National Collaborating Centre for Infectious Diseases
Centre de collaboration nationale des maladies infectieuses

Mod4PH Research Highlights Episode 4 Transcript

Welcome to the Mod4PH research highlights. This is a public health podcast produced by the National Collaborating Centre for Infectious Diseases. My name is Wendy Xie, and I am NCCID's modelling knowledge translation project manager.

Today will be one of several episodes for this Mod4PH series, where we showcase mathematical modelling research for public health.

In this episode, we will be speaking to Dr Michael Li, who is a Senior Scientist at the National Microbiology Lab, Public Health Agency of Canada. After completing his postdoctoral fellowship at McMaster University, Michael joined the Public Health Agency of Canada in October 2020. During his postdoc, Michael developed math models to support many global COVID modelling activities. He continues to use his modelling skill set at PHAC in the development and analysis of disease transmission models of COVID-19, mpox transmission, and other infectious diseases in Canada.

Today, Michael spoke with us about a fairly gigantic topic - the past, present, and future of infectious disease modelling for public health.

Wendy - Hello to everyone joining us for this episode, and welcome to Dr Michael Li. Thank you so much for being with us today.

Michael - Thank you for the kind introduction and invitation. Hello to everyone listening, it is my pleasure to be here today.

Wendy - It is great to have you here, and you're definitely no stranger to talking about modelling for public health. I know you've previously described modelling as a way to bridge information from the past, present, and future. Would you please elaborate a bit more on this point?

Michael - So I think it is important to understand what modelling means. The modelling process is broader than what people are used to, which is just making forecasts or predictions. Models are simplified representations of various things, ranging from tangible objects, like action figures, to abstract concepts or generalizations of the real world.

Conceptually, model building is the process of shaping these representations so that we can study their properties and features and explore their possibilities. Infectious disease modelling involves leveraging knowledge and lessons from the past to address present questions and challenges we experience in the present to best prepare for what's ahead in the future.

For example, during the COVID pandemic, when we have a new wave starting to pick up, we want to know how fast this new wave is spreading? how many people will get infected? who is more likely to get infected? and how long it will last. To model this, we begin the modelling process by creating models, fitting to historical data of the past, and estimate key characteristics and patterns, so that we can apply them to the current situation and see how things play out so that we can start preparing for what's coming and what can we do to best respond.

Wendy - And so you did a lot of modelling work for COVID-19. How do you think this work during the pandemic has reinforced this idea?

Michael – The sets of questions that are constantly being recycled are:

1. What's the current situation?
2. What are we up against right now?
3. What do we know from the past that can help?
4. What is likely to happen in the future?

At the very beginning of the COVID-19 pandemic back in 2020, COVID-19 was identified as a new and different type of Coronavirus, using whole genome sequencing of early cases from China. The first set of models were developed by looking back at the characteristics of other Coronavirus outbreaks, such as the MERS, Middle Eastern respiratory syndrome, in 2012, and SARS 1 in 2003. Using historical outbreaks, we built models to study the features of disease outbreaks. For example, the growth rate, which measures how fast the disease spreads, the reproductive number which measures the strength of spread, transmission route, and severity of the disease. When WHO declared COVID-19 a pandemic, we asked our standard questions (above). With prior knowledge of historical outbreaks, we used math models to create a range of difference scenarios and forecast to see what they look like -- ranging from a global pandemic to the extinction of the outbreak. Observations were then compared to scenarios to predict which scenario was most likely to occur, and to determine the appropriate responses. We repeat the process as new data from active surveillance programs and new findings from research studies comes in and they automatically become new information we feed to improve existing models and update our understanding of the situation. Then we create new predictions and responses accordingly using up to date information.

The modelling process is a routine process that we do weekly, and the output gets presented to various levels of decision makers in the Public Health Agency of Canada and helps guide public health decision making. For more details, they can be found on the PHAC official website, on the Science of Health.

Wendy - That's great, thank you. And for our listeners I will also drop the link to the science blog that provides more details on the same page where this episode will be posted on the NCCID website. So my next question is, what are some major challenges that you think all math modelers have to deal with in their research?

Michael – This is a very good question, and it reminds me of a quote from a British statistician named George Box. "All models are wrong, but some are useful". Modelling is a very challenging task because reality is extremely complicated. The point of making models is to simplify so that we can understand certain aspects by leaving others out. That is why all models are not perfect and are wrong. It is important to realize that the goal is not to make the most realistic model – which sounds a little counter-intuitive. To make models useful, we create question-driven models that can provide insights on specific features that can help address questions of interest at various stages to support decision making. Some examples of features are human behaviours and interactions, immunity, viral evolution, types of surveillance and interventions, and others. It is the modeler's job to incorporate these features into the models, and to do so, it will require a solid understanding of how these features work, how to add them to the models, and if there are data supporting these features.

