they remain high and predict continued hospital demand in the near future**.**

Source (S. Otto; BC COVID-19 Modelling Group) New cases per day in 10-year age groups were downloaded from the **BCCDC COVID-19 data portal**. Cubic spline fits to log-case data were obtained (curve) and estimates for those <70 obtained by applying the fits for those 70+, shifted up to match the projection for that age class on 21 December 2022 when testing limits were initially reached in many parts of BC. *From the daily BC Gov News reports. **Linear regression through log case counts among 70+ from last 14 days of data.

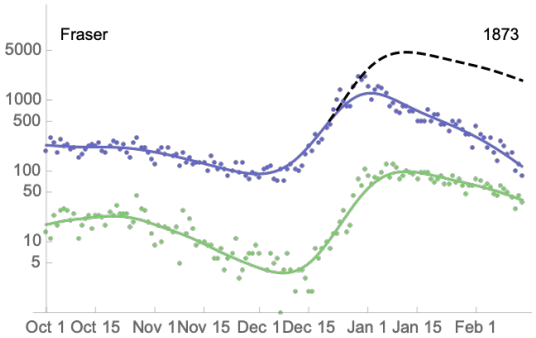
Age-corrected case counts: Health Authority

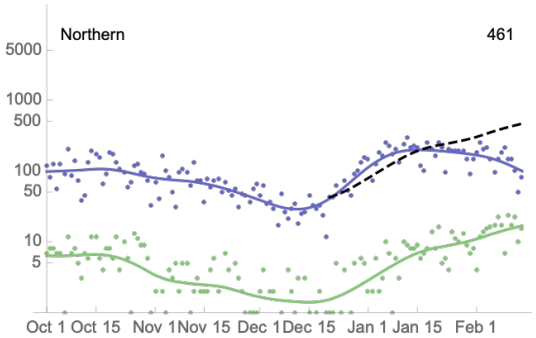






Corrected total
<70 (blue)
70+ (green)



