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Research and Applications

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Rising to the challenges of the pandemic: Telehealth innovations in U.S. emergency departments

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ABSTRACT

Objective: During the first 9 months of the coronavirus disease 2019 (COVID-19) pandemic, many emergency departments (EDs) experimented with telehealth applications to reduce virus exposure, decrease visit volume, and conserve personal protective equipment. We interviewed ED leaders who implemented telehealth programs to inform responses to the ongoing COVID-19 pandemic and future emergencies.

Materials and Methods: From September to November 2020, we conducted semi-structured interviews with ED leaders across the United States. We identified EDs with pandemic-related telehealth programs through literature review and snowball sampling. Maximum variation sampling was used to capture a range of experiences. We used standard qualitative analysis techniques, consisting of both inductive and deductive approaches to identify and characterize themes.

Results: We completed 15 interviews with EDs leaders in 10 states. From March to November 2020, participants experimented with more than a dozen different types of telehealth applications including tele-isolation, tele-triage, tele-consultation, virtual postdischarge assessment, acute care in the home, and tele-palliative care. Prior experience with telehealth was key for implementation of new applications. Most new telehealth applications turned out to be temporary because they were no longer needed to support the response. The leading barriers to telehealth implementation during the pandemic included technology challenges and the need for "hands-on" implementation support in the ED.

Conclusions: In response to the COVID-19 pandemic, EDs rapidly implemented many telehealth innovations. Their experiences can inform future responses.

Key words: telehealth, telemedicine, COVID-19, emergency preparedness

INTRODUCTION

During disasters, emergency departments (EDs) must triage, stabilize, and care for large numbers of patients. Further, disasters require EDs to rapidly shift from directing maximal resources to a few individuals to directing limited resources to many individuals.[1,2] In recent years, EDs have devoted considerable energy to disaster planning. They have coordinated with healthcare and public health partners to share resources, developed plans to ensure continuity of service delivery, and increased ED surge capacity as a vital component of their hospitals' responses.[3] Although EDs are well positioned

to respond to many disasters, new challenges may overwhelm the healthcare system and require rapid and drastic changes in care delivery.

When the coronavirus disease 2019 (COVID-19) pandemic was declared a national emergency in the United States in March 2020, EDs anticipated or directly experienced a surge of COVID-19 patients. To manage this surge, they set up alternative sites for triage and testing,[4–6] reconfigured waiting rooms to promote social distancing,[7,8] changed staffing models,[9–12] and implemented rapid cleaning and disinfection procedures.[13,14]

While many of these strategies have been part of the disaster response playbook for decades, telehealth, the use of telecommunications technology to support care delivered at a distance, emerged as a leading strategy for the first time.[15] Certainly, there was some use of telehealth before the pandemic. Most commonly this was in the form of teleconsultation in which remotely located specialists like neurologists and psychiatrists consult on a case in the ED. Other applications included tele-emergency, in which ED physicians at a hub consult with less resourced spoke EDs, and tele-triage, in which a remote provider screens patients presenting to the ED.[9,16] However, in general, ED telehealth services were relatively rare and underutilized.[17–23] During the early days of the pandemic, many EDs experimented with telehealth applications to reduce the risk of exposure, decrease ED volume, conserve personal protective equipment (PPE), and more effectively leverage the workforce (eg, enable staff in quarantine or isolation to continue working).[24,25] Widespread adoption of telehealth by EDs was recommended by government agencies at multiple levels and facilitated by numerous policy changes removing regulatory and reimbursement barriers, as well as the ubiquity of personal devices and low-cost software platforms.[26]

Since the COVID-19 pandemic, telehealth services have grown exponentially,[27,28] and EDs have modified existing telehealth applications[29,30] as well as stood up new applications.[31–33] Owing to the urgency of the pandemic, it is unlikely that EDs had the time or resources to carefully plan the deployment of telehealth, including undertaking the systematic evaluation of different platforms, workflows, and staffing models. Therefore, we conducted interviews with ED leaders to explore experiences implementing telehealth programs in the context of the COVID-19 pandemic. We aimed to uncover lessons to inform the healthcare system response to future waves of COVID-19 and to future disasters.

MATERIALS AND METHODS

Study design and participants

From September to November 2020, we conducted semi-structured interviews with ED leaders in the United States. We identified EDs for inclusion through review of the peer-review and gray literature and through snowball sampling. Snowball sampling was incorporated to capture EDs that had implementing telehealth programs but had not yet published about their experiences.

