COVID Safe USA

Prepared for Steve Oberste, CDC Director of the National Center of Immunization and Respiratory Diseases

Date: August 26, 2020

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COVID Safe USA Mobile App

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Executive Summary

COVID Safe USA is a mobile contact tracing application (app) designed for the Center for Disease Control and Prevention (CDC) to help slow the spread of COVID-19 in the United States. Using Bluetooth wireless technology based on Apple and Google's protocol, phones detect other phones within proximity and exchange anonymous identifiers. This app will incorporate data into contact tracers' current workflow to significantly speed up exposure notifications and quickly isolate people who could be contagious. One national app and proximity technology will ensure that phones are successfully communicating, and it will provide a unified data set for public health and laboratory systems integration.

Key App Features

- Users can opt to share a positive COVID test result in real-time
- Rapid, anonymous exposure notifications are sent (no identity ever shared)
- Nearby testing sites with current turnaround test result times are provided
- CDC instructions for quarantine/self-isolation are sent
- Users receive daily symptom checker and tailored daily information
- COVID-related statistics by location are provided in the opening dashboard
- The app is secure, encrypted and users opt-in or out at any time

COVID lockdowns and restrictions damage our economy and our way of life, while the virus grows exponentially. Additional options are needed to help Americans detect exposure and isolate to slow the spread and protect public health. This app can help us do that and reopen our economy and our schools.

COVID Safe USA Mobile Contact Tracing App

Introduction

The COVID-19 pandemic continues to circulate in the United States, despite community restrictions and prevention methods. Additional measures are needed to isolate contagious people quickly and stop this disease. This report will analyze digital contact tracing and present the Center for Disease Control and Prevention (CDC) with a national mobile application (app) solution and successful implementation recommendations.

This paper begins with a background on the COVID-19 pandemic and ways to slow the spread, a description of contact tracing and its importance on disease containment, and a discussion on the current limitations of contact tracing in the United States. Then, the various benefits and issues involved in digital contact tracing are explained, and the analysis of design decisions is presented, leading to the best solution for the American public. An overview of the proposed app is provided, the technology is explained, and the app features are outlined in detail. Finally, implementation strategies are recommended, as public participation is essential to the success of this project.

Background

The first coronavirus (COVID-19) case in the United States was confirmed on January 21, 2020 (CDC, 2020a). Seven weeks later, on March 11, the World Health Organization declared it a

global pandemic. The United States implemented lockdown measures and restrictions to slow the community-based spread. In August, five months later, the epidemic continues to spread in the United States with devastating impacts on our lives. There are over 5 million confirmed cases and 163,000 deaths in the United States (New York Times, 2020) due to COVID. Figure 1 shows how the disease has continued to spread since March, and cases are accumulating exponentially. Many businesses and schools closed, causing the American economy to plummet and unemployment rates to rise dramatically. The economy shrank at a 32.9% annual rate, the lowest ever recorded (BBC, 2020). Figure 2 shows the dramatic decline of US gross domestic product (GDP), and economists warn it will take years for the US to rebound from this recession.

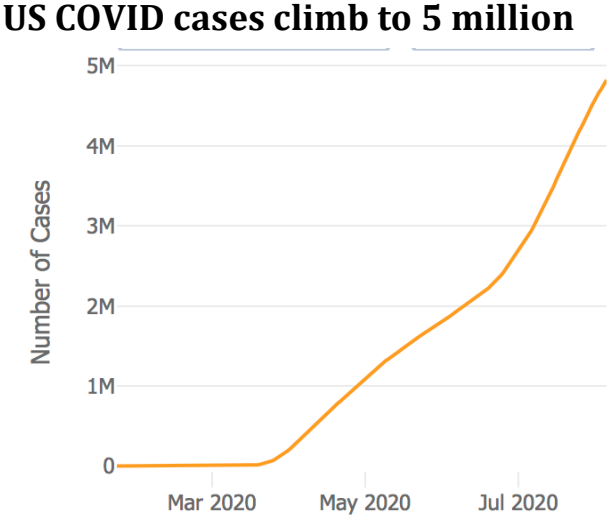

Figure 1. Total US COVID Cases (in millions). ***Cases continue to grow exponentially in the US.***
Source: John Hopkins University & Medicine

Imposing strict lockdowns can slow the spread, but this strategy is not economically sustainable, and social isolation deteriorates our communities' mental health (Psychiatric Times, 2020).

