Supporting First Responders and Essential Workers During a Pandemic: Mixed-Methods Evaluation of a COVID-19 App-Based Intervention

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Abstract

Background: The COVID-19 pandemic has created unprecedented challenges for first responders (e.g., police, fire, and emergency medical services) and non-medical essential workers (e.g., food, transportation and other industries). Health systems may be uniquely suited to support these workers given their medical expertise, and mobile applications (“apps”) can reach local communities despite social distancing requirements. Formal evaluation of real-world mobile app-based interventions are lacking.

Objective: We aimed to evaluate the adoption, acceptability and appropriateness of an academic medical center’s app-based intervention (COVID-19 Guide App) designed to support first responders and essential workers’ access to COVID-19 information and testing services. The secondary objective was to better understand the COVID-19 related needs of these workers early in the pandemic.

Methods: To understand overall community adoption, COVID-19 Guide App views and download data were described. To understand appropriateness and acceptability of the app and workers’ unmet needs, semi-structured qualitative interviews were conducted by phone, video and in-person with first responder and essential workers in the San Francisco Bay Area, recruited through purposive, convenience, and snowball sampling. Interview transcripts and field notes were qualitatively analyzed and presented using an implementation outcomes framework.

Results: From April 2020 launch to September 2020, the app received 8,262 views from unique devices and 6,640 downloads (80.4% conversion rate, 0.61% adoption rate across the Bay Area). App acceptability was mixed amongst 17 first responders interviewed and high amongst 10 essential workers interviewed. Select themes included the need for personalized and accurate information, access to testing, and securing personal safety. First responders faced additional challenges related to inter-professional coordination and a culture of heroism that could both protect against and exacerbate health vulnerability.

Conclusions: First responders and essential workers both report challenges related to obtaining accurate information, testing services, and other resources. A mobile app intervention has the potential to combat these challenges through the provision of disease-specific information and access to testing services but may be most effective if delivered as part of a larger ecosystem of support. Differentiated interventions that acknowledge and address the divergent needs between first responders and non-first responder essential workers may optimize acceptance and adoption.

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ABSTRACT

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(e.g., police, fire, and emergency medical services) and non-medical essential workers (e.g., food, transportation and other industries). Health systems may be uniquely suited to support these workers given their medical expertise, and mobile applications ("apps") can reach local communities despite social distancing requirements. Formal evaluation of real-world mobile app-based interventions are lacking.

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potential to combat these challenges through the provision of disease-specific information and access to testing services but may be most effective if delivered as part of a larger ecosystem of support. Differentiated interventions that acknowledge and address the divergent needs between first responders and non-first responder essential workers may optimize acceptance and adoption.

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Introduction

The COVID-19 pandemic has presented unique obstacles for first responders as well as other essential workers who ensure public health and basic needs continue to be met.[1], [2] Health systems may be uniquely positioned to support these individuals given their expertise and position embedded within local communities. Efforts to understand the challenges of first responders and essential workers and evaluate health systems' support of these groups during a pandemic response are needed.

The definition of a "first responder" varies between state and federal agencies, but commonly encompasses emergency medical personnel, firefighters, and law enforcement officers.[3] Their duties can lead to adverse mental, physical, and social consequences.[4] While academic attention has focused on the intense mental and emotional strain on health workers, for instance during the severe acute respiratory syndrome (SARS) epidemic[5], [6] and the COVID-19 pandemic,[7]–[9] non-medical first responders also face adverse mental health consequences.[10], [11] Other adverse effects include worker absenteeism,[12], [13] an exacerbation of pre-disaster socioeconomic inequalities,[14] and an increased risk of contracting the disease itself in an outbreak setting.[15], [16]

Less is known about the impact of disasters on essential workers not otherwise considered first responders, defined by their work in food and agriculture, construction, transportation, and other sectors of the economy deemed essential.[17], [18] COVID-19 has spurred research in this population, with documented increased rates of depression and anxiety[19] and substance abuse[20] during the pandemic. Most concerning, essential workers' relative economic vulnerability and need to leave home to work further exacerbates existing socioeconomic and racial disparities seen in COVID-19 morbidity and mortality.[17], [21]–[23]

Certain factors can mitigate the stress first responders and essential workers experience.[20]

Knowledge about a disease process may be protective, as essential workers without a healthcare background appear to experience a higher level of distress than workers who have training in disease processes.[24] Open, reliable information channels—even in a setting with many unknowns—may also be protective.[25] To date, documented efforts to support these workers have focused on prioritized access to testing[26], mental health support,[18] and other health resources,[27], [28] but not necessarily access to information.

Such information dissemination occurs through formal and informal networks during a pandemic response.[29] However, the challenges brought on by COVID-19 have highlighted a pre-existing disconnect between the health system and public health infrastructure.[30], [31] Without these partnerships, first responders and essential workers cannot benefit from the health systems' expertise located right in their communities. Given the uncertainties inherent in an unfolding pandemic, additional channels that draw upon health system expertise may be needed.

To this end, digital technologies including mobile applications ("apps") appear to provide unique support in the context of social distancing efforts during a pandemic.[32]–[34] Formal evaluations of digital efforts to support first responders and essential workers are lacking, yet optimizing such upstream interventions may help mitigate health disparities and other adverse effects associated with their roles during a pandemic.

Methods

We conducted a mixed-methods evaluation of an academic medical center-sponsored app-based intervention designed to support information and testing needs of first responders and essential workers early in the COVID-19 pandemic. We analyzed qualitative interviews with both populations and describe app download data to understand the implementation outcomes (adoption, appropriateness, and acceptability)[35] of the publicly available mobile app.

