Review Article

Exploring the role and mechanism of COVID-19 apps in fighting the current pandemic

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ABSTRACT

As COVID-19 pandemic spread worldwide, policies have been developed to contain the disease and prevent viral transmission. One of the key strategies has been the principle of "'test, track, and trace" to minimize spread of the virus. Numerous COVID-19 contact tracing applications have been rolled around the world to monitor and control the spread of the disease. We explore the characteristics of various COVID-19 applications and especially the Aarogya Setu COVID-19 app from India in its role in fighting the current pandemic. We assessed the current literature available to us using conventional search engines, including but not limited to PubMed, Google Scholar, and Research Gate in May 2020 till the time of submission of this article. The search criteria used MeSH keywords such as "COVID-19," "pandemics," "contact tracing," and "mobile applications." A variable uptake of different COVID-19 applications has been noted with increasing enrolment around the world. Security concerns about data privacy remain. The various COVID-19 applications will complement manual contact tracing system to assess and prevent viral transmission. Test, track, trace, and support policy will play a key role in avoidance of a "second wave" of the novel coronavirus severe acute respiratory syndrome coronavirus 2 outbreak.

Keywords: COVID-19, Coronavirus, Pandemics, Contact tracing, Mobile application

INTRODUCTION

The World Health Organization declared the novel coronavirus severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (COVID-19) outbreak as a pandemic on March 11, 2020. This highly contagious viral disease has now spread across the globe to more than 213 countries with 17,771,634 confirmed cases of COVID-19 disease including 683,278 deaths reported to the World Health Organization (WHO).[1] COVID-19 spreads by droplet transmission causing a spectrum of illness from simple sore throat to viral pneumonia.[2] Serious illness requires hospital admission and may need ventilatory support.[3] To prevent the spread of this contagious virus, national governments have introduced "lockdown" measures with infection control strategies including "social distancing" and "self-isolation" guidelines which severely restricts the movement of people and affects their daily life.[4,5] The World Health Organization has urged countries to scale up the testing, isolation, and contact tracing of COVID-19 patients to combat the pandemic and this process has been supported by recent interventions.[6] Over recent years, the number of individuals with access to a smartphone has risen exponentially.[7] Smartphone technology (SMT) on its own and as extension of telemedicine has significant applications in the current COVID-19 pandemic.[8] It has a significant role which is monitoring and managing chronic conditions such as diabetes and hypertension.[9] SMT has been

further extended with introduction of mobile contact tracing applications (app) to support global effort to control the pandemic. Various national governments have launched mobile COVID-19 contact tracing applications (apps) to monitor and minimize the spread of COVID-19 thus being able to safely reduce lockdown measures.[10,11] India, with its limited health resources, has been significantly affected by the COVID-19 pandemic due the strict "lockdown" measures and application of infection control strategies to prevent the spread of coronavirus SARS-CoV-2 outbreak.[12] We explore the characteristics of various COVID-19 apps and especially the Aarogya Setu COVID-19 app from India in its role in fighting the current pandemic. However, as COVID-19 is still evolving with new features and information being available everyday as such this article highlights the overall mechanism of COVID-19 app in contact tracing philosophy and the current available knowledge.

COVID-19 APPS

COVID-19 apps are mobile software applications that use digital tracking to aid contact tracing in response to the COVID-19 pandemic, that is, the process of identifying persons ("contacts") who may have been in contact with an infected individual. These apps are designed to be downloaded on people's smartphones or tablets to keep track of when they come in contact with each other and for how long by Bluetooth wireless signals. Some of these also use Global Positioning System (GPS) location data.

