Life Equation: How math is helping with COVID-19 and other catastrophes

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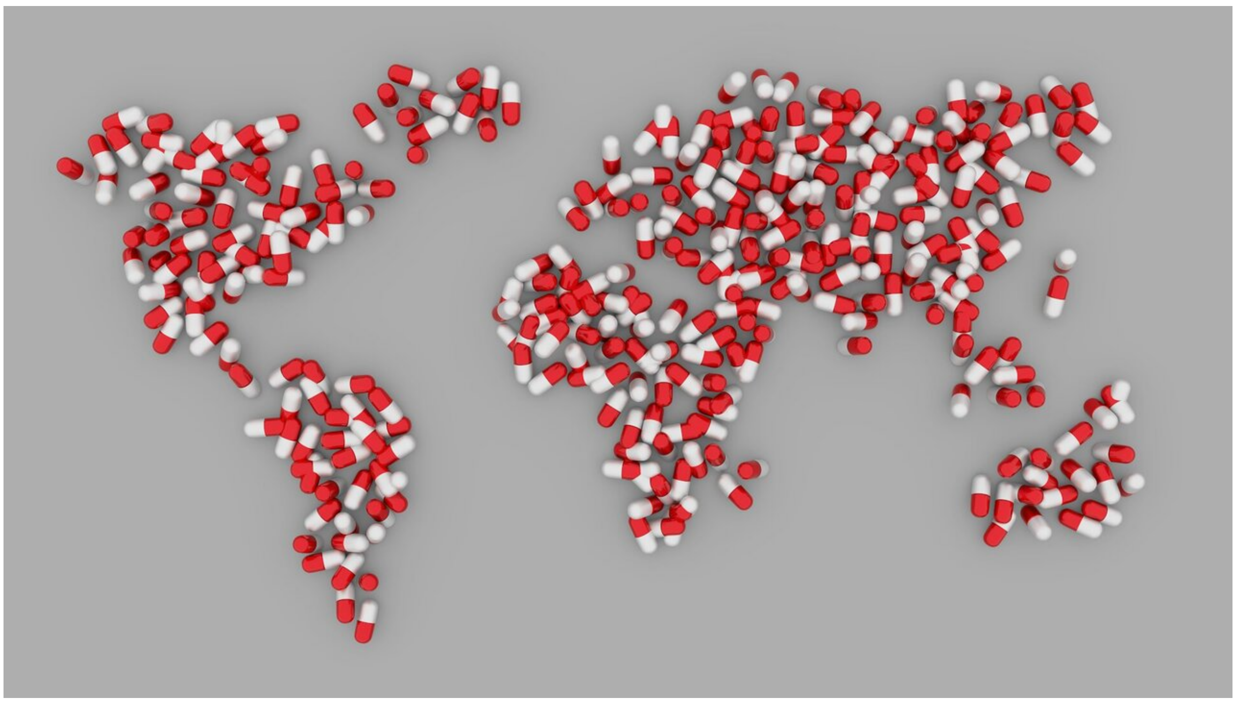

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It's the best tool we have, according to Dr. Mark Flegg a mathematician in the Monash School of Mathematics.

Dr. Flegg was commenting on the use of mathematical models for guiding policies and analyzing data on COVID-19; models like those published this week by Doherty Institute researchers.

Released on Tuesday, the Prime Minister Scott Morrison said the data backs up the 'flattening the curve' principle adding that "Australia was on track."

"It [the data] will help us plan the way out for now and certainly over the weeks ahead... the lesson is simple—and that is that we must continue to do what we are doing," the Prime Minister said.

The primary purpose of the modeling is to explore the possible strategies for flattening the curve. Scientists and modelers are working together to address the predicament of finding the strategy which achieves the desired flattening in the most efficient way with the least impact on society.

Dr. Flegg agrees that the data that we are starting to see seems to suggest we are 'doing well' in Australia.

"The modeling gives us the best tool to assess what we mean by 'doing well' when looking at the data, it provides context to the data," Dr. Flegg said.

"Without a model, it is plausible that people might worry because the total number of confirmed cases continue to rise. It is important to understand that the models all predict the same shape for the curve that represents the number of infected people. Evidence that the curve is flattening does not mean that the number of infected people decreases early. On the contrary, if we have successfully flattened the curve, we expect to see the number of infected people decrease after a longer period of time than if we take no measures to stop the virus. According to the models, we will know the curve is being flattened when we see a change in the rate of new infections. We are interested in deviation of the growth in the number of infections away from exponential growth."