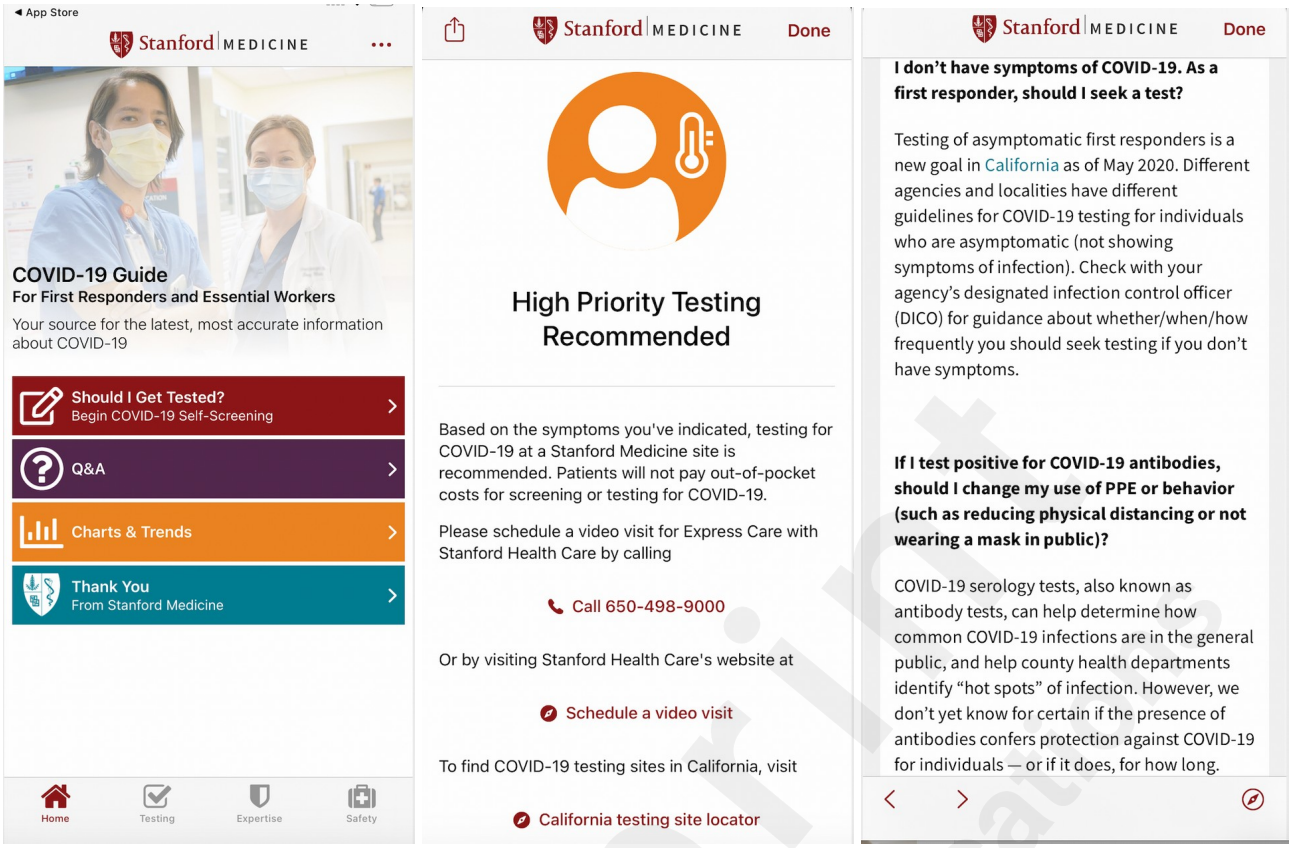
Setting

In April 2020, a quaternary academic medical center (Stanford Health Care “SHC”, Palo Alto, CA, USA) in partnership with a large technology company (Apple, Cupertino, CA, USA) launched the *Stanford Medicine COVID-19 Guide for First Responders and Essential Workers* application (COVID-19 Guide App) with the goal of providing evidence-based information related to COVID-19, screening guidance, and access to testing services to support 1.1 million first responders and essential workers in the San Francisco Bay Area.[36]–[38] The institution’s dissemination effort included emails to local first responder and essential worker representatives, facilitated in part through previously established partnerships between SHC emergency physicians and EMS/Fire organizations within the community, facilitated by the institution’s EMS fellowship.

Intervention

The COVID-19 Guide App includes a screening questionnaire that provides testing recommendations with links to access further testing care, COVID-19 resources from Stanford Health Care physicians and scientists, as well as foundational information on viruses and prevention (Figure 1).[36]

Figure 1. Example User Displays from Stanford Medicine COVID-19 Guide for First Responders and Essential Workers



Population & sampling

First responder participants were drawn from police, fire, and EMS departments in the Alameda, San Mateo, San Francisco, and Santa Clara counties through email and phone call outreach to local departments. All fire personnel were cross-trained in EMS, though not all EMS have fire training[39]; participants from both groups were recruited. Emergency medicine physicians who partnered with local Fire and Police Departments through the EMS Fellowship[40] at Stanford School of Medicine were also interviewed using a convenience sampling approach. Snowball sampling was leveraged across all categories to connect with additional participants in harder to reach groups. Interviews were conducted until thematic saturation within each professional sub-population was reached.

Essential workers were recruited using a convenience sampling approach in which researchers presented in person at local businesses. When a paucity of Spanish-speaking essential workers was recognized, we shifted to a virtual convenience sampling approach targeted at this

population to better reflect demographics of the region[41] until thematic saturation for both English- and Spanish-speaking essential workers was reached.