To identify EDs for inclusion, we reviewed journal and news articles from March 2020 to September 2020 that mentioned the creation of new telehealth programs implemented within the physical ED or staffed by ED providers in response to the COVID-19 pandemic. To identify relevant literature, we used the following search terms (telehealth or telemedicine or virtual) and (COVID-19 or coronavirus or pandemic) and (emergency medicine or emergency department). We then invited the lead authors of these studies, or in the case of the gray literature the ED clinician mentioned in the article text, to participate in the study. To represent a range of experiences of EDs during the COVID-19 pandemic, we used maximum variation sampling, a common sampling strategy in qualitative research. We sought to include EDs that varied with respect to U.S. region, hospital type (academic medical center vs community hospital), community COVID-19 burden (eg, early COVID-19 hot spot vs not), and type of telehealth program. We sought to include several EDs from New York City. While most EDs experienced a drop in total ED volume during the pandemic, New York EDs were somewhat uniquein that they deployed strategies to address surge in the spring of 2020.[34] We continued to recruit until we reached thematic saturation, defined as the point at which new interviews did not uncover new types of telehealth applications that met our inclusion criteria.

Interviews were conducted via videoconference using Microsoft Teams and followed a semi-structured protocol. Topics included (1) basic information about the ED (eg, location, patient volume); (2) impact of COVID-19on the ED; (3) prior experience with telehealth and the role of prior experience in informing the response to COVID-19; (4) new telehealth applications piloted in response to the pandemic and duration of use; (5) changes to existing telehealth programs in response to the pandemic; 5) telehealth applications that were considered but never implemented; (6) barriers to implementation; (7) policies that facilitated adoption of telehealth; and (8) future plans for telehealth. Three members of the study team who are trained in qualitative research conducted the interviews. Each interview was 60 minutes, and study staff recorded and transcribed the interviews. Each participant received a $150 gift card for their time, and they provided verbal informed consent to participate. Harvard's Institutional Review Board approved this study.

Analysis

We coded interview transcripts using qualitative research software (Dedoose, Manhattan Beach, CA). We developed a hierarchically organized codebook to summarize themes and identify patterns. We used standard qualitative analysis techniques, consisting of both inductive and deductive approaches to identify and characterize instances of themes arising from the domains covered in the interview guide (eg, prior use of telehealth), as well as unanticipated themes that emerged (eg, decision to de-adopt/terminate certain telehealth programs). The lead author (L.U.-P.) conducted ongoing coding of all transcripts, refining the codebook as she worked and adding relevant probes to interviews in progress.

We defined a theme as a concept noted by at least 25% of participants. When identifying themes, we not only considered cohesiveness and prevalence across participant responses, but also incorporated perspectives that were inconsistent (ie, negative case analysis). We achieved consensus regarding the characterization of themes through interactive discussions among the research team.

RESULTS

We conducted 15 interviews with ED leaders from 14 institutions in 10 states. To obtain our final sample, we invited a total of 35 individuals (26 identified in published literature and 9 through snowball sampling), giving us a response rate of 43%. ED leaders who did not participate did not differ substantially from participants with respect to U.S. region or hospital type. All participants were ED physicians; however, most also held leadership positions such as ED medical director or ED telehealth director (Table 1). Interviews uncovered 8 distinct themes about the implementation of different telehealth applications (Table 2).

Table 1. Characteristics of participating ED physicians

Participant characteristic	n	%
ED role		
Chair/director	3	21
Medical director	5	36
Telehealth director	3	21
Other	2	14
No ED leadership role	1	7
U.S. region		
Northeast	6	43
South	4	29
Midwest	2	14
West	2	14
Hospital type		
Academic medical center	12	86
Community hospital	2	14
ED telemedicine programs in place prior to COVID-19		
Yes	10	71
No	4	29

Data were self-reported by participants.
COVID-19: coronavirus disease 2019; ED: emergency department.

