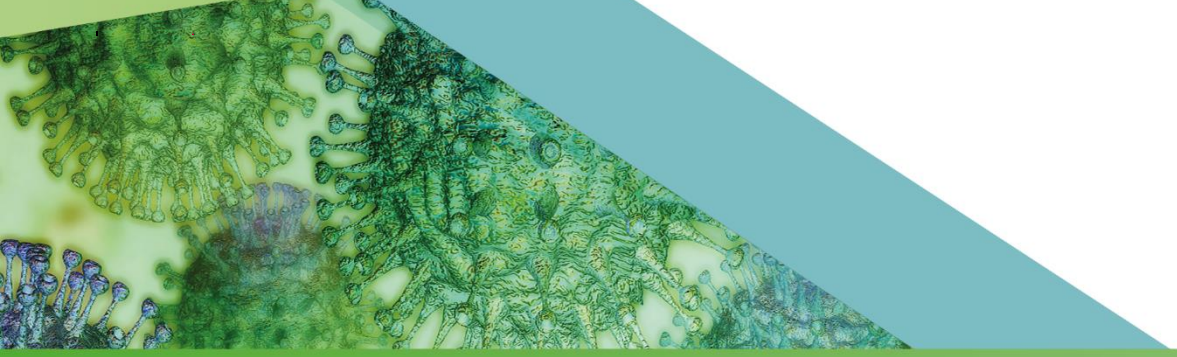

Mobile applications in support of contact tracing for COVID-19

A guidance for EU/EEA Member States

10 June 2020

Summary

- Contact tracing is of particular significance as containment measures are lifted.
- Mobile applications (apps) can help trace and alert more contacts as they do not rely on the memory of the infected case. Apps can also trace contacts unknown to the case and can notify contacts quickly and can facilitate cross-border contact tracing.
- Mobile apps can complement but never replace regular contact tracing efforts. Not everyone will have a smartphone, in particular the elderly, and not everyone will have downloaded the tracing app. The use of mobile apps should be voluntary.
- This document outlines several epidemiological and operational issues that public health authorities and app developers should consider.
- Public health authorities should be involved in all stages of the selection, development, piloting, roll-out and evaluation of apps to ensure that they protect public health in the best way with due consideration to privacy and data protection.

Purpose

Voluntary and temporary mobile apps to support contact tracing are new tools for a new challenge. Many developers are working on initiatives in parallel and public health authorities in a large number of EU/EEA countries are exploring different options. It is crucial that public health authorities, epidemiologists and staff involved in the day-to-day operations of contact tracing are closely involved in the development process to ensure that apps function in accordance with our best available knowledge of the epidemiology of COVID-19, and that mobile apps are designed to complement conventional contact tracing efforts.

This document is intended to facilitate the dialogue between public health authorities and app developers to ensure that the main epidemiological and operational considerations are taken into account, while also understanding the technological limitations. The public health perspective should be at the centre when the efficacy and safety of mobile apps are evaluated. Additionally, apps should be designed in such a way that allows for updating settings and parameters. Therefore, the focus of this guidance is the epidemiological and operational considerations that public health authorities could take into account when choosing a solution or working to implement and evaluate a particular solution.

There are many concerns related to the use of mobile apps around privacy and anonymity as well as legal and data protection issues. These will not be elaborated on in this document as they are covered in full in the document 'eHealth: Network Mobile applications to support contact tracing in the EU's fight against COVID-19 Common EU Toolbox for Member States' [1] and in the European Commission 'Guidance on Apps supporting the fight against COVID 19 pandemic in relation to data protection' [2].

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This document is intended to be a living document with regular updates, as both app developers and public health experts rapidly learn about what can and cannot be done by this new technology and as our collective understanding of the epidemiology of COVID-19 evolves.

Target audience

The target audience for this guidance is public health authorities and developers of mobile applications.

Background

Contact tracing

Contact tracing is a key public health intervention for COVID-19 and is particularly important now, when many EU/EEA countries start to phase out their stay-at-home policies and adjust community-level physical distancing measures. The purpose of contact tracing is to interrupt transmission chains by ensuring that persons who have been in contact with an infected individual are notified that they are at increased risk of infection and how to take action to prevent passing the infection to others.

The ECDC guidance on contact tracing for COVID-19 provides the basic principles on how to undertake conventional contact tracing, including the classification of contacts [3]. ECDC has also published guidance on how to scale up contact tracing efforts to handle larger numbers of cases, using both additional human resources and different types of technology [4]. Of note, conventional contact tracing should continue, as mobile apps can only complement and not replace regular contact tracing due to several limitations and unknown efficacy.

