ETAJOE/stock.adobe.com

Published 3 June, 2020

ALL MODELS ARE WRONG, BUT SOME ARE USEFUL

Gary Burd, Phd, CMPP, SVP, Global Medical Director, Caudex, McCann Health Medical Communications and Richard Ashdown, BA, formerly Senior Director, Product & Service Innovation, McCann Health Medical Communications

WHAT IS PANDEMIC MODELING?

A line of scientific discipline connects John Snow's actions in preventing the spread of cholera in the late 19th century to Larry Brilliant's drive to eradicate smallpox in 1980. That discipline is epidemiology, and it is a cornerstone of public health and pandemic modeling. In short, epidemiology is the study and analysis of patterns of disease, used to shape policy and healthcare decisions. In the context of coronavirus disease (COVID-19), pandemic modelling is how epidemiologists are examining data and establishing predictive trends to indicate how and where we need to address the outbreak.

WHAT ARE THE COMMON COMPONENTS OF MODELS?

A fundamental principle of pandemic modelling is to split the population into three categories according to disease status. This is the "SIR model," which defines people as **S**usceptible, **I**nfected, and **R**emoved/**R**ecovered. This model predicted the course of dengue fever in Latin America, swine fever in the Netherlands, and norovirus in Belgium, amongst others.

Another critical parameter in modelling is the Reproduction (R_0) number, which is the average number of individuals infected by a single disease carrier. If the R_0 value is less than 1, the model is suggesting that the disease will quickly die out, as it is not spreading widely. If it is greater than 1, then the outbreak will grow. For instance, an R_0 of 2 means that the first person with the infection spreads it to 2 others, those to 2 more, etc. for exponential growth. The graphs here show that coronavirus infections grow exponentially without control measures in place. Indeed, Larry Brilliant has already stated that there are concerns that the current R value may yet be underestimated and that policy and government needs to react accordingly. Planning the course of the spread of the virus is how we can attempt to mitigate the wave of pressures imposed on health care systems.

There is a full breakdown of various models in the Coronavirus Tech Handbook. These are open datasets that can be used by others. The project is open source and welcomes contributions from others. The Institute for Health Metrics and Evaluation (IHME) also provides detailed projections.

WHAT ARE THE CHALLENGES?

Pandemic modeling is difficult with COVID-19 mainly because the disease is entirely novel. Also, because of the severity and scope of the disease, systems of data collection are under intense pressure to operate at high speeds, effectively trying to save lives. This is why the World Health Organization emphasizes the need to test, track and trace every COVID-19 case. This is also why those countries that witnessed outbreaks of SARS, with tracing of actual incidents of infection, reacted to coronavirus with a rapidity that others have missed. It also needs to be remembered that models are best guesses. Models depend on data parameters being weighed against each other for relative importance, based on best available information. Furthermore, datasets are often interdependent on each other, which can introduce hidden biases and emphasizes the importance of data sharing. Ultimately, all models deal with unknowns which means that their predictions are not certainties.

WHY IS IT IMPORTANT?

Epidemiologists rushed to model the spread of coronavirus and have been working without rest since the first days of the outbreak. As John Snow found in Victorian England, changing disease understanding takes more effort than removing the source of the outbreak; such as in the case of cholera, a handle of a water pump. Models provide us with guidance to make decisions. Models don't provide perfect answers, but they provide potential scenarios which allow governments, policy makers, hospitals and the general public to prepare for worst cases, best cases, and anywhere in between. As we have seen over the course of the COVID-19 pandemic, as more data have been gathered, predictions become more accurate, and decisions become clearer.

WHAT HAVE WE SEEN WITH CORONAVIRUS?

The early models and original recommendations were based on an assumption of an outbreak of a SARS-like disease, but COVID-19 is novel. The popular initial description of it being 'flu-like' has perhaps led to a sense of a lower threat than was realistic, likely due to our ability to manage flu worldwide in a way that people hardly notice its yearly impact on life. Indeed, some countries' original strategy of 'herd immunity' was based around a lack of realisation that coronavirus was particularly infective, and that COVID-19 was as deadly as it was. As data were collected, the models were updated in response to give a clearer picture, and countries like the UK changed their approach in response to the increasing threat. The UK experience clearly demonstrates the challenges with predictions using models, and ultimately their benefits too.

More data equals better modelling. The importance of tracing infections and tracking the disease is apparent, though there are concerns about infringements on civil liberties. Cognizant of this, the UK NHS and others are working on apps that ensure privacy isn't infringed. There is an official UK self-reporting tracker, one from MIT, one from Mount Sinai Hospital specifically for New York, and one from Singapore, as examples. There is also a major endeavour to track in California using Verily's website and COVIDnearyou.org is also tracking symptoms of the disease. Kaggle are running an open data crowdsourcing challenge, as are others. This crisis has brought out some of the best in tech, with both Apple and Google joining forces to create a tracker that allows for user anonymity.

Country level details on such activities can also be found in https://coronavirustechhandbook.com/home. If you want to become involved in their research and activities, you can join the relevant WhatsApp group.