

The COVID-19 Risk Assessment Model: an Interactive Epidemiologic Modelling Platform

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Background

Decision makers are challenged with formulating robust responses to the current COVID-19 pandemic.

They must determine

- when to introduce and relax interventions,
- which groups to target, and
- how to allocate scarce resources across multiple demands and patient groups.

There is a lack of modelling resources which interactively predict outcomes under combinations of public health interventions (contact tracing, quarantine, social distancing) and prevention and treatment options (immunization, antiviral treatment).

Objective

Provide a modelling platform which is:

- (i) is broadly applicable and accessible,
- (ii) evaluates current and potential future interventions, and
- (iii) is structured to use high quality surveillance inputs, and account for uncertainty in model parameters.

The COVID-19 Risk Assessment Model (CRAM) is the basis of our platform. The full platform includes model fitting, evidence synthesis, expert elicitation, as well as probabilistic and interactive modelling components.

Methods

The model: CRAM is an ordinary differential equation model with the following features:

- Two risk, and 16 age groups.
- Disaggregation of social distancing interventions into work, school, home, and other locations.
- Inputs from Alberta Health data holdings wherever possible,
- Adaptable to other jurisdictions.
- Evaluation of quarantine, test and trace, and social distancing interventions.
- Adaptable for future immunization and antiviral treatment options.

Health economics: Costs and utilities are included to estimate Net Monetary Benefit (NMB) from payer and societal perspectives.

Data: Model leverages jurisdictional data as inputs. For inputs which cannot be estimated with jurisdictional data, such as the duration of the infectious and latency periods and economic inputs, we draw from the literature and a national review produced by the Public Health Agency of Canada (PHAC).

Calibration: Calibrated to observed data using a latin hypercube generated with plausible parameter values for simultaneous calibration of unknown parameters.

Analysis: The fitted model samples from the distribution for each input over a number of simulations as defined by the user, and uncertainty in model outputs is represented as quantile-based credibility intervals. We estimate uncertainty distributions (comparing the fit of beta, uniform, and gamma distributions) for each of the calibrated parameters.

By providing a platform to synthesize epidemiologic and economic outcomes in an NMB framework, better decisions will be made. The reasons for this are twofold: (i) jurisdictions will be enabled to evaluate tradeoffs between public health and broader economic concerns, and (ii) across jurisdictions and decision-making levels, decision makers can access a single platform, providing consistency and coherence in decision outcomes.

