NCCID Video #2 Script: Mathematical Modelling – Flu Vaccine

Mathematical modelling is a research method that can inform public health planning.

For example, we can use a model to investigate the best vaccine to protect an elderly population at increased risk of infection and severe complications from seasonal influenza.

For adults over 65, the **high dose trivalent inactivated vaccine** is currently recommended when available.

Other options for this population include:

- **standard dose trivalent inactivated vaccine,**
- **adjuvanted trivalent inactivated vaccine** and
- **a standard dose quadrivalent inactivated influenza vaccine**

Step 1: Determine the Research Question

Our research question could be:

'Is a new vaccine more beneficial that than the vaccine currently in use in reducing the number of influenza infections, hospitalizations and deaths in older adults for the next flu season?'

With mathematical modelling, we can show which seasonal influenza vaccine provides better protection to this population.

Step 2: Identify the Key Biological Processes

Next, we need to understand the natural history of the disease, including transmission dynamics and immunity development, to create the model.

Step 3: Adapt the disease process to a model

In our model, we can illustrate how different vaccines affect the spread of seasonal influenza between susceptible and infected peoples.

Step 4: Collect and input data as parameters and assumptions

To answer our research question, data inputs can include:

- rates of infection
- strain infectivity
- vaccine efficacy and
- vaccine uptake and coverage

We can also use expert opinions on the vulnerability and resilience of the population.

Step 5: Apply and investigate the effects of changing parameters

To answer the research question, we create models of 3 virtual trial worlds for an elderly population:

- in World 0, the base scenario, they receive no vaccine;
- in World A, they receive **Vaccine A**; and
- in World B, they receive **Vaccine B**.

We determine a base scenario that produces outcomes closest to observed data for past infection and hospitalization rates through model calibration. That is, changing the numbers related to transmission rate and other assumptions about the population.

Step 6: Model Scenarios

We can explore the minimum vaccine coverage needed to significantly reduce influenza infection in the elderly population through adjustments to each vaccine scenario.

Step 7: Interpret the findings

To answer our question, we compare the base model – no vaccine – to the vaccination models for:

- the number of infections,
- the number of hospitalizations, and
- the number of deaths.

If our model finds, for example, that **Vaccine A** reduces the rates of hospitalization and death among the elderly, this would reduce stress on families and the health care system.

We can also estimate the costs and potential costs-savings of this intervention.

Mathematical models are used to test 'what if' experiments and represent simplified versions of a complex system.

They will always be limited by how well we understand the biology of the disease, interactions between people and consequently, the data used in the model.

And because there are so many things that we do not know, the model will always give a range of estimates that reflect these uncertainties.

Modelling is a time and cost-effective strategy and a valuable research method for helping to make public health decisions that can improve the health of a population.

You can learn more about modelling for public health at the National Collaborating Centre for Infectious Diseases (nccid.ca).

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