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Rapid review of contact tracing methods for COVID-19

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This research was carried out during two weeks of April 2020 leading up to 24th April. The information contained within the report is accurate as was on the 24th April 2020.

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Introduction

This rapid review explores the question “How can we undertake ‘people-powered’ contact tracing activity at scale? What types of options are available?”. The main focus of the report will be on investigating any methods and evidence around digitally enhanced people-powered contact tracing. The spectrum of available methodologies for contact tracing range from paper-based methods to fully automated, anonymous digital contact tracing using mobile phone Apps and Bluetooth or geolocation services. Selected examples are provided.

Methodology

The rapid review is based on desk-research carried out over two weeks of April 2020.

A combination of the following search terms was used: “COVID-19”, “coronavirus”, “digital tool”, “contact tracing App/tool”, “contact tracing methods”, “digitally/technology enhanced contact tracing”, “pandemic”, “disease control”.

The search primarily covers information published or released during the previous 4-month period from 1st December 2019 to 16th April 2020. Academic articles are an exception, with some of them dating back to early 2010s, focussing on Ebola or Tuberculosis related contact tracing.

The available sources consist of news items, blog posts, government and policy statements and company or product websites, and academic articles where available. The landscape changes extremely fast. The information contained in this report is accurate as of 20th April 2020. The report has taken a look at the main methods of contact tracing available in literature.

Summary of findings

What is contact tracing?

- Contact tracing is the process of identifying, assessing, and managing people who have been exposed to a contagious disease to prevent onward transmission. Those who have been in contact with an infected individual will be asked to self-isolate.

- Contact tracing is a key component of infectious disease control and response.

Summary table of key contact tracing methods and their pros and cons:

Method	Definition	Pros	Cons
Traditional contact tracing	People-powered, often paper-based	• Deemed the most effective method at present	• Expensive, time-consuming, takes a lot of resources, relies on human memory
Digital contact tracing	Automated contact tracing carried out by mobile phone apps. 1) Bluetooth handshakes 2) GPS-tracking 1) Centralised data processing 2) Decentralised data processing	• Can be done at scale; • Less costly than people-powered method; • Automated; • Helps with contact tracing in large populations and busy urban contexts.	• Privacy- and online security concerns; • Relies on prevalence of smart phones; • Relies on citizen uptake of method (60% of the population would have to use the app for this to work); • Creates a lot of false positives, as Bluetooth signals carry through walls or pick up signals from passing vehicles or pedestrians; • Relies on connectivity; • Bluetooth does not allow for loction-based tracking; • GPS does not work well in urban settings and is not as accurate as Bluetooth
Digitally enhanced contact tracing	Like traditional paper-based but supported by digital data collection tools.	• More effective than the paper-based method; • Accelerated data-entry; • Improved data completeness and accuracy; • Improved data storage and access to data; • Improved reporting and sharing of results with authorities; • Helps with creating better informed epidemic control strategies and in identifying outbreak hotspots; • Helps support Public Health decision making.	• Still requires human resource • Training on contact tracers • Access to digital tools for data collection • Connectivity issues in certain contexts

Importance of testing

- The success and reliability of any kind of contact tracing activity is interdependent with a rigorous testing regime to be in place.

> *"…The effectiveness of a contact tracing strategy is entirely dependent on speedy, and accurate positive test results identifying those who are infectious and who are spreading the virus, allowing for fast interventions by contact tracing teams to interdict to prevent further spread. Without accurate and timely positive test results, contact tracing will be greatly sub optimal, allowing many infected persons to continue to spread the disease without their 'contact's being informed and instructed to self-isolate or quarantine." (Walton et al., 2020, 37.)*

- Testing is even more critical if digital apps are being used for contact tracing. Self-entry of symptoms is not accurate and does not give a person a diagnosis.

