

New study models ways of emerging from a pandemic lockdown

Enlarge / Testing and contact tracing may be essential for exiting pandemic lockdowns.

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As the scale and threat of the COVID-19 pandemic became clear, researchers who trace the spread of diseases were pretty unanimous: to buy us time to develop a therapy or vaccine, countries needed to implement heavy-handed restrictions to limit the opportunities for the virus to spread. Experts painted frightening pictures of huge peaks of infections that would overwhelm local hospital systems if lockdowns weren't put in place, leading to many unnecessary deaths. For countries like Italy and Spain, which were already in the throes of an uncontrolled spread, reality bore these predictions out. Peaks rose sharply in advance of restrictions but fell nearly as sharply once they were put in place.

But those same models also predicted that ending the restrictions would put countries at risk of a return of the

virus a few months later, forcing governments to again decide between strict restrictions or an out-of-control pandemic in the next step of a cycle that would repeat until a vaccine or therapy became available. Those countries now have a somewhat different question: are there ways of controlling the virus without resorting to a cycle of on-and-off lockdowns? For countries like the US, which implemented restrictions briefly, erratically, and half heartedly, such that peaks haven't been separated by much of a trough, the same question will become relevant if we ever get the virus under control.

A new study by a large international team uses epidemiological models to explore ways of keeping things in check while allowing most of the population to resume a semi-normal life. It finds that there are ways of handling restriction easing, but they require a combination of an effective contact tracing system, extensive testing, and a willingness of households to quarantine together.

From real world to model

The study relied on an epidemiological model—in this case, the basis was a fairly standard version that splits up the model population into pools of people who are susceptible, infected, or recovered. But the model used here was significantly more complex, thanks to the much better understanding we now have of SARS-CoV-2's behavior.

As normal, people in the susceptible pool become infected by coming into virtual contact with someone in the infected pool. But instead of going directly into the infected pool, they then experience a period of latency, in which they're not yet infectious. Some people exit latency into an asymptomatic infection, which still allows them to transmit the virus until they reach the recovered pool. Others follow a different path through a pre-symptomatic but infectious phase, through a symptomatic-and-infectious period that's modeled to have a

severity that could include time spent hospitalized and/or in an intensive care unit. This allows the researchers to track the sort of strain a given level of infection would put on the health system.

To model the sort of interactions that could enable the virus to spread, the researchers took advantage of a key source of real-world data: anonymized cell phone data. In this case, they had six months of pre-pandemic cell phone location data from the Boston area, which they used in conjunction with census data. This allowed them to generate a three-layered model of interactions, tracking infection opportunities at the level of people who shared housing, those who interacted at work or socially, and those who went to school.

To provide a baseline for their model, the researchers ran it without any restrictions in place. As with other, less sophisticated models, it produced a huge peak of infections that greatly exceeded the capacity of hospitals to handle patients. At its peak, the typical infected person passed the virus on to four people in the susceptible pool. By the time things slow down, 75 percent of the population had been infected.

Restrictions, and how to end them

The researchers then switched to focusing on what happens after restrictions start being eased. They ran the model in a scenario in which an eight-week-long stay-at-home order was followed by reopening workplaces for four weeks, before most restrictions, including those on restaurants and theaters, are lifted. Schools and universities, however, remain closed. The model here successfully matched what has happened in New York City in terms of the number of contacts people typically have each day under the different restrictions.

But it also has bad news for New York City and elsewhere: a very large peak of infections happening in the wake of the

full lifting of restrictions. This hasn't happened in most places, in part because many workplaces haven't reopened, and many people have adopted additional measures, such as face mask use, that limit the pandemic's spread. But it does indicate the risks of a complete reopening, especially in places where the other measures can't be guaranteed. While the surge in cases is only about half of what the model indicates we'd see if we did nothing, it's still easily enough to overwhelm healthcare systems.

But the researchers' main focus was on a way of handling reopening that they argue could greatly reduce the risk. It requires a testing capacity that's large enough that about half the symptomatic COVID-19 cases can be identified within two days of the onset of symptoms. Once identified, these people quarantine at home for two weeks. Critically, anyone who normally lives with that person also has to quarantine at home for two weeks—essentially, it treats households as single units for the purposes of quarantine. Another key to the researchers' plan is that contact tracing is efficient enough to track down a reasonable percentage of the people who have been in proximity to those who get a positive test (they try values ranging from 20 percent to 40 percent of contacts traced) and that said individuals go into quarantine.

Overall, this seems pretty reasonable. It doesn't demand that we identify asymptomatic cases or the people with symptoms with complete efficiency. It also doesn't expect high levels of successful contact tracing, which would probably require most of the population to install contact tracing applications on their smartphones. But it also needs to be acknowledged that the US' testing capabilities are nowhere near good enough to make this a reality today.

The results in this model are pretty dramatic. Even at 20-percent successful contact tracing, the "second wave" peak of new infections drops to about 20 percent of the size it would be otherwise, and it remains within the capacity of hospital

systems. If contact tracing reaches 40 percent, then the second wave is essentially eliminated, with only a slight and gradual rise above background cases. And while the quarantine restrictions seem severe, the researchers find that at the wave's peak, only nine percent of the population has to be in quarantine.

Flexible exit

This system also allows for a certain degree of flexibility. If we're better at identifying infected people, we could get away with some fraction of the households breaking quarantine. Having the testing capacity to regularly check the status of those in the same household as a positive case could allow a more flexible quarantine. The research team also modeled opening schools and universities and found that we could manage that move and keep the pandemic in check by increasing the efficiency of contact tracing to 50 percent.

The authors also show that key additional safety measures, like face mask use, improve the effectiveness of this exit strategy, allowing us to get away with lower efficiency at other steps.

It's also clear that the approach can actually be tried in the real world. There are a large number of countries where the testing capacity is high enough to ensure that cases get identified quickly, and few enough cases that contact tracing is likely to be effective. For countries like the US, where neither is the case, it provides guidance for how states and cities might set goals to reach before restrictions can be eased, and what to do as they are.

More generally, the focus on how to effectively exit lockdowns marks a critical transition in how health experts are thinking about the pandemic. The initial models were run simply to understand the potential consequences of an uncontrolled pandemic, and they suggested we were in for a year of surges

in infections, followed by lockdowns—an obviously depressing future. Over time, however, research shifted into trying to figure out how to exit the lockdowns in a way that reduces the risk of future surges. Now, we're at the point where models are being used to identify the approaches that put the lightest restrictions on society while still keeping the pandemic in check.

The key question will remain whether we can get society to trust the public health experts when they indicate the safest paths out of the current mess.

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