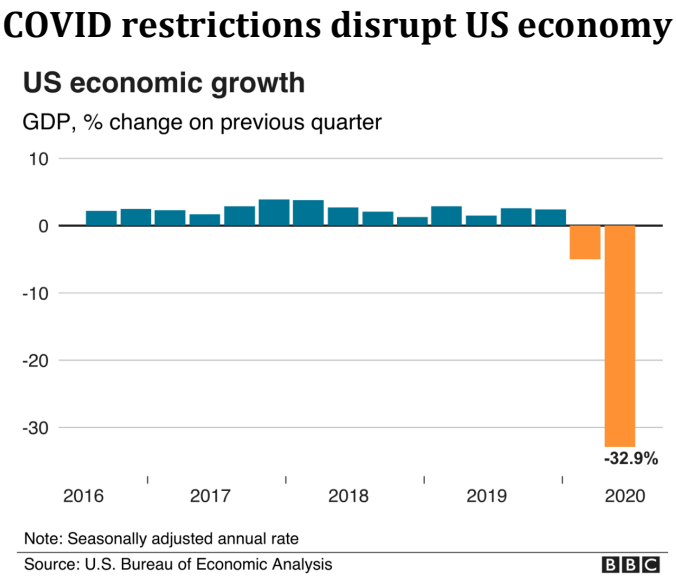

Figure 2. US economic growth. ***The GDP declines 32.9% due to COVID related lockdowns and restrictions.***
Source. BBC

Until the population is vaccinated, a study from the UK shows that the following four measures are vital in slowing the COVID-19 spread (John Parkinson, 2020):

- Ample testing with quick results
- Physical distancing
- Mask adherence
- Contact tracing

Contact Tracing Defined

An effective contact-tracing program is a vital tool for helping America safely reopen our economy (Molly Bode, 2020). Contact tracing has been used globally for decades by health departments to slow and prevent infectious disease (CDC, 2020b). It consists of identifying people infected with a contagious illness, identifying others whom they came into contact with, and quarantining them to disrupt the disease spread (CDC, 2020b). Contact tracing has successfully controlled Ebola, SARS, MERS, tuberculosis, and other disease outbreaks (Molly Bode, 2020).

United States public health contact tracers work for local and state health departments. They receive training in the science of COVID-19, the infectious period, the clinical symptoms, transmission methods, and contact tracing effectiveness. They also learn case investigation skills such as building rapport, identifying contacts, supporting patients, addressing isolation issues, and employing strategies to overcome barriers (CDC, 2020c).

The success of contact tracing depends on the rapid detection of cases and the rapid isolation of contacts

(Journal of Epidemiology & Community Health, 2020).

Typical Steps for COVID-19 Contact Tracing Performed by Public Health Staff

- Case Investigation:
    - Interview patients following a positive COVID-19 test result to identify people they had close contact with during their infectious period (CDC, 2020b)
    - Inform patients that their identity will remain confidential
- Contact Tracing:
    - Notify contacts of their potential exposure to COVID-19 without revealing the infected patient's identity (CDC, 2020b)
- Contact Support:
    - Instruct contacts and patients on self-isolation and self-quarantine measures for 14 days after exposure
    - Provide education resources about COVID-19
    - Refer contacts for testing
    - Monitor contacts for symptoms and signs of COVID-19 for 14 days
    - Provide support to contacts and patients for services they may need during self-quarantine

US Contact Tracing Limitations

Most US states have not implemented any digital contact tracing efforts and rely entirely on manual contact tracing (David Ingram, 2020). These time-consuming phone interviews are prone to errors due to non-compliance and human memory mistakes (Matt Richtel, 2020). It can take days to get in touch with patients or contacts, and often people do not return phone calls. Furthermore, patients can only share contacts they know, so public health staff cannot notify many potentially exposed people, making this process limiting.