Data Collection

From May-September 2020, 30-minute semi-structured interviews using a protocol grounded in the Consolidated Framework for Implementation Research (CFIR) were conducted by multiple authors (SV, NS, AA, MF, CBJ) (Appendix A).[42] Interviews were conducted with two or more researchers present with rare exceptions for note taking, training, and analytic purposes. First responder interviews were conducted by phone and video conference; essential worker interviews were conducted by phone and in person. For Spanish speakers, a professional interpreter was enlisted to interpret interviewer questions and interviewee responses. First responder interviews were recorded and transcribed verbatim (Rev.com, Austin TX, USA). Essential worker interviews were not recorded to protect these more vulnerable interviewees in their work-based setting. For these interviews, field notes were taken. Descriptive quantitative data including total number of downloads at the conclusion of the evaluation September 1, 2020 were drawn from the app administrator account. User characteristics, including demographic and use data were not available due to restrictions in data use agreements.

Qualitative analysis

Interview transcripts were analyzed using an inductive rapid analytic process where two researchers coded all interviews (SV, AA).[43], [44] We used an inductive-deductive approach to identify a priori themes related to access to information and testing services and emergent themes. Excerpts were presented in a matrix format following rapid analytic procedure methodology.[45] The matrix was populated with notes and quotations (AA) and reviewed by qualitative team members (SV, AA, MF) to reach consensus and compare themes across worker subpopulations.[46] The

Implementation Outcomes Framework guided the evaluation and presentation of implementation outcomes (appropriateness, acceptability, and adoption).[47]

Throughout the assessment, early findings were reported back to operational leads to inform ongoing improvement using Brown-Johnson et al. (2019)'s Lightning Report Method.[48] This project was reviewed by the Stanford Institutional Review Board and did not qualify as human subjects research (Protocol ID #56126). All participants gave verbal consent to be interviewed, and first responders gave consent to be audio-recorded.

Results

Participant Characteristics

A total of 27 interviews were conducted with 17 first responders and 10 essential workers (Table 1). The number of participants within each sub-category was comparable, including 5 Police (18.5%), 7 EMS (25.9%), 4 EMS with Fire training (14.8%), 5 Physician Police/EMS Advisor (18.5%), 5 Food & Agriculture (18.5%), and 5 Transportation & Civil Infrastructure (18.5%) interviewees. The Food & Agriculture sub-population included 4 grocery workers and 1 dining supervisor while the Transportation & Civil Infrastructure included 3 gas attendants, 1 bus driver, and 1 electrician. First responders tended to be male (55.6%), 30-49 years old (40.7%), White (37.0%) and reported working in their field for greater than 10 years (37.0%). Essential workers were 50% male, of varying ages, roughly one quarter Hispanic/Latino (27.9%), and had worked in the field for either less than 5 years (14.8%) or more than 10 years (18.5%). Half of the essential workers' primarily language was Spanish, whereas all first responder interviews were conducted in English.

Table 1. First Responder and Essential Workers Participant Demographics

Variables	% First Responders (n)	% Essential Workers (n)
Role		
Police	18.5% (5)	-

EMS Overall	25.9% (7)	-
Physician Police/EMS Advisor	18.5% (5)	-
Food & Agriculture	-	18.5% (5)
Transportation & Civil Infrastructure	-	18.5% (5)
Gender		
Male	55.6% (15)	18.5% (5)
Female	7.4% (2)	18.5% (5)
Age		
20-29	7.4% (2)	3.7% (1)
30-39	25.9% (7)	7.4% (2)
40-49	14.8% (4)	7.4% (2)
50-59	11.1% (3)	3.7% (1)
60-69	3.7% (1)	11.1% (3)
70-79	0.0% (0)	3.7% (1)
Years in Occupation		
0-4 Years	3.7% (1)	14.8% (4)
5-9 Years	22.2% (6)	3.7% (1)
10+ Years	37.0% (10)	18.5% (5)
Race/Ethnicity		
Hispanic/Latino	18.5% (5)	25.9% (7)
American Indian or Alaskan Native	0.0% (0)	0.0% (0)
Asian	7.4% (2)	3.7% (1)
Black or African American	0.0% (0)	0.0% (0)
Native Hawaiian or other Pacific Islander	0.0% (0)	0.0% (0)
White	37.0% (10)	0.0% (0)
Other/ Multiracial	0.0% (0)	7.4% (2)
Primary Language		
English	63.0% (17)	18.5% (5)
Spanish	-	18.5% (5)
Total	**63.0% (17)**	**37.0% (10)**

The Role of Digital Support

The COVID-19 Guide App received 8,262 views from unique devices, of which 6,640 individuals downloaded the app (80.4% conversion rate) from the launch date of April 7, 2020 to the end of evaluation period September 1, 2020. Assuming all downloads were in the target demographic within the Bay Area, this suggests 0.061% adoption rate of the region's 1,093,781 first responders and essential workers.[37], [38]

In qualitative interviews, a few participants had used the app and were able to share their experience directly. The majority were not familiar with the app but shared their perspectives based on a short description of the app. These perspectives varied by group, with moderate to low adoption, mixed appropriateness and acceptability seen in first responders, and low adoption, high appropriateness, and high acceptability seen in essential workers.

First responders: Moderate to low adoption, mixed appropriateness, mixed acceptability

A few participants who had directly used the app had positive perceptions (EMT/Fire3, Police1), sharing benefits of "quick answers" that were "super easy to access" (EMT/Fire3).