Of note, contact tracing is the term used to describe the overall public health strategy and actions involved in tracing and following up contacts. Mobile apps cannot be said to do 'contact tracing' but rather 'proximity tracking' and 'exposure notification', i.e. tracking and alerting users who have been in close proximity with each other, which can support contact tracing. Throughout this document the term 'mobile apps to support contact tracing' is used to describe this.

Mobile applications

Mobile technology to support contact tracing was first used in Singapore. The 'Trace Together' app used there is downloaded voluntarily and collects data, via Bluetooth, on which other devices have been in close proximity with the user's device. If a user tests positive for COVID-19, the app enables at-risk individuals to be informed about what to do.

Several initiatives to develop mobile contact tracing apps are ongoing in European countries and elsewhere. Most are Bluetooth-based which allow proximity detection but not location tracking. Other apps are based on GPS technology. The European Commission and the 'Toolbox,' developed by Member States with the Commission's support, states that 'location data is not necessary nor recommended for the purpose of contact tracing apps' [1]. None of the apps launched so far have been fully evaluated. However, a number of strengths and limitations may already be anticipated. The Toolbox therefore emphasises the need for key performance indicators to be developed.

Mobile apps as a complement to manual contact tracing

Mobile apps have some clear strengths which can help complement the shortcomings inherent in conventional contact tracing.

- Apps do not rely on the ability of the case to recall who they have been in contact with, how close and for how long, or how to get in touch with persons they have been in contact with.
- Apps allow for tracing contacts unknown to the case, for example people they were in close proximity to on a train or in a gym.
- Apps can facilitate cross-border contact tracing, provided that interoperability is ensured during the design phase.
- Apps can potentially speed up the contact tracing process by rapidly tracing and alerting contacts.
- Apps could facilitate follow-up of contacts by health authorities.

There are some limitations of the mobile apps and conventional contact tracing needs to continue alongside.

- Not everyone will have a smartphone, in particular the elderly, and not everyone will have downloaded the app. Some populations may be particularly wary of downloading the app.
- People with the app may not carry their phone with them at all times or may have the phone switched off.
- Some apps may not work on older smartphones or operating systems.

- Mobile apps have limitations in terms of their utility in investigating outbreaks in healthcare settings or long-term care facilities, which is outlined in more detail below.

There are some factors that need to be taken into consideration to ensure that the number of people notified unnecessarily are limited.

- Evaluation and calibration of the apps are key to avoid tracing and alerting people who are not at high risk of infection and cause unnecessary concern to those alerted.
- Apps may also trace and alert people who are not at risk at all asking them to self-quarantine without an actual need, for example, neighbours with a wall in between them and the case.. There are ways to address this as outlined below.
- Apps may trace and alert a large number of additional contacts and strain the resources of public health authorities in terms of follow up, but this may be mitigated by drawing on the advantages of the apps in terms of how they can save resources of public health authorities in terms of follow up of contacts.

Definitions of contact persons

A contact person is a person potentially exposed to SARS-CoV2 through being in proximity to an infected person for a sufficient time and at a close enough distance.

Current ECDC contact tracing guidelines [3] defining high-risk and low-risk exposure contacts were developed for conventional contact tracing and define two types of contact persons defined by the type of exposure as outlined in Table 1.

Table 1. Classification of contact based on level of exposure [3]

High-risk exposure (close contact)	Low-risk exposure
A person: • having had face-to-face contact with a COVID-19 case within two metres for more than 15 minutes; • having had physical contact with a COVID-19 case; • having unprotected direct contact with infectious secretions of a COVID-19 case (e.g. being coughed on); • who was in a closed environment (e.g. household, classroom, meeting room, hospital waiting room, etc.) with a COVID-19 case for more than 15 minutes; • in an aircraft, sitting within two seats (in any direction) of the COVID-19 case, travel companions or persons providing care, and crew members serving in the section of the aircraft where the index case was seated (if severity of symptoms or movement of the case indicate more extensive exposure, passengers seated in the entire section or all passengers on the aircraft may be considered close contacts); • A healthcare worker or other person providing care to a COVID-19 case, or laboratory workers handling specimens from a COVID-19 case, without recommended PPE or with a possible breach of PPE.	A person: • having had face-to-face contact with a COVID-19 case within two metres for less than 15 minutes; • who was in a closed environment with a COVID-19 case for less than 15 minutes; • travelling together with a COVID-19 case in any mode of transport*; • A healthcare worker or other person providing care to a COVID-19 case, or laboratory workers handling specimens from a COVID-19 case, wearing the recommended PPE.

