Actuaries Institute Podcast
Title: Modelling COVID-19 infections – lessons and reflections

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Interviewer: Martin Mulcare
Speaker: Matthew Tiong
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Martin: Hello and welcome to another episode of the Actuaries Institute Podcast. My name is Martin Mulcare and I'm a fellow of the Actuaries Institute. Today, I'm joined by Matt Tiong, who is a young Actuary that recently joined the data and analytics team at NMG Consulting, based in Sydney. Prior to joining NMG, he spent the first five years his career working in Quantum's insurance consulting practice. Welcome, Matt.

Matthew: Thanks for having me, Martin. It's good to be here.

Martin: **In this podcast, we're going to be discussing your role in creating models to assist in combating the COVID-19 pandemic. Just to set the scene for the audience, not surprisingly, the Actuaries Institute has been following COVID-19 closely and many members are obviously directly impacted in their role, whether it be life insurance, in general insurance, health insurance, superannuation.**

Some time ago, a working group was set up under the leadership of Jennifer Lang to address all of those professional issues facing Australian Actuaries, in fact, Actuaries who are members around the world. As part of that, there was very strong interest, I understand, from a number of members in modeling the pandemic and that's where Matt comes in. Matt, tell us a bit about how NMG began its involvement in that modeling subgroup.

Matthew: I think Mark Prichard, our CEO at NMG Consulting, was keen for NMG to play their part and contribute where we could. He reached out to Jennifer Lang, got involved in the group and decided that we participate on the modeling side of things. The reason that position came about was basically because we made a lot of headway in South Africa on similar matters. I think it's probably worth going into the background a little bit on how that came about.

Martin: **Sure. Tell us a bit about the work in South Africa and how the modeling evolved there. Who was that for?**

Matthew: The work was conducted by two of my colleagues from NMG, Gary Scott and Adam Lowe. Basically, it started out as a bit of thought leadership. When the pandemic was first emerging in South Africa, Gary and Adam who have a number of healthcare clients in that market, built a model and tried to help their healthcare clients understand what the impact of COVID-19 would be for them, albeit that the information was quite limited at the time.

As they were developing, calibrating their model, the healthcare committee of the Actuarial Society of South Africa almost pretty soon after decided that they would collaborate across the industry to try and model the pandemic as well, and given that Adam actually represents NMG on that committee, he naturally became involved in the effort.

Martin: **Well, we love collaboration and that collaboration within South Africa has led to collaboration in Australia. Tell us a bit about the broad thrust of your paper.**

Matthew: I guess the broad thrust of my paper was to explore a couple of scenarios having actually calibrated that model to Australia. I guess the key point I would make here just before we discuss those scenarios in any detail, is that COVID-19 and prediction in this particular instance, is particularly difficult due to a number of factors, as I'm sure you're aware, but just to name a few.

We don't properly understand many aspects of the virus. Its progression in a population is highly dependent on actions which are very difficult to model. For example, spread can be very volatile and difficult to model. We don't have reliable data in many respects.

Martin: **Sure, that's clear. Matt, to what extent would you describe the paper as counterfactual to the lockdown?**

Matthew: In my paper, I talk about two scenarios. The first of which is about a counterfactual. I guess the point I'd like to emphasize, is that it is a-counterfactual, not the counterfactual, which is that it's one possibility for what might have occurred if we had not gone into lockdown. How we've calibrated that scenario is we basically looked at transmission rate prior to and leading up to the

lockdown and assume that through the lockdown period, that transmission rate had actually continued at that rate.

Matthew: That's one possibility for what might have occurred but what it doesn't capture and what I've highlighted in my paper is that if we had continued to see transmission rates at the levels that we had seen immediately prior to the lockdown, then we assume that individual Australians would've taken firm actions to try and control the spread in the absence of any state led lockdown.

Matthew: It's a-counterfactual. It's trying to present effectively a worst-case scenario to give the reader a sense of how bad it could've been. It really is a worst-case scenario. It's a-counterfactual but one of many, I would say.

Martin: **All right, that's clear. Now you also made it evident that lack of data makes assumptions difficult but the model itself is a difficult one to put together when we haven't really had this experience before. Let's explore the model a little bit more depth. Now in your paper, you think about the model or the explanation behind it in two dimensions, the structure and the assumptions. Can we start with the structure?**

Matthew: Sure. The model itself, as you say, it's quite a simple model. It's a multi-state model that consists of seven states. It follows a high-level epidemiological framework that's known as the SIR or the SEIR framework. Those letters, S-E-I-R, stand for Susceptible, Exposed, Infected and Recovered, so the four main states in the commonly used model. As I said, we have seven states in our model which is to account for a couple more states that are specific to this disease.