COVID-19 as a catalyst for change

While most EDs had some prior experience with telehealth, COVID-19 was the catalyst for the creation of new programs and significant changes to existing programs. Most participants had experience with telehealth in the ED prior to the COVID-19 pandemic. The most common applications before the pandemic included teleconsultation services, in which remotely located specialists evaluate patients physically located in the ED (eg, telestroke). In addition, several participants described experience with tele-triage, in which an ED physician or other ED provider (eg, physician assistant) performs screening and initiates workups via telehealth for patients who have presented to the ED, and direct-to-consumer tele-urgent care programs operated by the health system and staffed by ED physicians. Several participants noted that this prior experience with telehealth helped to facilitate the expansion of telehealth services during the COVID-19 pandemic. They noted that having established processes to train clinicians, existing relationships with telehealth and technology companies, stockpiles of hardware and peripherals, and established workflows facilitated implementation of new or expanded programs. As described by participant 13 operating a telemergency program with rural EDs, "[Because we had this program in place prior to COVID-19] we already had the infrastructure, the IT team, we actually had a lot of the hardware, [and] a lot of the peripherals."

Implementation of new telehealth programs

During the pandemic, EDs experimented with more than a dozen new telehealth applications to conserve PPE, protect healthcare providers from exposure, better leverage the workforce, and increase surge capacity. EDs stood up or expanded a variety of telehealth applications during the COVID-19 pandemic, and it was common for individual EDs to implement a suite of applications at one time (Table 3). The most common goals of these applications were to conserve PPE, given actual or anticipated shortages of N95 masks, and to protect healthcare workers from exposure. Other goals were to better leverage their workforce across multiple locations (eg, by allowing quarantined physicians to continue working from home, or by allowing a remotely located ED physician to supervise advance practice providers at several different EDs). EDs overrun with COVID-19 patients used telehealth to improve surge capacity (eg, to prevent avoidable ED visits and reduce ED crowding, avoid hospitalizations, and reduce ED length of stay). Less commonly, EDs reported communicating about telehealth applications as a method to reassure patients that the ED was safe, in the context of reduced ED volumes and widespread fear of in-person care. Participant 12, operating a tele-isolation program that used videoconferencing to communicate with suspect COVID-19 patients in the ED, explained, "We were trying to encourage patients that maybe had emergent issues besides COVID, or if they did have COVID, they would be able to be protected [through telehealth] while they were in the emergency department. I think that the third goal of telemedicine was just to encourage them that you aren't going to be exposed when you come into the emergency department." Further, participant 14 discussed implementing a tele-isolation program in part to improve the patient experience:

Table 2. Interview themes

Number	Theme
1	COVID-19 as a catalyst for change: While most EDs had some prior experience with telehealth, COVID-19 was the catalyst for the creation of new programs and significant changes to existing programs.
2	Implementation of new telehealth programs: During the pandemic, EDs experimented with more than a dozen new types of telehealth applications to conserve PPE, protect healthcare providers from exposure, better leverage the workforce, and increase surge capacity.
3	Changes to established telehealth programs: Many telehealth applications that were in place prior to the COVID-19 pandemic expanded in size and scope and their primary objectives changed over time.
4	Temporary nature of new applications: Most of the new telehealth applications started early in the pandemic were discontinued or significantly declined in volume over time because they were no longer needed to support the response.
5	Factors contributing to sustainability: New telehealth applications that were sustained for a prolonged period were both operationally successful and had a clear business case or external funding source.
6	Leading barriers: The leading barriers to telehealth implementation during the pandemic included technology challenges and the need for staff physically located in the ED for "hands-on" implementation support.
7	Facilitators of telehealth: Participants noted a variety of policy factors that facilitated implementation of telehealth during the COVID-19 pandemic.
8	Limited Use of Regional Approaches: There were few examples of EDs coordinating their telehealth applications with other EDs at the local, regional, or national level.

COVID-19: coronavirus disease 2019; ED: emergency department; PPE: personal protective equipment.

