Modelling Covid-19 Risk Factors

A SUMMARY OF IN-PROGRESS RESEARCH FOCUSING ON THE PROVINCE OF ONTARIO

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Before we Begin

Disclaimer:

The subject of this presentation is an in-progress research project which has not been fully reviewed or published. However, the results and insights to-date are still quite interesting.

Please exercise appropriate judgement when interpreting specific results

Special Thanks:

Drs. Ashleigh Tuite, David Fisman and Amy Greer for sharing their model with us.

RSM Canada for providing many of the volunteers on the team.

Goal: Analyze the Covid-19 Pandemic and Response through an Actuarial Lens

- Existing Epidemiological model was leveraged to ground research.[1]
- Focus of research is to understand the relative risks of various factors associated with Covid-19 through modelling, as well as demonstrate how actuarial thinking would apply to understanding the pandemic
- Work included updating the core model for any factors we wished to analyze.
- Key results:
  - Existing and potential future variants present a tangible and ongoing risk to recovery from Covid-19
  - Model uncertainty must always be considered when planning. Focusing on the current best-estimate leads to an incomplete understanding of the pandemic.

Mathematical modelling of COVID-19 transmission and mitigation strategies in the population of Ontario, Canada

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Affiliations + expand

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Free PMC article

Abstract

Background: Physical-distancing interventions are being used in Canada to slow the spread of severe acute respiratory syndrome coronavirus 2, but it is not clear how effective they will be. We evaluated how different nonpharmaceutical interventions could be used to control the coronavirus disease 2019 (COVID-19) pandemic and reduce the burden on the health care system.

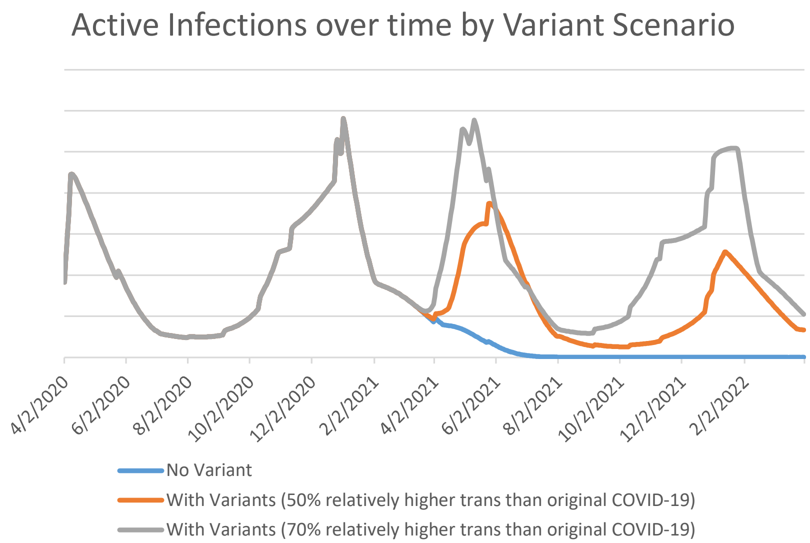
Methods: We used an age-structured compartmental model of COVID-19 transmission in the population of Ontario, Canada. We compared a base case with limited testing, isolation and quarantine to scenarios with the following: enhanced case finding, restrictive physical-distancing measures, or a combination of enhanced case finding and less restrictive physical distancing. Interventions were either implemented for fixed durations or dynamically cycled on and off, based on projected occupancy of intensive care unit (ICU) beds. We present medians and credible intervals from 100 replicates per scenario using a 2-year time horizon.

Results: We estimated that 56% (95% credible interval 42%-63%) of the Ontario population would be infected over the course of the epidemic in the base case. At the epidemic peak, we projected 107 000 (95% credible interval 60 760-149 000) cases in hospital (non-ICU) and 55 500 (95% credible interval 32 700-75 200) cases in ICU. For fixed-duration scenarios, all interventions were projected to delay and reduce the height of the epidemic peak relative to the base case, with restrictive physical distancing estimated to have the greatest effect. Longer duration interventions were more effective. Dynamic interventions were projected to reduce the proportion of the population infected at the end of the 2-year period and could reduce the median number of cases in ICU below current estimates of Ontario's ICU capacity.

Interpretation: Without substantial physical distancing or a combination of moderate physical distancing with enhanced case finding, we project that ICU resources would be overwhelmed. Dynamic physical distancing could maintain health-system capacity and also allow periodic psychological and economic respite for populations.