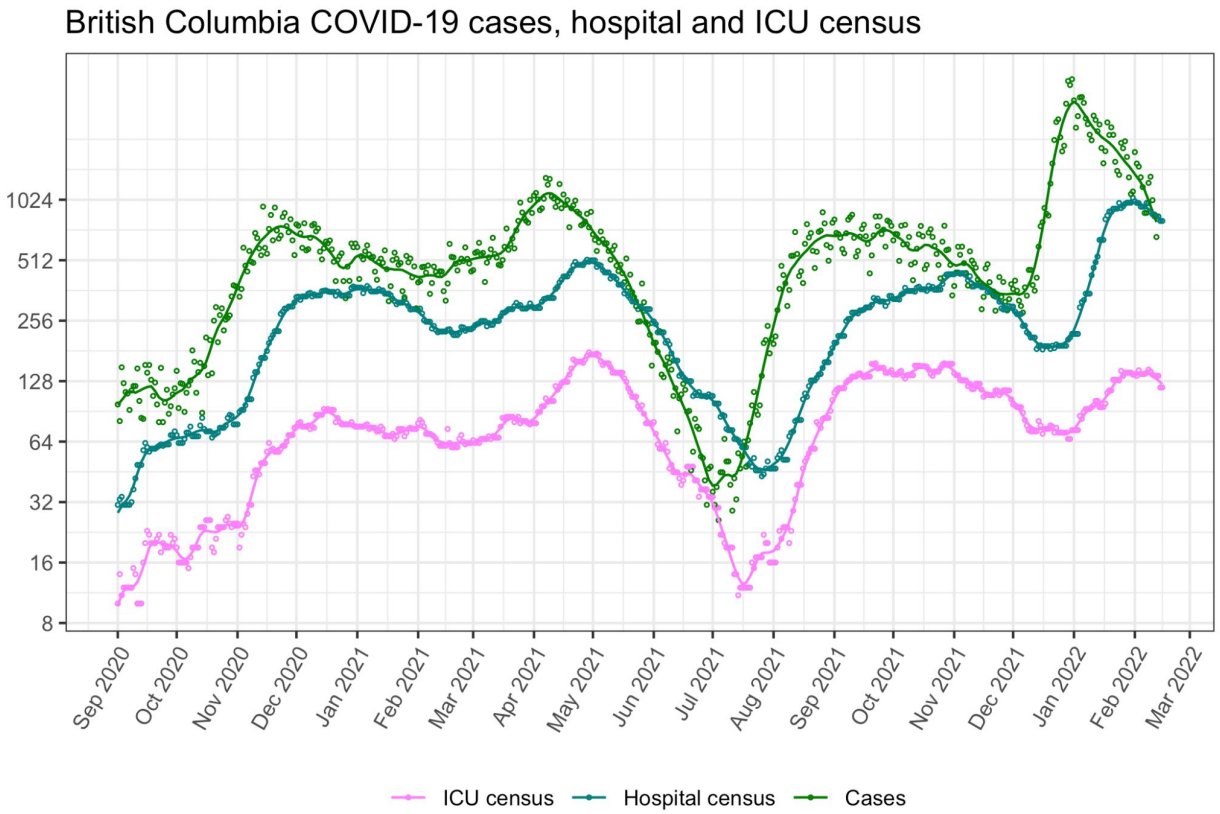


The Omicron wave has not yet peaked in all Health Authorities based on the case numbers among those aged 70+.

→ Significant declines among those aged 70+ are mainly observed in Vancouver Coastal and Fraser Health Authorities; cases in Northern HA is trending upwards.

Source (S. Otto) New cases per day in 10-year age groups were downloaded from the **BCCDC COVID-19 data portal**. Cubic spline fits to log-case data were obtained (curve) and estimates for those <70 obtained by applying the fits for those 70+, shifted up to match the projection for that age class on 21 December 2022 when testing limits were initially reached in many parts of the province. *Linear regression through log case counts among 70+ from last 14 days of data.

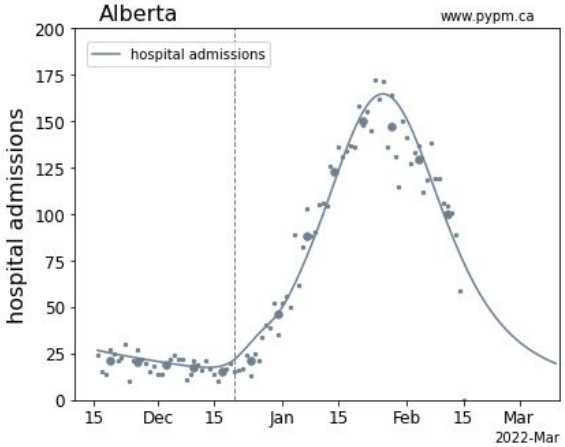
Hospital trends in BC

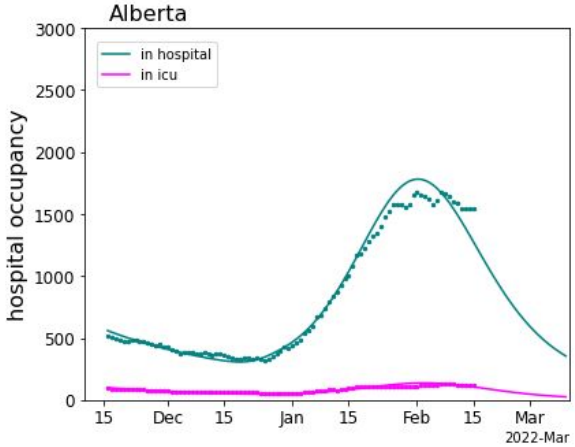


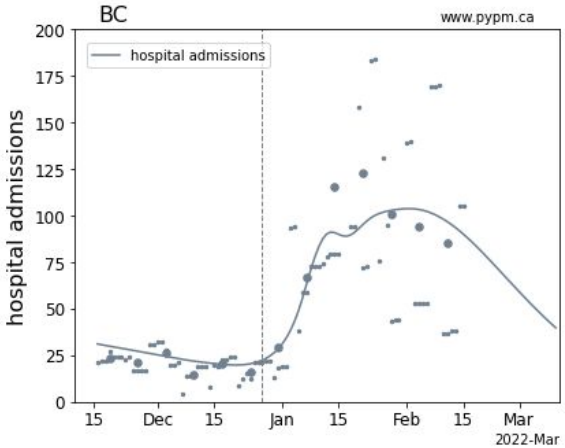
While declines in case numbers in early January largely reflected testing limitations, the number of COVID patients in hospital peaked at the end of January and is now declining.