COVID-19 is highly contagious, and on average, 36 contacts are traced per case of COVID-19 (Molly Bode, 2020). This situation creates numerous investigations, which is straining public health departments and the effectiveness of contact-tracing efforts. A robust program is expensive but far less than the relative impact of a full lockdown (Molly Bode, 2020). Due to the current limitations, we have contracted with the CDC to create a digital solution to improve contact tracing efforts in the United States.

Benefits of Digital Contact Tracing

Bluetooth proximity tracking will identify exposed contacts that phone-based interviews would miss. Manual contact tracing relies on a patient's memory and familiarity with contacts. Bluetooth technology will detect when phones have close and extended contact, even when those people are strangers who happen to sit in adjacent subway seats, for example. This technology will capture more exposed contacts helping to slow and prevent the spread. Figure 3 shows how person A has no symptoms on Day 1 and has close contact with eight different

Digital Contact Tracing – Discover Cases Quickly

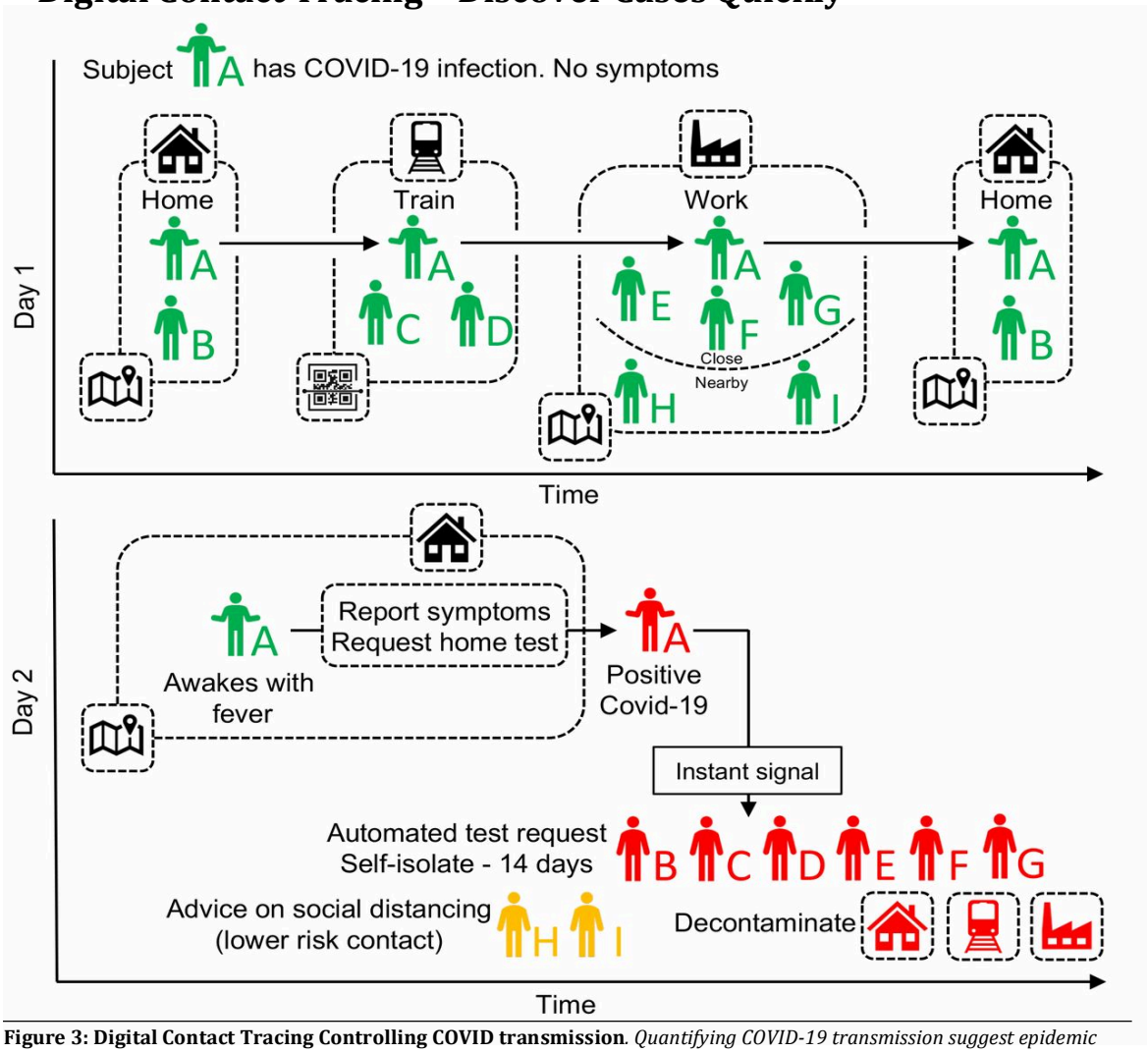

Figure 3: Digital Contact Tracing Controlling COVID transmission. *Quantifying COVID-19 transmission suggest epidemic control with digital contract tracing.*
Source. By Ferretti, Luca; et al (2020-03-31

people. On Day 2, person A awakes with a fever, gets tested, and reports the positive test. Digital contact tracing will notify all eight people who can alter their behavior immediately. Imagine the situation without digital contact tracing. It could take several days for an infected person, such as person A, to connect with public health staff on the phone. During that time, each of those eight exposed people could continue spreading exponentially to other subjects, and each of those subjects could continue spreading. Furthermore, in this example, person A did not know people exposed on the train and could not share their contact information.

Data from digital contact tracing will be incorporated into current contact tracers' workflow to speed up exposure notifications and contact education. The public can alter their behavior quicker. When a positive test result it shared, the app sends exposure notifications immediately, enabling exposed contacts to begin quarantining and get tested quickly. This behavior slows and prevents further spread of COVID.

Automated exposure notifications will alleviate the massive workload that public health officials are facing. Technology speeds communication and delivery of information in a way that is impossible for humans to replicate. Contact tracers' interviews can focus on gathering contacts Bluetooth has not detected, making their workload more manageable and enabling them to reach those contacts quicker. The app can also provide a map of users' daily locations, helping patients remember recent events, serving as a digital memory.

Mobile App Overview

- When two people meet, their phones exchange a key code using Bluetooth signals.
- When someone tests positive for COVID, they update their status (in the app) and consent to share their key with the database.
- All phones regularly download the database and check for matching codes.
- Users receive exposure notifications and next steps if a matching code had close *(less than 6 feet)* and extended (*more than 15 minutes)* contact in recent days.

