Developing a pandemic influenza mitigation model for Cambodia

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Project Aim

To develop an approach to evaluate the cost-effectiveness of pandemic mitigation options in Cambodia.

Why Cambodia?

South East Asia is a hotspot for emerging infectious diseases, including novel influenza strains.

Cambodia in particular has the highest regional burden of respiratory tract infections and to date has reported 19 cases of H5N1 avian influenza, 17 of whom have died.

Estimates suggest a future pandemic influenza event may cause up to 62 million deaths globally, with 96% occurring in low and middle income countries.

Cambodia continues to recover from decades of political turbulence; the health system is under-resourced and faces limitations in its capacity to control communicable diseases.

Why Economic Evaluation?

Economic evaluation incorporates information on the costs and effects of an action to tell us not only what public health policies are effective but also which are the best use of resources.

Low and middle income countries face stark choices in the allocation of scarce public health resources. Pandemic preparedness must justify investment against other options for inexpensive public health gains.

Cost-effectiveness modelling can contribute to making evidence informed choices but non-standard approaches are required to evaluate this unusual and complex public health problem.

Pandemic Costs and Consequences

A pandemic event can have far reaching consequences, only some of which can readily be quantified (Box 1).

Box 1: Pandemic costs and consequences

Costs

- Policy investment costs
  - Including stockpile replenishment or other future costs
- Health system costs from a pandemic event
- Societal costs
  - Including lost economic productivity from a pandemic event

Only these consequences will be modeled!

It is important to place results within the wider context of pandemic consequences.

Pandemic Consequences

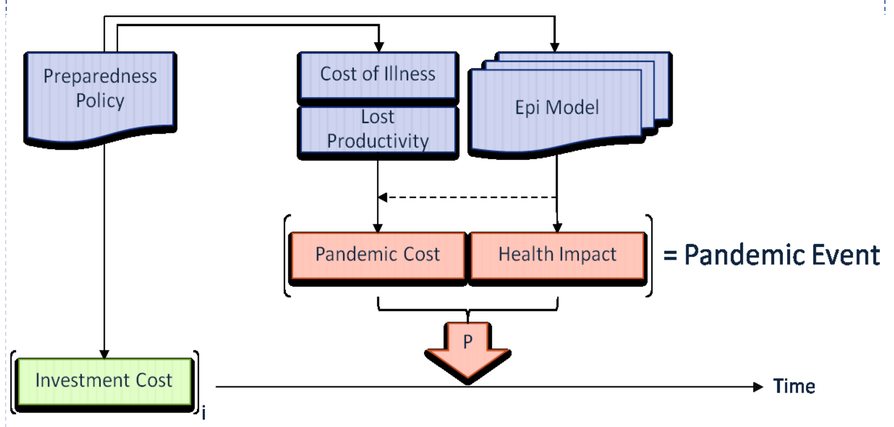
- Mortality
- Morbidity – mild, moderate and severe
- Disruption to health services
- Disruption to other public and private services
  - E.g. threat to food security
- Impact on mental or psychosocial health
- Extra-national consequences of pandemic spread

Policy Consequences

- Reduced pandemic consequences
- Externalities
  - E.g. Increased routine health system capacity

Developing the Pandemic Model

Fig 1: Economic-Epidemiological Pandemic Model



Calculating an **Incremental Cost Effectiveness Ratio (ICER)**

$$ICER = \frac{\text{Investment Cost}_i - \Delta_i \text{Pandemic Cost}}{\Delta_i \text{Health Impact}}$$

Model System

The model system (Fig 1) hinges on the epidemiological model which describes disease transmission.

Pandemic costs are quantified by linked models.

All are dependent on parameters determined by a policy scenario.

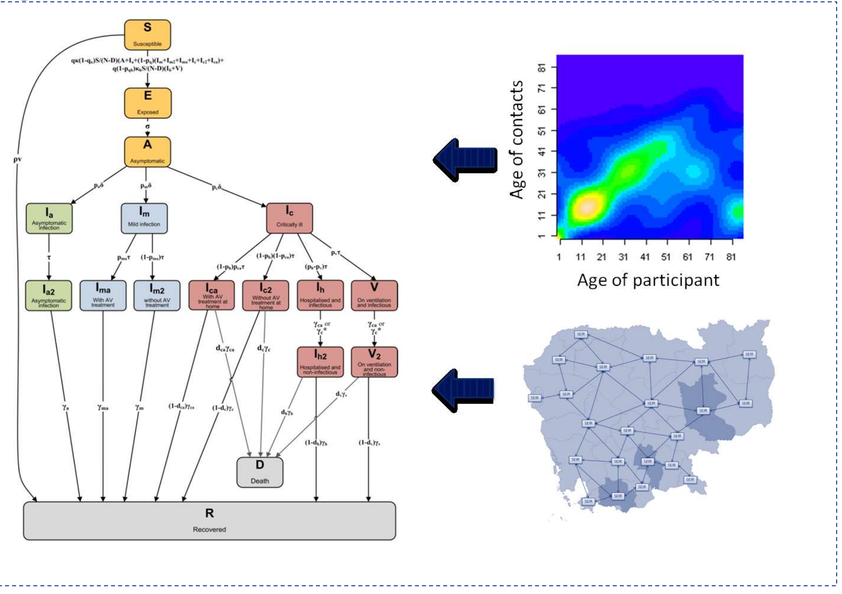
For each scenario the model is run with and without the policy, the difference in cost and health impact allows calculation of a cost-effectiveness ratio.