** Except if sitting in an aircraft as specified in the relevant point in the left column.*

Longer duration of contact is assumed to increase the risk of transmission; the 15-minute limit is arbitrarily selected for practical purposes. Public health authorities may consider some persons who had a shorter duration of contact with the case as having had high-risk exposure, based on individual risk assessments.

These definitions cannot be directly translated to proximity tracing by mobile apps. For example, apps will not know if a contact occurred face to face or in a closed environment, or whether there was a barrier between such as a screen used in banks, or face masks for example. Nevertheless, the definition of an exposure at two metres or less for 15 minutes or more is proposed as a starting point for the definition of a high-risk exposure contact.

Mobile apps are only just being implemented and a process of piloting, evaluation and calibration will be key to define the optimal time-and distance settings that adequately capture people at risk of infection. This will be discussed in more detail below.

Specific issues to consider

This section outlines a few issues for public health authorities to consider when reviewing different solutions or when working with app developers to design, implement and evaluate an app. A more detailed discussion on what epidemiological parameters to use can be found in Annex 1.

Confirmation of infection

The trigger that starts the process of notifying contacts is when a person diagnosed with COVID-19 by a molecular detection assay enters this information in their app. It is recommended that this can only be done through a code or similar key provided by the public health authority, or directly by the lab following a positive result, rather than individuals self-reporting positive results.

It is important that people with symptoms compatible with COVID-19 have easy access to testing and are encouraged to test as soon as possible after symptom onset to ensure that contact persons are notified before they are able to transmit infection to others.

Epidemiological parameters

Proximity settings and calibration

As outlined above, the optimal proximity settings need to be determined by a process of calibration and evaluation. This section outlines what to consider in this process.

How apps determine risk

Depending on the design of the app it could be possible to programme a definite cut-off such as all contacts who meet the definitions of having an exposure at less than two metres for more than 15 minutes get notified. Some apps also allow a total risk score to be calculated based on different combinations of time and distance, so that an exposure shorter than 15 minutes but at a very close distance could still trigger a notification. There may also be the possibility of including other parameters to calculate risk such as what day the contact occurred relative to the onset of symptoms in the case. The result of such a risk calculation would be a total risk score. Determining what an appropriate cut-off would be for notifying contact persons will require evaluation and calibration. More details on how to determine values for parameters in the apps is included in Annex 1.

Considerations when determining settings

Public health authorities have to ensure that time and distance settings are broad enough to 'capture' contacts most at risk. However, if settings are such that a large number of people are determined to be contacts and asked to take measures such as self-quarantine, this could incur a burden on individuals and society and over time likely reduce the acceptability and uptake of the app. Depending on the intensity of follow-up of contacts, a large number of additional contacts traced through apps could also incur a burden on public health authorities.

Evaluation and calibration

Calibration and evaluation is critical as apps start to be used in order to ensure that the settings are optimal. Public health authorities are recommended to work with app developers to ensure that it is possible to obtain and analyse data to evaluate proximity settings. The way this can be done will vary with the app design. Information that can be used for calibration and evaluation are the proportion of contacts notified who test positive, or the exposure history of contacts that later become cases.

Proportion of contacts notified who test positive

The proportion of contacts notified who later test positive can be one key metric used when evaluating time and distance settings of the apps. Anonymous apps allow for such analyses provided that contacts who later test positive upload their positive test result in the app. Public health authorities can work with app developers to try and obtain anonymised information on number of contacts per case.

The proportion of contacts notified through the app who later test positive can be compared to the proportion of contacts found through conventional contact tracing who later test positive. These may however not be directly comparable, as contacts traced through manual tracing are more likely to be known to the case and include household members who are at high risk of infection. The proportion of contacts who later test positive would likely not be as high for contacts traced through mobile apps which should be taken into consideration when comparing the two. Also keep in mind that not too much time should have passed between the last exposure to the case and the contact person testing positive – a reasonable cut off could be just over 14 days taking into account that most people would likely have developed symptoms, gotten tested and obtained the result by then. If infection develops later, the contact person is likely to have gotten it from somebody else and not the index case.