Contact tracing

Contact tracing is the process of identifying, assessing, and managing people who have been exposed to a contagious disease to prevent onward transmission. Those who have been in contact with an infected individual will be asked to self-isolate. Contact tracing is a key component of infectious disease control and response. (Michaud & Kates, 2020, April 3rd; Ward 2020, April 15th.) Effectiveness of contact tracing has been an essential feature for curbing the spread of the virus, for example in Ireland, China, Germany, South Korea and Singapore, which is widely held at "Gold Standard" example (ibid; Vaswani, 19th March 2020).

Traditional, people-powered contact tracing

Traditionally, contact tracing has been carried out by public health investigators through phone calls and outreach in the communities, and it has been identified as still being the most effective tool for contact tracing (Newton 2020, April 10). However, this activity is time consuming and takes up a lot of resources. Other issues include reliance on human ability to accurately recall events that may have taken place in the preceding weeks. (Selbie, 2020; Lee 2020.)

Examples of effective contact tracing operations come from Ireland (McGhee 2020) and Massachusetts (Barry, 2020). Information about the contact tracing practices in Germany were hard to come by.

Public Health experts in the UK are urging UK government to recruit an army of contact tracing volunteers to warn people who may have been infected by a COVID-19 sufferer (Tapper, 2020).

Ireland

As of 11th April, Ireland has had 6,000 confirmed cases of COVID-19. Each of these patients and their contacts have been contacted and traced since the beginning of the COVID-19 crisis. The Irish government acted fast, setting and scaling up a contact tracing system in a matter of weeks for a process that would normally take up to 18 months to set up.

Ireland scaled up the contact tracing operations from a few dozen people up to a few hundred very quickly. In total, Ireland has trained 1,700 contact tracers, although (as of 11th April) approximately 200 of them have been deployed.

In scaling up the system, the secondment of Defence Forces cadets has been key. The military training that these officers receive enables them to react quickly to emerging situations, and to become as efficient as possible in a short period of time. On a daily basis 20-30 cadets make phone calls to contacts and feed the data into the system.

When being tested, everyone is required to supply a mobile number; at nursing homes and hospital settings, the information gathering is done in conjunction with specialist Public Health staff, or designated contacts face-to-face.

The contact tracing process consists of three phone calls.

1) The first call is done by people with a clinical background. They deliver the positive test result, record patient's symptoms and give medical advice.

2) The second call is done by a contact tracer from one of the call centres after about an hour. They go through a long list of questions and enter the details into an information system. The person is asked to identify all close contacts for the past fortnight, before they became symptomatic. "Close contact" is defined as closer than two metres for more than five minutes.

3) The third call is done by a contact tracer to all the contacts listed by the person who has a diagnosis. They are asked whether or not they have symptoms. If they do, they are advised to contact their GP. Patient privacy is protected in the call. Everyone who is contacted is asked to self-isolate for 14 days irrespective of presence of symptoms.

The number of contacts per person is currently going down because of social distancing measures. However, the 14-day delay in receiving diagnosis results has made the situation more challenging.

While Ireland are developing an App and hope to use this to supplement the contact tracing program (a Bluetooth-based App is most likely to be the option considered for use in Ireland), Public Health officials believe that using people to track contacts of people with COVID-19 infections is more effective than using digital solutions.

(Sources: McGhee 2020; Wall, 2020)

Massachusetts, USA

Each state in the USA is organising their own contact tracing programme. Massachusetts is the first state to invest in an ambitious programme to hire 1000 contact tracers (at a cost of $44M). The aim is to identify pockets of infections as these emerge and then isolate the infected people, preventing further spread of the virus. The programme has been arranged by a non-profit Partners in Health organisation, which has led responses to other infectious diseases, including Ebola and Zika. (Barry, 2020)

Rather than relying on technology, Massachusetts is relying on a ramped-up testing and robust programme of contact tracing, according to Governor Baker (Barry, 2020).

The contact tracing programme is based on one-to-one telephone interviews with newly diagnosed patients and their contacts. The founders of Partners in Health organisation align with Irish Public Health officials in that human to human contact tracing will have greater impact in conveying a serious health message.

