Improving Pandemic Preparedness

A new model coordinating international influenza vaccination programmes aims to reduce the global financial and health cost of the influenza virus.

Seasonal influenza outbreaks kill between 300,000 and 500,000 people every year and cost hundreds of billions of dollars in healthcare and days off work.

Vaccination programmes have reduced the intensity of the impact but - given the interdependent risk of infectious disease transmission - the potential of misaligned incentives in the influenza vaccines' supply chain may result in less than ideal coverage from a global health viewpoint.

The challenge in aligning the incentives and health goals of different purchasers of influenza vaccines to achieve a globally optimum allocation is the focus of recent research conducted by Stephen Chick, INSEAD Professor of Technology and Operations Management; Hamed Mamani, Assistant Professor of Operations Management at the Foster School of Business at University of Washington; and David Simchi-Levi, Professor of Civil and Environmental Engineering at Massachusetts Institute of Technology.

Their study, A Game-Theoretic Model of International Influenza Vaccination Coordination came up with a new global contract to reduce inefficiencies in the supply chain and the overall financial and health burden of influenza outbreaks.

Numerical experiments suggest the contract could prevent millions of influenza cases and save tens of millions of dollars every year, says Chick . "The benefits would be derived through financial incentive to improve vaccine coverage, prevent influenza transmission in countries where key strains emerge and reduce international transmission."

Interdependent risk

Currently influenza vaccination programmes are designed by individual states based on their perceived risk and cost of infection. Often, however, these individual objectives fail to take into consideration the interdependent risk which comes from cross border infection.

Chick, Mamani and Simchi-Levi's model accounts for those interdependent risks and shows how these global health outcomes might be improved by coordinating vaccination programmes across state boundaries.

Outbreaks, says Chick, typically start in Southeast Asia and transmit globally.

Despite voluntarily sharing samples of emergent flu strains to enable pharmaceutical companies to manufacture new vaccines, many developing countries in the region are unable to afford vaccination programmes to counter the seasonal

influenza outbreaks.

Compensating source countries

In 2007, Indonesia temporarily stopped sharing samples of human cases of avian influenza with the World Health Organisation (WHO), claiming it was not adequately compensated or given affordable access to the very vaccines its samples were used to create.

The country's actions were seen as a threat to the construction of global health strategies for fighting avian flu and prompted a series of initiatives aimed at ensuring regions that are the source of infections receive guaranteed vaccine quantities.

The question now is how to coordinate vaccination manufacturing and administration to ensure the risks, costs and benefits are evenly shared.

Chick's paper uses a game-theoretic, or mathematical, approach to construct contracts with a formula that provides a win-win-win situation for developing countries (often the source of the infection), wealthier nations and vaccine manufacturers.

The key idea is that the source country is subsidised by wealthier nations to increase its vaccination efforts. The wealthier nations will ultimately benefit by the lower risk to cross border infection.

The subsidy would be in a lump sum dependent on number of factors including the total burden of treating people (the cost of vaccinations plus healthcare associated with the influenza virus), the fraction of people being vaccinated, the total population and the vaccine procurement cost.

"The equation used accounts for the financial burden of the season with an epidemic model that predicts the number of people that get infected as a function of the number of people that are vaccinated and a model for vaccination costs," says Chick. "What we're trying to do is minimise these totals." While formally the contracts seek to minimise the global direct and indirect costs of the influenza outbreak, in numerical experiments they also reduce the total number of individuals infected.

The contract does not necessarily require the participation of vaccine manufacturers, but would need to involve both the source country or region and the health ministries of countries most at risk from interdependent or cross border infection.

Quantifiable benefits

The contract has been published in a number of academic papers which quantify the potential benefits of coordination for achieving these global health goals, both to developed and developing countries. The benefits can then be compared with the cost of implementing such coordination mechanisms. This process, says Chick, would need to be done by a respected third-party such as WHO or the Global Alliance for Vaccines Immunisation (GAVI).

"We do not prognosticate as to whether governments could agree to a contract such has been structured here," Chick, Mamani and Simchi-Levi note in their paper. "This paper quantifies however, that there is non-trivial financial and health benefits if such an agreement can be found."

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