Overall, interviews shed light on the underlying reasons limiting widespread adoption. Physicians largely felt their involvement occurred "fairly late in the game" (FireMD1,2) perhaps due to the poor visibility of the fellowship program within the institution pandemic (FireMD1, 4).

First responders noted the need for a succinct, trusted data source (EMT/Fire2), particularly one that "agreed" with county information (Police3, FireMD4, PoliceMD1). Indeed, brevity and trusted branding was seen as highly valuable and missing after a mid-implementation shift to outside partnership "…now it's just too hard to filter what is coming as sort of a medical recommendation versus what almost seemed like an ad" (FireMD4).

While some thought the screening features and link to testing resources were personally helpful (Police/MD3, EMT/Fire2) or useful for patients (EMT/Fire7), others felt these features were already covered in their organization. Some reported frustration with the app's inability to link a positive symptom screen to a scheduled test due to technical and privacy limitations; instead, the app would "take [them] to the end of a little pathway that would be like, 'You should call your [department infection control officer] to get tested.' No [kidding]." (FireMD2).

Essential workers: Low adoption, high appropriateness, high acceptability

While no essential workers reported direct experience with the app, their attitudes towards a theoretical app that provided COVID-19 testing and disease information were overwhelmingly positive, “I’m looking forward to this app” (Grocery1). All participants owned smart phones, and an overwhelming majority indicated the use of mobile applications for work, indicating an ability to access and navigate mobile applications. Like first responders, essential workers reported a desire for succinct, up-to-date, and trusted information (Grocery4, FoodServices5). Essential workers noted that ideally information would be presented in multiple languages to address widespread misinformation in non-English speaking communities (Gas2, Electrician4) and delivered through social media channels by doctors or nurses, since trust in the health system was reportedly higher than media or government.

Challenges Facing First Responders and Essential Workers

First responders and essential workers experienced a number of related challenges, described in the following themes: a need for personalized information with no clear playbook, parsing information takes time, misinformed beliefs fuel conflict, priority testing gets them back to work, fear of bringing an amorphous enemy home, and a lack of resources to fight the pandemic. First responders faced additional challenges relating to the need for inter-professional coordination and a double-edged culture of heroism that could both protect against and exacerbate mental and health vulnerabilities (Table 2).

Table 2. Impact of COVID-19 on First Responders and Essential Workers

Challenges	First responder	Non-First Responder Essential worker
Need for personalized answers with no clear	“When COVID hit, I was taken out of my primary role… and put into a COVID response detail” (Police 1)	“Before, food was served in a dining room…now residents eat in their own rooms. We set up dining carts to bring food to residents, which is

playbook	"And early on it was a lot of questions [from EMS] 'this patient … didn't tell us she had a fever but when they got to the hospital, she had a fever and she turned out to have been on the Princess Cruise' [early COVID-19 outbreak] …it was tough because there wasn't a clear playbook for so many different situations." (Fire MD 4)	exhausting." [paraphrased] (Food Services 5) "I want information in Spanish" (Gas 2) "I think it would be helpful to have more knowledge on herbal treatments for COVID… I prefer to use this" (Electrician 4)
Parsing information takes time	"I pretty much rely on my division chief to disseminate information, because he spends all day reading and looking at case studies and such." (EMT/Fire 7)	"We are being bombed by so much information everywhere, so it is hard to know what is true." (Bus Driver5)
Misinformed beliefs fuel conflict	"The amount of misinformation has been pretty surprising. So, I don't know that our fire departments are affected more heavily than anyone else, but there's a lot of suspicion and a lot of misinformation." (Fire MD 2) "We've had a couple people who have come up and said, 'COVID-19 is a conspiracy. It's not real.'…. just acting as though we're propagating this lie, which, as firefighters, we're not used to kind of conflict with our community members…It's a little bit disappointing to see people, A: deny it and B: be confrontational with us." (EMT/Fire 3)	"We have to deal with [people not complying with mask policies] every single day… A lot of people have the mask on but around their neck" (Bus Driver 1) "I don't trust information from the government. I don't think it is accurate or reliable. The number of sick people is overexaggerated… they are trying to scare people. (Food Services 5) "A German doctor is leading the work around chlorine dioxide to balance pH which improves immunity…there are some websites that are against chlorine dioxide but many that show that it works, so it is a matter of perspective what you believe" [paraphrased] (Electrician 4)
Priority testing gets them back to work	"But yeah, there hasn't been much else as far as support, like where we could get tested, information on how we get tested." (EMT 1) "I didn't want anybody [in law enforcement] to get sick at work from it, and I didn't want community members to get sick from my teams. So I would just err and put them off	"[My employer] didn't give us a place to get tested… I wish that we had more access to testing for drivers… We drive every day, for 5 days a week and we take care of all kinds of people" (Bus Driver 5)