1. https://www.irishtimes.com/opinion/public-must-have-confidence-in-covid-19-contact-tracing-app-1.4233505

The method for contact tracing in Massachusetts comprises three stages:

1) When a citizen gets a positive COVID-19 diagnosis, the result is immediately shared with a case investigator through a secure database. The patient is contacted within two hours to compile a list of every person they have been in close contact with within the 48 hours before the onset of the symptoms.

2) Names of the contacts are passed onto contact tracers, who will attempt to reach each one by phoning them within 48 hours. They will call back three times in succession to signal that the call is important. Tracers do not leave messages or ask for call back at this stage.

3) The contact traces use a prepared script to inform the contact of approximately when they were exposed and take an inventory of any symptoms, talk through quarantine requirements and help arrange assistance with food or housing if the contact cannot easily quarantine.

(Source: Barry, 2020)

Digital and automated contact tracing

Countries around the world are turning to digital solutions to trace the spread of the virus through symptom tracking and human contact tracing. 29 countries around the world are now using mobile data to help with contact tracing COVID-19 cases (Hui 2020, April 22).

Our recently published report “Global Examples of COVID-19 Surveillance Technologies” (Rimpiläinen et al., 2020) focussed on the different technologies available around the world in more detail. Here, we highlight two examples of countries, Singapore and China, that have successfully implemented a regime of testing, contact tracing, quarantine and isolation of infected individuals supported by digital tools. The other two examples showcase fully GDPR compliant Apps or software being developed, or being about to launch, for the purposes of contact tracing in the EU (PEPP-PT) and UK (NHSX).

A recent data simulation carried out by a research team at Oxford University has shown that digital contact tracing App, if used alongside with other measures, has the potential to “substantially reduce” the number of new COVID-19 infections. The epidemic could be stopped if ca. 60% of the population would use the App. The study also shows that even with lower numbers of App users there is an estimated reduction of coronavirus cases and deaths. (Big Data Institute 2020, April 16.)

Singapore: TraceTogether

Singapore's TraceTogether App is a community-driven, open-source contact tracing app aimed to help prevent the spread of COVID-19, developed by GovTech. It utilises automated Bluetooth-based contact tracing technology, which has been hailed as a "Gold standard"-approach in many countries. There are, however, various privacy concerns, which have been discussed in more detail in our recent Flash Report (Rimpiläinen et al., 2020). The Government released the code in April (Hui 2020, April 22), available at https://bluetrace.io/.

The TraceTogether App works by generating a random user ID every few hours to pair with the users' mobile number. According to the developers, it does not collect personal data (GovTech 2020). The Bluetooth on the phone scans its vicinity for 8 sec every 40sec to look for nearby devices with the App. When found, each device sends back encrypted information, which the App decrypts and saves into a database stored in the phone.

Data is stored locally on the phone for 21 days, after which it is deleted. (Meshead 2020, March 24; DigitalReach 2020, April 2.) Current guidelines define "close proximity" as 2m apart or up to 5m, for 30mins. If the person using the app gets a positive COVID-19 diagnosis, Ministry of Health will ask the user to share the records stored on their phone so that they can contact the people they have been in the vicinity of as part of their contact tracing investigation. Refusal to share the information may result in prosecution under the Infectious Diseases Act. (GovTech 2020, March 25; Wong, 2020, April 1.) The Singaporean Government is now calling for the app to be made compulsory to be used by all (Hui 2020, April 22).

While the App is not meant to collect any personal data, it was discovered that the developer team had "inadvertently" included a government data collection service wogaa.sg into its build, which might have allowed state agencies access to people's personal data (Vadaketh, 2020, April 2; DigitalReach, 2020, April 2). This has now been removed (Chu 2020, April 3).

