Speed of testing is most critical factor in the success of contact tracing strategies to slow COVID-19 transmission

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Speed of contact tracing strategies is essential to slowing COVID-19 transmission, according to a mathematical modelling study in *The Lancet Public Health* journal which models the effectiveness of conventional and app-based strategies on community transmission of the virus.

If COVID-19 testing is delayed by three days or more after a person develops symptoms, even the most efficient contact tracing strategy cannot reduce onward transmission of the virus.

The researchers say improving access to COVID-19 testing, combined with digital that minimise tracing delays, will be key to the success of a contact tracing approach to reduce spread of the virus.

Professor Mirjam Kretzschmar, one of the lead authors of the study, from the University of Utrecht, the Netherlands, said: "This study reinforces findings from other modelling studies, showing that contact tracing can be an effective intervention to prevent spread of the SARS-CoV-2 virus, but only if the proportion of contacts traced is high and the process is fast. Our study builds on this to show, in detail, what role each step in the process plays in making this approach successful. This will help policy makers understand where best to prioritise resources to maximise the chances of success. For example, we found that mobile apps can speed up the process of tracking down people who are potentially infected, but if testing is delayed by three days or more even these technologies can't stop transmission of the virus."

Contact tracing involves tracking down all of the people who have been in contact with an infected individual so they can be isolated to prevent further spread of the virus. This approach is an established public health measure recommended by the World Health Organisation as a potential exit strategy to enable the alleviation of COVID-19 lockdown measures.

Conventional contact tracing methods involve a public health professional contacting the infected person and asking them to recall everyone they have been in contact with over a defined period before the onset of symptoms. Several countries have introduced mobile apps to speed up this process, by automatically alerting people who have been in proximity to the infected person using data from their mobile device.

To be successful, contact tracing measures must keep the rate of transmission of the virus, known as the Reproduction or R number, below 1. This means that, on average, the number of individuals who will be infected by a single infected person must be less than one.

In the new study, the researchers used a mathematical model that reflects the various steps and delays in the contact tracing process. This enabled them to quantify how such delays affect the R number and the fraction of onward transmission cases that can be prevented for each diagnosed person.

The model assumes that around 40% of virus transmission occurs before a person develops symptoms. In the absence of any strategies to mitigate the spread of the virus, each infected person will transmit the virus to an average of 2.5 people. Introducing physical distancing alone, assuming that close contacts are reduced by 40% and casual contacts by 70%, will reduce the reproduction number to 1.2.

In the best case scenario, the model predicts that contact tracing could reduce the number of people

a person with COVID-19 passes the virus on to from 1.2 to 0.8. For this to work, at least 80% of people who are eligible must be tested, there must be no delays in testing after the onset of symptoms and at least 80% of contacts must be identified on the same day as the test results are received.

If testing is delayed by two days, keeping the R number below 1 would require contacts to be traced within a day and at least 80% of contacts must be identified, the model predicts.

The model assumes that conventional contact tracing takes a minimum of three days and is less efficient at tracking down contacts than mobile app technologies, which are assumed to be instantaneous.

The findings predict that conventional contact tracing will only work to keep the R number below 1 if people with COVID-19 receive a positive test result on the same day they develop symptoms of the virus.

Contact tracing based on mobile app technology can accommodate a delay in testing of up to 2 days and keep the R number below 1, as long as at least 80% of contacts are tracked down. In this case, the number of people infected from those contacts would be reduced by half.

Once testing is delayed by three days or more, even a perfect system that [would] trace 100% of contacts with no delays cannot bring the R number below 1, according to the model.

Overall, the study found that reducing the time between a person developing symptoms and receiving a positive test result is the most important factor for improving contact tracing effectiveness.

Professor Marc Bonten, one of the lead authors of the study, from the University of Utrecht, the Netherlands, said: "In our model, minimising testing delays had the largest impact on reducing transmission of the virus and testing infrastructure is therefore the most critical factor for the success of a contact tracing system. This means that as many infectious people as possible need to be tested, and policymakers might consider lowering the eligibility threshold for access to testing. This will lead to a large proportion of negative test results, however, and future studies should focus on identifying the optimal balance between the proportion of negative tests and the effectiveness of contact tracing."

The authors note that their model does not take into account the age structure of the population. This might influence the proportion of asymptomatic cases, as these are more common in younger people and children, and might also influence mobile app usage. The model also does not account for infections acquired in hospitals and other healthcare settings, such as care homes.

Writing in a linked Comment Article, Professor Louise Ivers and Daniel J. Weitzner, who were not involved in the study, highlight four crucial questions that remain to be investigated. Firstly, an assessment is needed of how well smartphones measure proximity. Secondly, better understanding of how mobile apps will integrate with overall contact tracing programmes needs to be investigated. The Comment authors also call for further research to understand what factors will encourage users to trust the privacy and security properties of mobile apps. Finally, they highlight the potential for conventional and digital contact tracing strategies to perpetuate health disparities, and further evaluation is needed to prevent this.

Professor Ivers, of Harvard Medical School, and Daniel J. Weitzner, from the Massachusetts Institute of Technology, USA, said: "As contact tracing remains a crucial component of the COVID-19 response, mobile apps offer promise, especially when considering the speed and scale required for tracing to be effective—as highlighted in Kretzschmar and colleagues' study.4 However, understanding the potential impact of apps as part of a comprehensive integrated approach requires more evaluation of their use in real life and multidisciplinary engagement of technologists, epidemiologists, public health experts, and the public."

More information: Mirjam E Kretzschmar et al, Impact of delays on effectiveness of contact tracing strategies for COVID-19: a modelling study, *The*

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