Table 3. Telehealth applications for clinical care and primary goals

Application	Example Description	Primary Goals			
		Conserve PPE/Protect Healthcare Workers	Better Leverage Workforce	Facilitate Medical Education	Increase Surge Capacity/Address COVID-19 Surge
Virtual attending	Attending ED physicians (located remotely or within the ED) supervise residents and/or other ED providers who are at the patient's bedside via telehealth.	x[a]	x	x	
Virtual rounding	Multidisciplinary teams of clinicians and staff (eg, physicians, nurses, pharmacists, case managers, social workers) use telehealth to facilitate bedside rounding and medical education in the ED while treating suspect or confirmed COVID-19 patients. Team communication and care coordination take place via telehealth.	x	x	x	
Tele-triage	ED physicians or other ED providers perform a medical screening examination and initiate workups via telehealth. Patients can be located in the ED or a forward triage setting (eg, outdoor tent, parking garage) near the ED. Tele-triage can support the start of the ED visit; however, patients are not discharged without additional in-person or telehealth care outside of this initial step.	x	x		x
Direct to consumer tele-urgent care	ED clinicians conduct urgent care visits with patients located at home or at assisted living facilities as a substitute for in-person ED visits. These visits can also be a form of tele-triage to determine if transport to the ED is necessary.	x	x		x
Tele-isolation/ePPE	ED clinicians and staff use telehealth to treat suspect or confirmed COVID-19 patients while they are in the ED. These programs allow staff to minimize time at the bedside. For example, clinicians communicate with patients about laboratory results without entering the room.	x	x		
Tele-consultation	Remotely located specialists (eg, psychiatrists, neurologists) treat patients physically located in the ED via telehealth. Tele-consultation can also include resuscitations, in which some members of the care team observe and consult on an intubation from outside the trauma or critical care bay via telehealth.	x	x		
Tele-emergency (hub and spoke model)	ED physicians at a hub site consult with ED providers in spoke originating sites via telehealth.	x		x	
On campus virtual ED visit for suspect COVID-19 patients	ED clinicians conduct a medical screening exam, order COVID-19 testing, and conduct other activities via telehealth with patients who are	x			x

(continued)

Table 3. continued

Application	Example Description	Primary Goals			
		Conserve PPE/Protect Healthcare Workers	Better Leverage Workforce	Facilitate Medical Education	Increase Surge Capacity/Address COVID-19 Surge
	present in a location on the ED's campus (eg, in an outdoor tent) and physically accompanied by a nurse. Patients are generally discharged from the ED following a series of virtual interactions with ED clinicians.				
Post discharge monitoring for COVID-19 patients	ED clinicians monitor COVID-19 patients located at home through remote patient monitoring and telehealth visits to determine if and when patients should seek additional care.	x			x
EMS tele-emergency	Paramedics in the field (eg, at a patient's home) consult with ED providers via telehealth to determine if the patient requires ambulance transport to the ED.	x			x
Virtual postdischarge assessment	ED clinicians conduct assessments for geriatric patients (that were previously conducted prior to discharge) via telehealth with patients located at home to reduce ED length of stay.	x			x
Acute care at home	ED clinicians screen low-acuity inpatient admissions for discharge to home, where patients receive home-based inpatient care through a combination of telehealth visits, home visits (eg, infusion services, nursing), and remote patient monitoring.	x			x
Tele-express care/fast track in the ED	ED clinicians treat low acuity patients located in the ED through telehealth. Patients can be treated and discharged from the ED without any in-person interactions.	x			x
Tele-palliative care	Palliative care team members (eg, palliative care physician, nurse, social worker, chaplain) meet with patients located in the ED via telehealth to facilitate advance care planning, provide support, and communicate with patients' family members.	x			
Virtual care coordination	ED clinicians and staff use telehealth to coordinate with clinicians and staff in other departments (eg, ICU, inpatient medical/surgical units) to share important patient information.	x			

COVID-19: coronavirus disease 2019; ED: emergency department; EMS: emergency medical services; ePPE: electronic personal protective equipment; ICU: intensive care unit; PPE: personal protective equipment.

[a]Primary goal of the application.

I remember the early days of COVID when we would basically close the door on a patient, ask them what their cell phone number was, and everything else after that was interaction by cell phone. That really made the patients feel isolated. So, I think… by having video, it really makes the patients feel less trapped in that room. You can have more touches with the patient in terms of updating them more easily. What we are going for with this is to try to improve the patient experience.

Changes to established telehealth applications

Many telehealth applications that were in place prior to the COVID-19 pandemic expanded in size and scope and their primary objectives changed over time. Several EDs reported that established teleconsultation programs grew in volume during the pandemic and that additional specialties began to do teleconsultations in the ED. One ED reported that while it already had teleconsultation services for psychiatry and obstetrics prior to the pandemic, it added neurology in the spring of 2020. Also, the primary goal of the services changed. Prior to COVID-19, the primary objective was to help specialists avoid travel to the ED. During the pandemic, the primary goal was to protect specialists from potential exposure to COVID-19. Participants generally attributed this growth in teleconsultation programs to the fact that specialists were using it for their own ambulatory patients and as a result, were more comfortable with the technology. As a participant 3 operating a teleconsult program explained, "[The growth was fueled by] just the familiarity with it, and the broad acceptance that this is how you're going see your patients."

