Risk for COVID-19 Resurgence Related to Duration and Effectiveness of Physical Distancing in Ontario, Canada

Background: Insights from epidemiologic models have helped to guide and improve understanding of mitigation policies for coronavirus disease 2019 (COVID-19) across the globe. As the pandemic progresses, models can be used to quantify what may unfold when such measures are relaxed.

Objective: To explore the effect of physical distancing measures on COVID-19 transmission in the population of Ontario, Canada.

Methods and Findings: We previously described a transmission model of COVID-19, stratified by age and health status, in the Canadian province of Ontario (1). It evaluated nonpharmaceutical interventions to control the COVID-19 pandemic and preserve intensive care unit (ICU) capacity. The model found that physical distancing effectively mitigated spread but needed to be applied for long durations in either a sustained manner or with periodic dialing up and down of restrictions to prevent resurgence of infections and keep the number of cases requiring ICU care below ICU capacity.

To update the model, we calibrated it to observed Ontario data using maximum likelihood estimation, incorporated recent data on durations of latent and presymptomatic periods (2), and revised values for the proportion of mild infections that were detected and isolated (10%) and the proportion of exposed cases that were quarantined (10%) based on data from local public health partners and other modeling groups (1, 3). We assumed a 70% reduction in contacts with the implementation of physical distancing measures (4) approximately 3 weeks after the model start date of 6 March 2020. Fitting involved varying the basic reproductive number (\( R_0 \)), initial number of infected persons, infectious period, and average length of ICU stay, with all other parameters unchanged (1).

After being fitted to confirmed case patients occupying ICU beds and COVID-19–attributable deaths among hospitalized case patients in Ontario for 19 March to 3 May 2020 (Figure 1), the model projected up to 37.4 cases (95% credible interval [CrI], 27.7 to 59.4 cases) in ICUs per 100 000 per-
sons in the population without intervention, compared with 2.0 cases (95% CrI, 1.6 to 2.3 cases) per 100,000 with physical distancing. Similarly, deaths among hospitalized case patients without intervention (12.7 deaths [95% CrI, 9.9 to 18.7 deaths] per 100,000) were 5-fold higher than with physical distancing (2.5 deaths [95% CrI, 2.0 to 2.9 deaths] per 100,000).

Relaxation of physical distancing measures without compensatory increases in case detection, isolation, and contact tracing was projected to result in a resurgence of disease activity. Figure 2 illustrates the number of days until ICU capacity may be exceeded when contact rates are varied from 70% to 0% of normal after a period of 8 to 12 weeks with strong reductions in contacts (70%). A return to normal levels of contact would rapidly result in cases exceeding ICU capacity. Maintaining physical distancing for a longer period delayed this resurgence, but the level of contact after restrictive distancing was the major factor determining how quickly ICU capacity was expected to be overwhelmed.

Discussion: To date in Ontario, the number of cases in ICUs has remained below current (recently expanded) ICU capacity. The provincial response was initiated in mid-March with the declaration of a state of emergency on 17 March 2020. Without intervention, we projected that Ontario would have rapidly exceeded ICU capacity and observed substan-

Figure 1. Model-projected COVID-19 outcomes with and without physical distancing measures.
Our modeling also shows the challenges associated with relaxation of physical distancing measures without a concomitant increase in other public health measures. Specifically, when the number of contacts between persons returns to more than 50% of normal, we expect disease activity to resurge rapidly and ICUs to quickly reach capacity. Our model results suggest that in the absence of improved capacity for testing and contact tracing as a means of controlling COVID-19 spread, policymakers could consider staged relaxation of physical distancing and monitor changes in contacts (for example, using digital approaches) as an early warning signal.

A limitation of our model is that it was fitted to mortality among hospitalized case patients; thus, the results presented here apply to community transmission. Ontario, like many other jurisdictions, is experiencing outbreaks in long-term care homes. To date, 65% of confirmed COVID-19 deaths in the province have occurred outside hospitals, and there is a divergence between trends in hospitalizations and mortality that represents different pathways of care for persons in long-term care homes (5). Understanding and describing the dynamics of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission in long-term care homes and other institutional settings is important for protecting the most vulnerable members of our society and requires alternate modeling approaches and control measures.

We show deterministic outputs for the epidemic projections with different levels of relaxation of physical distancing. Given variability in $R_0$, local community transmission may be eliminated or time to resurgence delayed. However, as long as SARS-CoV-2 is circulating globally, population susceptibility remains, and while we have open borders, the risk for re-introduction and resurgence continues. Our results show the challenges that lie ahead as we move to the deescalation phase of the first wave of the pandemic.

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Reproducible Research Statement: Study protocol: Correspondence regarding methodological issues should be directed to Dr. Fisman (e-mail, david.fisman@utoronto.ca). Statistical code: Available at https://github.com/ashleighrt/Ontario-COVID19-model. Data set: Data used for fitting are not publicly available.

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