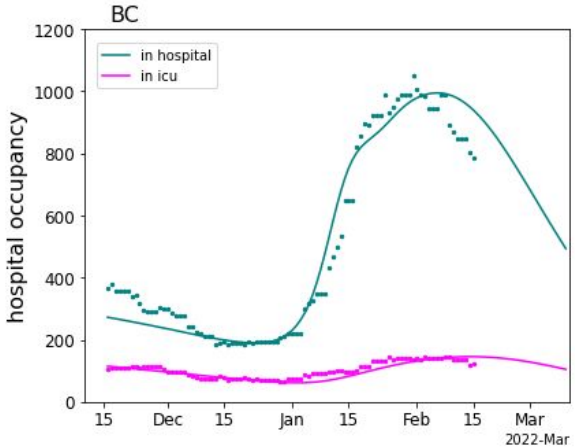
Source (J. von Bergmann) Case data from BC COVID-19 Database (http://www.bccdc.ca/health-info/diseases-conditions/covid-19/data). STL trend lines on log scale.

Hospital projections for Alberta and BC









Model of Omicron (BA.1 and BA.2 combined) fits Alberta hospital admission data well. Even though BA.2 is now dominant, admissions continue to decline.

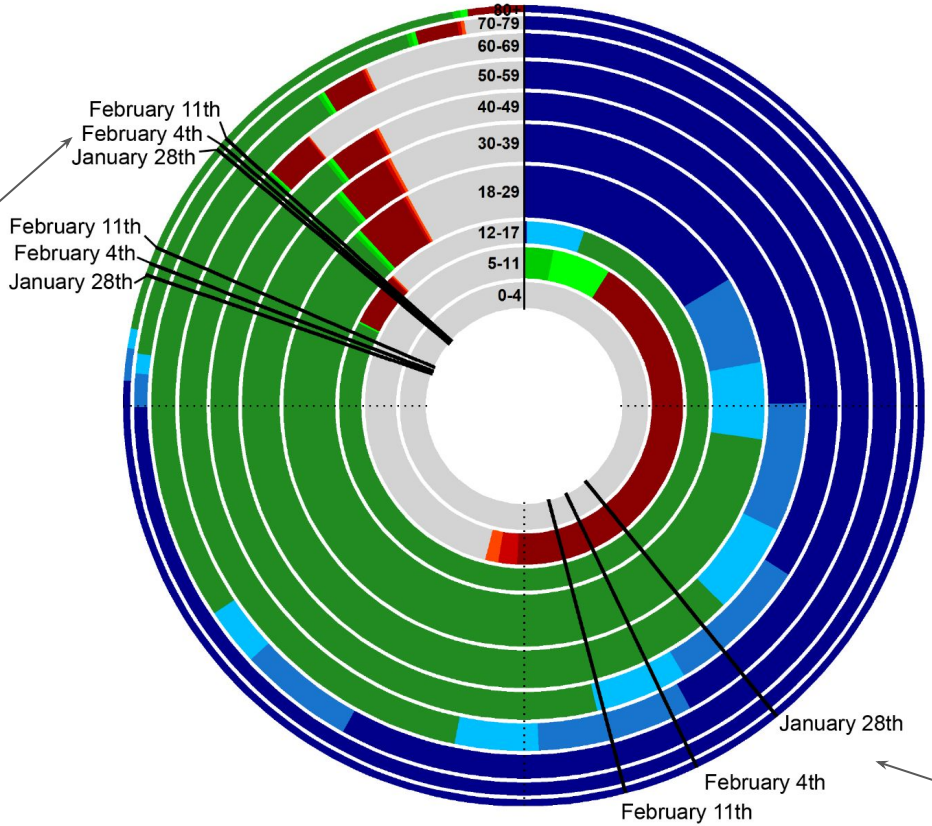
Hospital admission data from BC continues to be poor quality (widely scattered grey dots). Using this noisy data, the model still predicts a decline in hospital occupancy, as is now clear in the data.