China: HealthCode

The Chinese Government has developed an app called HealthCode, which is mandatory to all Chinese citizens and residents, who wish to travel. This service runs ubiquitously across various social media platforms (including Alipay and WeChat). Anyone wishing to travel have to prove their "health status" before entering any public transport. Officials are in place to check people's permission to travel.

Based on detailed personal information submitted (personal and contact details, current location, passport number and travel history, details of mode of transport and location in public transport, relevant medical certification, any symptoms, medical treatment, and if the person has been in contact with a COVID-19 patient in the past 14 days, etc.), the App automatically generates a coloured QR-code. This signifies the person a health status (green, yellow or red), and enforces quarantine rules.

Issues with the app include serious data protection and privacy concerns and lack of transparency. The data collected by the App can be shared with the police and is stored at a national data base. There is also little information on how the colour codes are generated, as the parameters of data entry are vague.

The system is made possible by the Chinese public's almost universal adoption of smartphones and the ruling Communist Party's embrace of "Big Data" to extend its surveillance and control over society.
(Davidson 2020, April 1; Associated Press 2020, April 2, Wang 2020, April 1.)

European initiatives

Pan-European Privacy Preserving Proximity Tracing Initiative PEPP-PT

The European PEPP-PT (Pan-European Privacy Preserving Proximity Tracing Initiative) proposes a similar Bluetooth based technology as in Singapore, but one that is advertised as fully GDPR compliant: it transmits no personal or location data, or user IDs. The initiative is based on a consortium of 130 scientists and technology experts from 7-8 European countries. It is open-source and available for free.

PEPP-PT is not an App, but an approach that provides software code, standards and services for the development of contact tracing technology that national authorities can use to develop their own COVID-19 Apps. The software can be adapted to the processes of each national health and policy context. National authorities remain free to decide how they inform persons who have been in contact with an infected individual. The Apps created will be assessed by national cyber security and data protection agencies using the code released by PEPP-PT. Being a European initiative, it also has cross-border reach and interoperability
(Lomas 2020, April 1; Cooper 2020, April 2; Fraunhofer Heinrich Hertz Institute 2020, Apr 1)

NHSX Contact Tracing App

UK government are currently testing an NHSX App based on "Bluetooth handshakes", the purpose of which is to log the proximity of other phones using the NHSX App and log their encrypted details into a database (Kelion 2020, April 22). Receiving a COVID-19 diagnosis, the App would alert everyone whose proximity has been logged on the other App user's phone.

The NHS hopes to release the App end of April, although a final decision on timing will be taken by the government. However, they are also planning on introducing the App towards the end of the lockdown to help relax the lock-down measures. The app is based on a mathematical simulation on how "instantaneous digital contact tracing" would influence the spread of the virus (Ferretti et al., 2020). Like Singapore's TraceTogehter, the NHSX App works through using Bluetooth signals, a "Bluetooth handshake", to log the proximity (defined as "a person closer than 2m for more than 15mins") of one app user to another app user. The app generates temporary user IDs which are exchanged between the apps. The data is stored on the phone. The key developers of the App have been involved in the European PEPP-PT consortium.

The research team have estimated that 56% of the general public, or 80% of all Smart phone owners, should install and use the app in order for the method to halt the outbreak. The use of the app will be voluntary, but even a lower rate of uptake will help slow down the outbreak.

(Clarke 2020, April 2; Kelion 2020, March 31; Kelion 2020, April 16; Kelion, 2020, April 22; Pegg et al. 2020, April 13)

The is criticism towards the NHSX app in terms of recent developments of making if a multipurpose app, also to be used for tracking compliance with social distancing and lockdown rules (Kobie 2020, April 13).

Centralised vs decentralised contact tracing apps

PEPP-PT, like TraceTogether and the NHSX App, are based on mobile phones' Bluetooth signals, the so-called "Bluetooth handshake", which logs the proximity of another phone with the App installed, storing the encrypted details into a database on the users' phone.