CONTACT TRACING

Contact tracing is used to slow down the spread of viral outbreak. Contact tracing has been credited with helping lifting "lockdown" restrictions in other countries such as South Korea and Germany when combined with other measures.[13] The COVID-19 App will work with other contact tracing strategies, for example, manual and web-based contact tracing systems to (i) identify people at risk of infection so they can take action to protect themselves, others, and the wider health-care system in curtailing the virus outbreak, (ii) contact tracing can then determine who should be tested or asked to self-isolate or given advice, (iii) it can reveal how the disease is spreading, and (iv) help prevent a "second wave" of COVID-19. The Bluetooth technology allows phone users who have downloaded the COVID-19 app to communicate with each other. This identifies people with suspected COVID-19 and further action can be undertaken following assessment. The GPS location technology helps to trace wider contacts.

Application in the current pandemic

Table 1 shows basic applications of COVID-19 app in the current pandemic.
a. Early detection and diagnosis of infection: The COVID-19 app allows exchange of a key code in between smartphone

users after the app has been downloaded. Following reporting of an infected status on the individual smartphones, this information is collected by a centralized or decentralized database. NHSX and Aarogya Setu have opted for a centralized database so the contact matching happens on a central computer server rather than individual smartphones. Notification to the database triggers an alarm and alerts are cascaded to contacts that have interacted with suspected patient's smartphones. These contacts are then traced and risk assessment done. Following risk assessment decision regarding COVID-19 testing or self-isolation advice or monitoring of symptoms with support is given. Depending on the COVID-19 test results, further steps are undertaken [Figure 1] to support the person.

b. Identify "Clusters" or "Hotspots" of infection: By contact tracing in a community, clusters or hotspots can be found. This will help epidemiologist to learn how the coronavirus has spread and precise dynamics of transmission. It will help in understanding the demographics involved in this infection and shed light on intrahousehold and/or community spread. Cluster assessment will also help to analyze socioeconomic

Table 1: Basic applications of COVID-19 app in the current pandemic.

Number	Applications	Description
1	Identify	Identify symptomatic person Confirm identity of COVID-19-positive patient Alerts results of COVID-19 tests
2	Contact tracing	Trace contacts of symptomatic and or positive patient Advice contacts at risk about self-isolation, testing, quarantine procedures Support them with appropriate information and advice
3	Tracking	Track active cases Track contacts of symptomatic and or positive patient Track distant contacts, for example, public transport
4	Monitor	Movement of active cases and contacts Quarantine and containment zones regulations "Hot clusters" or "Confirmed clusters" Health of people in containment zones
5	Advice	Self-isolation COVID-19 test Where to seek treatment, support, and alleviate concerns about mental well-being
6	Education and information	Highlight COVID-19 developments to public Health information campaigns Publish latest health recommendations Tools for self-care.
7	Research	Epidemiological data collection for future preparation "Syndromic mapping" for modeling studies.

areas predominantly affected and the influence of high-density population in the spread of COVID-19.[9]

c. "Location App:" Some of these contact tracing apps are combined with a "location tracking" smartphone application which will let trace location and movements an infected person and others they may have been in contact with using GPS, for example, travelers on public transport or visitors in a supermarket, for example, Aarogya Setu app.[11] This mechanism also allows monitoring of the pandemic as well.

Overview of current COVID-19 apps

There have been a number of COVID-19 apps developed by several institutions and government agencies around the world. Table 2 gives an overview of the characteristics of various COVID-19 apps currently available. Many of them function similarly differences are highlighted in the table. These are at separate stages of application in the current pandemic and use platforms such as Apple iOS and Google Android systems. There has been a surge in the number of mobile phone apps that attempt to monitor and prevent the spread of the virus. The first such app was the TraceTogether App, developed by the Singaporean government and first released on March 20, 2020.[13] This app makes use of the phone's Bluetooth contact tracing to communicate with other phones in the vicinity. When a person tests positive for COVID-19, the phone then catalogs all the people whom that phone had been in close proximity and allows the government to contact trace these phones for potential viral transmission. Experiences of countries such as South Korea and Germany where mobile-based contact tracing has helped in reducing the spectrum of the pandemic have encouraged various national governments to develop and utilize them in their own countries to stem the spread of COVID-19.[10,11,14-19] Following the initial control of the spread of infection, the process should provide geographical evidence to support removal of "lockdown" measures with an extended belief that mobile contact tracing with other contact tracing strategies and infection prevention measures will eventually help to prevent a "Second wave" of the virus outbreak.