Mobile App: Steps 1-6

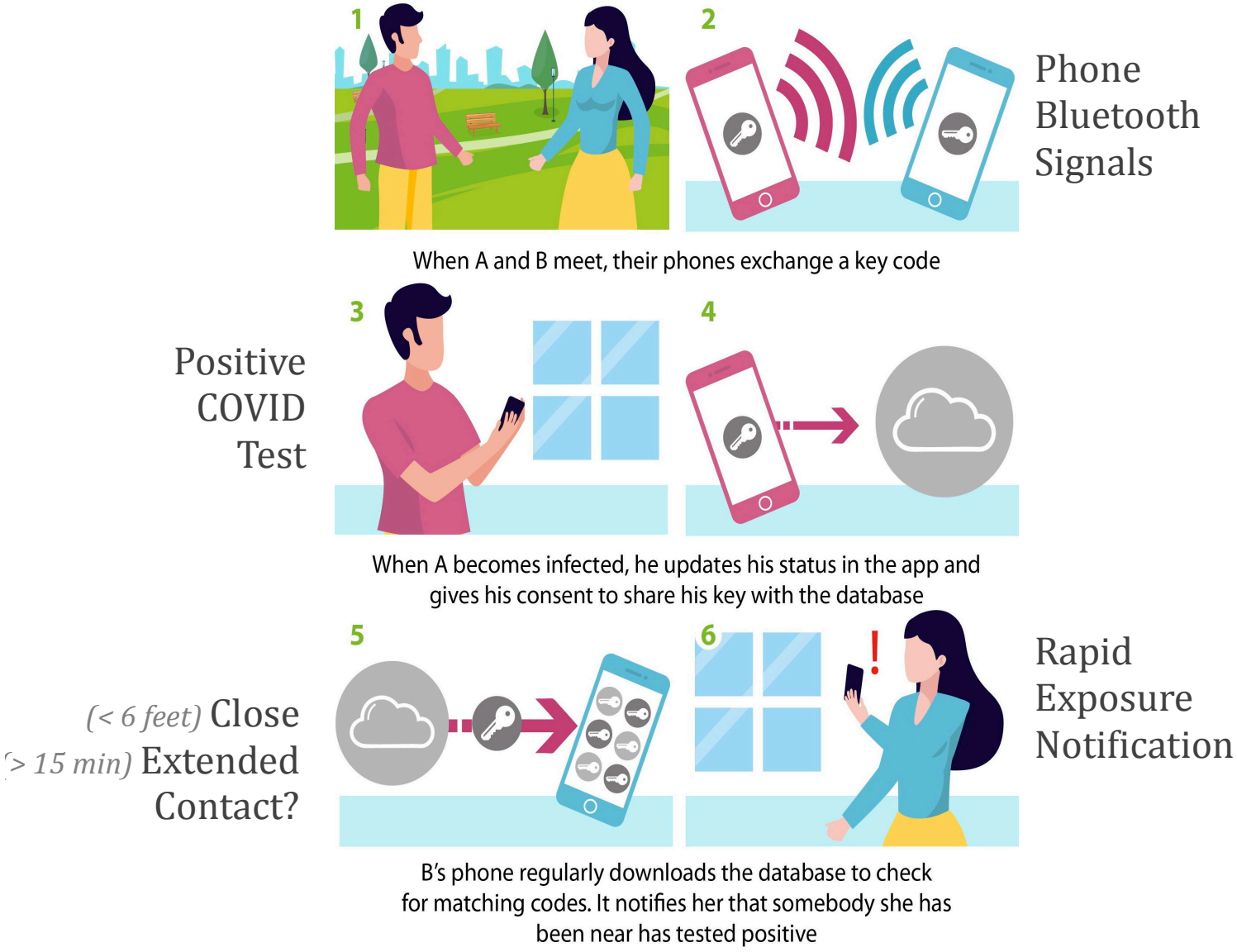

Figure 4: COVID Safe USA Mobile App Overview. *Bluetooth signals detect phones in proximity and they exchange key codes. If someone tests positive, these key codes are used to identify possible exposed people.*
Sources. European Data Protection Supervisor, Europa.eu and Center for Disease Control and Prevention, CDC.gov

Figure 4 reinforces how easy this app is for users. They download and enable the app. If they receive a notification, they follow the instructions. If they ever test positive for COVID, they share their results. It is as simple as that.

National App Benefits

The United States has not implemented any digital contact tracing at the national level, and each state is separately considering it, along with private companies (David Ingram, 2020) and (NASHP, 2020).

Having multiple proprietary apps would be counter-productive.

Different apps may not communicate properly between phones; using one app ensures that Americans' phones are successfully communicating using the same proximity technology. Suppose the CDC releases one app to the entire country. It will save each state millions of dollars and provide a central collection of data to be analyzed by city, county, state, and national government health agencies. The aggregate data will provide useful insights into hot spots and transmission methods. The CDC can learn which situations are most dangerous, whether in airplanes, elevators, offices, restaurants, grocery stores, private parties, or outdoor venues. Institutions, schools, and universities can use this information to create effective protocols and practices under CDC guidelines.

Technology, Security and Privacy Concerns

The app will use the Google and Apple protocol, which has a privacy-first design, and users can opt-in or out any time. It does not share identities or locations and uses a rotating and random Bluetooth identifier (Apple.com, 2020). Google and Apple require our app to meet specific privacy, security, and encrypted data control criteria (Apple.com, 2020).

Platform

Based on an open-source design, the app will be available to the masses and designed with the flexibility to incorporate changes easily. The app is compatible with Apple iOS and Android mobile platforms. It utilizes cloud computing software and supports offline data entry and caching. A sister website will also be available on various operating systems and browsers within both the desktop and mobile environments. User administrators can configure and fine-tune exposure risk levels (more than 15 minutes and less than 6 feet).

Interoperability

Application Programming Interfaces (APIs) will allow easy integration with all state and local public health agencies' information systems, testing center systems, and diagnostic laboratory systems. The app will support both direct import/export and real-time synchronization of data. The app can also import and utilize Bluetooth data from smartwatches and wearable devices.

