Quantifying the risk of pandemics created through air travel: Creating models for efficient response

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Disease mappers. Travis Waller and Lauren Gardner. Credit: Grant Turner, Mediakoo

A viral disease is contracted abroad and transported unknowingly by a human host. Discrete symptoms linger beneath the skin as the person boards their flight home, delivering the virus across oceans and borders to a previously unexposed and susceptible region.

The scenario has been well documented by Hollywood thrillers. In a time when global transport networks move people, animals, commodities and pathogens faster and in larger volumes than ever before, these are the challenges facing biosecurity and disease-control organisations: predicting the origin of infections and pinpointing high-risk destinations before invasions and outbreaks can occur.

"We can't monitor everyone at every airport, at every gate, but if we can help identify certain passenger routes and locations that are much higher risk than others, we can more effectively deploy often limited resources," says Dr Lauren Gardner, a lecturer in the School of Civil and Environmental Engineering.

Gardner is part of the newly formed Research Centre for Integrated Transport Innovation (rCITI) at UNSW and is investigating the ways global transport systems can facilitate the spread of contagious diseases.

She has been developing mathematical models to help identify high-risk passenger air traffic routes between origins where diseases are endemic and susceptible foreign destinations, with a view to further investigate high-risk shipping routes.

"The ability to quantify this risk is fundamentally new," says Professor Travis Waller, rCITI director. "The necessary data exists – at least in part – where it historically hasn't, and computational and methodological advances have reached the point where we can now make sense of this data in meaningful ways."

The models require extensive travel data, including passenger numbers and distances between different cities and airports; outbreak and infection data by region; and environmental suitability maps, comprising ecological, biological and climatic data. These are used to assess the likelihood that destinations will be able to sustain invading species.

"We are trying to identify the most probable outcome for spreading scenarios within and between regions," says Gardner.

Researchers in the centre have already developed models around flu outbreaks and the risks of dengue fever importation to the US and Europe. An accompanying article detailing their results has been accepted for publication in the *Journal of Tropical Medicine*.

Dengue fever is the most common mosquito-borne disease in the world, and with increased air traffic volumes, the number of travel-acquired cases in the US and Europe has risen steadily over the past decade.

"This model includes the probability that someone leaving the origin is infected, and the likelihood of them successfully transmitting to someone else at the destination," says Gardner. And while their results may look intuitive, with greater risks observed between locations with high-frequency travel and similar climates, they are backed up with historical data.

It is in essence, a framework. The model can be scaled up or down, and extended to different geographic regions, diseases and modes of transport, so long as the necessary data are available.

But lack of disease and infection data, particularly in underdeveloped nations, remains a major challenge.

"We have travel data. We know exactly how many people are travelling by air between every airport in the world. But what we don't have is extensive disease data. It's not collected at the same scale or in the same way across cities, countries and regions," says Gardner.

Part of the larger aim of the project is to motivate better disease and infection data collection.

"We really want disease data at the city level and at a minimum, aggregated temporally by season rather than by year – as this feeds into environmental suitability for spreading."

"It's very much a chicken and egg scenario," says Waller. "One reason the data isn't collected in a consistent format is because we've never had a reason to do so without these types of models. We now have this capability."

Provided by University of New South Wales

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