COVID-19 Response: What Data Is Necessary For Digital Proximity Tracing?

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SARS-CoV-2 is currently spreading around the world, and many governments have responded with drastic measures to limit its spread. While these measures are slowly bringing about the desired effect to reduce the number of daily new cases, they have at the same time had severe negative effects on the economy, and society more generally.

The big question now is, how can we adjust these measures to reach two goals at the same time: 1) keep the numbers of new cases low in order to not overwhelm healthcare systems, and 2) allow for a step-by-step return to a normal life, and to a relatively open society and economy?

Many have argued, ourselves included, that a strategy based on testing, isolation, contact tracing, and quarantine (TICQ) is a key approach to achieve the above goal. The process is as follows:

- Testing: one of the many goals of widespread PCR-based testing is to find most acute SARS-CoV-2 cases, i.e. cases that are currently infected and contagious.

- Isolation: These cases should isolate so that they won't infect others.

- Contact Tracing: A key containment problem with COVID-19 is that pre-symptomatic transmission is common. Infected cases can transmit the virus 1-3 days before they develop the symptoms that make them feel sick. Contact tracing allows to find the contacts of an infected person who have been exposed

- Quarantine: The exposed contacts should go into quarantine. Many of these contacts will not have been infected, but some will. Because of the quarantine, the latter ones will not transmit the virus further.

If TICQ is done thoroughly, transmission chains can be interrupted. In combination with other measures, COVID-19 outbreaks should become manageable without overwhelming healthcare systems.

How to do contact tracing in practice? Normally, contact tracing is done through interviews. But interviews alone can be problematic because i) they are slow, ii) they are difficult to scale because of resource requirements (e.g., required human effort), and iii) a "contact" in the case of a respiratory disease may be anyone who has been in close-range physical proximity (i.e. 2

meters) for some time (i.e. a few minutes). This can of course include strangers which one would never be able to recall in a traditional interview.

Digital proximity tracing through apps could help solve these problems. There are many proposals on the table for digital proximity tracing. The basic idea is always the same - use Bluetooth to estimate physical proximity of two mobile phones. A recent modeling study (Ferretti et al. 2020) has shown that this would in principle work, confirming the intuition that digital contact tracing through apps could importantly contribute to keeping COVID-19 spread under control.

There is now a debate about what data such apps should collect in order to be effective. This debate often confuses two distinct questions, which can be posed as follows:

1. What data is necessary at minimum so that such a system can fulfill its basic function - which is to inform contacts of an infected person that they may have been exposed through close-range physical proximity?

2. What data could such a system collect that would help epidemiologists understand SARS-CoV-2 spread better?

It is essential to differentiate between these two questions. Undoubtedly, answers to question 2 would inform question 1. But they are nevertheless two separate questions.

We can rephrase question 1 from the perspective of a contact. What data is needed for an app to tell you that you may have been exposed through close contact transmission? The only information that is necessary is a) that you have been in physical proximity of an infected person for a sufficiently long time, and b) that this occurred during a time period when transmission from the infected person could have occurred. No additional information about the infected person, their other contacts, location of that contact, context for that contact, or any other information is necessary.

We would like to note that a direct consequence of this observation is that a decentralized implementation of a digital proximity tracing protocol generates data that is sufficient for such a system to fulfill its basic function.

FAQ

What about location? Isn't it important to know where an infected person was situated in space?

For proximity tracing, location information - in the geographical sense - is not relevant: Proximity tracing rests on the notion that the transmission of a pathogen occurs through the close contact route. In the case of SARS-CoV-2, this transmission occurs primarily through respiratory droplets, based on our current understanding of transmission. In its situation report published on April 2, 2020, the WHO wrote: "*Data from published epidemiology and virologic studies provide evidence that COVID-19 is primarily transmitted from symptomatic*

people to others who are in close contact through respiratory droplets, by direct contact with infected persons, or by contact with contaminated objects and surfaces. This is supported by detailed experiences shared by technical partners via WHO global expert networks, and reports and presentations by Ministries of Health."

What about fomite or airborne transmission? How would digital proximity tracing capture fomite or airborne transmission?

Fomite transmission, i.e. the transmission through surfaces of objects, likely plays an important role in the transmission of SARS-CoV-2 (see WHO statement above). Proximity tracing specifically focuses on close proximity contacts, and will only be able to capture fomite transmission to the extent that the object was part of a close proximity contact.

Airborne transmission - i.e. the transmission via aerosols that remain suspended in the air for some time (i.e. not via large droplets) - may play an important role in COVID-19, but as of now, its relative contribution is unclear. As with fomite transmission, proximity tracing will only be able to capture airborne transmission to the extent that the people involved in the transmission were in close proximity to each other.

Most importantly, any answer to the questions about fomite and airborne transmission are interesting with respect to question 2 above. They have, however, no bearing on the basic function of a close proximity tracing system.

References

Ferretti et al. Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing. Science 10.1126/science.abb6936 (2020).