A further consideration is that as the transmission intensity changes, so may the proportion of contacts notified who later test positive. After all, contact persons are not only at risk of infection from a single case, but are also at risk from other people who are infected within the community. The proportion who test positive is therefore likely to go down as the intensity of community transmission decreases, so changes in the proportion who test positive are not necessarily an indication that the settings of the app need to be adjusted. Similarly, as containment measures are introduced or lifted, the number of contacts per case and the proportion who test positive may also change. Changes in the proportion of contacts notified who later test positive therefore need to be considered in relation to the wider epidemiological context.

Exposure history

Another metric that may be used to evaluate apps could be the exposure history of contacts that later become cases. This could include the duration over which an individual has been exposed to other infected individuals recently before they were diagnosed themselves. If this information shows that most people who test positive had exposures that occurred below a certain distance and for a minimum of a certain time , this can give valuable information to help calibrate the app. Depending on the design of the app, such data may not be automatically transferred to public health authorities but may necessitate asking the user to donate this date on an opt-in, voluntary basis.

Other considerations

To gain an understanding of who is captured by the app and who is not, one option could be to do a pilot in one area and carry out conventional contact tracing and tracing using apps in parallel and directly compare who is traced by either or both methods. This will enable public health authorities to calibrate settings of the apps as well. In such a pilot study appropriate informed consent should be ensured.

Public health authorities could also consider other methods of evaluation during implementation such as anonymous surveys to app users concerning the acceptability of the app, or an invitation to participate in a focus group or one-on-one interview.

Levels of exposure

Current ECDC contact tracing guidelines recommend that high-risk exposure contacts are asked to self-quarantine, whereas low-risk exposure contacts are asked to respect physical distancing measures and avoid travel [3]. Public health authorities may work with app developers to analyse whether it is feasible to enable different kinds of alerts to contact persons with different levels of exposure. This would also enable public health authorities to tailor the advice given and, if applicable, the intensity of follow-up by levels of exposure as is done during conventional contact tracing, where authorities usually follow up only high-risk exposure contacts with a phone call and daily monitoring. However, the app may facilitate automated follow up and enable authorities to follow up low-risk exposure contacts more regularly as well, on a voluntary, opt-in basis. Public health authorities can consider whether it is possible and desirable to display the level of exposure to the contact person in the app so that if they contact the public health authority they can mention this and get advice accordingly.

During the start-up phase as the app is being calibrated, public health authorities may consider only asking the contacts with the highest risk exposure to self-quarantine to avoid large numbers of people being quarantined unnecessarily which may result in low acceptability and uptake of the app.

Detection of cumulative exposure

Public health authorities could work with app developers to ensure that the apps can detect cumulative exposure. For example, if the current definition of a high-risk exposure contact is 15 minutes or more at a distance of two metres or less, the apps should be able to detect a cumulative exposure of 15 minutes over a period of time. In other words, the two people should not have to be within two metres for 15 minutes continuously for the app to recognise this exposure. Aggregating exposures of five minutes or longer over 24 hours might be the most pragmatic option, but other possibilities may be considered.

Look-back period

Public health authorities could discuss with app developers whether it is possible to enable a feature in the app where infected persons are asked to enter what day they were first symptomatic. This would enable the app to only notify the contact persons who had an exposure during the infectious period of the case, starting from two days before symptom onset until the case was isolated, as is done during conventional contact tracing.

Additionally, if the first day of symptoms is known, the app could potentially assign a higher risk score to the contacts that occurred just before and shortly after symptom onset when transmission risk is known to be highest (See Annex 1).

For asymptomatic cases, conventional contact tracing recommends a look-back period of 48 hours from before the test was taken [3]. For the purpose of the apps, one to two days can be added to account for the time it takes to get the test result, resulting in a look-back period of three to four days from the time that the user uploads the positive test in the app.

Some apps will not have the option for people to enter their day of symptom onset and instead notify all contacts for a blanket period counting back a certain number of days prior to the day that the infected person enters their test result in the app. Public health authorities should consider what a reasonable number of days could be during which contact persons should be considered for notification. A longer look-back period (e.g. 14 days) will capture most people at risk, but may also unnecessarily notify many people who had an exposure well before the case became infectious. A shorter look-back period risks missing some contacts[i]. The length of the look-back period would preferably be guided by up-to-date local data on distribution of times from symptom onset to the receipt of a positive test result. Public health authorities can then evaluate over time how many traced contacts later test positive and adjust the look-back period accordingly.

