Oxford's OpenABM-Covid19 mathematical model helps to control the coronavirus epidemic

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A team of mathematical modelers and epidemiologists at Oxford University's Nuffield Department of Medicine release the latest model of a population responding to the coronavirus epidemic. The model—OpenABM-COVID19—provides public health decision-makers with the ability to review the potential progression and outcome of the coronavirus, including fluctuations in infected individuals,

hospitalisations, intensive care unit (ICU) admissions and deaths, and assess the impact of test and trace programs.

OpenABM-COVID19 supports public health services, including the UK's NHS England and NHS Wales, to forecast the epidemic and decide on the best balance and scale of epidemic control interventions over the coming months. Modeled interventions include digital contact tracing (exposure notification system), testing, ongoing physical distancing, self-isolation, mask wearing and further localized or national lockdown measures.

Ming Tang, director of data and analytics at NHS England and NHS Improvement, says: "Essential NHS services have been available throughout the pandemic, and this open-source model from Oxford University is providing the NHS in England with yet another tool to help understand potential demand on hospital services across the country, and ensure we can continue to offer care to patients and anyone concerned about worrying symptoms."

The UK's latest demographic and coronavirus data feed into the model, providing a tool which is fast, adjustable and scalable and can be updated with any country or regional demographic data and contact networks. Infectious individuals are not randomly spread throughout a population, and the networks on which they interact have a profound effect on the dynamics of the epidemic and the final number of people infected. Various sized populations are modeled using real world interactions—each person with routine and random encounters in settings such the workplace, with family and friends, at school or university. The severity of the disease, including the probability of hospitalization and death, increases with age. Higher levels of transmission within households, and mild or asymptomatic individuals, are also factored into the simulations.

Professor Christophe Fraser, scientific advisor to the Department of Health & Social Care and Group Leader in Pathogen Dynamics at Oxford University's Nuffield Department of Medicine, says: "The fact that COVID-19 affects different population groups, and that we live and interact in distinct ways, needs to be integrated into our understanding of the potential effect of different public health measures. The UK and other national governments are adjusting our Oxford model to evolving policy scenarios, new measures and the latest scientific evidence. Our model supports decision making as countries ease or scale-up policies as the epidemic continues to evolve and as we try to return to the workplace, school, visit friends and family, and consider how to manage safe social activities."

The Oxford team is also supporting the development and deployment of digital contact tracing. As apps and exposure notification systems are tested and rolled out in different countries, the model can be adjusted to see the impact of notifying contacts based on different test result timing and digital contact tracing configurations, such as community-level testing or not, or change configurations to respond to adjusted guidance on self-isolation duration. The model helps to gage the number of tests required with different notification approaches, allowing for testing delays or surges in incidence.

Professor Mark Briers, program director at The Alan Turing Institute and Department of Health & Social Care advisor, says: "OpenABM-COVID19 has been instrumental in helping us to understand the potential implications of the contact tracing app as a non-pharmaceutical intervention, providing a scientific basis for the exploration of relevant policy options. Scientists at Oxford University's Nuffield Department of Medicine have provided continual expert scientific advice, delivering significant impact to the UK, helping to reduce the negative health consequences and societal implications of COVID-19."

Dr. David Bonsall, advisor to the Department of Health & Social Care, clinician and senior researcher at Oxford University's Nuffield Department of Medicine, says: "We need the best data and latest analyses to retain control of COVID-19. Our epidemic model can be updated to ensure we optimize the speed and effectiveness of contact tracing and testing. Contact tracing apps / Exposure notification systems should be introduced alongside other fast and effective disease control measures to help save lives, protect people, reduce the need for widespread lockdowns and enable us to return to more normal activities."

The model supports public health decision-makers anywhere in the world to look at the progression and outcome of infection and how different measures affect the population. It also demonstrates the impact of policy decisions on people's lives and health systems, including the number of people in quarantine. The model has been further enhanced in partnership with Google Research, including studies to assess the uptake needed for Exposure Notification Systems (contact tracing apps) in the U.S.. Thanks to the Python interface for the model, developed in close collaboration with the IBM UK team, it can be used and adapted by others.

Dr. Nicole Mather, life sciences lead at IBM UK Services, says: "IBM UK developed the Python interface which allows the OpenABM-COVID19 to be run by third parties. It has allowed public health authorities to use the model not only for digital contact tracing development, but also to support resource management and epidemic response planning for health services and other institutions. It has been important to enable a wider range of contributors to aid the building of OpenABM-COVID19—we are delighted to help broaden access to this model."

Craiger Solomons, technical advisory cell for the Welsh Government,

says: "We've adapted the Oxford University model to reflect the impact of COVID-19 on Wales. With support from the team at Oxford University, the Welsh Government has integrated Welsh data and considered different policy scenarios based on the differing contact ratios; including random, workplace and school interactions. These data were not available for Wales previously, they're now informing the evidence base used by Welsh Ministers to consider national and local policy actions."

Dr. Robert Hinch, first co-author of the paper and senior researcher at Oxford University's Nuffield Department of Medicine, says: "Our Oxford model can be adjusted to other coronavirus epidemic settings. Digital exposure notification systems based on the Google-Apple API are being developed in many countries across Europe, Africa and in the US. It is critical that we have the ability to analyze the possible effects of different public health interventions using national or regional-specific demographic and contact network data. We hope this model will continue to contribute to our response options now, and strengthen our preparedness efforts for future pandemics."

Provided by University of Oxford