Transmission Model

The transmission model describes Susceptible (S), Exposed (E), Infectious (I) and Recovered/Dead (R) populations separately per province of Cambodia (Fig 2).

The population is stratified by age group using empirical data on social mixing patterns (Box 2).

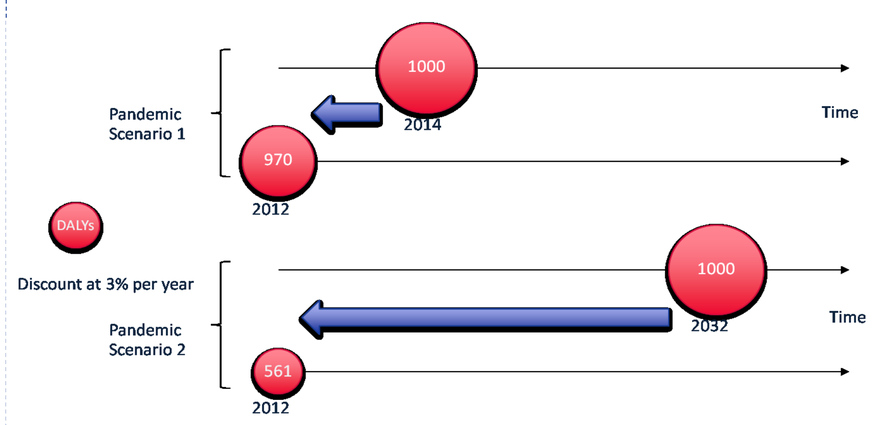
Fig 2: Cambodia Influenza Transmission Model (Epi Model)



Box 2: Data collection on person-to-person contact rates

A survey of 2000 households in three provinces was carried out to collect data on human contact, animal contact and treatment seeking behaviour.

Fig 3: Discounting future pandemic outcomes



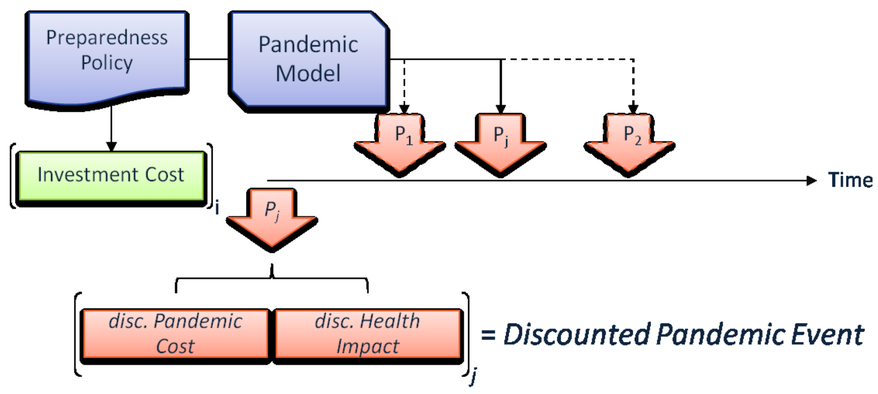
Pandemic Uncertainty

Future costs and consequences might be discounted to reflect their present day value (Fig 3).

Therefore assumptions about pandemic timing have the capacity to affect cost-effectiveness results.

Using Monte Carlo simulation to vary the characteristics of the pandemic strain and timing of the pandemic event allows probabilistic analysis of policies in a range of scenarios (Fig 4).

Fig 4: Modeling pandemic uncertainty



Incremental Cost Effectiveness Ratio (ICER)

$$\frac{\sum_{1}^{j} ICER}{j} = \frac{\left[\text{Investment Cost} - \Delta_i \text{disc. Pandemic Cost}\right]_j}{\left[\Delta_i \text{disc. Health Impact}\right]_j}$$

Summary

We have developed a sophisticated model system which incorporates variability in population, health system and pandemic characteristics. This model system facilitates pandemic mitigation cost-effectiveness analysis in a range of scenarios.