If the App user tests positive to COVID-19, an alert is sent to the user telling them they've been in the vicinity of a COVID-19 positive person (a distance of 2m). While the app use is optional and data retrieval is consent-based, PEPP-PT approach has recently attracted criticism for lack of transparency due to centralised storage of users' contacts in database. Its main critic has been another European initiative, which emerged from within the PEPP-PT consortium, but has since broken off from it: Decentralised Privacy-Preserving Proximity Tracing (DP3T). DPT3 has been developing a decentralised COVID-19 contact tracing solution with emphasis on privacy.
(Clarke 2020, April 17; Clarke 2020, April 20.)

Critique is exemplified through a German implementation of the PEPP-PT approach NKT. Clarke (2020, April 20) explains that the Bluetooth feature tracks the proximity of other phones; if the app user is diagnosed by COVID-19, they enter their diagnosis details into the App. At that point, the App runs through the phone's list of contacts from the past three weeks, assessing each for a "risk score" based on the degree and duration of proximity, and other population level epidemiological factors. A push notification is sent out to those deemed at risk, with information on the need to isolate.

"In terms of privacy, the app assigns each handset a persistent identifier (PUID) that is used to create ephemeral IDs (EBIDs) for the handset that change periodically. These are created by encrypting the PUID with a global broadcast key that is renewed periodically. After four weeks, the key is deleted. It's the ephemeral EBIDs that are broadcast by the phone, and the EBIDs of other phones in close proximity that are recorded. Once a patient is diagnosed, with the patient's consent and authorisation from a health authority, the app uploads all the EBIDs recorded over the prior three weeks to the server, along with time of contact, Bluetooth metadata and some other information. The backend server then uses the global broadcast keys to decrypt the EBIDs, revealing the PUID (and therefore the pseudonymised identity) of all the devices that were close to the infected person in the specified date range."
(Clarke 2020, April 20, underline SR.)

Many of the former PEPP-PT advocates have "defected" to the DP-3T consortium, which represents a competing approach to PEPP-PT. DP3T present some major divergencies in how the contact tracing approaches being developed works. The most noteworthy one is that with DP3T approach, the risk calculation is performed on the app user's phone rather than on the server, as is the case on PEPP-PT. This means, the data never leave's the user's phone. (Clarke 2020, April 17; Clarke 2020, April 20; Stolton 2020, April 21.)

DP3T proposes a “privacy-friendly, decentralised solution that reveals minimal information to the backend server”. DP3T system limits the data that is collected, uploading location details of people who have been infected. One key aspect is to use temporary identification markers, rather than a phone number, name or even specific Bluetooth data, which sticks to your device.

In a decentralised structure, data collected is held in a distributed manner, so no single organisation has complete control over it. Using a truly anonymous, temporary and changing IDs is a design constraint. This enforces privacy by design and prevents future abuses of the data. (Kobie 2020, April 13.)

> *“The proximity tracing process is supported by a backend server that shares anonymous contact information with the app running on each phone. This backend server is trusted to not add or remove information shared by the users and to be available. However, it is untrusted with regards to privacy (i.e. collecting and processing of personal data). In other words, the privacy of the users in the system does not depend on the actions of this server. Even if the server is compromised or seized, privacy remains intact.” (Troncoso et al., 2020, April 12, p. 9, underline SR)”*

Decentralised digitised contact tracing works similarly to the centralised digitised contact tracing, but the key difference is that the data does not leave the user’s phone. There is, however, also criticism for the DP3T approach for creating more privacy threats than solving them (please, see Vaudenay, S. (2020). Analysis of DP3T. Between Scylla and Charyblis. EPFL, Lausanne, Switzerland. https://eprint.iacr.org/2020/399.pdf)

Issues with digital contact tracing

There is scepticism on how effective digital and automated solutions are in containing the virus. The main concerns focus around lack of testing, privacy issues and level of ownership of smartphones by the population, as well as uptake and use of such tech by the population (e.g. Stokel-Walker, 2020; Chazan, 2020; Chestney, 2020). Furthermore, while Bluetooth technology is said to work better in urban contexts and preserve citizens’ privacy, it provides little data that could be useful for Public Health Agencies.