The success of various COVID-19 apps will, however, depend on the uptake of the application system. Academics estimate 80% of the smartphone users which is about 60% of the population will have to actively use it. Second, it is a technology-dependent process hence people should be able to navigate the system.

Security concerns

Researchers have warned use of the application system can pose a risk to users. The use of centralized database has triggered security concerns about data privacy; however, the Government of India and National Cyber Security Centre have tried to allay these concerns.[11,20] NHSX believe centralized database will give better insight into how the disease spreads and helps it to make the app more efficient. However, this has highlighted privacy concerns. A decentralized database on individual smartphones has been put forward by Apple and Google who suggest their system makes it harder for data breaches. The debate continues with privacy protection remediation steps underway.

Aarogya Setu and India's effort to fight the pandemic

On April 2, 2020, the Government of India introduced an ambitious project to curb the spread of the COVID-19 pandemic with its own Aarogya Setu COVID-19 contact tracing app.[11] Aarogya Setu is an open-source cross-platform for tracking mobile applications developed by the National Informatics Centre and comes under the Ministry of Electronics and Information Technology. This app is designed to help control the spread of coronavirus and make its information accessible to the common people. Currently available in 12 different languages and as of May 2, 2020, the app has more than 115 million users, which is more than any contact tracing app in the world. The Aarogya Setu app uses data provided by users, Bluetooth and location generated social graph to track if one has come close to anyone who could have tested COVID-19 positive. With the Bluetooth feature, it tries to determine the risk if one has been near (within six feet) of a COVID-19-infected person by scanning through the database of known cases across India. Using location information, it determines whether the location of an infected person is amongst an infected area. Thus, it provides a mobile tracking and tracing service which is monitored by the Government of India with the aim of controlling the spread of disease and eventually permits lifting the lockdown and other restrictive measures.

The Aarogya Setu app in mandatory to be download by all public health officials including people residing in the isolation and containment zones. The biggest difference between the Aarogya Setu app and Google and Apple technology is that the former uses both Bluetooth and GPS location data while the latter is only dependent on Bluetooth to function. Almost 98% Aarogya Setu users are Android platform.

As with other COVID-19 apps, there have been concerns about security and data privacy. There is an apprehension that since the location app linked with it may be used by law enforcement officials to monitor movement, quarantine, and self-isolation restrictions and if found in breach of them leading to punitive actions. However, people have been reassured about the need of monitoring to control the spread of the virus outbreak and also that the users' data in the app are secure. To make it transparent and with the philosophy of providing transparency, privacy, and security in line with India's policy of Open Source Property, the source code of Aarogya Setu has been made open source on May 24, 2020. The terms and privacy policy have been changed. This suggests only data relevant to COVID-19 infection will be collected.

Table 2: Characteristics of COVID-19 apps around the world.