Source (D. Karlen). See www.pypm.ca. The larger dots show weekly averages. The vertical lines indicate dates that transmission rate was changed to fit data. Projections do not account for recent or future changes to public policy or personal behaviour.

Vaccination status by age

February 11th update includes data through February 6th

The fraction of BC's entire population with one or two doses increased **0.3%** and **0.7%** respectively over the past week



Single vaccinated before:
- February 6th
- January 30th
- January 22nd

Double vaccinated before:
- February 6th
- January 30th
- January 22nd

Triple vaccinated before:
- February 6th
- January 30th
- January 22nd

Unvaccinated

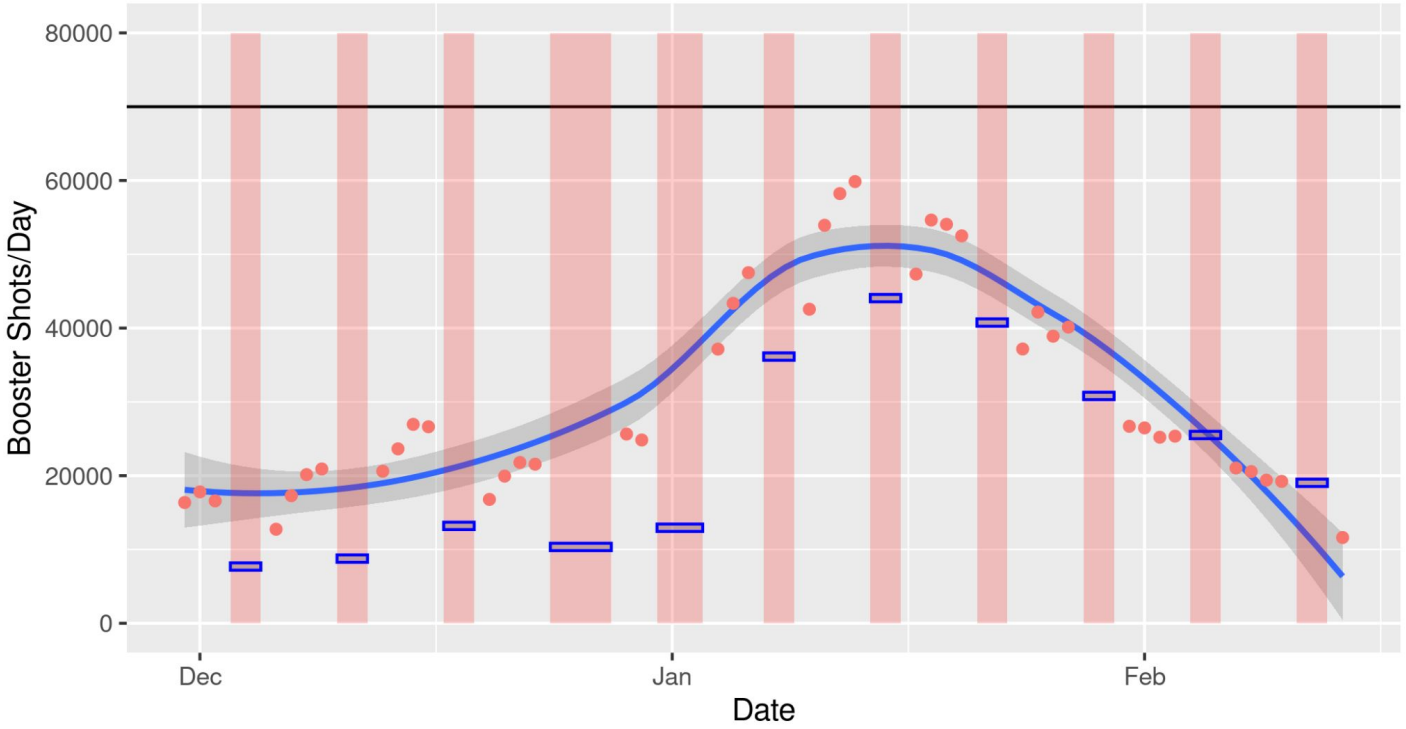
Booster Progress

The fraction of BC's entire population with three doses increased **3.0%** over the past week

