Quantifying meaningful adoption of a SARS-CoV-2 exposure notification app on the campus of the University of Arizona

Joanna Masel[1], Alexandra Shilen[2], Bruce Helming[3], Jenna Rutschman[4], Gary Windham[5], Michael Judd[6], Kristen Pogreba-Brown[2], Kacey Ernst[2]

1. Department of Ecology & Evolutionary Biology, University of Arizona, Tucson, AZ, USA

2. Mel and Enid Zuckerman College of Public Health, University of Arizona, Tucson, AZ, USA

3. Campus Health, University of Arizona, Tucson, AZ, USA

4. College of Science, University of Arizona, Tucson, AZ, USA

5. Information Technology, University of Arizona, Tucson, AZ, USA

6. Centers for Disease Control and Prevention, Atlanta, GA, USA

Abstract

Objective. To measure meaningful, local exposure notification adoption without in-app analytics.

Methods. We surveyed app usage via case investigation interviews at the University of Arizona, from September 6 to November 28, 2020. As independent validation, we compared the number of secure codes issued to verify positive diagnoses to the number of local cases.

Results. 46% of cases reported having the app, and 54% of these app users shared their diagnosis in the app prior to the case investigation interview. Combining the 25% probability that a primary case rapidly shares their diagnosis with a 46% probability that the secondary case can receive exposure notifications, an estimated 11% of transmission pairs exhibit meaningful app usage. We attribute these high rates, despite the lack of "push" notifications, to a successful marketing campaign that identified social influencers.

Conclusions. Usage can be assessed in clusters, without in-app analytics. With marketing, high uptake in dense social networks like universities make exposure notification a useful complement to traditional contact tracing. Integrating verification code delivery into patient results portals was successful in making the exposure notification process rapid.

Introduction

Smartphone applications (apps) for exposure notification have the potential, given sufficient uptake, to significantly reduce the spread of SARS-CoV-2, by making contact notification faster, more scalable, and potentially more acceptable due to greater privacy (1, 2). The University of Arizona community piloted the Covid Watch app, which through the Google/Apple Exposure Notification API (GAEN), uses Bluetooth to measure date, distance, and duration of contact, and assess infection risk (3). App users who tested positive for SARS-CoV-2 could anonymously trigger notifications, including testing and quarantine recommendations, for other Covid Watch users with whom they had been in contact.

Here we quantify meaningful uptake. App download numbers are readily accessible, but overstate active app usage (4). Effective uptake requires not just app installation in both a primary and a secondary case, but also that the primary case report a positive diagnosis by obtaining and entering a secure verification code.

The potential for exposure notification to prevent SARS-CoV-2 transmission depends on usage specifically among individuals who go on to be infected. One concern is that individuals who are more likely to download an exposure notification app are less likely to be infected by SARS-CoV-2, making population statistics overestimates of effective usage. With the help of a third party, the University of Arizona used social marketing tools to promote app usage. Identified influencers (5, 6) proved successful with quick download rates among students.

Methods

Evaluating GAEN apps is challenging because of their strict privacy protections (7). We therefore incorporated three questions into case investigation interviews: (i) Have you downloaded the Covid Watch app?; (ii) If yes, did you already enter the verification code following your positive test?; and (iii) If yes, have you received an exposure notification yourself? A university team (8) interviewed faculty, staff and students who tested positive through the on-campus testing program. We also compared the numbers of positive tests to the numbers of requests for a verification code, tabulated through our on-campus testing program. We do not report here on question (iii) because early in the pilot, smartphone operating systems (not the app) issued notifications even for insignificant exposures, creating user confusion, and rendering notification data unreliable. This issue affected all GAEN version 1 apps that implemented their own risk scoring calculations, but has been resolved in later versions.

Our data span August 23 to November 28 (Fall semester), during which there was a significant outbreak of SARS-CoV-2 in the student population. Verification code issuance peaked in the same week as confirmed cases (Figure 1). Automated code delivery via an end-user test results portal began Sep 9; we therefore sometimes separate the first two weeks, August 23 to September 5, from the rest of the data.

Results

Campus testing programs recorded 2,728 positive tests from August 23 to November 28, triggering the investigation of 1,359 cases by the university contact tracing team, who split the caseload with the local health department. 64% (876/1359) assigned cases were interviewed, of whom 381 (44%) reported having previously downloaded the app (79/213=37% in the first two weeks, rising to 302/663=46% after). From the third week onward, 163/302 (54%) had entered a positive diagnosis code into their app prior to the case interview, enabling rapid contact notification; this represented 25% (163/663) of the interviewed cases. In the first two weeks, only 26/79 (33%) app-using cases reported prior code entry. Among all interviewed cases, 35% (302/869) reported no contacts during manual contact tracing.