"Since late March, we have definitely seen a drop in the number of new confirmed cases. This is a good sign. It is likely that the decrease is due to measures that have made transmission from travelers more difficult. It is important not become complacent. As the models and historical experience predict, the number of infections can resurge if we change our behavior. This is because most Australians still have no immunity to COVID-19."

For Dr. Flegg, a senior Lecturer of Applied Mathematics who specializes in mathematical biology, the role of mathematics in making wise choices when it comes to crises like the one we are facing is similar to the foundations of a house; they are usually not seen but without it the house comes crashing down.

"Historically, we see mathematical minds and their approach to public health, Florence Nightingale is a well-known example, can lead to effective medical strategies with profoundly positive impacts."

Mathematical modeling of human diseases is not new, just unfamiliar to the public.

The same modeling ideas that are being used for the COVID-19 outbreak were thought up about 100 years ago by researchers such as Ronald Ross and William Hamer and widely used to successfully model most of the infectious diseases of the 20th and 21st centuries, leading to effective control measures. The idea of using mathematics in disease spread more generally goes back to the 18th century.

Similarly, according to Dr. Flegg, strategies such as social distancing are not new.

"They are not without precedent in their effectiveness—social distancing was used with great success for the 1918 Spanish Flu, saving many lives."

modeling of a pandemic allows for predictions to be made about outcomes (specifically infections but also economic and social outcomes) of particular courses of action.

This gives us some insight into which action will lead to the least objectionable outcome.

It doesn't always mean that we will make the right decisions, but at least the decisions will be informed.

According to Dr. Flegg, the type of model that might be applied in a given context comes down to basically two fundamental questions which have to be answered by modelers in consultation with experts in various fields and then translated into mathematical statements:

- What is it you want to know from the modeling?
- And—How do you believe the system you are modeling actually works?

"There is a lot of information now available that answers the second question—although the assumptions should always be open for debate—but the first question leaves open many avenues of investigation which now can be explored at large by researchers around the country since expert data has been released," said Dr. Flegg.

For example, how does individual person-to-person interactions and practices such has handshaking and distancing quantitatively affect transmission rates? What about other specific strategies? To answer some of these questions, new or adapted models could be written with different directions and focus which allow for differentiation between more varied human behaviors.

For some complex questions, mathematicians can use a wider array of techniques. For example stochastic models were important when 'noise' plays a role in the model predictions (and often this takes a trained eye to see), but also rule-based simulations were sometimes used.

"There are many different approaches and these mostly depend on what it is that you want to investigate," Dr. Flegg said.

The government already has in place dedicated mathematicians who deal with precisely crises like COVID-19 and other crises facing the modern world; for example the Bureau of Statistics gathers data for use in models, and researchers at the CSIRO as well as many other university and non-university affiliated institutions are constantly modeling a wide range of phenomena and investigating many complex quantitative questions from many fields such as science, industry, economics, engineering and many others. The work of these mathematicians are used to improve our quality of life.

"The chances are, if you ask 'why is that so?" or "I wonder what would happen if…?" there is a mathematician somewhere who has tried to incorporate descriptive equations into a model to answer the question," Dr. Flegg said.

Solving a crisis like the COVID-19 pandemic is a multifaceted scientific endeavor.

"Mathematics and models are fundamental to this process but it also depends critically on the discoveries in other sciences," said Dr. Flegg.

In Dr. Flegg's opinion, mathematical models at the population level like the ones used to fight COVID-19 can be used to address particular questions but do not capture the nuances of individual diversity; the small business owner, the overloaded teacher, the healthcare worker who also has to look after elderly family members. The government has taken an appropriate stance when it comes to using mathematical modeling in their decision making. It only informs, and does not determine, the decision making when it comes to safeguarding against a COVID-19 medical catastrophe. Ultimately governmental decisions at this time should be made with the welfare of the people as top priority, across the spectrum of suffering that is being experienced.

We are still learning about the coronavirus, and there is a high degree of uncertainty in its transmissibility and severity, as reported by the scientists that are leading the modeling efforts, according to Dr. Theodore Vo, also from the Monash School of Mathematics.

"What the modeling is trying to achieve is a best possible outcome in a terrible situation," he said.

"Given all the uncertainty and unknowns, how can we minimize casualties, slow the spread of the virus, and minimize the load on the healthcare system?"

According to Dr. Vo, the current model indicates that we are on the right track with the social distancing measures in place.

And this was further supported by data from countries that were ahead of Australia in the progression of the infection and started social distancing measures early, such as South Korea.

Provided by Monash University