

Epidemiological requirements for app-based contact tracing of COVID-19

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Digital contact tracing apps are a key component of many national strategies for suppressing COVID-19. Designing an effective app requires expertise from diverse fields including information security [Vaudenay, 2020], ethics [Morley et al. 2020; Parker et al. 2020], and behavioural science [Abeler et al. 2020]. For these apps to achieve their core purpose of stopping COVID-19 transmission, epidemiological considerations must be at the heart of their design. We present five key epidemiological and public health requirements which COVID-19 contact tracing apps should satisfy:

1. **Sensitively and specifically quarantine infectious individuals**

The purpose of contact tracing apps is to quarantine only potentially infectious individuals. Failure to quarantine infectious individuals and time spent in quarantine for non-infectious individuals should both be minimised.

To achieve this, the algorithm must be **adjustable**. In this rapidly developing epidemic, our knowledge of the disease is continuously improving. It may vary across populations and social networks, and over time through the impact of interventions such as physical distancing or wearing of masks. To freeze an algorithm before the app is released, with no capacity for change, is to risk locking the app in a state of poor performance.

It should be possible to send out **early release notifications**. These are needed as a means of correction if a quarantine notification is sent out erroneously, either due to a malfunction or through malicious use. They are also important for implementations where an index case can trigger an alert based on reporting symptoms but may later receive a negative test result.

2. **High user uptake and adherence**

Even at low levels of **uptake**, apps can reduce transmission and have a protective effect on the population, including those without smartphones [Hinch et al. 2020]. However, achieving epidemic control in the absence of other strong interventions will typically require uptake by around 60% of the population. Once installed, an app will only affect the epidemic if users follow the recommendations it issues. Trust in the app and a positive user experience are therefore essential components for digital contact tracing to be effective. Any design choices which could hinder **adherence** should be avoided, such as frequent notifications with changing advice. Further, in order to resume travel without increasing the risk of epidemic resurgence, apps should be **interoperable** across public health regions. Without this, users would have to install multiple apps, with a likely

detrimental effect on accuracy, uptake, and adherence.

3. **Rapid notification**

The time between onset of symptoms in an index case and the quarantine of their contacts is of key importance to COVID-19 contact tracing; any delay reduces its effectiveness [Ferretti & Wymant et al. 2020]. Where a design feature introduces a delay, such as awaiting test results, it should only be implemented if the delay is outweighed by other gains such as in specificity, uptake, adherence, etc. The relative impacts of these factors should be quantitatively compared at the design stage in open-source models such as [OpenABM-COVID-19]. If the delays exceed the period in which most contacts transmit the disease, the app will fail to have an impact on epidemic growth.

4. **Integration with local health policy**

The advice given by an app notification should be adjustable to remain consistent with current local health policies. Ideally the app should be integrated within the full range of public health interventions providing access to further advice, medical care and testing, and working in conjunction with manual contact tracing where available.

5. **Ability to evaluate effectiveness transparently**

Users must be confident that notifications are based on the best available evidence. The contact tracing algorithm should therefore be transparent, auditable, under oversight, and subject to review. Any intervention in an epidemic should be evaluated, both alone and in combination with other measures. Multiple independent approaches should be used in these evaluations and the metrics of success and failure should be decided upon in advance.

Aggregated data (not linked to individuals) is essential for evaluating and improving the performance of the app. Although some such information could perhaps be gained via surveys, there are strong practical and ethical justifications for gathering these data via the app itself. These justifications are particularly concerned with the speed and scale of the epidemic, and the huge social and economic costs of failing to control it.

- **Instantaneous summary statistics**

Aggregated summary statistics such as the numbers of index cases and contacts should be available. This data is crucial for evaluating the app and rapidly identifying malfunctions or malicious use, as well as being extremely valuable for public health planning.

- **Geographical summary statistics**

Knowledge of local uptake is vital for assessing the app's effectiveness and the reliability of its evaluation of individual risk. Without this, individuals in areas with low app uptake and high incidence of COVID-19 could erroneously be given the impression that they are at low risk, especially if there is an inverse correlation between epidemic growth rate and app uptake.

References

[Ferretti & Wymant et al. 2020] Ferretti, L., Wymant, C., Kendall, M., Zhao, L., Nurtay, A., Abeler-Dörner, L., Parker, M., Bonsall, David G., Fraser, C. (2020) Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing, *Science* 2020.

[Morley et al. 2020] Morley, Jessica and Cowls, Josh and Taddeo, Mariarosaria and Floridi, Luciano, Ethical Guidelines for SARS-CoV-2 Digital Tracking and Tracing Systems (April 22, 2020). Available at SSRN: <https://ssrn.com/abstract=3582550> or <http://dx.doi.org/10.2139/ssrn.3582550>

[OpenABM-Covid19] Available at <https://github.com/BDI-pathogens/OpenABM-Covid19>

[Parker et al. 2020] Parker MJ, Fraser C, Abeler-Dörner L, Bonsall, D, Ethics of instantaneous contact tracing using mobile phone apps in the control of the COVID-19 pandemic, *Journal of Medical Ethics* Published Online First: 04 May 2020. doi: 10.1136/medethics-2020-106314

[Vaudenay. 2020] Vaudenay S, Analysis of DP-3T (April 8, 2020). Available at IACR: <https://eprint.iacr.org/2020/399>

[Abeler et al. 2020] Abeler J, Altmann S, Milsom L, Toussaert S, Zillesen H, Support in the UK for app-based contact tracing of COVID-19 (March 26, 2020). Available at OSF: <https://osf.io/3k57r>