	from work until we heard back, but the priority testing… is really the only option I have" (Police 2)	
Fear of bringing an amorphous enemy home	"[Police officers] have a lot of anxiety about bringing it home to their families and that sort of thing." (PoliceMD 3) "The thing that obviously is concerning to people is the last thing we want to do is bring this thing home, right? Especially those of us who have small kids …and spouses." (Police 4)	"It's been very tough. I need to work even though I don't feel comfortable doing so" (Grocery 4) "At first, I couldn't breathe. The first two weeks, I was panicked. What happens if I die? I stopped reading the news, and it's getting much better now." (Gas 1)
A lack of resources to fight the pandemic	"I think what we're having that's been a disappointment is the lack of PPEs. And then the people that have been price gouging with the PPEs… And then we get them, and they're not N95s. So… we can't use them in the field." (EMT 6) "…I mean our city fire departments are getting… [mixed] messages of 'you're heroes, but the city's not going to make nearly as much money this year as they normally do, so we're going to slash your budget.'" (Fire MD 2)	"We have coworkers that already died, we have coworkers they already have COVID. Now they give us a set of masks, a little thin piece of material. Come on." (Bus Driver 5)
Need for inter-professional coordination (First responders only)	"And I can say that we've [transported] 13 positive COVID cases. I've only been notified on two of them." (EMT/Fire 5) "Where to park, where to go, what the entrance point is, what's the exit point [at the hospital], is there a priority line? If law enforcement comes in, and they need to do something, do they have to wait in the general line and wait behind 10 people, or are they going to be let in a different way or checked in quickly, or given priority?" (Police 4)	Did not emerge in this group
A double-edged culture of heroism (First responders	"There's a certain expectation that we hold ourselves to when we come to work and put a uniform on. Regardless of the environment or whatever's presented…we just do our	Did not emerge in this group

only)	best to protect ourselves. Are some of us fearful of it [COVID-19]? Sure, but it doesn't create necessarily anxiety." (Police 5) I think that because [police officers] tend to be the typical first responders, they hold things in … so they don't deal with anxiety about these sorts of issues…They only reach a crisis point before they admit it, is what tends to happen." (PoliceMD 3) "…I think that it was tricky because I felt like we were testing pretty much anybody we wanted to at Stanford if we had a suspicion, but it was harder to tell a firefighter, 'Hey, you probably should get tested. You had a high risk exposure.'" (FireMD 1)	

Need for personalized answers with no clear playbook

First responders and essential workers reported that throughout the pandemic, they found themselves adjusting to new protocols and professional responsibilities, which came with many uncertainties. Some took on entirely new roles "overnight" (Police1) with significant changes to work protocols, for instance asking the public to come outside of their houses during a call (EMT/Fire3, Police4) or delivering food carts directly to resident rooms rather than the dining room (Food Services 5).

First responders wanted to know how standard work protocols should change in the setting of COVID-19, particularly in the setting of limited PPE resources (FireMD1). These protocol questions impacted standard procedures (e.g. transporting evidence from an out-of-state crime scene involving suspects with confirmed COVID-19 (PoliceMD5)) as well as human resource and personal health concerns (e.g. contemplating how to manage COVID-19 risk for pregnant staff and officers (Police3)). In the absence of any precedent, professionals were forced to make challenging decisions with limited information. In one extreme example, contact tracing showed "over a hundred" first

responders were potentially exposed to the virus early in the pandemic (PoliceMD5):

> You're talking about then losing so many people that you can't staff your department and you can't staff the engines. And does that mean you have to take engines out of service and decrease your response time? And what does that mean for public health and the EMS agency? So there were a lot of really novel questions that hadn't come up before. (FireMD4)

Essential workers also wanted personalized information (Gas2, Electrician4, Gas1), though these needs were not typically related to altered professional responsibilities but were instead related to language and personal preferences. Both groups wanted more local dynamic information about COVID-19 positive cases (Gas3, Police4, EMT/Fire5).

Parsing information takes time

Members of both groups acknowledged an overabundance of COVID-19 information through media, internet, social media, and their professional settings. Many shared the sentiment of a bus driver that, “we are being bombed by so much information everywhere, so it is hard to know what is true” (Bus Driver5). This was particularly challenging given the dynamic nature of available evidence, which interviewees noted changed constantly (EMT/Fire3, Police2). While first responders appreciated county-level dashboards, professional daily emails and Incident Command Center communications that made this information easier to digest (Fire/MD4, EMT/Fire5, Police3, 5), others acknowledged significant time spent by either themselves (Gas2, Grocery3, Police1) or someone in their work setting to digest the information (EMT/Fire 7).

While first responders received their information largely from professional networks, essential worker information sources leaned towards social media (Electrician4), and other websites (Grocery2). In one workplace setting, COVID-19 related information from the company was only posted on the store’s bulletin board and could not be accessed by individuals needing to isolate at home (Grocery1, 2). The quantity of data led to skepticism: “Is there any [accurate data]? I feel so in

the blind. I feel like there's information flying from every direction and so much of it is unreliable" (EMT/Fire7).

Misinformed beliefs fuel conflict

The lack of reliable data sources seemed to fuel mistrust and misinformation. Both groups expressed an explicit distrust of media (EMT4, BusDriver5) and government who "are trying to scare" people (FoodServices5). One participant described her Latino community as feeling a "mistrust towards a [COVID-19] vaccine." She wondered "…is the government going to control us?... No one trusts…" (BusDriver5). Workers also reported encountering community members through their work who were misinformed, many of whom were reported to believe the pandemic was a conspiracy (EMT/Fire3). Lapses in community cooperation with mask requirements created novel conflict on the job, include the need to address "hostile" behavior in the community (Gas1, EMT/Fire3).

Priority testing gets them safely back to work

Both groups acknowledged some challenges in scheduling testing through both the app and in general through a work referral or on their own. Once a test was scheduled, however, experiences were positive. Interviewees emphasized that prioritizing testing was critical for getting first responders/essential workers back to their duties. In first responder organizations where testing access was straightforward, this was thought to be due to designated COVID-19 support within the organization (Police5, Electrician4, EMT/Fire5).

By contrast, essential workers reported frustration with accessing testing (BusDriver5). In the majority of cases where testing support was not available through work, participants sought alternate options through their primary care or the county (BusDriver5, Grocery4, Gas2), yet one was unsure of how to access testing at all (Gas3).