Name	Country	Platform iOS/Android	Offered by	Technology Bluetooth/GPS	Size (mb)	Type	Open source?	Deletion of data time bound or not	Concerns	Version
COVID Safe	Australia	Both	Australian Department of Health	Both	5.77	Automate contact tracing	No	Yes	Data privacy and connectivity issues	1.0.17
Aarogya Setu	India	Both	NIC e-Gov mobile apps	Both	2.8	Contact tracing	Yes	Yes	Data leak	1.1.3
Be Aware	Bahrain	Both	Information and e-government authority	GPS	8.7	Tamper-proof GPS tracking bracelet	Yes	No	Poor networking	0.1.5
CoronApp	Colombia	Both	INS.GOV	Bluetooth	8.1	Incorporates technology from pioneer contact tracing	Yes	No	Inaccuracies in logging contacts	1.2.45
eRouska (eFacemask)	Czech Republic	Android	Ministerstvo zdravotnictví České republiky	Bluetooth	3.26	Anonymized Bluetooth identification	Yes	Yes	NO English Version	1.0.437
GH-COVID 19	Ghana	Android	IQUENT Technologies	GPS	12.6	Telephone data contact tracing	No	No	Security breach	1.0
Virus Radar	Hungary	Android	Biztributor	Bluetooth	10.33	Random Bluetooth contact tracing	Yes	Yes	Contact lagging issues	1.0.0
Rakning C-19	Iceland	Both	Embætti landlæknis	GPS	10.50	Location data for contact tracing	Yes	Yes	Frozen data registration	1.1.0
HaMagen	Israel	Both	Israel Ministry of Health	GPS	26	Cross Referencing GPS	Yes	Yes	Multiple patch problem	1.3.8
AMAN App	Jordan	Android	Jordan e-Gov Program	Both	3.8	Contact tracing	No	Yes	Technical Wi-Fi Glitch	1.0
MyTrace	Malaysia	Android	Government of Malaysia	Both	30	Proximity information	Yes	Yes	Data privacy	1.0.30
NZ-COVID Tracer	New Zealand	Both	Ministry of Health NZ	Both	9.8	Contact proximity tracing	Yes	Yes	Poor designing	1.0.2
StopKorona!	North Macedonia	Both	Ministry of Information Society and Administration	Bluetooth	15	Bluetooth-based contact tracing	Yes	Yes	Data leak	1.1.0
Smittestopp	Norway	Both	Folkehelseinstituttet	Both	4.2	Anonymized movement about data patterns	Yes	Yes	Security concerns	1.2.0
TraceTogether	Singapore	Both	Government Technology Agency	Bluetooth	4.1	Bluetooth proximity data	Yes	Yes	Battery draining problem	1.8.1
NHS Covid19	United Kingdom	IOS	NHSx	Bluetooth	5.7	Web-based contact tracing	Yes	Yes	Data privacy	1.0.1
CoronoMap Saudi	Saudi Arabia	Both	National Health Information Centre (NHIC)	Bluetooth	9.7	Bluetooth proximity data	Yes	Yes	Concerns about accuracy of the data collection and privacy (Ref 2)	2.0.3
SwissCOVID	Switzerland	Both	Swiss Federal Institute of Technology	Bluetooth	9.8	Bluetooth proximity data	Yes	Yes	Concerns about privacy (Ref 1)	1.0.3

Ref 1: https://www.swissinfo.ch/eng/swiss-to-pioneer-use-of-coronavirus-tracing-app-in-europe/45823496; Ref 2: https://www.barrons.com/news/contact-tracing-apps-which-countries-are-doing-what-01588092604 (*Contd...*)

The Aarogya Setu app has several advantages compared to other COVID-19 contact tracing apps with possibly the most reach and impact nationally, while pioneering new data driven epidemiology logical flattening of the curve through "syndromic mapping." This approach of "syndromic mapping," combined with principals of path tracing and movement patterns COVID-19-positive people, thus permits epidemiology modeling. The platform has been able to reach many users and helps advise them for quarantine, caution, or testing providing much needed education and information about COVID-19 to the general population. Analytics of Bluetooth contacts and location data has also helped identify potential hotspots with higher probability of COVID-19 cases allowing state governments and district administrations and health authorities to take necessary steps to contain the COVID-19 pandemic. The precision achieved by a combination of Bluetooth-based contact tracing and identification of hotspots will hold the key to effectively break the chain of infection, flattening the curve, and thus save lives in India.

CONCLUSION

The various COVID-19 apps will complement contact tracing system to assess and prevent viral transmission. There are various advantages of using the app with some concerns. However, we believe that the test, track, trace, and support policy will play a key role in suppression of the current pandemic and help in prevention of a second wave of the coronavirus outbreak.

Declaration of patient consent

Patient's consent not required as there are no patients in this study.

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Conflicts of interest

There are no conflicts of interest.

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