NCCID Video Script #1:
Mathematical Modelling in Public Health

A model is a representation, or simulation of something in the real world.

Mathematical modelling is a research method that uses mathematics to create simplified descriptions of systems, behaviours and processes.

In public health, mathematical modelling is used to help answer difficult questions and understand complex relationships between biological, demographic, and environmental factors.

Mathematical modelling cannot answer everything, but it can be very useful to understand certain types of public health problems and improve evidence-based decision-making with transparency.

For example, modelling can help uncover drivers and dynamics of disease and mortality; forecast future disease burden and intervention outcomes; and evaluate the cost-effectiveness of public health strategies.

Every mathematical model begins with a question. Using *tuberculosis prevention planning* as an example, our research question could be:

What are the potential effects of 3 interventions on TB incidence?

- ONE - purchasing a rapid diagnostic machine;
- TWO - conducting regular screening in schools; or
- THREE - improving treatment success rates with incentives and enablers.

TB is a complex disease, and its transmission is affected by many inter-related factors, but mathematical modelling can use what is most relevant to our question to untangle this complexity.

An effective model of the world we are simulating requires gathering good information from sources like existing modelling studies, surveillance data, research papers, and expert opinion.

A modeler will help us decide which specific method works best for our question. For example:

- Dynamic or static;
- Individual or compartmental
- Stochastic or deterministic
- Cohort or transmission

Next, to create a model diagram, we will need to use what is known about TB and how it spreads, as well as information on our interventions and local context.

The model is then filled with the *model parameters*: the numerical data representing the essential elements of our simulations.

When reliable information for a parameter does not exist, modelers must make assumptions based on the best available knowledge and expert opinion.

The model is calibrated by fine-tuning the parameters and assumptions to ensure that it is an accurate and useful representation of reality that can reproduce observed and historical data.

Modelers can then create other scenarios and simulate what would happen if certain conditions or assumptions change.

In our example, we would be analyzing the potential outcomes of scenarios that match our 3 different interventions.

It is important that modelers analyze the results for sensitivity and uncertainty; always include a range of estimates for each scenario; and pay attention to any information limitations used to create the model.

Finally, modellers and public health personnel interpret the model outcomes, draw conclusions and make recommendations for action.

For example, we might find that incomplete treatment is a major driver of TB transmission in a population, so in this case, intervention 3 would be an effective response.

Public health decisions are based on many different considerations. Mathematical modelling is one research method to support systematic, evidence-driven, and transparent decision-making for complex public health problems.

You can learn more about modelling for public health at the National Collaborating Centre for Infectious Diseases:

nccid.ca

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