Fear of bringing an amorphous enemy home

The stressful effects of the pandemic were salient across several interviews in both groups. These concerns centered on the amorphous nature of the disease (EMT/Fire2), a need to go to work despite not feeling safe (Grocery4), and fear of bringing the virus home to family (PoliceMD3, EMT4, Grocery4, FoodServices5). Early high mortality rates documented in other countries contributed to widespread "paranoia" (EMT/Fire5, Electrician4), and reading the news worsened anxiety for some (Gas1, Grocery1). An alternate view one EMT shared was the psychological benefit in leaving the house for an essential job (EMT4).

The nature of a pandemic also meant workers' families were affected, demanding attention on top of existing professional duties: "it was affecting everybody, both professionally and personally. So everybody was really task-saturated with figuring out 'What do I do for my family? How do I get groceries? What do I do if my office closes? How do I work if I have kids…?'" (FireMD4). The prolonged and unpredictable nature of the pandemic was described as a "roller coaster" (EMT/Fire7) with a "hurry up and wait" pace (EMT/Fire2). One responder had "never been so scared and so bored in my life" (EMT/Fire2). The mental suffering that resulted from this pandemic impacted both first responder and essential worker communities, though open discussions related to mental health were described as "muted" (BusDriver5). While no first responders acknowledged wanting additional mental health support (see "Culture of Heroism" below), at least one essential worker did not have the support she needed (FoodServices5).

A lack of resources to fight the pandemic

A lack of resources emerged as a dominant theme in conversations for both first responders and essential workers. Several participants noted insufficient quantity of PPE to the point where police officers were reported to go "begging" at one point to obtain a sufficient supply (PoliceMD3).

Public budget cuts and subsequent staffing shortages were also cited as major challenges (Police4). While some workers belonged to unions which made some efforts to support workers, their impact was perceived to be limited (BusDriver5, Grocery4).

The broader economic impact of the pandemic also shifted workers' financial situations. While some felt the essential nature of their jobs made them more secure (Grocery1, 2), this sentiment did not extend to everyone, as essential workers reported being furloughed (BusDriver5) or felt insecure in their position (Gas1, 2). Finding financial support in the case of illness was a major challenge (EMT1), particularly for workers who were new or did not have sick days (EMT/Fire7). For this reason, some cited a reluctance to get tested because they were unable to take two weeks off work (EMT6). Essential workers, more than first responders, cited financial insecurity as a major ongoing challenge (Grocery4, FoodServices5).

Need for inter-professional coordination (First responders only)

Some themes emerged that were specific to first responders, including the need for inter-professional coordination. Health system support of first responders was felt to be critical given their role as "the tip of the spear" (EMT/Fire5). Specific areas for coordination with health systems were follow-up information regarding a transported patient's health status, which was reported to be both "tremendously helpful" (EMT/Fire5) at SHC but sub-optimal in other health systems (EMT6). When these communication channels fail, "anxiety increases significantly" as first responders wondered about exposure (EMT/Fire5).

Another challenge emerged relating to hospital entry to respond to a crisis while bypassing the COVID-19 fever checkpoint (Police4). In this case, the participant pointed out that since the other professionals already screen their workers prior to starting the shift, the health system should be able to skip this step. Finally, coordination of COVID-19 information across health systems and counties up the incident command chain was also cited as a challenge (Police3, FireMD4,

PoliceMD5).

A double-edged culture of heroism (First responders only)

Several first responders shared their ongoing willingness to face the pandemic despite unfavorable circumstances because they had made a commitment to serve when choosing their profession (EMT1, 4, EMT/Fire3, 14, Police1, 4, 5). Some described an underlying desire to be helpful--“I've washed dishes on scene, I've installed smoke warrants, I routinely bring in papers off porches” (EMT/Fire2)---and an expansive view of their own roles in the community: “we are police officers, we're counselors, we're marriage therapists, we're counselors to children, we're teachers, we're priests, we're healthcare workers” (Police4). The role of choice in their profession was reported to protect against adverse mental health effects of their roles, as with the attitude that “this is what I signed up for” (EMT/Fire3).

However, this “cavalier” culture also led to a reluctance to report symptoms and obtain health services (PoliceMD 3). Even physician advisors shared reluctance to tell first responders they needed testing (FireMD 1). One EMT/Fire responder noted that few first responders recognized their own colleagues may be struggling and undergoing therapy to handle their mental stress (EMT/Fire2).

Solutions to Challenges in the Field

Participants provided several solutions to address these challenges, some of which they thought could be delivered through an app (**Table 3**). To address misinformation and fear of the virus, several validated the benefit of succinct, accurate information delivered through an app. Others thought sharing accurate information through social media would be most effective given increased visibility of these platforms amongst the essential worker population. Yet others felt the need for “higher touch” strategies that might include holding local question and answer (Q&A) sessions (FireMD2). The personalization of information in any solution was a recurrent theme:

> "So to me that [personalized information] seems more in line with our overall philosophy at Stanford of precision medicine. It's more like *precision information* because then it's filtered, it's more specific to you. You don't get confused when you're reading about stuff that doesn't apply to you." (Fire MD 4).

In the absence of precision information, many solutions were developed in the field: "Some of the crews just kind of came up with stuff on their own" (FireMD4). Other essential workers found support in managing conflict with the pubic from their employers (Grocery4) or through their own volition: the bus driver reported company instructions to call a hotline when riders were not compliant with wearing masks, yet she instead refused to drive the bus— "I use my [face covering gesture] until they put it on" (BusDriver5).