A handful of health systems operated direct-to-consumer tele-urgent care services prior to the pandemic. All participants affiliated with these programs observed increased demand for visits in the spring of 2020 that they accommodated by recruiting and training clinicians from other departments in the hospital. In addition, several EDs had pre-existing tele-triage programs that continued to operate but with different goals. Before the pandemic, tele-triage within the ED was a tool to help manage crowded waiting rooms and reduce the fraction of patients left without being seen. During the pandemic when volume was down, the goals of tele-triage were to reduce exposure for ED staff and to address staffing shortages. Participant 10 operating a tele-triage program explained, "The whole idea and the reason we did it [tele-triage] is to decrease our left without being seen rate. So, when our ED is very busy, that's why we needed it. Now [with COVID-19] our volume dropped significantly, so we didn't actually need it for that reason."

Temporary nature of new applications

Most of the new telehealth applications started early in the pandemic were discontinued or significantly declined in volume over time because they were no longer needed to support the response. Participants frequently pointed out that telehealth in the ED is cumbersome and adds logistical challenges. Participant 4 operating a tele-isolation program explained, "When you do telemedicine, there's inefficiencies. . .When providers are right next to each other, in-person, communication is very easy. When we were trying to do things by telephone or by tablet, it's just a little bit harder." Participant 9, who implemented a different tele-isolation program, added, "If you have a generally healthy staff at a relatively low patient volume, and feel like you have the protective equipment, I think almost universally, people aren't going to find the hassle worth the time." It follows that there must be an acute need for telehealth that outweighs its disadvantages. However, participants noted that many telehealth applications that were implemented for the pandemic were initially designed for dire circumstances that did not materialize or addressed problems that proved temporary. For example, one remote patient monitoring program was specifically designed to support moderate-risk COVID-19 patients at home because the hospital had limited capacity to admit them. Once the first wave of cases subsided and capacity increased, the program was discontinued.

In addition, although numerous applications were designed to address insufficient PPE, this was not a problem for all EDs during the pandemic or was only a temporary challenge. Further, EDs initially stood up various telehealth programs because they predicted that more clinicians would contract COVID-19; yet, as the pandemic progressed and many EDs saw lower rates of morbidity and mortality among healthcare workers than anticipated, ED clinicians became more comfortable treating patients in person. Participant 1, who operated a discontinued virtual attending program, explained, "I think all of us feel comfortable being back in-person in the emergency department with our PPE."

It should be noted that a handful of telehealth applications were discontinued because of design flaws that prevented programs from ever being successful. For example, one emergency medical services tele-emergency program had such strict inclusion criteria that very few patients qualified to use the service. One tele-palliative care program depended on the participation of patients, but in reality the patients were too sick to engage with the technology and with the remote provider.

Regardless of the reason for discontinuation, participants universally acknowledged that the experience implementing new telehealth programs was important for emergency preparedness, and they were pleased to have the improved infrastructure and capability in case of a future disaster. Participant 1 operating several discontinued programs explained, "I think we were pretty happy with the way the program turned out, and we'd probably be able to pretty quickly jump back into the program if the needs changed. . .All the telehealth carts are still in the ED. They're all working and could be used at any time."

One threat to long-term sustainability was that several new and expanded programs did not have long-term staffing plans. Most leveraged staff that had excess capacity for a limited time, such as outpatient providers who had very few patients in March and April 2020 and temporarily assumed new responsibilities. The problem with this model is that when these staff resumed their prior duties, there was no obvious supply of alternative staff. As participant 11 operating a tele-urgent care service explained, "We had the pediatric providers see adults because they were really twiddling their thumbs. They were just sitting there with no kids to be seen. So, they said, 'I could tell patients the same things you are telling them. I could give them options for [COVID-19] testing centers.'

Factors contributing to sustainability

New telehealth applications that were sustained for a prolonged period were both operationally successful and had a clear business case or external funding source. New telehealth applications that were still in operation as of November 2020 not only worked well, but were also financially sustainable because they generated revenue or were supported by grants. One direct-to-consumer tele-urgent care application that was first implemented for the pandemic allowed ED clinicians to convert uncompensated telephone calls to the ED into billable visits and freed up the nurses who were managing incoming calls. One virtual attending program allowed the ED to better leverage its physicians across multiple locations within its system. Finally, one remote patient monitoring program received external recognition and grant funding to test the efficacy of different technology-enabled care models.

