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Covid-19: The Imperial College modelling

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The March 16 Imperial College report[1] generated a lot of controversy. The study explores the effectiveness of various non-pharmaceutical interventions (NPI) in respect to limiting the spread of the Covid-19 and moderating its impact on the general population and the healthcare system. It's claimed that the modelling was, in part, responsible for influencing the UK government and other jurisdictions to reverse policies originally aimed at achieving a level of herd immunity to a severe government-mandated lockdown of the economy and enforced social distancing.

Conceptually the Ferguson et al. SIR model is simple, whereby the population is apportioned between various subgroups labelled as Susceptible, Infected, Recovered or Deceased, with the latter two immune to reinfection. Transmission events occur through contacts made between susceptible and infectious individuals in the household, workplace, school or randomly in the community. The model attempts to estimate numbers of deaths, the time course of these and the demand for hospital Intensive Care Units.

In the absence of any mitigation efforts, by individuals or as mandated by government, the model projects large numbers of deaths, 510,000 in Great Britain and 2.2 million in the US. It's hard to imagine any government ignoring these, particularly as they come with the imprimatur of Imperial College, London.

As a result of this study most of us are now very aware of the importance of the basic reproductive number (R0). R0 is a measure of the average number of people infected by each already infected person. R0 is thought to have a mean value of between 2 and 3, but, importantly, is not a constant and will vary over the course of the epidemic, a point to which we will return shortly.

In reviewing elements of the Imperial College modelling and its purported political influence, we must accept that for all its faults it was undertaken during a public health emergency, at a time when there was still a lot to be learned about a new disease. Given this climate and the urgent need for decisions, the report was not peer-viewed. By necessity it makes a large number of assumptions, not just about basic epidemiological variables fitted to limited data, but also about the supposed degree of public compliance with various NPIs aimed at reducing transmission of the virus, the main point of the study.

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[1] Ferguson et al. 2020. Report 9: Impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand. Imperial College London. https://www.imperial.ac.uk/mrc-global-infectious-disease-analysis/covid-19/report-9-impact-of-npis-on-covid-19/

Some have questioned the model's fitness for-purpose. We cannot comment on the coherence of its coding and so, for our part, we assume *a priori* that the model faithfully reflects its conceptual framework and underpinning assumptions. Our concerns relate more to its usefulness as a guide to public decision-making.

For its worse-case scenario, Ferguson et al. hold R0 at the same value through time at 2.4 with each infection leading to another 2.4 until the virus runs out of people to infect.

What this means is that regardless of the carnage going on around them, no one makes any attempt at self-preservation -- minimising contacts with infected people, hand washing, avoiding large gatherings, and working at home. Infections and deaths accumulate to the point where some 81% of the population is infected. Then take an Infection Fatality Rate of 0.9% and you get the extraordinary numbers mentioned above.

Ferguson and his colleagues acknowledge that this scenario as "unlikely" but nonetheless use it for their base case against which all other government-mandated NPIs are evaluated. Alan Reynolds at the Cato Institute nicely explains why R0 is not a constant.

"Suppose an infected man walks into a small elevator with three other people and begins coughing. The other three get infected from droplets in the air or from virus on objects (such as elevator buttons) they touch before touching their faces. In this case, we observe an R0 of 3.0. But if the coughing man is wearing a mask then perhaps one person does not become infected by inhaling the virus, so the R0 falls to 2.0. If the other two quickly use an alcohol-based hand sanitizer before touching their face, or wash their hands, then nobody becomes infected and the R0 falls to zero.[2]"

In the 1918 influenza pandemic, Sydney was the most heavily affected Australian city and the virus was estimated to have infected 36-37% of its population[3]. According to Reynolds, the same virus reached 28% of the entire US population. Thus, a figure of 81% for the corona virus does seem a bit of a stretch. In short, the key assumption of a constant R0 is that people are stupid. People are certainly not always rational, but stupid? Everyone, and at the same time?

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[2] Alan Reynolds. 2020. How one model simulated 2.2 million US deaths from. Cato at Liberty. https://www.cato.org/blog/how-one-model-simulated-22-million-us-deaths-covid-19

[3] Kevin McCracken and Peter Curson. 2019. A century after the Spanish flu, preparing for the next pandemic. Sydney Morning Herald. https://www.smh.com.au/national/a-century-after-the-spanish-flu-preparing-for-the-next-pandemic-20190130-p50uhm.html

It would have been far better, in my view, if the base case had assumed a most likely scenario in which people were assumed to undertake plausible degrees of self-preservation, regardless of government controls. It's always dangerous in decision-analysis to adopt pessimistic (or optimistic) choices at every step of the way. It can only lead to bias.

The model has other curious features. While it claims to be a stochastic model, it seems more deterministic with some few stochastic elements. Most key variables and assumptions are hard-wired and so it's difficult to understand what variables are driving the numbers and where the uncertainties lie. Sensitivity analyses principally around R0, are basic.

The model also imagines a vaccine becoming available in 12 to 18 months but there is no exploration of the best policy option should no vaccine arrive. This issue is of particular importance for New Zealand as it joins a handful of other countries in having successfully eliminated the virus before any significant herd immunity was achieved. The NZ government's decision-making was presumably informed by similar models to that employed by the Imperial College team.

The question now facing NZ, with tourism as its most significant export earner, is how to re-engage with the global economy. And how to avoid a second wave of the epidemic like that which accompanied the 1918-19 influenza pandemic.

In the words of its Prime Minister, NZ chose to go "hard and early" and with the latitude afforded by its isolation did so before any significant community transmission developed. It is difficult to fault the government's comportment on this issue and the daily press conferences became compulsive viewing for much of the country. However, now having squashed the virus, what is the long-term plan? If faced with a second wave, one hopes that the answer will not be another total lockdown with its network of unintended consequences.

One positive thing is to accept that R0 is not a constant. The distribution of R0 is heavy-tailed with a few extreme cases (super spreaders) responsible for much of the viral seeding. In one of the country's largest clusters, one person infected ~90 people at a wedding.

In response the government may consider reintroducing measures limiting numbers at gatherings where people are in close contact for extended periods -- weddings and funerals, churches and choir practice. In short, we need to lower R0 as much as possible via the least GDP-destructive choices as possible.

We know the consequences now, we know how to minimise the chances of getting infected, so let's be clever about how we manage it next time around. As pointed out by Scott et al. (2020)[4] we have to be careful that we are not killing more people indirectly than we save by

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[4] Scott W. Atlas, John R. Birge, Ralph L Keeney and Alexander Lipton, The Covid-19 shutdown will cost Americans millions of years of life. https://thehill.com/opinion/healthcare/499394-the-covid-19-shutdown-will-cost-americans-millions-of-years-of-life

lockdown. These lives are lost because of reduced family incomes, healthcare treatments delayed or missed diagnostics. This will preferentially affect low-income families who are more likely to lose jobs and have higher mortality rates.

To date our response to Covid-19 has been framed as a public health problem. The voice of economists, psychologists, geographers and historians have all been missing in action, at least publicly. For all its faults, the Imperial College report caught our attention whether we liked it or not; but relying on a constant R0 as if we are a bunch of rats rather than humans, and to work with that as your base case was more than silly.