Personal follow-up of contacts

There is value in public health staff being able to make a personal phone call to someone who has been exposed and is at risk in order to explain the measures they need to take and to answer questions, as is done during conventional contact tracing. For some people, just getting a message or notification through an app can be frightening, or they may dismiss the alert and not be motivated to self-quarantine. There are a few options to enable public health authorities to call contact persons notified through an app. The feasibility of each of these can be discussed and agreed upon with developers depending on the preferences of the public health authorities, keeping in mind that the perception of the general public may be that the app is not anonymous if the first two options are used even though consent is asked. Such a perception may limit the uptake of the app.

- A user can give consent upon downloading the app that their phone number is automatically transferred to public health authorities in case of a match with an infected user. This should be an opt-in system and not a condition of using the app, and ethical and data protection issues should be carefully considered if using this option.
- In case of a match with an infected user, contact persons are notified with a message and are then asked to upload their phone number should they wish to be contacted.
- In case of a match, contact persons are notified by a message with a phone number that they are asked to call.
- In case of a match, contact persons are notified by a message with comprehensive public health information (see below) included and the number to a hotline that they can call if they want.

Public health authorities should carefully consider the contents of messages sent, in particular if there is no personal follow up. Such messages could contain information on measures to take such as self-quarantine, hygiene practices, how to avoid transmission to household members, how to check for symptoms and what symptoms to check for and how to access medical services for testing and care if symptoms develop or worsen. This is outlined in further detail in the ECDC guidance on contact tracing [3]. The message could be a text message, a recorded voice message or a video. Public health authorities can also consider including a link to a website with more information. It would be important to consider making the app available in English and different local languages as appropriate and to make the information accessible to people with disabilities. At no point should the contact person be given information that can lead them to understand who the infected person is.

Integration with conventional contact tracing

Neither conventional contact tracing nor mobile apps will on their own capture all contact persons at risk. While conventional contact tracing and tracing through mobile apps could run in parallel, one option can also be to integrate these processes where feasible while preserving privacy and anonymity. For example, as described above, contact persons can be asked to share their phone number on a voluntary, opt-in basis, or to call public health authorities. If such a call takes place, public health authorities could ask whether contact persons are willing to share further details on a voluntary basis and they may then be included in the main public health database used to keep track of contacts that are traced through the conventional contact tracing process. The benefit of this could be that when doing conventional contact tracing, authorities could check if some contacts had already been alerted through the mobile app. In many app designs it would however not be possible to derive information on which infected case the person is a contact of.

[i] The contacts who would be missed are those who were exposed early during the infectious period to a case that then took a long time to get diagnosed. However, most such contacts who became infected would already have developed symptoms and (ideally) already be self-isolated.

Follow-up of contact persons

Apps may facilitate more regular follow-up of contacts by health authorities. There could be a messaging system whereby authorities can follow up contacts on a regular basis during the relevant period to ask whether contacts have developed symptoms. Developers can also program a symptom-checker feature linked to the app to enable contacts to self-monitor for symptoms compatible with COVID-19 and for them to get appropriate advice accordingly. There should be consideration as to how any such automated follow up activities are integrated with conventional contact tracing processes. If implemented, such follow-up should be done on a voluntary, opt-in basis.

Length of quarantine

The currently recommended length of self-quarantine is 14 days after the last exposure [3]. Staff carrying out conventional contact tracing may give tailored advice on how long contacts should self-quarantine based on the date of the last known exposure. For example, if the case tests positive on May 10, but the last contact occurred on May 3, the contact person will only be asked to self-quarantine for another seven days.

Some mobile apps may give automatic advice of a certain length of self-quarantine from the day the case tested positive (for example 14 days). This may lead to many contact persons being asked to self-quarantine longer than necessary. It may be feasible for the apps to give tailored advice on how long contacts should self-quarantine based on the last day of exposure. It is important to note, however, that giving this kind of information might compromise the privacy of the infected person. Contact persons may, based on the number of days that they are asked to self-quarantine, back-calculate and estimate the precise date of the exposure if they know that the total recommended length of self-quarantine is 14 days. If they only met one person that particular day they might deduct that this person was infected.

If contacts are asked to call health authorities in case of a notification, information of length of self-quarantine can be given by public health authorities as is done during conventional contact tracing, and public health staff can deliver this information in a more nuanced way to preserve privacy of the infected case.

Related to this issue is that some apps have the option of directly displaying to the user the day on which a high-risk exposure occurred. This of course also risks revealing the identity of an infected case and so it is not recommended for public health authorities to allow this display to take place.