Leading barriers

The leading barriers to telehealth implementation during the pandemic included technology challenges and the need for "hands-on" implementation support in the ED. Despite improvements in the

quality and availability of low-cost technologies in recent years, participants often mentioned how equipment failure, equipment shortages, connection issues, device incompatibility with available software, lack of EHR integration, and limited functionality undermined their telehealth programs. Participants also noted that these problems are even more likely to affect use of telehealth applications during disasters, because the rapid pace of adoption does not allow EDs to evaluate and test alternative platforms, hardware, and peripherals. For example, 1 participant from a tele-isolation program expressed frustration that the Zoom meetings connecting patients and ED staff would time out and need to be restarted numerous times.

Several EDs reported hardware shortages in the early months of the pandemic that prevented them from implementing telehealth as they had originally envisioned. For example, 1 participant pointed out that by the time his staff secured the iPads they wanted, the program they had hoped to implement was no longer needed. Technology and connection issues also required some programs to redesign applications on the fly. One EMS tele-emergency program reported that because of limited cellular coverage in rural areas, program staff had to replace provider-to-patient video visits with provider-to-provider telephone calls.

Another challenge is that to effectively implement telehealth in an ED, you need staff who are physically on site. This need for hands-on support to wheel in telehealth carts, set up connections, and troubleshoot problems is challenging in disasters such as COVID-19, because EDs may experience workforce shortages or reduce their ED staffing to prevent disease transmission and facilitate social distancing. Participants frequently expressed frustration that servicing telehealth equipment often requires staff to enter patients' rooms. As participant 11 operating multiple telehealth programs explained:

> *To do telehealth, you need bodies in the ED…This is an issue when trying to keep staff down. And I would say this, ultimately, telehealth still needs people, you still need somebody on the ground, or somebody who can either connect that patient with Zoom, someone who could explain it, somebody who could roll a cart over to a patient…. I mean, people joke and say we should fly the tablets around on drones…All the volunteers who would roll a cart for us are gone, and now we can't roll a cart.*

One ED actually reported discontinuing a tele-medication reconciliation program that had been in place prior to the pandemic to reduce the number of people in the ED and shorten ED length of stay. Participant 11 explained, "We couldn't rationalize having someone else on the ground to move that cart around, because we were trying to get everybody out of the ED."

It should be noted that several tele-isolation programs experimented with having patients answer telehealth video calls from clinicians in the ED so that staff would not be required to enter the room and assist with this task. However, these programs faced their own challenges because patients were not always prepared or comfortable doing this.

Acilitators of telehealth

Participants noted a variety of policy factors that facilitated implementation of telehealth during the COVID-19 pandemic. Participants appreciated expanded reimbursement for telehealth, including relaxation of originating site requirements, and took advantage of the following regulatory changes that were put in place during the public health emergency:

Remote supervision of ED providers. One program was able to use physician assistants overseen by remote ED physicians via telehealth to conduct urgent care visits.

Waiving of licensure requirements. Several direct-to-consumer tele-urgent care programs were able to onboard new clinicians much faster, and individual providers were able to serve more patients (eg, outside of the state).

Lack of HIPAA (Health Insurance Portability and Accountability Act) enforcement. One direct-to-consumer tele-urgent care program used non–HIPAA-complaint platforms to support patient care, training of new clinicians, and quality assurance efforts.

Medical screening exam changes. Several tele-triage programs benefited from changes allowing the medical screening exam to be performed via telehealth.

Limited use of regional approaches

There were few examples of EDs coordinating their telehealth applications with other EDs at the local, regional, or national level. Almost all of the EDs in the sample reported implementing telehealth applications as part of an individual ED or health system's response, rather than coordinating efforts across health systems. Although participants pointed out that direct-to-consumer tele-urgent care and EMS tele-emergency could be coordinated and offered at the regional or even national level, they cited numerous barriers to coordination, including licensing, credentialing, and incentives and competitive factors.

DISCUSSION

The COVID-19 pandemic was the catalyst for many EDs to start new telehealth programs and adapt existing programs. Prior experience with telehealth helped to facilitate innovation. Interestingly, many new applications proved temporary. The leading barriers to telehealth implementation during the pandemic included technology challenges and the need for "hands-on" implementation support in the ED.

