Creating an open-source tool to model opioid overdoses and deaths

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I. Background

Canada has seen an increasing number of opioid-related harms and deaths, with an estimated 39,435 opioid-related hospitalizations and 40,462 apparent opioid toxicity deaths between January 2016 and June 2023[1]. The objective of this project is to develop an open-source modelling tool aimed to provide insight into the opioid epidemic at multiple levels of health administration across Canada. In particular, the model will be directed towards analyzing the impact of policies and intervantions at sub-provincial geographic units.

II. Methods

We are developing a compartmental agent-based risk model which will leverage detailed socio-demographic and other data to simulate the frequency and locations of opioid use as well as fatality of overdoses. The model focuses on stimulating counterfactual scenarios by allowing a number of policies and interventions to be applied to the simulated population and assessing their impact. A key feature of the model is the capability to produce outputs at a health region or public health unit level, enabling region-specific analysis for local health authorities.

III. Implementation

The implementation of the model will follow an open-science approach to research and dissemination:

- Written completely in the Python
- Accompanied by Dash/Plotly user interface
- Pre-packed datasets tailored for public use
- Publically available on the Statistics Canada Github page

IV. The Model

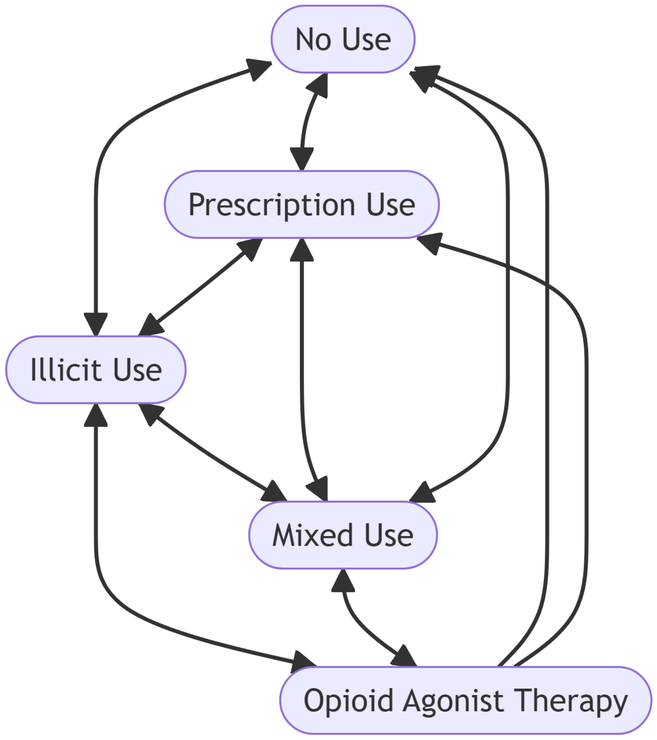
The model simulates opioid use and outcomes over a number of days, weeks or months for a synthetic population representative of a public health unit. The synthetic population is derived from the following:

- Statistics Canada internal data + local population characteristics
- Population profile is represented as a set of probability distributions
- Large number of indidividual characteristics, e.g., socio-demographic, socio-economic, geographic, health conditions

V. Opioid Use State

These states compartmentalize the ways in which a model individual may use opioids. Directed arrows represent possible transitions between use states, with transition rates dependant on any of the following:

- An individual's personal characteristics
- Location of opioid use
- Events that have occured for the individual or in the world
- Interventions or policies that have been applied to the simulation
- Transition multipliers specific to the health care system of the public health unit



VI. Locations

These states include the location in which the agent is currently using opioids:

1. Housing status
2. Hospital
3. Prison
4. Safe site
5. Other

VII. Events

Certain events may impact on opioid-related outcomes, on a personal or global level:

1. Supply contamination
2. Injuries
3. Social assitance cheques
4. Overdoses
5. Compartment changes

VIII. What-If Decision Making

A key feature of a modeling approach is the ability to simulate counterfactual ('what-if') scenarios. For example:

- What if there are more take-home naloxone kits available in the community?
- Do supervised safe consumption sites reduce the burden of opioid-related harms?

Our model can be adapted to include a number of policies or interventions related to opioid use and outcomes in order to explore different scenarios and their impact on the community. The model includes the following:

i Take-home naloxone kit availability
Determines the number of naloxone kits available to take home at each moment in time.

i Opioid prescription alteration
Affects the rate at which opioid prescriptions are administered

i OAT prescription alteration
Affects the rate at which Opioid Agonist Therapy (OAT) is prescribed.

i Point-of-contact interventions
This intervention represents a broad class of interventions which may occur when an opioid-using actor comes into contact with some form of system. For example, visits to the hospital, emergency room/department, prison, or supervised safe consumption sites.

IX. Conclusion

We are developping a tool that can support policy makers and researchers intersted in opioid-related outcomes, while being openly available and easy to use. A focus on sub-provincial geographies and model adaptability will further ensure that the model remains useful in a variety of scenarios.

X. Acknowledgements

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[1]Public Health Agency of Canada: Opioid- and Stimulant-related Harms in Canada