One possible option may be to let the contact know that their exposure occurred within a certain 'window' of a few days without letting them know the precise day (this may not be compatible with local regulations where quarantine is compulsory for a fixed number of days). Contacts can then be asked to self-quarantine 14 days from the last day in that window.

Possibility to turn off tracking

Countries can consider asking app developers for a feature that would allow people to select certain time periods to opt out of proximity tracing. This could be when they know that they are at home and want to avoid a neighbour being erroneously traced as a contact through thin walls. Healthcare workers may want to turn off the app while at work if they know that they work in a ward with COVID-19 patients and that they wear appropriate PPE.

Healthcare settings and long-term care facilities

In healthcare settings and long-term care facilities, conventional contact tracing and particular outbreak investigation methods are needed above and beyond what can be facilitated by mobile apps.

Many elderly residents in long-term care facilities will likely not have a smartphone or have downloaded the app. Mobile apps can still help prevent the introduction of infection in these settings if staff use them in their daily life, so that when they get a notification that they have been exposed they can stay home from work or take additional precautions depending on national/local policies. ECDC guidance recommends that if a case in a long-term care facility is confirmed, all residents and staff should be tested even if they have no symptoms [5]. Similarly, if a staff member is identified as a contact to a confirmed case this could also trigger immediate testing in the facility to identify cases as early as possible given the possibility of asymptomatic transmission, the time delay between symptom onset, lab test and confirmation and the high impact and severe outcome in such settings.

In healthcare settings, visitors or patients seeking care may benefit from carrying a phone with the app in case they come into contact with others who later test positive, for example while in a waiting room. Patients who are already confirmed positive and treated in hospital should already be isolated to minimise the risk of transmission.

With regards to healthcare workers using the app while at work, there are a few things to consider. Healthcare workers could turn off the tracking functionality as mentioned above, provided they wear adequate PPE. If there is a breach of PPE while they treat a known COVID-19 patient, the exposure is known and should be managed by occupational health at the healthcare facility. Healthcare workers who see patients in general wards or in

outpatient clinics or primary care facilities without wearing PPE could benefit from using the app should any such patient test positive later.

Cross-border interoperability

As borders open in the EU/EEA, citizens using apps from different countries will come into contact with each other. Work is ongoing within the eHealth Network and the European Commission to develop guidelines ensuring that apps are interoperable. The technical aspects of interoperability will be covered by this work [6]. However, there are some epidemiological aspects to consider. Different apps have different risk calculation algorithms although all will be based on time and distance as the basic parameters. Some may use a cut-off such that an exposure has to have occurred at less than two metres for more than 15 minutes whereas others may take into account different combinations of time and distance, cumulative exposure as well as other parameters such as symptom onset to calculate a risk score. It is recommended that information is exchanged between apps in a way that enables different types of risk calculations to take place. Such information would include the time and distance of exposures including those of short durations such as five minutes (or less if appropriate). If apps have a feature enabled whereby the infected user can enter information on what day he or she started having symptoms, this information should ideally be exchanged between apps if feasible. Finally, the day(s) when the individual proximities occurred should also be communicated in order to enable some apps to consider when the exposure occurred relative to symptom onset or diagnosis and to enable appropriate recommendations for length of quarantine if applicable.

There are some additional operational considerations regarding travel. Example scenario: a citizen and app user from country A (user A) travels to country B for a period of time. When (s)he is in country B, (s)he comes into contact with a citizen of country B (user B) who later tests positive. User A will receive a notification. If user A is still in country B at that time, public health authorities need to consider which country (s)he should receive the notification from. The most straightforward way would be that (s)he receives the notification through her/his own app from country A. The information will be in the language (s)he understands and from a trusted authority. However, it might not have locally appropriate information. Public health authorities could also consider working with app developers to enable advice to be tailored accordingly, for example giving a follow-up number to call relevant to the country of visit.

Second order contacts

Depending on the design, it may be feasible for some mobile apps to alert so-called 'second-order' contacts as well. This means that when a user is declared to be positive their contact persons ('first-order contacts') are alerted as normal, but the app can also alert the people who have been in proximity to these first-order contacts. These can be thought of as 'second-order' contacts. The advice given to the second-order contacts might be 'lighter', for example just alerting them to be particularly mindful of respecting physical distancing measures and look out for symptoms, rather than self-quarantine. If one of the first-order contacts tests positive later, the relevant second-order contacts then become first-order contacts themselves and are given advice accordingly, such as to self-quarantine. Public health authorities should consider that enabling the notification of second order contacts might result in a very large number of people getting alerts. It would be advisable to test and calibrate the apps first before considering alerting second order contacts, and to only consider such 'cascaded notification' to the second order contacts with a high-risk exposure to a first order contact with a high-risk exposure to a case.

