On the fallibility of simulation models in informing pandemic responses

Authors' reply

We welcome the correspondence from Deepti Gurdasani and Hisham Ziauddeen and agree that models that influence policy should be open to scrutiny, be informed by the best available evidence, and be constantly reviewed as more information and better estimates emerge. For these very reasons, we made the computer code needed to run the model available with the publication. This allows others to run the model using different parameter values when more information becomes available and explore the resulting effects. We are heartened to see that Gurdasani and Ziauddeen have done so.

In our Article,[1] we evaluated one method through which countries could potentially control coronavirus disease 2019 (COVID-19) outbreaks due to seeding from imported cases: ascertaining the known contacts of symptomatic cases, tracing them, and isolating them upon symptom onset. We did not consider the effects of mass testing or untargeted testing within the wider community and drew no conclusions on their use.

Gurdasani and Ziauddeen quote a conclusion of our study, namely that achieving control using contact tracing and isolation alone was unlikely to bring the outbreak under control. Unfortunately, they did not include the second half of our paper's concluding statement in their quote: "Rapid and effective contact tracing can reduce the initial number of cases, which would make the outbreak easier to control overall. Effective contact tracing and isolation could contribute to reducing the overall size of an outbreak or bringing it under control over a longer time period." These conclusions do not promote the complete abandonment of case isolation and contact tracing efforts, as the authors suggest. Instead, they point to the long-term benefits of such measures in reducing overall transmission.

As Gurdasani and Ziauddeen note, the model parameter for the delay from onset to isolation plays a crucial role in determining the probability of controlling the outbreak within 12 weeks. At least some of this delay will be mitigated by the speed at which testing can return results, and we agree that the availability of rapid tests with high sensitivity could play a key role here, as could other technologies. In the manuscript our short delay of 3·4 days was based on empirical data of delay from onset to hospitalisation during the late stages of the 2003 severe acute respiratory syndrome (SARS) outbreak in Hong Kong.[2] Early studies of SARS coronavirus 2 (SARS-CoV-2) suggested similar delays; a delay of 4·6 days from onset to isolation was reported from symptom-based surveillance in Shenzhen,[3] and in Singapore the average delay from onset to isolation for local cases was 3 days by the end of February, 2020.[4] Other new information has emerged about the natural history of SARS-CoV-2, suggesting our baseline assumption of 15% pre-symptomatic transmission was optimistic; one recent estimate suggests around 45% in the presence of active case-finding.[5] We also assumed 0% or 10% of cases were subclinical, whereas newer studies suggest the percentage is higher.

We would advise the authors to be cautious about presenting the probability of controlling an outbreak as a standalone metric to describe the feasibility of contact tracing and isolation. Our model assumes that a health-care system has unlimited capacity to perform contact tracing but, as we show in figure 5 of the Article, some scenarios require the tracing of a considerable number of contacts per week. Governments and public health agencies will have to consider what scale of contact-tracing effort is logistically possible. In the USA, for example, an estimated 100 000 new contact-tracing workers would be needed to manage future COVID-19 epidemics.[6]

We agree with Gurdasani and Ziauddeen that there is a pressing need to disentangle the effectiveness of the varied responses to COVID-19 outbreaks around the world. As the authors state, the response in South Korea, which has so far managed to keep mortality low, involved a strong component of contact tracing and testing. However, in line with our original conclusion that this measure might not be sufficient to contain COVID-19 outbreaks on its own, many other strategies have been implemented in South Korea, including the closure of schools, kindergartens, community centres, and universities, and mandatory quarantines enforced by GPS-based mobile phone applications.[7] Nevertheless, we agree that contact tracing and isolation will probably play a major part in future strategies to combat the pandemic, and we firmly reject the notion that we recommended its abandonment.

We declare no competing interests.

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For the **code for the model from Hellewell and colleagues** see https://github.com/cmmid/ringbp

1 Hellewell J, Abbott S, Gimma S, et al. Feasibility of controlling COVID-19 outbreaks by isolation of cases and contacts. *Lancet Glob Health* 2020; **8:** e488–96.

2 Donnelly CA, Ghani AC, Leung GM, et al. Epidemiological determinants of spread of causal agent of severe acute respiratory syndrome in Hong Kong. *Lancet* 2003; **361:** 1761–66.

3 Bi Q, Wu Y, Mei S, et al. Epidemiology and transmission of COVID-19 in Shenzhen China: analysis of 391 cases and 1,286 of their close contacts. *medRxiv* 2020; published online March 27. DOI:10.1101/2020.03.03.20028423 (preprint).

4 Ng Y, Li Z, Chua YX. Evaluation of the effectiveness of surveillance and containment measures for the first 100 patients with COVID-19 in Singapore—January 2–February 29, 2020. *MMWR Morb Mortal Wkly Rep* 2020; **69:** 307–11.

5 He X, Lau EHY, Wu P, et al. Temporal dynamics in viral shedding and transmissibility of COVID-19. *Nat Med* 2020; published online April 15. DOI:10.1038/s41591-020-0869-5.
6 Watson C, Cicero A, Blumenstock J, Fraser M. A national plan to enable comprehensive COVID-19 case finding and contact tracing in the US. April 10, 2020. https://www.centerforhealthsecurity.org/our-work/pubs_archive/pubs-pdfs/2020/a-national-plan-to-enable-comprehensive-COVID-19-case-finding-and-contact-tracing-in-the-US.pdf?stream=top (accessed April 21, 2020).
7 Cha V, Kim D. A timeline of South Korea's Response to COVID-19. March 27, 2020. https://www.csis.org/analysis/timeline-south-koreas-response-covid-19 (accessed April 21, 2020).