Source (B. Wiley). Design by Blake Shaffer (https://blakeshaffer.shinyapps.io/app_vaccines/) BC Vaccination data for first and second doses from https://health-infobase.canada.ca/covid-19/vaccination-coverage/, with area of each circle segment proportional to BC's population in that age class. BC 2022 Population projections for vaccination percentages from BC Stats: https://www2.gov.bc.ca/gov/content/data/statistics/people-population-community/population/population-projections

Booster Shot Progress

As reported by day and estimated for weekends and holidays



Data via R Dumont from daily briefings.
Salmon coloured columns are periods where day-specific booster are not available: e.g. weekends & holidays.
Red dots are reported single-day booster #s.
Blue bars are per day mean boosters where number was reported for multiple days (total/# of days).
Horizontal line is 70K/day, the value assumed in 14 Jan 2022 Epi Modelling.

Booster doses continue to provide important protection from Omicron.

The daily booster dose are now nearing 10K/day.

As of 11 Feb, 12-17 y/o are eligible for boosters, but no evidence of an ‘uptick’ in our data

Key messages

State of the Omicron wave in BC:

- Cases in individuals >70 in age are now declining significantly in BC, although this largely reflects declines in Vancouver Coastal Health and Fraser Health, with rising trends continuing in Northern Health.
- Declines in the number of people hospitalized with COVID is a strong indicator that many parts of BC are now past the Omicron peak.
- The biggest source of uncertainty over the next few weeks is whether a further surge will occur because:
  - Reopening on 17 February 2022 could increase transmission rates more than the current rate of decline
  - The selective advantage of BA.2 could allow it to spread further, despite growing immunity in BC
- **What is certain is that Omicron remains prevalent in BC, and we should expect many more infections, even if infection rates are declining.**

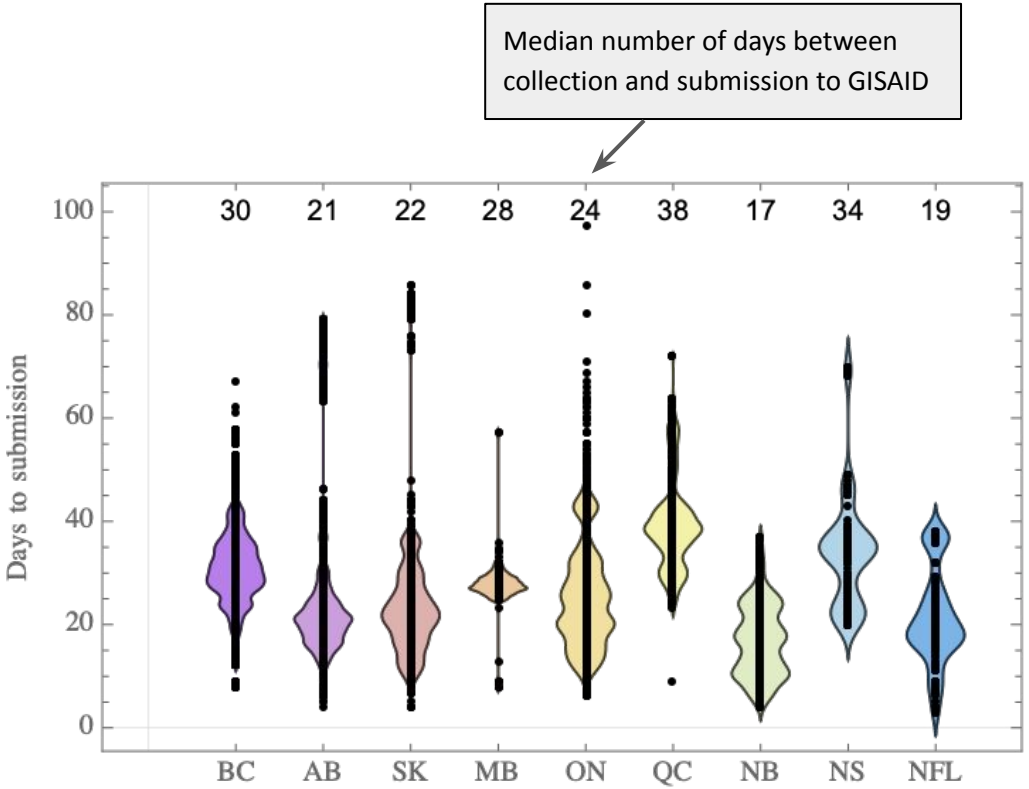
→ Measures to reduce risk are important to maintain while Omicron remains prevalent (masking, booster shots, avoiding crowded poorly ventilated areas)