Interviewed cases may have higher app use than other cases on campus. However, we get a similar estimate of 26% for this date range by dividing the 578 verification codes issued by the 2,202 positive tests from our campus testing facilities (rising from 35/526 (7%) in the first two weeks when codes were issued only by phone). We count verification codes at point of issue rather than upon usage, but because obtaining a code requires action from an infected individual (either a phone call or clicking on a request link), we expect this to be only a slight overestimate. Other factors might lead to underestimation; we count positive tests not cases, and some individuals tested positive on multiple test platforms (PCR and antigen).

Because the three questions regarding app usage were asked during the case investigation interview, our results demonstrate that notification via the Covid Watch app was more rapid not only than traditional contact tracing at the University of Arizona, but also than digital exposure notification workflows used elsewhere in which traditional contact tracers provide verification codes over the phone. Our automated code delivery via an end-user test results portal is now adopted by commercial test providers in Arizona.

Public Health Implications

We propose and estimate a metric of meaningful usage among cases. Because the app's purpose is to quarantine the infected prior to diagnosis, focusing on cases is more epidemiologically meaningful than usage among the general population. We consider the scenario where a primary case infects a secondary case within a tightly interconnected college campus, and estimate the probability that both cases have used the app to the minimum necessary level to potentially impact transmission. From the third week of semester onward, the estimated probability of sufficient usage by the primary case is 25% (where verification code entry is required, occurring at a similar 54% rate as Germany (9)) and 46% for the secondary case (requiring only app activation). Combining these by assuming a well-mixed population, and neglecting transmission from outside campus given low community prevalence at the time this pilot study was conducted, app usage is estimated to affect 11% of transmission pairs. In a structured population where individuals in the same transmission pair have more similar app usage rates, this value will be higher than 11%.

Our app usage metric can be used to estimate the expected reduction in R(t) due to the direct impact of exposure notification influencing the quarantine, testing and ultimately isolation behavior of secondary cases. This reduction could be ~11% if 1) all cases carried their phones with them at the time transmission occurred, 2) primary cases are tested sufficiently rapidly, 3) the app detects exposures that led to transmission, and 4) notifications following infection eliminated forward disease transmission by sufficiently changing the behavior of secondary cases. The direct reduction in R(t) will be smaller, because of violations in these assumptions, especially the fourth given reports of low quarantine compliance (10, 11). However, R(t) is also indirectly reduced when the far larger number of exposure events that do not lead to transmission also lead to behavior change, which either prevents infection in the notification recipient, or elicits first quarantine and then isolation after they have been infected by a different exposure within the same social network (12).

Here we have proposed a new metric for assessing app usage within a tightly interconnected community that does its own testing and tracing. Usage on the University of Arizona campus is high enough to make it a useful tool that complements and augments traditional contact tracing. Highly interconnected communities such as college campuses, large workplaces, tribal nations, and congregate living facilities can rapidly benefit from targeted adoption campaigns. Further evaluation is needed to assess the extent of compliance with quarantine among contacts receiving notification via such apps.

References

1. Ferretti L, Wymant C, Kendall M, Zhao L, Nurtay A, Abeler-Dörner L, et al. Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing. Science 2020;368(6491):eabb6936.
2. Wymant C, Ferretti L, Tsallis D, Charalambides M, Abeler-Dörner L, Bonsall D, et al. The epidemiological impact of the NHS COVID-19 App. 2021;2021(February 9):https://github.com/BDI-pathogens/covid-19_instant_tracing/blob/master/Epidemiological_Impact_of_the_NHS_COVID_19_App_Public_Release_V1.pdf.
3. Wilson AM, Aviles N, Petrie JI, Beamer PI, Szabo Z, Xie M, et al. Quantifying SARS-CoV-2 infection risk within the Google/Apple exposure notification framework to inform quarantine recommendations. Risk Analysis 2021;manuscript accepted.
4. Federal Statistics Office. SwissCovid App Monitoring. 2021;2021(January 17. 2021):https://www.experimental.bfs.admin.ch/expstat/en/home/innovative-methods/swisscovid-app-monitoring.html.
5. Baer J. Just How Powerful Is Influencer Marketing? 2016;2021(Feb 22):https://www.convinceandconvert.com/convince-and-convert-podcast/how-powerful-is-influencer-marketing/.
6. Schaffer N. The age of influence: the power of influencers to elevate your brand: Harper Collins Leadership; 2020.
7. Benzler J, Bogdanov D, Kirchner G, Lueks W, Lucas R, Oliveira R, et al. Towards a common performance and effectiveness terminology for digital proximity tracing applications. arXiv preprint 2020:arXiv:2012.12927.
8. Pogreba Brown K, Austhof E, Rosa Hernández AM, McFadden C, Boyd K, Sharma J, et al. Training and Incorporating Students in SARS-CoV-2 Case Investigations and Contact Tracing. Public Health Reports 2020;0(0):1-7.
9. Robert Koch Institut. Kennzahlen zur Corona-Warn-App. 2020:https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/WarnApp/Archiv_Kennzahlen/Kennzahlen_04122020.pdf?__blob=publicationFile.
10. Smith LE, Potts HWW, Amlot R, Fear NT, Michie S, Rubin J. Adherence to the test, trace and isolate system: results from a time series of 21 nationally representative surveys in the UK (the COVID-19 Rapid Survey of Adherence to Interventions and Responses [CORSAIR] study). medRxiv 2020:2020.09.15.20191957.
11. Steens A, Freiesleben de Blasio B, Veneti L, Gimma A, Edmunds WJ, Van Zandvoort K, et al. Poor self-reported adherence to COVID-19-related quarantine/isolation requests, Norway, April to July 2020. Eurosurveillance 2020;25(37):2001607.