Expanding the physician-first responder partnerships to a broader audience, particularly to the police where only informal relationships existed, was suggested. A specific request was for a designated number or person within the health system to call when the COVID-19 status of a transported patient was under question.

Personalized information also encompassed health system-specific COVID-19 information. Some first responders expressed a desire for health systems to be forthcoming about their own infection control practices and current rates: "That's where you just put the notion of, 'Hey, we're [health system] safe…You can transport patients to our hospitals and we won't get you contracted'" (EMT4). First responders also wanted detailed, localized COVID positive data, expressing a desire to better understand the geographic spread of cases throughout the county (Police4, EMT/Fire2, 7).

Table 3. Participant-derived digital and non-digital solutions to support first responders and essential workers during a pandemic

Challenge	**Participant-derived digital and non-digital solutions**	**Example quotation**
Need for	- Physician – First Responder	"[E]specially in our early stages of

personalized answers with no clear playbook	Department Partnerships (Fire MD 1, 4, Police MD 3, 5, Police 1, 3, 5, EMT/Fire 7) - Physician-led Q&A sessions (Fire MD 2) - Colocation of county officer (Police 2)	our incident command center, we created an entire team called a Virus Response Team… at the end of the day… they're just your everyday cop… I think it would have been helpful to have guidance from somebody a little bit more knowledgeable in the field versus just picking up the information from the distributor and figuring it out from there." (Police 3)
Parsing information takes time / Misinformed beliefs fuel conflict	- Physicians coming into work huddles to provide relevant, accurate COVID information (Grocery 2, 4, Police 5) - Provide information on an app (Grocery 1, 4, Gas 1, EMT/Fire 2, 3, EMT 4, Police 4, Electrician 4, Food Services 5) - Provide information and/or advertise app on social media (Electrician 4), telanovelas (Food Services 5)	"Maybe coming and visiting. There are two huddles a day--maybe you [health workers] could pop in during those." (Grocery Worker 2) "I think that's a large part of my role is that for the most part, the personnel in my departments know me and so if they ask me a question and I answer a question, or if I bring something up, they basically trust most of what I say. Or at least have enough kind of history with me that they at least need to think about it... So, I mean part of my role is to be kind of a sounding board for what's true and what's probably not true"(Fire MD 2)
Priority testing gets them back to work	- Provide information on testing resources in the county other than SHC (Police 1, Fire MD 4) - Provide priority testing for first responders and essential workers (Police 1, 4, 5, Police MD 3)	"I think just a formalized priority testing system for law enforcement has a huge impact on the organization… these are the essential workers that if they're not at work or they are sick, it affects teams of people, and cars, and community contact." (Police 1)
Fear of bringing an amorphous enemy home	- Provide resources for First Responders to help them manage stress and anxiety (Police MD 3) - Ask the public to share whether someone is sick in the presence of emergency personnel (EMT/Fire 5)	"[M]aking sure you've got reliable sources of information and things like that [can be helpful]…because it can just help identify that yes, you're having anxiety about this. Here's some tools to help with it." (Police MD 3)
A lack of resources to fight the pandemic	- Share PPE and other resources when possible (EMT 4, 6) - Promote consistent mask use to the public (EMT/Fire 7, 3)	"I guess just shortages on masks… It's our company that was supposed to provide for us, but it's even hard for us to get supplies sometimes."

		(EMT 4) “Wearing masks and not getting other people sick. That's kind of supporting us... I've been telling people that have been asking me the best thing they can do is to keep themselves healthy, to not over impact our system by, all the things that everyone's being asked to do by washing their hands and covering their face when they're in public. That's certainly a factor.” (EMT/Fire 7)
Need for inter-professional coordination (first responders only)	- Keep First Responders updated on the outcomes of Patients Under Investigation (PUIs) (EMT 6, EMT/Fire 5, 7) - Keep First Responders informed on the process of entering hospitals to facilitate efficient emergency response (Police 4)	"Hospitals should have their infectious disease control departments, and they should be responsible for reaching out to people when they make positive COVID results." (EMT 6)
A double-edged culture of heroism (first responders only)	- Physician – First Responder Department Partnerships (Police MD 3)	“They're not that kind of group that usually shares those things, unless you have a preexisting relationship with them. That can be hard to get to.” (PoliceMD 3)

Heath worker partnerships at the heart of a community solution

A number of participants desired a stronger connection to a health worker during COVID-19. The physician partners themselves felt they were often the best resource to support first responders during the pandemic: “we are the best conduit [through] the already established trust that we've built up through the years” (FireMD1). These participants felt their role encompassed the development and maintenance of long-term, trusting relationships with these first responder communities (FireMD1, PoliceMD5). First responders corroborated the special nature of the relationship in times of crisis, as one physician partner was described as “a really good resource. He's been coming by the station now too, to talk with us and to check in on COVID related topics, as well as other [topics]”

(EMT/Fire7).

In addition to the formal physician partnerships, participants also received information through informal networks into the health care community (e.g. a former employee who now worked at SHC (Grocery3)). Those with shift-based work welcomed the idea of health worker presence at the beginning of their shift: “That may be an opportunity…to have someone present during those briefings to talk on any new developments or anything COVID related” (Police5, Grocery2). The human, in-person element of this relationship was emphasized.