Dependence on Testing

This app's effectiveness in slowing the spread of COVID depends on the availability and speed of testing. The CDC recommends turnaround times of less than two days (Modern Healthcare, 2020); however, a recent spike in COVID cases around the country has increased testing demand beyond their capacity. Some large companies, such as Quest Diagnostics, are currently averaging turnaround times of 7 - 10 days for non-priority patients (Quest Diagnostics, 2020). These delays will hamper our app's efforts to notify users of exposures and our users' ability to take responsible actions.

Scientists estimate that people become contagious four or five days after exposure to COVID (Sophia Bollag, 2020). Therefore, rapid exposure notification is necessary to schedule testing and share positive test results within a short timeframe. People will unknowingly spread COVID if there are delays to exposure notifications, derailing our app's effectiveness in contact tracing efforts.

To address this issue, we included current metrics for testing center turnaround times and appointment availability on the testing center page to encourage app users to choose a testing site with fast turnaround times. Furthermore, testing centers are sorted by lowest turnaround times and color-coded with green for quick test results and red to warn about slower test results.

Community Adoption

For the app to be useful, we need many people within the same communities to enable it. Therefore, we must gain public trust and adoption. One national application supported by the CDC will help create public confidence and participation in contact tracing. Emergency messages with a download link would stress the importance of exposure notifications in slowing the spread (Chiara Farronato, 2020). Small communities like universities, offices, airline companies, or restaurants can mandate app participation by scanning Quick Response (QR) codes at entry points (Chiara Farronato, 2020). These small communities can demonstrate effectiveness scaling to larger cities (Chiara Farronato, 2020).

App Features

Rapid Exposure Notification Features

- Sends automated exposure notifications within 24 hours via SMS and app alerts, similar to Figure 5.
- Includes an exposure timeframe in the notification
- Supports real-time synchronization
- Sends link for app test center page and QR code to scan at a testing site

Figure 5: COVID Safe USA notification

Testing Sites Page Features

- Includes QR Code for the user to scan at a testing center, linking their app profile to test results
- Lists nearby test centers with link to schedule an appointment
- Displays metrics for current test result turnaround time (in days and hours)
- Sorts centers by lowest test result turnaround time
- Highlights in green if fast turnaround (one day or less)
- Highlights in red if slow turnaround (more than two days)
- Displays metric for next appointment availability (in days and hours)
- Highlights metric in red if appointment availability higher than five days
- Allows the user to search for different locations by zip code or city
- Allows the user to filter results by distance

Test Result Features

- Receives test result from the testing center and alerts the user
- Provides a view of test results and related documentation
- Informs the user of their privacy if they test positive and that sharing their status helps public health
- Provides a button to share COVID test result (positive or negative)
- Allows the user to attach documents and images related to a specific case
- Categorizes test results as laboratory-confirmed or self-reported
- Supports multiple laboratory reports for an individual patient
- Matches case to existing data/records at testing sites and health agencies
- Creates a new case from a contact record if none exists and sends to health authorities

Positive Patient Identification / Contact Tracing Features

When a user tests positive, the app:

- Sends SMS and in-app notifications with a confidential survey
- Includes instructions on identifying contacts not detected by proximity tracking
- Provides access to a map of all recent locations by day to assist users in remembering past events and places while completing the survey.
- Allows the user to enter contact information (address, phone number, email address, photos), notes, and risk factor data in the app or website
- Supports uploading a list of contacts from spreadsheets
- Supports contact information for a facility rather than an individual

- Instructs user to expect a phone call from a trained public health contact tracer and encourages the patient to participate
- Allows the user to schedule phone call appointment with public health contact tracer
- Allows the user to conduct secure chat within the app with a public health contact tracer
- Categorizes source of information as user-entered, interview-based, or proximity tracker identified
- Combines contact information from Bluetooth proximity tracker, manual user entry, and public health agency via phone interviews into the app database
- Provides history and synchronization of patient-related workflow activities (phone call, SMS, email, alert notification)