12. Guttal V, Krishna S, Siddharthan R. Risk assessment via layered mobile contact tracing for epidemiological intervention. medRxiv 2020:2020.04.26.20080648.

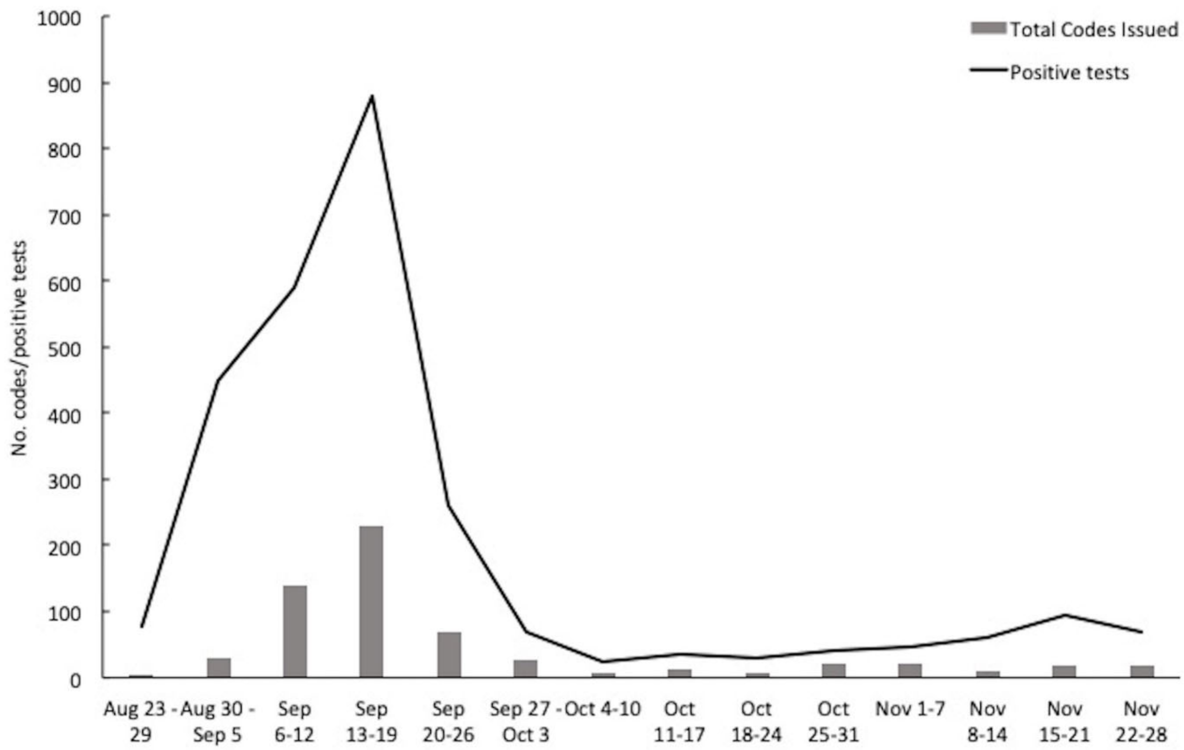

Figure 1. The number of verification codes issued tracks the number of positive tests during an outbreak among students on the campus of the University of Arizona. The total number of codes issued represented only 6.7% of the number of positive tests in the first two weeks, prior to the automation of code delivery, and rose to 26% for the remainder of the study period.