Testing

Current ECDC contact tracing guidelines recommend testing contacts who develop symptoms. The perception of some may be that testing will automatically be offered to all contact persons traced and alerted by the app, even if asymptomatic, which may not be possible due to lack of resources. The strategy to test contacts should be done in alignment with countries' testing strategies and should be the same for contacts identified through conventional contact tracing and through apps. Importantly, even if a contact person tests negative, in particular early during the incubation period, that is no guarantee that they will not develop infection later in the incubation period and be at risk of transmitting it to others. Thus, self-quarantine is recommended regardless of testing results. However, testing asymptomatic contacts to determine if they are infected (instead of waiting until symptoms develop) would enable tracing of their contacts to start sooner. This would be beneficial from the point of view of breaking transmission chains.

Uptake and scale-up of contact tracing

It is likely that the more anonymous and private the app solution is, the more likely people are to download it. This should be considered by public health authorities.

Mobile apps will be more effective the higher the uptake. However, considering that conventional contact tracing should always still be done, mobile apps can potentially add some value even if their uptake is low, although more analyses are needed to understand this better.

Uptake could be actively encouraged and authorities could consider enabling app users to easily share a link to download the app, for example via SMS, and other ways of improving uptake across population groups.

The apps must remain voluntary, not only in name but also in practice in that having downloaded the app should not be a condition for access to particular locations or services. Mobile apps should also be temporary and dismantled when no longer needed [1].

Public health authorities should also be clear in their communication about what the app can and cannot do, to ensure users do not get a false sense of security and avoid taking other precautionary measures.

Note that mobile apps are not the only way to scale-up contact tracing, and ECDC has provided guidance on how to scale up contact tracing efforts with trained non-public health staff as well as by using other technical solutions such as websites where cases can enter details of their contacts enabling staff to save time and helping with follow up [4].

Data altruism

The main purpose of the apps is to do proximity tracing and alert people who have been in contact with infected persons in order to break transmission chains. Additionally, data from contact tracing can be a valuable source of information that can enable public health authorities to understand transmission dynamics and the impact of measures. App developers can enable an option where users can consent to upload additional epidemiologically relevant information related to themselves, for example age, to public health authorities. Users may be more motivated to do so if they are informed that the upload of such data may enable public health authorities to better understand the epidemiological situation in the country and transmission dynamics. Such data should only be retained for a limited period of time in compliance with local regulations, and security and confidentiality should be ensured. Public health authorities should be mindful of how this request would be perceived by population and whether it risks limiting the uptake of the app.

Resources

Webinar on mobile apps for the European Parliament – the three panels give a good overview of the opportunities and challenges with using mobile apps for contact tracing. Available from: https://re.livecasts.eu/webinar-on-contact-tracing-applications/

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6. eHealth: Interoperability guidelines for approved contact tracing mobile applications in the EU. https://ec.europa.eu/health/sites/health/files/ehealth/docs/contacttracing_mobileapps_guidelines_en.pdf

Annex 1. Epidemiological parameters in the apps

There are many different applications currently under development that use a variety of ways to calculate risk of exposure based on time, distance and in some cases other parameters. Some countries may be at the stage of choosing how apps should calculate risk whereas other countries may already have chosen an application but need advice on how to choose values for the different parameters.

A detailed review of ways to set parameters in specific apps is beyond the scope of the current guidance but may be considered for the future. Some principles that can be considered when calculating risk scores are however outlined below.

Due to the limitations of the current science available, it is not possible to state with any certainty the risks associated with exposure to an infected individual during different durations and at different distances, or at different stages of infection. The values provided here can be seen as a starting point, but public health authorities will have an important role in evaluating the data gained from mobile apps for contact tracing and calibrating and refining the risk calculations accordingly.

Using a simple time and distance cut-off

ECDC defines a high-risk exposure (close) contact as face-to-face contact for at least 15 minutes at a distance of two metres or less. Apps cannot detect whether a contact is face-to-face, but this example still uses the 15 minutes/two metres as a cut-off.

Time: 15 minutes or more

Distance: two meters or less.

Exposure could be measured as cumulative over for example each 24 hours (for example 5am-5am to enable exposure that occurred during an evening out to be aggregated. All contacts who fulfil both criteria (total of more than 15 minutes exposure at less than two metres in any 24 hours) are notified.