Matthew: The three extra states are two additional infected states in addition to the one that was already there. In total, the three infected states are those that are infected and reported, those that are infected and also not reported due to not being tested and then also that are infected but aren't showing symptoms – asymptomatic cases

Matthew: Once we've got those seven states and we set up that framework, effectively all we need to do then is to calibrate the assumptions that basically define how people between the states. The only other thing I'll highlight is that the framework, it's a commonly used framework that a lot of models out in the public domain actually use in order to model the transmission of diseases and COVID-19 but the difference- is in the calibration so there's many approaches in terms of how you calibrate.

Matthew: There are really complex ones around stochastic simulations. There are more deterministic approaches and ours is a more deterministic approach, a more simplistic approach. That's where the differences lie in the various models.

Martin: **It sounds like the assumptions then are those governing the transitions between the various stages. Have I got that right?**

Matthew: Yeah, that's right.

Martin: **From your perspective, what were the key assumptions for the model and which ones were the most problematic?**

Matthew: Okay, so going through the key assumptions. If you start within that first state, the susceptible state. In order to move into the exposed state, the disease needs to be transmitted from someone who is in one of the infectious states. I guess that's our first and most important assumption – transmission rate, which is the number of individuals that one person in one of the infectious states transmits the disease to on average over a day. The other thing on that particular assumptions is that those that are asymptomatic are assumed to be less infectious.

Matthew: Once they're infected, they move to the exposed state where they will say for a length of time, which is our next assumption, and that's basically what we call the incubation period. Following that, they pass into one of the three infected stat es and we need an assumption to define how they move between those three states. Then once they're in one of those three infectious states, how long they stay in one of those states before then passing to the either the recovered state or the pass away state. We need an assumption to define how they move that way.

Matthew: In terms of the ones that were most problematic, to be quite honest, several of them are very problematic. There's little information to base assumptions on and where there is information, the results of different studies can vary widely depending on the population it was conducted on, the timing of the study and different factors that they can or can't control for in each of these studies.

Matthew: In performing our calibration, we've had to adopt our assumptions from these other studies, which is problematic. The one that does have an impact though, at least in my view, is around unreported cases. By definition, unreported cases are unknown and when you start to look into unreported cases, you introduce a whole set of new and well publicized problems, particularly around

testing, so whether testing is good or bad, whether it's changed over time and how you account for that.

Martin: **Matt, the assumptions are very difficult to fit from that explanation, especially of the critical one you refer to around unreported cases. What I was impressed with though is your word "calibration" and the application of the Actuary's commitment to control cycle. It sounds like you are reviewing the assumption against the actual experience. How much calibration has been required? Have you been changing the assumptions?**

Matthew: Yeah. To date, Gary and Adam in South Africa had spent a lot of time building, calibrating, re-calibrating and at the point at which I picked up the model, it had already been gone through quite a few iterations. On the Australian model, I've gone through a couple of iterations up until the point at which we were ready to release the first draft version, which I wrote about in my paper and which we're looking at recalibrating now actually.

Matthew: Since releasing it, we have continually looked at what else we can do to make it better. I've received a number of suggestions from people who have read my paper and people who we've spoken to. In fact, the working group of the Actuaries Institute has been a great source of information. To give you an example of some of the things that we don't actually allow for in our assumptions, some of which we already knew about and some of which were brought to our attention through that feedback process that you mentioned.

Matthew: Things like differences in susceptibility to the disease. We assume that everyone in the population is equally susceptible, which is not necessarily correct. Different population density, differing mobility factors, co-morbidity groups, ... things like the impact of the climate on transmission rate is another interesting one that's been suggested and also a potentially big issue around future immunity of those that have already contracted the disease.

Matthew: Those are three or four really valid suggestions that we're looking at, somehow making some allowances for in the model, which we may or may not do just depending on the practicalities of it around data and calibration but valid suggestions, nonetheless.

Matthew: I guess the one thing that I would flag though is that what I've found since playing with the model is really how sensitive the model is and how sensitive the outcomes are to effectively what we've called the transmission rate. It's worth keeping in mind when thinking about all these different factors that hadn't been accounted for in the model, that some of these effects are actually secondary to other effects and the transmission rate I

found does tend to outweigh many of these other effects. That's the sense I get from playing with the model.

Martin: **Thanks, Matt. One point I picked up was the collaboration within the Australian profession, within the working group, in fact beyond the working group. Great to hear that you're picking up suggestions from other Actuaries and willing to apply. I guess that's one of the strengths of the paper is being able to share it with those and being willing to take feedback as well.**

Martin: **Let's look more broadly now, Matt. It's obvious to anybody that's had a look at COVID-19 that the experience in different countries has been very diverse and responses in various countries have been very diverse. The paper mentions a few and I'm at least interested. Sweden and Japan, for example, have taken very different paths. What thoughts have you got on the success of their respective approaches?**

Matthew: Yeah, I don't really have any expertise on the economic side of lockdown, so it's very hard for me to comment on the success of their approach per se. What the two examples do provide are a benchmark and we can use those benchmarks to generate more scenarios, which in the two examples you've raised, Japan and Sweden, they would be good ways of adding more color or context to the potential counterfactual scenario that we've discussed earlier.