Appendix: Timely contributions of genomic data

This plot shows delays in uploading sequence data to GISAID for samples collected in Canada since November 1, 2021 (relevant to Omicron).

Across Canada, the median delay is 28 days between collection and submission, not including the sequences that have yet to be uploaded. This is greatly improved over the 88 days found earlier (Kalia et al.).

New Brunswick is the leader of the pack, comparing favourably to international standards (e.g., UK at 16 days).



→ Delays in submitting data make it challenging to detect the spread of variants such as BA.1 and BA.2 and their impact on public health.

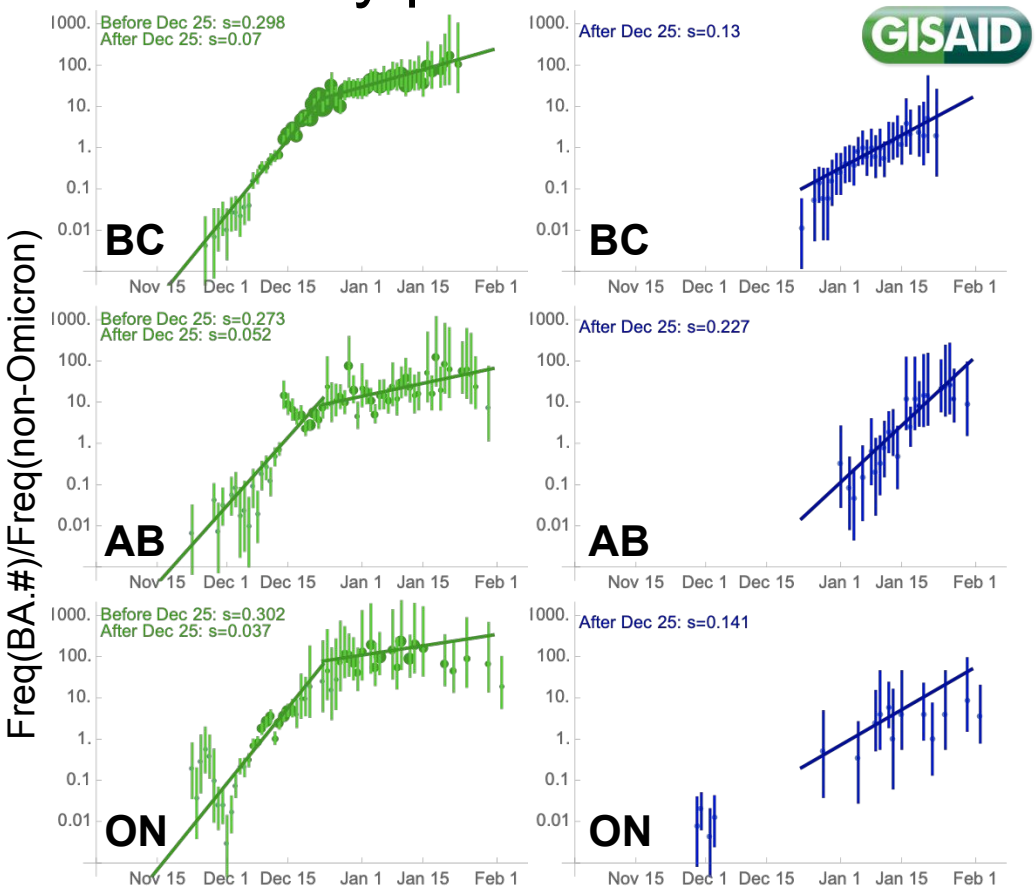
Appendix: Selection on BA.1 and BA.2 by province

The frequency of BA.1 (green) or BA.2 (blue) divided by the frequency of non-Omicron is shown on the right for the three provinces with enough data on BA.2.