Bluetooth-based apps are said to be more privacy friendly by design, as they focus on the “who” rather than “where”, and they broadcast and receive encrypted, pseudonymous signals from near-by phones. Other tracking techniques use GPS or cellular phone data. Bluetooth is also more reliable in urban settings than GPS, which as longer signal length. GPS signals cannot differentiate if you are in the same building as another person, something Bluetooth can do. (Aravindan et al., 2020; Wong 2020.)

There are, however, a lot of issues with Bluetooth-based technology. These include:

Issues with accuracy and generation of false positive alerts between people who have never been in contact with one another:

- The NHS definition of “proximity” is people 2m apart. The range of Bluetooth varies between 10m-30m depending on the smartphone and the Bluetooth chipset. The technology cannot differentiate the direction the person is in relation to the phone.
    - Latest Smartphones have chips that can identify locations better.

- Bluetooth signal can penetrate walls in a building. This means it could log a person in a different apartment or a different floor in a building.
- Possibility of interference, which could amplify false positive reports. (Newton 2020, April 10; Lee 2020, April 10; Hui 2020, April 22.)
- Without testing, the user of the App will never know who has had Covid-19 - just that they have been in the vicinity of a person with an infection within a period of time. (Lee 2020, April 10.)

Privacy and data security issues:

- E.g. TraceTogether App requires the Bluetooth to be on 24/7. This creates leaves the user’s phone open to other devices and Apps to access it.

- “A major security risk with contact tracing apps is that a malicious hacker or a government wanting to violate the privacy of a user can still crack the anonymized location and time- stamped data, in a process known as “hash-cracking” (Hui 2020, April 22).

Requires a high level of uptake:

- Many sources point out to the fact that these devices only work to curb the spread of the virus if a meaningful number of people install the App.
    - A study found (Big Data Institute 2020) that ca 60% of the population, or 40M people in the UK should download the App for it to be effective.
    - 21% of UK residents do not have Smartphones (Boyle, 2019).
    - People would have to carry their phones with the at all times.
    - It is estimated that in Singapore, 75% of the population would need to download the TraceTogether App for it to be truly effective (Ng 2020, April 18). To date, just 12% of the population has downloaded the App (Hui 2020, April 22.)

Lack of testing is slowing down the impact these types of Apps might have.

Digitally enhanced contact tracing – scientific evidence

Examples of using digital tools to support traditional (human-powered) contact tracing include trials of using mobile Apps and other digital tools to trace Ebolaor Tuberculosis outbreaks in sub-Saharan Africa (Danquch et al., 2019; Sacks et al., 2015; Ha et al., 2016).

While digital contact tracing did not replace the paper-based systems in any of these settings, the results from these studies demonstrate that the use of digital tools to support data collection:

- Accelerated data collection and entry times;
- Improved data completeness, and accuracy;
- Improved data storage;
- Improved access to data;
- Improved sharing of results and generation of summaries;
- Helped to create better informed epidemic control strategies; and
- Helped support decision-making on healthcare systems level in reducing the risk of future disease outbreaks.

(Sources: Danquch et al., 2019; Ha et al., 2016; Sacks et al., 2015)

The studies also highlighted challenges in using mobile Apps in the given societal and epidemic context of the study (e.g. Ebola epidemic in Sierra Leone and in Guinea; Tuberculosis in Botswana).

Digitally enhanced contact tracing - recommendations

The World Health Organisation

The World Health Organisation (2019a & b) have developed a Go.Data App, aimed which is “an outbreak investigation tool for field data collection during Public Health emergencies.”
The tool is also endorsed by the European Centre for Disease Prevention and Control (2020), above, and the newly released EU Toolkit by the European Commission (2020).