Matthew: At the moment, all we've done for that counterfactual scenario is look at the transmission rate prior to lockdown and if that had continued. What Sweden and Japan provide are good examples of cases where the government did not enforce mandatory lockdowns and instead provided advice to citizens and left it up to them to take action. That could be a really good benchmark for looking at the counterfactual.

Matthew: It's worth noting that within those two examples of countries, there were varying levels of success. What it provides is a range of possible outcomes and just gives us a better way to get a sense of what might've happened in Australia as well.

Martin: **Sure, thank you. Let's come back to Australia and speculation about a second wave. You've got a scenario which is looking at what might happen in terms of reemergence of infection. Where's that up to as of today, 29th of May?**

Matthew: Yes, a good question. I was actually having a look at the model yesterday morning, just playing around with it a little bit. In my paper, I talk about the model, which we calibrated at the end of April. I looked at it more recently just to get a bit of a sense of

what it looks like, albeit it hasn't been a full-on proper recalibration that I'm willing to discuss in any sort of detail.

Matthew: I've had a quick cursory look at the transmission rate and what I've seen is that shortly after we calibrated and released that model about a week later, I think from memory, the transmission rate it appears to pick up again. That's a good example because it highlights some of the issues with the model and the calibration of it, which is that on that particular day, there's a kink in the curve and it's hard to tell whether that means that transmissions had picked up again or whether there was actually just a delay in testing that forced a bit of catch up in cases. There's a bit of work to go into looking into that and what might be driving that and we might never get to the ultimate answer.

Martin: **Yeah. Well again delighted to see that you are reviewing the experience and reviewing the assumptions. Matt, having put some time and effort into the model and the development of your assumptions, and having had input from other people, where do you see you taking the model from here?**

Matthew: I guess the first most important thing from my perspective is since we've performed the last calibration in late April, a whole bunch of research has been released on different aspects of the disease. It's a fast-moving piece, so research is being released pretty rapidly. The first thing I think for me is that we'll need to review a lot of that research and decide whether and how to incorporate some of those findings into our model, whether it be the calibration of assumptions or the incorporation of new ones. In addition to those I already mentioned from suggestions from the working group and elsewhere.

Matthew: To take one example, as we were playing with the transmission rate, what we noticed and what I think is a common criticism of SEIR type models is that the model, can produce some pretty high outcomes in terms of the percentage of overall population that ultimately gets infected, if you were to let the transmission rate stay at a pretty high level.

Matthew: As I mentioned in my article, we assume that if such an event were to occur, individuals would take drastic action and so we point out that the ultimate number isn't so important and we recognize that it's unrealistic, but it's more just the trajectory of the curve that's important. For the next iteration I guess, what we would look to do, one suggestion is that we explicitly incorporate a parameter that applies an upper bound to try and limit the spread.

Matthew: That in itself is a difficult parameter because it basically means we have to look at past examples of diseases that have

completely ripped through a population and there aren't many examples of that but it is something we're looking at doing. The other final thing I guess is aside from looking at the most recent transmission rate and trying to extrapolate what that could mean for the future, one other thing we can do is actually look at the transmission rate experience in countries that have actually exited lockdown.

Matthew: Germany and South Korea are two examples – potentially look at those, albeit that they're quite different countries from our own. Again, as with the counterfactual example and using Sweden and Japan, it will provide some color.

Martin: **Thanks, Matt. It's great to hear that you're providing a reality check on the model and also bringing into the model the actual experience, where available, from overseas. In terms of your paper, in terms of the model, what for you is the main conclusion? What's one thing that you've learned from the experience?**

Matthew: I guess the key thing for me is that I recognize that the SEIR framework and our model is a high-level framework, high level model. It doesn't capture all the aspects of the disease and it would be very difficult to do so. The potential for error is undoubtedly very high.

Matthew: However I guess the key point is that the sensitivity of the model to the key assumptions does demonstrate how fragile the situation is and I guess what that's made clear to me, it's clear why the government in Australia and around the world are exercising such caution in easing any restrictions and it also emphasizes how important it is for each of us to heed the advice and play our part in trying to control the spread.

Martin: **Well that's a very good note to finish on, the reminder for all of us at about our individual responsibilities for limiting the spread. Thanks, Matt. That's all our time for today but thank you very much for joining this podcast.**

Matthew: No worries, Martin. Thanks for having me.

Martin: **Our listeners, we hope you enjoyed this discussion. Please check out our Actuaries Institute Podcast for more thought leadership content. You're most welcome to write in with your questions and comments on the show. We would love to hear from you. I'm Martin Mulcare. Bye for now.**