1. Model used was developed by Drs. Ashleigh Tuite, David Fisman and Amy Greer: “Mathematical modeling of COVID-19 transmission and mitigation strategies in the population of Ontario, Canada”

Variants Top the List of Risk Factors that can Lead to Future Waves



Variant Information as of Mar. 10, 2021:

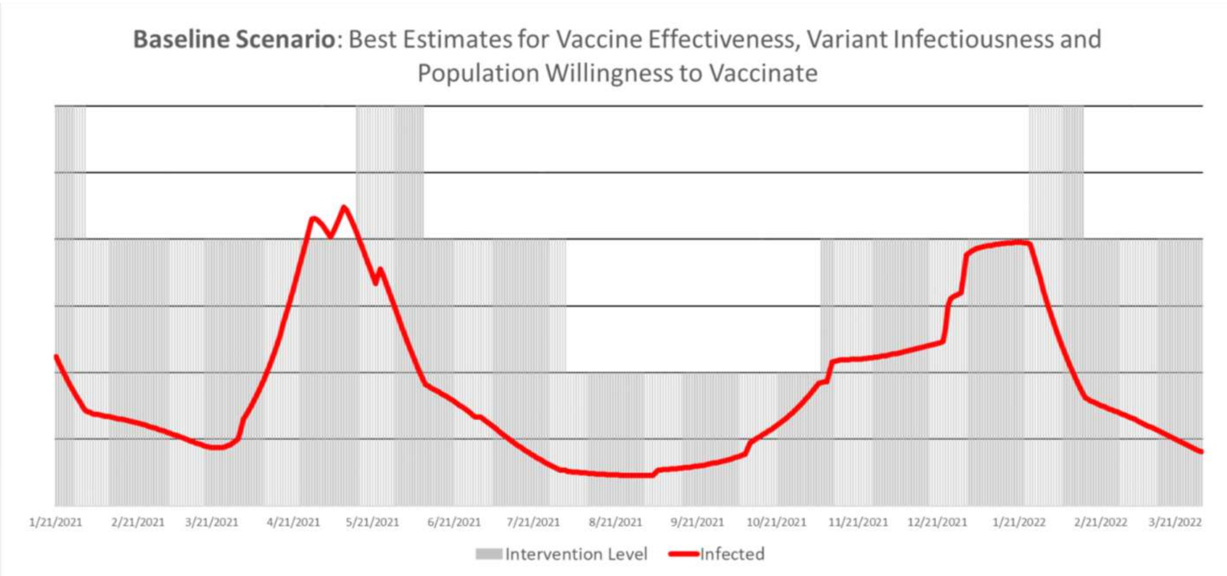
Variant Type	Number of cases	Excess Spread of Variant	Excess Death Rate
B.1.1.7 (UK)	908	50%	60%
P.1 (Brazil)	39	50%	60%
B.1.351 (South Africa)	17	70%	60%

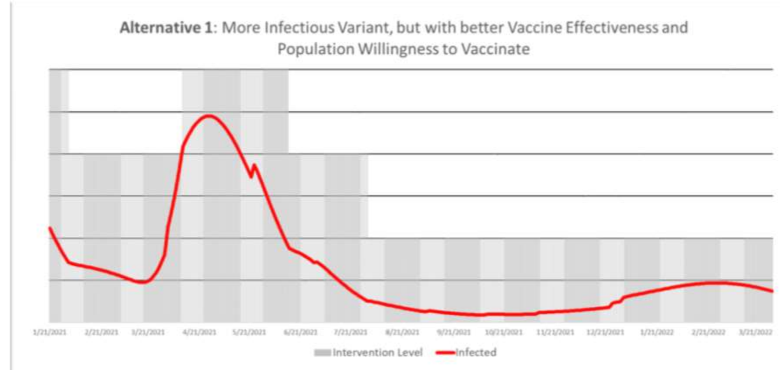
Other Factors Analyzed (risk level*)

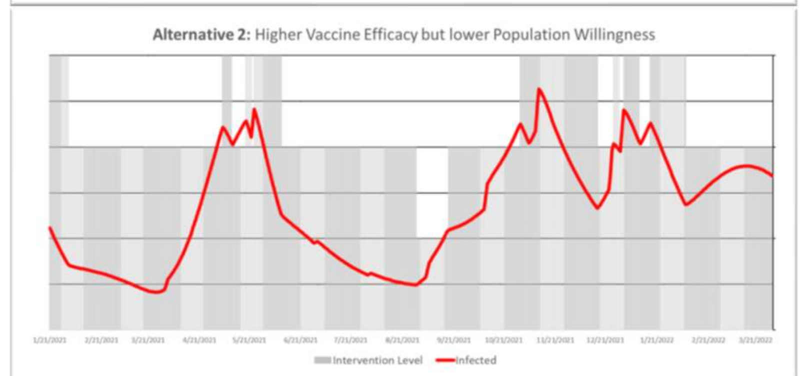
- Loosening Interventions Early (moderate)
- Social Distancing (moderate)
- Super-Spreading Events (moderate)
- Vaccination Willingness (moderate)
- Vaccine Supply (low)
- Vaccinated Return to Normal (low)

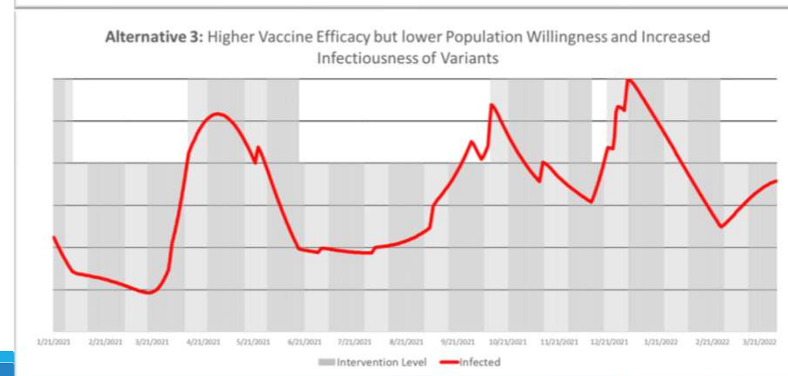
* Risk levels are relative to a no-variant scenario and become more significant as risks are analyzed together, showing interactions.