Fits (lines) were obtained by maximum likelihood and give estimates of selection for BA.1 and BA.2 relative to non-Omicron.

Selection favoring Omicron (BA.1) was stronger before measures were taken to slow its spread (late December).

→ Recently, BA.2 is spreading with a selective advantage per day relative to BA.1 of 6.1% in BC [95%CI: 4-8%], 17.5% in AB [16-19%], and 10.3% in ON [9-12%].



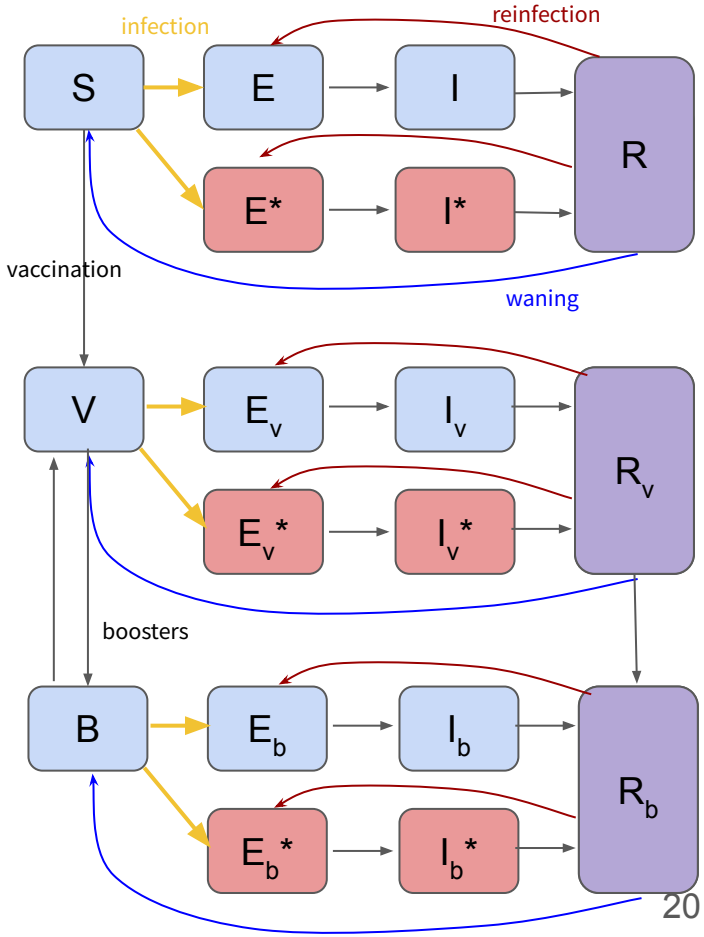
Source (S. Otto; BC COVID-19 Modelling Group) Parameters estimated by maximum likelihood based on a trinomial distribution given the expected frequencies under selection acting upon BA.1 (including BA.1.1) and BA.2, relative to non-Omicron (AY.25, AY.25.1, AY.27, AY.103). Selection for BA.2 vs BA.1 can be found by subtracting BA.1's advantage over non-Omicron from BA.2's; Hessian matrix used to obtain confidence intervals.

Appendix: Multi-strain model

This is a model with unvaccinated, vaccinated and boosted individuals, with two strains: blue (Delta) and red (Omicron).

The model allows for reinfection, different transmissibility and efficacy for Omicron, and waning of immunity.

Approach: Fit to reported cases, but adjust the fraction of infections that are reported to mirror changes in testing, using those aged over 70 as a baseline.



Boosters are ongoing in the model at a rate matching BC's reported levels in late December.