Dealing with data is another challenging task. If data are available, are they reliable? And how do we add them to models? If data are not available, why exactly are they not available? Modelling with lots of features that are not well supported with data is tricky, and sometimes will require a lot of assumptions.

Wendy - So let's switch gears a little bit. The using data, developing and analyzing of the model outcomes - that's only a part of a modeler's job. What would you say are the other responsibilities of a model that people may not be aware of?

Michael – This is a great question. I like to think about all the moving pieces in the modelling process and put myself in their shoes and try to understand where everyone is coming from. This is a growing field, and modellers are often expected to wear multiple hats and have multiple skill sets. Some of them include clients, subject matter experts, designer, and software developers.

Starting with clients, similar to tackling any scientific problem, we need to identify the questions of interest and what we want to model. In the context of public health, it is crucial to determine what policymakers need to know to support their decision or what is the best interest of the public. Next, we have subject matter experts. After we identify the questions from the clients, we have to identify the features required for the model to address the problem. This involves experience, knowledge, and expertise from various fields outside from one's expertise, such as biology, mathematics, and many more. Up next, we have the designer. Often, one of the models main job is to facilitate this broader process by gathering the questions from clients, the expertise from subject matter experts, so that they can start the designing process of combining all the pieces together and designing the model. Last but not least, we have the software developers. Once the design is finalized, we must consider how to effectively implement the model from design to software and carry out the actual analysis.

Wendy - We've already talked about some of the more technical challenges that modelers encounter. Out of these other responsibilities that modelers have. Which one do you think is the most challenging or the most important?

Michael – That's an excellent question. There are many, and I like to simplify it into 2 challenges. Technical challenge and an overall challenge. The increasing demand for modelling and the changing roles of modellers, all pose significant challenges. The field of modelling is constantly evolving and requires a wide range of expertise across various disciplines. Starting with the minimal requirement of using an array of mathematical and statistical methods and increasing larger expertise in handling data sources. Additionally, to answer a particular question about an infectious disease threat may require various modelling methods, along with epidemiological, social science, genomics data, and state of the art approaches. I like to consider it as a collaborative process because, in addition to working with subject matter experts, policymakers, software developers, and the public, modellers have different skill sets so it is ideal to work together as a team. It is essential to co-develop and work together throughout the process. Therefore, for modellers, it is a challenge to build interpersonal skills, vision, develop capacity for the future, and last but not least, to actively stay well informed of new approaches and improve technical skills.

Circling back to the increasing the demand in collaboration - the most important overall challenge is communication. So this is communication in the modelling process, facilitating and making sure all parties are on the same page, and then understand each other's needs. Lastly, distilling highly technical things into information that everybody involved, for example, senior managers, decision makers, and the public can easily understand.

Wendy - And for our last question, let's talk a bit about how the world of infectious disease modelling might look moving forward based on what we've learned from the past few years and what you've described today. How do you think modelling for public health will change in the future? And what are some areas that we could try to improve upon?

Michael – I think, or at least I hope that modelling will become more collaborative. I would like to revisit the theme of the past, present, and the future. The actions we take today will impact the future. One of the lessons we have learned in this pandemic is the reoccurring situation of saying if only we had done this X months ago, we would have had the data we need to make good decisions today. This experience highlights the importance of stepping back and planning for the future even as we are dealing with a crisis in the present.

There are a lot of interesting and useful new science that really advanced a lot during the pandemic. For example. wastewater as an early warning detection signal, where we sample from wastewater treatment plants and various sites to detect the presence of viruses; genomic surveillance - identifying the specific type of pathogen circulating. These surveillance tools are becoming more routine and frequently used around the world. Another big advancement is the use of artificial intelligence, AI, to assist in information gathering and analysis. All these new techniques have so much potential to provide support to traditional practices of surveillance and research. Learning and integrating these new techniques and combining new kinds of data and learning and developing capacity to utilize them effectively prepares us for the data and knowledge we need for the future threats.

Wendy – I'm especially looking forward to what math genomics can bring us in the future. So thank you so much, Michael, and that's all we have time for today. It was a pleasure talking to you about your perspectives on math modelling for public health, and I hope we get a chance to chat again soon.

Michael – Thank you Wendy, it was really great chatting with you and it was a really great conversation. Have a great day.

This concludes our conversation with Dr Michael Li from the National Microbiology Lab. If you have any other questions or would like another math modelling researcher and their work featured on this podcast series, please write to us at nccid@umanitoba.ca.

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