Figure 1. CRAM Structure

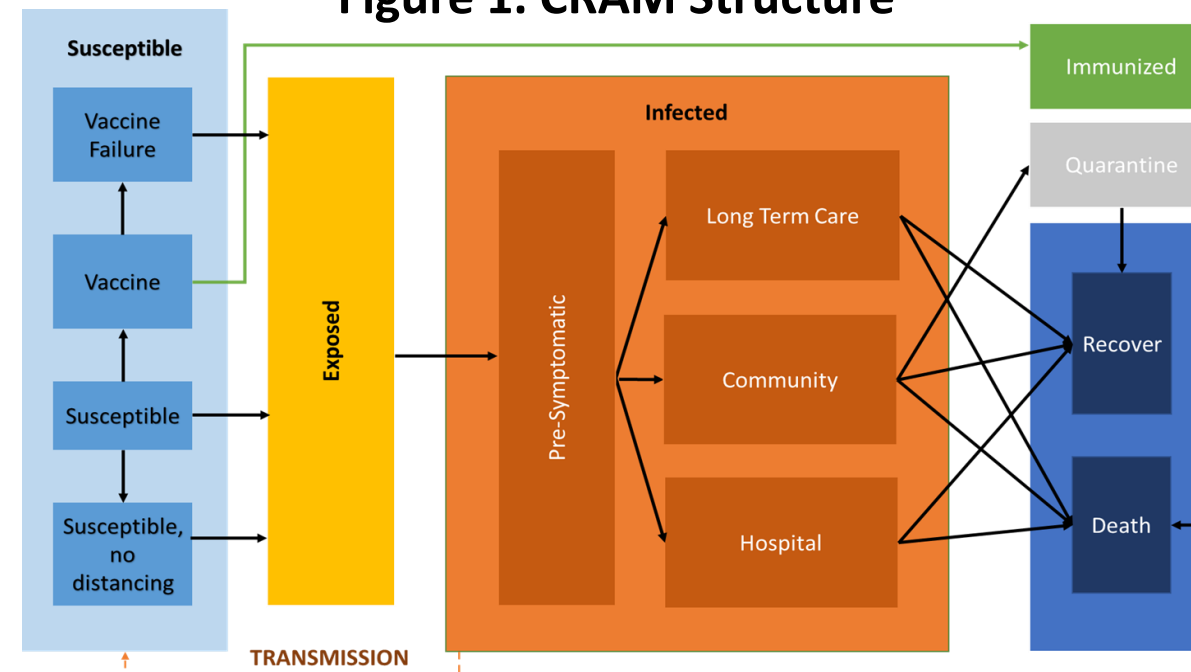
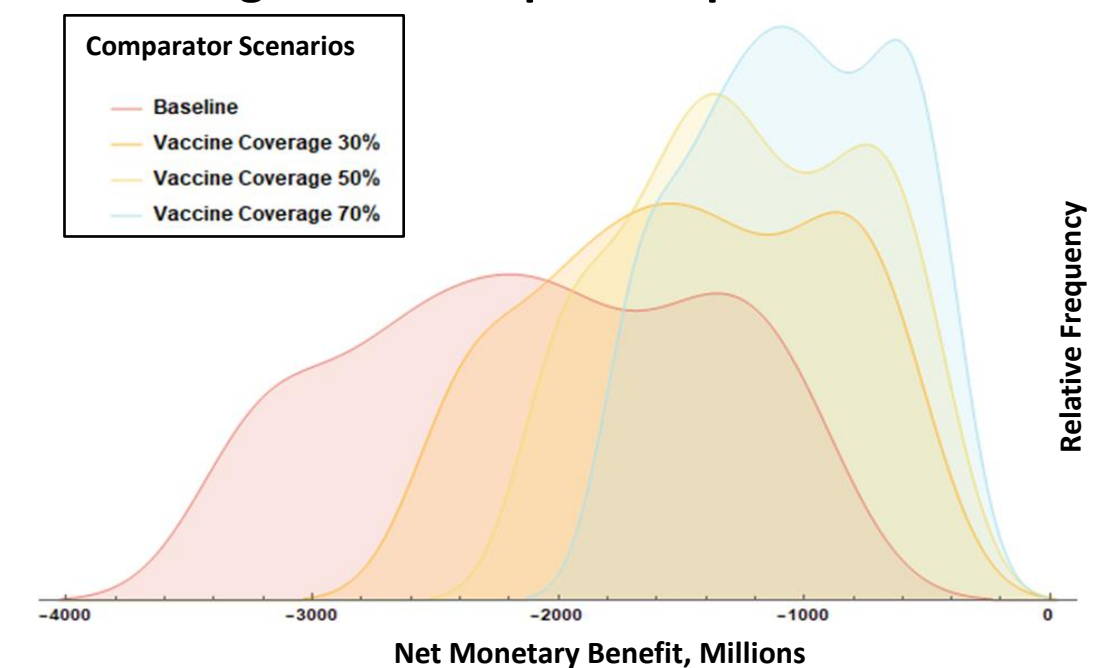


Figure 2. Exemplar Outputs



Results

Our platform makes a significant contribution.

- (i) Structured to incorporate jurisdictional data and new evidence
- (ii) Structured to allow any combination of intervention implementation and timing to be compared.
- (iii) Provides health economic outcome predictions.
- (iv) Will be made freely available with a simple user interface.

CRAM supports:

- (i) improved decision making and outcomes for end user jurisdictions,
- (ii) a consistent platform for decisions, improving coherence in policies at all levels of decision making and across jurisdictions.

Conclusion

CRAM offers a platform to synthesize epidemiologic and economic outcomes and improve decision making by:

- (i) Enabling jurisdictions to evaluate tradeoffs between public health and broader economic concerns.
- (ii) Providing a consistent platform across jurisdictions and decision-making levels, providing consistency and coherence in decision outcomes.
- (iii) Supporting governments to balance the health of individuals, the capacity of health systems, and the social and economic needs of the population.