COVID-19 model inspired by gas-phase chemistry predicts disease spread

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A COVID-19 transmission model inspired by gas-phase chemistry is helping the Centers for Disease Control and Prevention (CDC) forecast COVID-19 deaths across the country.

Developed by Yunfeng Shi, an associate professor of materials science and engineering at Rensselaer Polytechnic Institute, and Jeff Ban, a professor of civil engineering at the University of Washington, the model uses fatality data collected by Johns Hopkins University and mobility data collected by Google to predict disease spread based on how much a population is moving within its community.

The researchers tested their model against data from 20 of the hardest hit counties in the United States and found it to be valid. Their findings are available in preprint on medRxiv, an online repository of papers that have been screened but not peer-reviewed.

The team has also been able to show how the forecasts change as schools open, communities lockdown, and masks are mandated. The researchers' website, which illustrates those forecasts, was developed by Tanooj Shah, a graduate student in Shi's group.

"There's no mystery as to why there's an outbreak," Shi said. "There's no mystery to how we control it. The science is absolutely there. We want to use the model to give the local government some concrete predictive insight to implement certain policies."

Shi is a computational materials scientist who was curious about how simple chemical reaction analogs could be applied to forecasting COVID-19 transmission. Combined with Ban's expertise in transportation and mobility, the two have developed a straightforward model that has been accurately predicting disease transmission. They are now sharing their unique approach to forecasting COVID-19 spread with the CDC on a weekly basis, along with a collective of other research teams made up of infectious disease specialists, machine learning experts, and modelers from across the nation. Combined, the models form an ensemble forecast from a multitude of perspectives.

"The novelty of the model lies in the integration of physical modeling and data-driven approaches, which can bring useful insights about the infection and outbreak of COVID-19," said Jeff Ban, a professor of civil and environmental engineering at the University of Washington. "The findings of the research, such as the critical relative mobility indicator, can be used by policy makers for making informed decisions about when and how to reopen local economies."

The engineers plan to continue sharing their model results each week for the duration of the pandemic.

"What is remarkable about this model is its simplicity, from the perspective of cause and effects, indicating that societal mobility is the major factor controlling the spread of COVID-19," said Pawel Keblinksi, the head of the Department of Materials Science and Engineering at Rensselaer. "This is an example of 'the minimalist' approach that Professor Shi used successfully to model complex physical reactive processes, including polymer or complex crystal growth."

More information: Yunfeng Shi et al. Capping Mobility to Control COVID-19: A Collision-based Infectious Disease Transmission Model, (2020). DOI: 10.1101/2020.07.25.20162016

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