There is Significant Variation in Future Outcomes as Variables Interact





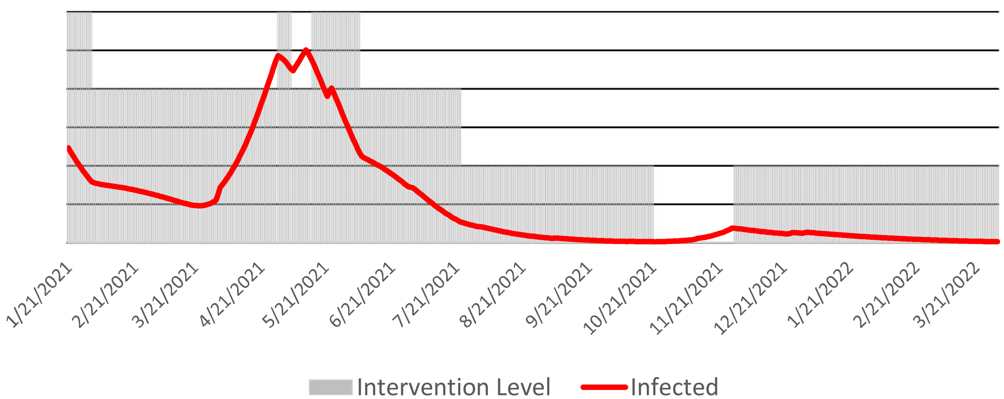




Significant Intervention in Terms of Vaccination or Lockdown may be Required to Eliminate Future Waves

Vaccination

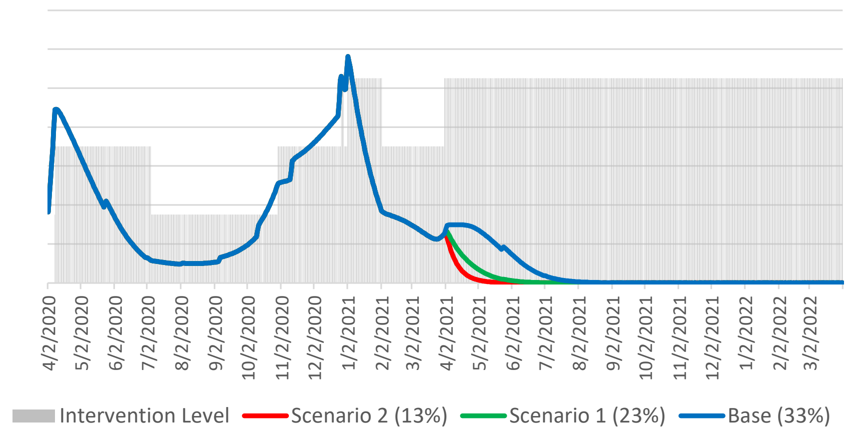
Infected Cases Over Time - 100% Population Willingness to Vaccinate and Increased Vaccine Supply



A very effective vaccine rollout with full participation could see "back to normal" in the fall for a short period, but minor restrictions may be required again to mitigate seasonality.

Lockdown Intervention

Infected Cases Over Time - Strict Lockdown Intervention



A strict lockdown starting Apr 1, would have taken 2-6+ months to reach zero cases, depending on how much contact is limited. Scenarios tested here varied from 13% - 33% of pre-pandemic interaction.

This assumes no new cases from travel.

Key Takeaways

- There is a lot of uncertainty related to the future of Covid-19.
- Moderately different assumptions can lead to significantly different outcomes.
- This is an evolving pandemic with unknown-unknowns that further cloud our ability to build accurate models.
- The interaction of various factors requires thoughtful exploration before drawing strong conclusions
- Opportunity: Actuaries are experts in understanding uncertainty and quantifying risk. We can contribute positively to public understanding of Covid-19.

Challenges related to this project

- It took time to go from “How can Actuaries contribute to Covid-19 Research?” to a specific mandate that could be actioned.
- Epidemiologists are busy! We had to engage many groups to find researchers who were generous enough to share their research and model with us.
- Significant effort was required just to begin our analysis. Anything we wanted to explore needed to be factored into our model.
- Scope Creep: Early results always lead to more questions than they answer.
- The “current” Covid-19 situation is constantly evolving.
- Future Challenge: Sharing insights publicly.