Education Features

- Provides easy to use dashboard with analytics containing virus information and statistics searchable by location
- Includes self-quarantine instructions
- Provides education on COVID-19 and symptoms
- Includes prevention methods (social distancing, hand washing, mask) and instructions on preferred mask types
- Provides information about services to help support the 14-day self-quarantine period (ex: food, medicine, safe housing)
- Provides counseling and support services

- Provides referrals to a medical provider if symptoms are severe or worsen

Patient Follow-up Features

- Sends daily information, tailored for the current stage of isolation and based on patient symptoms until 14 days after exposure
- Sends daily symptom checking and temperature requests for 14 days
- Suggests an intervention plan, based on pre-existing conditions
- Allows the user to document patient/contact treatment details and diagnostics
- Reminds user to get tested if they have not
- Alerts the user of missed events or missed symptom entry
- Tracks date of exposure and establishes an infectious period
- Captures and uploads documents using a mobile device camera
- Supports an algorithm to perform risk evaluation prioritization
- Closes case when the appropriate time has lapsed
- Allows the user to close a case manually
- Allows the user to delete data

Other Features

- Provides a toggle button to opt-in or out of GPS (Global Positioning System) tracking, which can provide hot-spot alerts (PathCheck Foundation, 2020)
- Displays COVID-related statistics and data about the current location or other selected locations providing immediate benefits to users (Chiara Farronato, 2020)
- Supports many languages

- Displays location-specific reopening status information which lists which activities are allowed and which are prohibited

Transmission of COVID-19

COVID-19 tracking has been challenging because people who never develop symptoms (asymptomatic) and people who have not yet developed symptoms (pre-symptomatic) can be contagious. With pre-symptomatic transmission, it is crucial to quickly identify exposed contacts from the days prior to the onset of symptoms and quarantine contacts. Pre-symptomatic COVID transmission increases the importance of rapid exposure notifications. A study in March 2020 suggested that 15% of COVID transmission was asymptomatic and environmental. Hence, most COVID transmission is symptomatic and pre-symptomatic, making contact tracing well worth the effort and expense. (Molly Bode, 2020)

Proven Effectiveness

A recent McKinsey study found that contact tracing apps can be successful against COVID, even with non-symptomatic carriers (Molly Bode, 2020). Many countries are successfully using digital contact tracing apps to help slow and control the spread. Canada, Japan, Australia, Singapore, Saudi Arabia, Iceland, Israel, Norway, Italy, Switzerland, Germany, and more have implemented mobile apps. Early in the pandemic, South Korea and China both implemented high-tech solutions, which have been downloaded by millions of their citizens and effectively contained the virus (Molly Bode, 2020).\

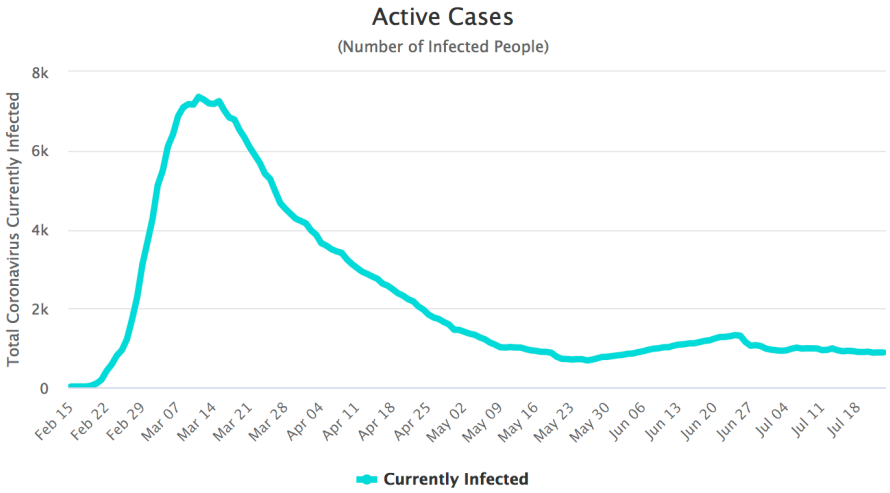

Figure 6: Active Cases in South Korea. *South Korea is containing the spread of COVID-19 using digital contact tracing as a key element of their program.*
Sources: Worldometers.com, McKinsey Study

Figure 6 shows how active COVID cases in South Korea peaked in mid-February, steadily declined after that, and remained low through July. Figure 7 shows a similar pattern for China, showing how their strict programs, including digital contact tracing, have been successful.