Discussion

Digital initiatives such as the Stanford COVID-19 Guide App have the potential to equip first responders and other essential workers with accurate information and access to testing resources, though adoption may depend on targeted publicity and early involvement of stakeholders with pre-existing relationships within these communities. While first responders are often included under the broader category of essential workers during outreach efforts, our findings suggest they face both overlapping challenges— related to the need for personalized and accurate information, access to testing, and ongoing personal safety—and divergent challenges, such as the need for inter-professional coordination and a double-edged culture of heroism in the first responder population. Optimal strategies for supporting each group should therefore differ based on their divergent needs, channel for outreach, appetite for digital and relationship-based approaches and relation to the health system (Table 4).

Table 4. Digital & Non-Digital Recommendations to Support First Responders and Essential Workers During a Pandemic

	First Responders	**Essential Workers**
High need areas	Advice on work adaptation Streamlined accurate and timely information Inter-professional coordination	Acceptable resources to access accurate and timely information Assistance navigating financial resources

	around follow up of patient diagnostic status and logistics Priority access to rapid testing Steady access to PPE	Priority access to rapid testing Steady access to PPE
Primary channels for outreach	Formal physician partnerships with first responder departments Employers (e.g. through county infection control officers)	Employers Social Media Telenovelas and other culture-specific channels
Role of an app-based intervention	**Small role** - Provide non-public up-to-date information on working with health systems directly (e.g. Priority building entrances, Rapid testing schedule, Contact information to receive outcome updates on patients under investigation (PUIs))	**Large role** - Source of credible health information that builds health literacy (e.g. “Protecting yourself and your family,” “Viral transmission,” symptom screening)
Role of physician/ health worker outreach	**Large role** - Provide guidance on safe work adaptations - Facilitate provision of rapid testing and follow-up medical support - Assist in the dissemination of relevant health information	**Small role** - Provide guidance on safe work adaptations - Present health information to local businesses
Role of local health system	**Large role** - Facilitate prioritized access to testing and follow-up health services - Provide follow-up information to EMS workers regarding patient diagnostic status - Develop and disseminate streamlined protocols for entering and exiting healthcare buildings during a pandemic	**Large role** - Facilitate prioritized access to testing and follow-up health services - Directly address misinformation related to pandemic

Physician partnerships emerged as a key resource for first responder departments, and such

relationships are recognized as a foundational underpinning of a pandemic response.[49]–[51] Formalizing and nourishing these relationships holds promise in strengthening the health system's overall ability to support its community during a pandemic. Inter-professional coordination was also cited as a major challenge, hampered by interoperability challenges between the electronic health records of EMS and the receiving health system.[52] Given these challenges, a trusted point of contact (e.g. emergency room nurse line) between EMS and the health system may be explored as an alternate solution in a pandemic setting.

Our findings also suggest first responders see the increased risk as an integral part of assuming their role, and may therefore adapt to a new pandemic more readily. Conversely, non-first responder essential workers decidedly *do not* see their roles as inherently risky outside a pandemic scenario. Without the training and cultural reinforcement around managing increased risk as a part of standard work, essential workers may suffer disproportionately from the onset of an infectious disease pandemic. Their contribution during a pandemic should therefore not be diminished, and prioritized health services and hazard pay may be justified.[53]

Similarly, misinformation emerged as a widespread challenge amongst the broader community. While first responders have at least a basic degree of medical training and serve as a source of information to laypersons during a pandemic,[54] essential workers often lack this formal training. Health literacy, defined as the ability to acquire, understand and enlist health information, [55] becomes essential during a pandemic as first responders and essential workers come into regular, direct contact with members of the community. Essential workers' reported reliance on social media for information is concerning given its link to the spread of unvetted information.[56]–[58] Efforts to build health literacy, not only through digital interventions but also through channels with widespread use amongst vulnerable populations, including essential workers and non-English speakers, are urgently needed.

We note the early learnings described here must be interpreted with the context that the

COVID Guide App was rapidly deployed in just under three months from the first reported COVID-19 case in the U.S.[59] Balancing an intervention's accuracy in achieving its aim with the goal for rapid deployment will no doubt remain a challenge during this pandemic and other disasters; we recommend a standing advisory board with representation from target populations that can mobilized in the short-term to inform intervention development. In the long-term, community-based participatory research and human centered design are parallel and overlapping methodologies that emphasize user expertise and creative problem solving, with documented success in vulnerable populations.[60]–[62] Such tools may inform improved evolutions of community interventions.

Limitations include a lack of systematic sampling across professions in the non-first responder essential worker populations, which resulted from challenges accessing this vulnerable population in the field. We are unaware of similar work reaching this vulnerable population, which suggests this sample is still of value. Further, Spanish-speakers predominated our non-English speaking sample population, reflective of local demographics.[41] However, future work will benefit from attention to the variety of first languages that exist within the community, including non-Spanish languages. The incorporation of a mental health component to this digital solution, reported as a need here and evaluated in other settings[63], [64], may also be an opportunity for future work. Finally, our learnings are limited to our local community, as the Bay Area may not be representative of populations and resources available elsewhere.

Conclusion

First responders and essential workers face shared challenges related to obtaining accurate information and testing services, and securing their personal safety. Digital interventions such as mobile applications have the potential to combat these challenges through the provision disease-specific information and access to testing services. Such solutions are most likely to be most effective if delivered as part of a larger ecosystem of support, and with early and direct input from

those in these professions to understand how best to meet their specific needs. Given varying challenges between first responders and non-first responder essential workers, our results indicate that differentiated interventions may leverage shared insights while also acknowledging differences in their occupational requirements and culture.

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Supplementary Files

Multimedia Appendixes

First responder and essential worker semi-structured interview protocol.
URL: https://asset.jmir.pub/assets/5a73fb6855055b67388bc4d32b1ec2ef.docx