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Predicting the pandemic

Modelling has its place, but outputs should be handled with care

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Mathematical simulation models play an important role in evaluating the course of an epidemic or pandemic in a population.[1] Such models are based on more or less strong assumptions that include mechanisms of spread, biological aspects of the infective agent, social characteristics of the host, and the expected effects of interventions. If these assumptions are realistic, the primary advantage of mathematical models is the ability to anticipate approximately what the direction of an epidemic or pandemic will look like—especially if conditions are intentionally changed by interventions such as social distancing or school closures. However, one of the challenges of simulation models is that consequences are often expressed as precise absolute numbers of expected or avoided outcomes (eg, cases, or deaths), which often leads to uncritical reporting and interpretation.

In the linked paper, Rice and colleagues (doi:10.1136/bmj.m3588)[2] re-ran the covid-19 computer simulation model CovidSim,[3] which attracted a lot of attention during the pandemic. This model was originally used by the Centre for Global Infectious Disease Analysis (GIDA) at Imperial College London to also help inform the UK government's early pandemic responses. In their rerun, Rice and colleagues used data available in March 2020 and compared the findings with the pandemic's actual trajectory until June.

CovidSim is a microsimulation of a population of several million individuals with characteristics similar to those of the real UK population, including age distribution, wealth, and family size, as well as geographical distribution of residential and business areas and associated commuting distances. CovidSim also includes information about healthcare resources, such as hospital and intensive care unit capacities. The data are from publicly available sources and allow detailed modelling of disease specific outcomes, such as number of infected people, demand for intensive care beds, and fatalities.

Rice and colleagues' main finding is that, with data available in March the CovidSim model predicted reasonably well what actually happened, providing a retrospective validation of the GIDA group's model.[2]

While Rice and colleagues replicated earlier findings from the GIDA group, the new paper also emphasises some of the less well known outputs from this model, which compared the effects of various non-drug mitigation strategies, such as school closures and social distancing.

Remarkably, all examined scenarios ultimately resulted in at least 260 000 predicted total covid-19 related deaths by March 2022 in the absence of a vaccine or a full lockdown. The authors' explanation is that reducing incident cases through mitigation strategies prolongs the pandemic, allowing deaths to accumulate in second and subsequent waves.

Furthermore, Rice and colleagues estimate that closing schools and universities would actually increase the number of deaths overall (compared with not closing schools). This is because school and university closures prevent transmission among young people but prolong the pandemic so a greater number of older and more vulnerable people eventually become infected (by the young) and die. They also predict that without a vaccine, up to 10 waves of severe acute respiratory syndrome coronavirus 2 infection (SARS-CoV-2) are possible in the UK during the simulation period from January 2020 to March 2022.

Models such as this have an important contribution to make, but they also raise major questions and concerns, including the extent to which findings from simulation models should influence policy. For example, if Rice and colleagues' predictions are realistic, should we conclude that the only way to end the pandemic quickly and save more lives (not just prevent cases) is to let SARS-CoV-2 infect younger age groups, while protecting older and more vulnerable people?

Some commentators are already suggesting this direction of travel.[4] However, neither the model nor these arguments take account of the possible long term health consequences of covid-19. Mass infection of younger people could result in large numbers of individuals with persistent symptoms,[5] with serious implications for their physical and mental health, healthcare resources, and the economy. Perhaps risk of "long covid" should be included in future simulations.

Another logical problem exists with a retrospective justification of this particular model. A model cannot consider the implications of novel interventions, particularly if those interventions are partly a consequence of the model's predictions. For example, the UK government put the first lockdown in place[6] a week after the CovidSim model[3] was published.

While it is important to look back and assess the real life performance of mathematical models and to modify new simulation models going forward, many aspects of the future trajectory of the pandemic remain extremely difficult to predict, particularly for outcomes and interventions not yet experienced.

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