Evaluation and calibration

When piloting and rolling out the app, assess the number of contacts notified and the percentage who later test positive. Alternatively review the exposure history of contacts that later test positive as outlined in the main text earlier.

Time and distance on a continuum

Another method of calculating exposure risk is to not use a defined cut-off but allow different combinations of time and distance and generate a risk score. Thus, a short duration at close distance could generate a similar score to a long duration at a longer distance.

Suggested weighting:

- Time: Give higher score for longer duration in a linear manner. For example, < five minutes would be given a very low score and >30 minutes a high score. Scores could be evenly distributed in between for each five minute interval.
- Distance: Closer distances are considered at highest risk, but with a relatively quick drop off. For example, distances less than one metre would be given the highest score (X), 1-2 metres would be given a score half of that (x/2), and other distances within the Bluetooth detection range could be given a score of 25% of the highest score (X/4)[i].

Please note that the way the Bluetooth apps measure distance is by 'attenuation' of the Bluetooth signal, measured in units called dBm. Public health authorities need to work with technical experts to understand how this score translates into distance.

Ideally, the app should be able to aggregate sets of different time and distance combinations over 24 hours as in the example above.

[i] Chu DK, Akl EA, Duda S, Solo K, Yaacoub S, Schünemann HJ, et al. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis. The Lancet. 2020.

Risk score:

The app may then compute a total risk score. Public health authorities can decide a cut-off to use for notifying contacts. One way of deciding a cut-off could be to determine the risk score that would be generated by an exposure of two metres for 15 minutes. Time and distance combinations that generate the same score or higher could then also generate a notification.

Evaluation and calibration

Depending on what data can be obtained from the app, assess the number of contacts notified and the percentage of contacts notified who later test positive when using a certain cut-off of the risk score. Alternatively, assess the most common exposure combinations among people who test positive as outlined in the main text earlier. Depending on the result, try a different risk score cut-off and reassess positivity rates or change the scores given for different distances and times.

Adding other parameters

Some apps allow for other parameters to be taken into account in addition to time and distance.

Timing of contact relative to onset of symptoms in the case

Transmission is most likely to occur just before and soon after symptom onset. Therefore, exposure that occurred during this window could be given a higher weight. This would necessitate the app to ask the infected person what day he or she first started having symptoms. Not all apps may have this feature.

- Timing: Contact exposure that occurred from two days before symptom onset until three days after would be given the highest relative weight (e.g. 3). Contacts that occurred from day 4-6 after symptom onset would be given a lower weight (e.g. 2), and those that occurred day 7-14 after symptom onset a weight of 1.[i,ii]

This parameter could be added to the time and distance calculation whereby exposure on a given day could be weighted by when the contact occurred relative to symptom onset in the case.

- Risk score: The total risk score would be based on all three parameters. Public health authorities decide a cut-off to use for notifying contacts, for example using as a reference the score given to an exposure of 15 minutes at two metres, 7 days after symptom onset (i.e. a timing relative to symptom onset with the lowest weight).

Evaluation and calibration

Depending on what data can be obtained from the app, assess the number of contacts notified and the percentage of contacts notified who later test positive when using a certain cut-off. Alternatively, assess the most common exposure combinations among people who test positive. Depending on the result, try a different risk score cut-off and reassess positivity rates, or change the scores given for different distances and times, or adjust the weight given to timing of exposure.

Time since exposure

If the app does not allow for the case to enter information on when symptoms started, it could be possible to use the day of reporting of the positive test result in the app as a starting point. Public health authorities could review existing surveillance data to detect what the median duration has been between symptom onset and reporting of test results, adding additional time to take account of the delay between when the test result is available and the person with the app enters it in the app.

This median time interval can then be used to *infer* the likely day of symptom onset from the day the test result is reported in the app. Exposure can then be weighted accordingly, as outlined above, by when they occurred relative to the inferred date of symptom onset. Note that as contact tracing becomes more widespread or testing increases in the community, the median duration between symptom onset and reporting may shorten and the risk score can be adjusted accordingly.

[i] He X, Lau EH, Wu P, Deng X, Wang J, Hao X, et al. Temporal dynamics in viral shedding and transmissibility of COVID-19. Nature medicine. 2020;26(5):672-5.

ii Cheng H-Y, Jian S-W, Liu D-P, Ng T-C, Huang W-T, Lin H-H. Contact tracing assessment of COVID-19 transmission dynamics in Taiwan and risk at different exposure periods before and after symptom onset. JAMA internal medicine. 2020.