The features of this App include:

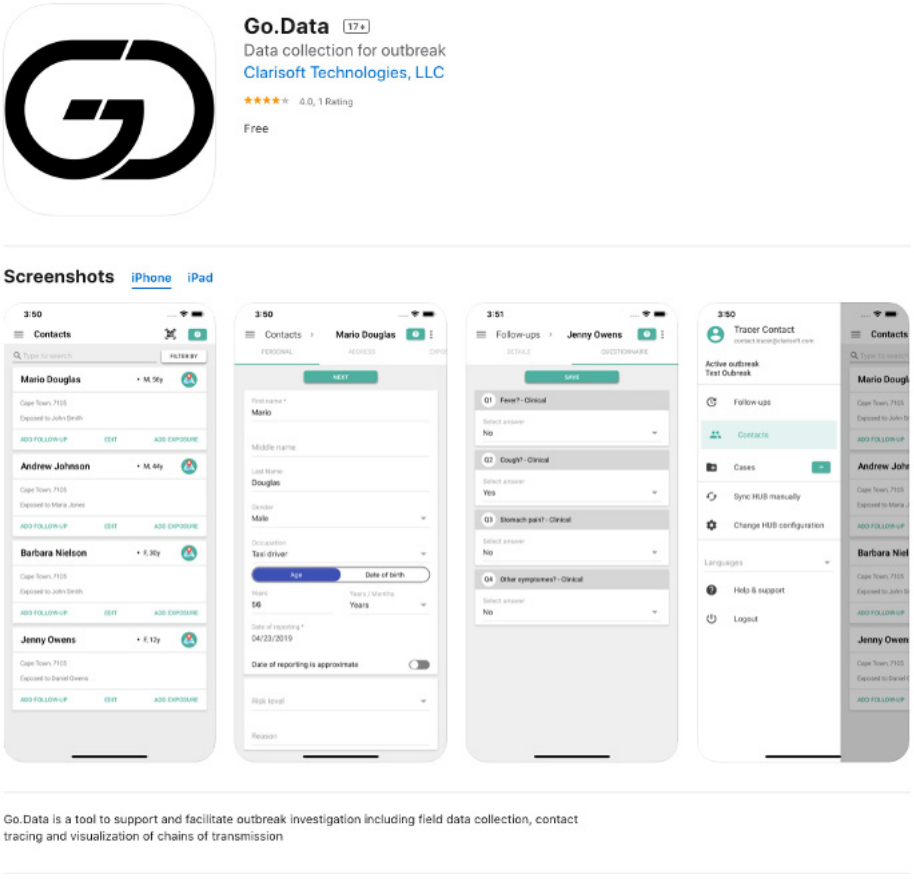
- Functionality for case investigation, contact follow-up, visualization of chains of transmission including secure data exchange and is designed for flexibility in the field, to adapt to the wide range of outbreak scenarios;

- Targeted at any outbreak responder;

- It has been used, for example, during Ebola-crisis or for tracing Diphtheria outbreaks in developing countries;

- Go.Data is open source, free, available for a download from AppStore, and work both offline and online; and

- Go.Data is the initiative of a group of Public Health partners and is managed by the Global Outbreak and Response Network coordinated by WHO.



Recommendations by European Centre for Disease Prevention and Control

The European Centre for Disease Prevention and Control (updated documents, 8th April 2020) also endorses the use of digital tools to enhance the process of contact tracing.

They highlight the following points which should be considered when digital tools are being used:

• Each country will need to adapt their contact tracing intensity to the local epidemiological situation and according to available resources;

• The available resources may be strengthened by recruiting non-medical staff, including volunteers, provided sufficient data protection safeguards and training are in place;

• Utilising other resources, e.g. call-centres, or switching to self-monitoring for close contacts instead of daily calls, or introducing an App or other online tools to assist with monitoring; and

• People who have been in contact with the virus carrier could also be contacted via SMS instead of phone calls.