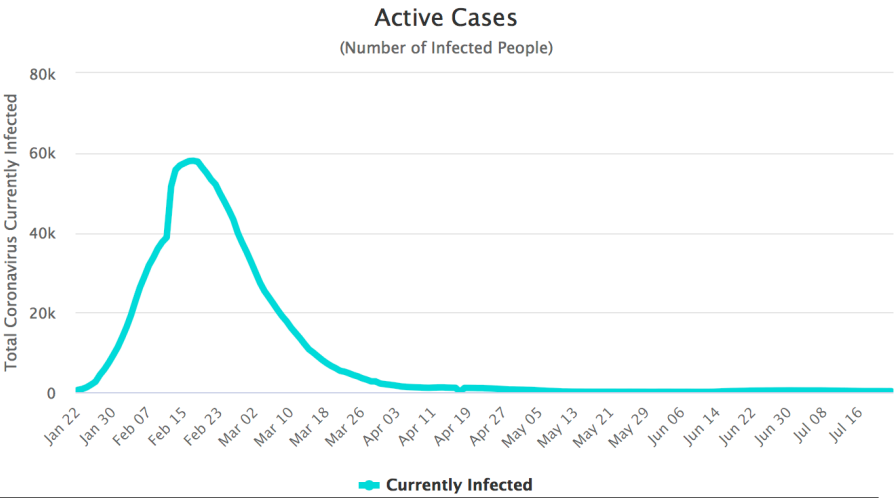

Figure 7: Active Cases in China. *China is containing the spread of COVID-19 using digital contact tracing as a key element of their program.*
Sources: Worldometers.com, McKinsey Study

Conclusion

This paper analyzed the issues and benefits of digital contact tracing, determining that a digital app would increase contact tracing effectiveness in the United States. Many other countries are currently using mobile contact tracing apps and are successfully containing the spread of COVID. Restrictions and lockdowns have damaged the economy, are not sustainable, and the disease continues to circulate. This app is essential to help the country open the economy while detecting and isolating contagious people quickly. Manual contact tracing has limitations and is strained under the magnitude of this pandemic. This technology will provide an additional level of speed and detection impossible for humans with manual contact tracing. Users' identities and privacy will be protected at all times. The app's effectiveness depends on testing turnaround times, so we implement strategies to encourage users to seek testing centers with fast turnaround times. This app can slow and control the spread of COVID by using technology to detect close and extended contact between people, send rapid exposure notifications, provide testing information, share COVID education, and encourage community participation.

Recommendations

This report recommends the immediate development of the COVID Safe USA app to fill the gaps created by manual contact tracing limitations and ease the massive workload. The app's API protocols should be released quickly to health departments and testing centers so they can begin preparing for the app by developing data connections and integration into their current systems.

This report recommends this app as a national app supported by CDC, state, county, and city health departments. The app's effectiveness in slowing the spread of COVID increases with more public participation; therefore, the report suggests that these departments each send public emergency messages with a link to the app, urging citizens to participate. Media campaigns should be enacted to encourage public participation through positive messages such as: "Be Part of the Solution," "Private COVID Exposure Notifications," "Slow COVID and Protect Privacy," and "Help USA Contain COVID."

The CDC should update COVID Safe USA immediately as changes are made to CDC guidelines, such as quarantine instructions, COVID symptoms, and contagious periods.

The report recommends urging universities, office buildings, airlines, and other communities to require app usage for their participants. Data from these communities can demonstrate the app's effectiveness on a smaller scale, encouraging larger communities to adopt.

The app design recommends using the Apple and Google Bluetooth technology for optimal security, privacy, and availability to the masses. This proximity detection allows the app to deploy multiple exposure notifications in seconds, which is impossible for humans.

I appreciate the opportunity to consult with the CDC on this essential project. Through our collaborative efforts, we can provide Americans with a digital tool to slow the spread of COVID. We are eager to begin the construction of our design and recommend proceeding soon.

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