To our knowledge, this is the first assessment of the experiences of a range of EDs across the United States in implementing multiple telehealth applications in response to COVID-19. While many individual EDs have described their experiences implementing telehealth,[4,7,13,29,32,35–38] we sought to aggregate common motivators, goals, and challenges across these programs. The most common application featured in the literature appears to be tele-isolation or electronic PPE programs, though such interventions were often implemented in combination with others (eg, tele-triage, virtual rounding).[13,32,36,39,40] Similar to what we have reported, many of these programs reported technology challenges that required staff time and resources to address.[13]

Our findings have several implications for individual hospitals or disaster response efforts that are considering implementing telehealth applications in response to subsequent waves of COVID-19 or to future disasters. First, our finding that prior experience with telehealth helped to facilitate the expansion of telehealth services suggests that disaster preparedness is greatly facilitated by existing telehealth programs and supporting infrastructure. For example, having a robust telestroke or telepsychiatry program ensures that at the onset of the disaster, the ED has established workflows, equipment, buy-in from hospital stakeholders, trained staff, and usable platforms that meet the needs of diverse populations. Offering telehealth services—as well as the instructions and communications to

facilitate use—in multiple languages is particularly difficult to implement quickly. Disaster preparedness might be an additional motivating factor to implement such programs.

Second, our finding that some programs faced hardware shortages implies that either at the health system level or at the regional level, there is a need to stockpile hardware and peripherals for potential telehealth applications. Hardware integral to the functioning of telehealth programs (eg, tablets, tablet stands, telemedicine carts, microphones, headsets) is likely to be in short supply at the onset of a disaster due to increased demand. Hospitals should consider maintaining a stockpile of relatively low-cost, scalable equipment that can be repurposed as needed.

Third, our finding that technology challenges required "hands on" implementation support suggests that hospitals should expect technological challenges and should seek out additional sources of information technology support and technical assistance beyond what is available within the health system. Also, they should set expectations with staff and patients that technological problems are likely to occur and will improve over time. It is also important to consider how new technology will interact with the protocols put in place specifically for the disaster. For example, additional ambient noise from powering tents or air filters can make it difficult to hear telehealth encounters.

Fourth, our finding that some applications relied on staff with temporary availability suggests that hospitals should develop both short-term and long-term staffing plans for new telehealth programs. While it may make sense to leverage clinicians with temporary availability at the beginning of a disaster, hospitals as well as other healthcare organizations should also plan for longer-term staffing solutions. For example, they may consider engaging recently retired clinicians, medical students, and volunteers.

Outside the purview of individual hospitals or health systems, there are several implications for state and federal policymakers. ED leaders reported that licensure waivers were important for telehealth applications that served patients in multiple states. States could create systems for rapidly implementing licensure reciprocity in disasters. Also, it was notable that nearly all of the telehealth applications were implemented by an individual ED or health system. There may be opportunities for EMS tele-emergency or teleurgent care programs to be implemented at a regional level that facilitates load balancing across multiple systems.

This study has several limitations. First, our search strategy was not systematic, and as such might have overlooked some potential participants and EDs. Second, although we aimed to include community hospital EDs in our sample, most participants represented academic medical centers, and our findings may be most applicable in these settings. We hypothesize that the larger academic medical centers were more likely to implement multiple telehealth programs at once, and that their efforts had greater visibility within the emergency medicine community. Third, our findings only address experiences responding to the COVID-19 pandemic. It is unclear how applicable these experiences are to other disasters with different characteristics and transmission dynamics.

Future research should track telehealth utilization by U.S. EDs as the pandemic evolves as well as describe implementation trends for the various applications we have identified here. Despite the tremendous challenges EDs faced in responding to the COVID-19 pandemic, there were numerous examples of rapid telehealth innovation by individual EDs and health systems. Their experience can facilitate future responses to the ongoing pandemic and to future disasters.

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AUTHOR CONTRIBUTIONS

AM, LHS, LU-P, and KSZ obtained funding. LU-P, JS, KSZ, AM, and LHS helped to design the study and interpreted the data. LU-P, JS, and KSZ collected the data. LU-P and JS wrote the first draft of the manuscript, and LU-P, JS, KSZ, AM, and LHS revised it critically. LU-P, JS, KSZ, AM, and LHS provided final approval and agree to be accountable for all aspects of the work.

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COMPETING INTERESTS STATEMENT

Authors have no conflicts to disclose.

DATA AVAILABILITY

The data underlying this article will be shared on reasonable request and application to the corresponding author.

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