EU Toolbox for the Use of Mobile Apps for Contact Tracing

The European Commission (2020, April 16th) have released a joint EU toolbox for the use of mobile applications for contact tracing and warning in response to the Covid-19 pandemic. The purpose of the toolkit is to coordinate a joint approach to support the gradual lifting of confinement measures relating to the Commission's recommendations.

The toolbox points out that:

- "in parallel with mobile applications, manual contact tracing will continue to play an important role, in particular for those, such as elderly or disabled persons, who could be more vulnerable to infection but less likely to have a mobile phone or have access to these applications. Rolling-out mobile applications on a large-scale will significantly contribute to contact tracing efforts also allowing health authorities to carry manual tracing in a more focussed manner. Public Health authorities will continue using currently available software (e.g. national contact tracing systems and Go.Data from WHO/GOARN) to manage the contact tracing and contact management process."

The toolbox sets out the essential requirements for these Apps:

- They should be fully compliant with the EU data protection and privacy rules, as put forward by the guidance presented today following consultation with the European Data Protection Board;
- They should be implemented in close coordination with, and approved by, Public Health authorities;
- They should be installed voluntarily, and dismantled as soon as no longer needed;
- They should aim to exploit the latest privacy-enhancing technological solutions. Likely to be based on Bluetooth proximity technology, they do not enable tracking of people's locations;
- They should be based on anonymised data: They can alert people who have been in proximity for a certain duration to an infected person to get tested or self-isolate, without revealing the identity of the people infected;
- They should be interoperable across the EU so that citizens are protected even when they cross borders;
- They should be anchored in accepted epidemiological guidance, and reflect best practice on cybersecurity, and accessibility; and
- They should be secure and effective.

Importance of testing

Evidence suggests that whilst 'people-powered' contact tracing is expensive, it is still the most effective and reliable method for tracing, notifying, informing and quarantining positive COVID-19 cases. Contact tracing processes can be enhanced through the use of digital technologies, which offer ways to improve and speed up data collection and data entry, data accuracy, data analysis and reporting, possibly even help with the follow up of COVID-positive patients in quarantine.

Contact tracing for infectious diseases is not a new concept, and countries such as Ireland provide us with good examples on how to quickly scale up a contact tracing workforce (in this case recognising that military training enables people to be good at reacting quickly to events, and becoming as efficient as quickly as possible).

However, the success and reliability of any kind of contact tracing activity requires rigorous testing regime to be in place. Policy Exchange thinktank state:

> *"…The effectiveness of a contact tracing strategy is entirely dependent on speedy, and accurate positive test results identifying those who are infectious and who are spreading the virus, allowing for fast interventions by contact tracing teams to interdict to prevent further spread. Without accurate and timely positive test results, contact tracing will be greatly sub optimal, allowing many infected persons to continue to spread the disease without their 'contact's being informed and instructed to self-isolate or quarantine." (Walton et al., 2020, 37.)*

Testing is even more critical if digital apps are being used for contact tracing. Self-entry of symptoms is not accurate and does not give a person a diagnosis:

> *"It can be argued that there is little point investing substantial sums of money and effort into a digital contact tracing strategy (using a digital App and contact tracing teams) if the UK is not able to identify quickly an extremely high percentage (if not 100%) of those who have become infected. If swab testing is sufficiently prolific and resourced to be able to test anyone with an immediately identified symptom of COVID-19, then a comprehensive digital contact tracing strategy is worthwhile" (Walton et al., 2020, 38).*

Hasell et al., (2020) from Our World in Data suggest testing is one of the most important tools in the fight to reduce the spread and impact of the virus. "Tests allow us to identify infected individuals, guiding the medical treatment that they receive. It enables the isolation of those infected and the tracing and quarantining of their contacts. And it can help allocate medical resources and staff more efficiently."

In addition, testing for COVID-19 also informs our understanding of the pandemic and the risks it poses in different populations.

"Mobile technology may be a useful adjunct but contact tracing and the behaviour change we subsequently want to engender needs an active human element". (Tapper, J., 2020)

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