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Research and Applications

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Rapid Deployment of Inpatient Telemedicine In Response to COVID-19 Across Three Health Systems

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ABSTRACT

Objective: To reduce pathogen exposure, conserve personal protective equipment, and facilitate health care personnel work participation in the setting of the COVID-19 pandemic, three affiliated institutions rapidly and independently deployed inpatient telemedicine programs during March 2020. We describe key features and early learnings of these programs in the hospital setting.

Methods: Relevant clinical and operational leadership from an academic medical center, pediatric teaching hospital, and safety net county health system met to share learnings shortly after deploying inpatient telemedicine. A summative analysis of their learnings was re-circulated for approval.

Results: All three institutions faced pressure to urgently standup new telemedicine systems while still maintaining secure information exchange. Differences across patient demographics and technological capabilities led to variation in solution design, though key technical considerations were similar. Rapid deployment in each system relied on readily available consumer-grade technology, given the existing familiarity to patients and clinicians and minimal infrastructure investment. Preliminary data from the academic medical center over one month suggested positive adoption with 631 inpatient video calls lasting an average (standard deviation) of 16.5 minutes (19.6) based on inclusion criteria.

Discussion: The threat of an imminent surge of COVID-19 patients drove three institutions to rapidly develop inpatient telemedicine solutions. Concurrently, federal and state regulators temporarily relaxed restrictions that would have previously limited these efforts. Strategic direction from executive leadership, leveraging off-the-shelf hardware, vendor engagement, and clinical workflow integration facilitated rapid deployment.

Conclusion: The rapid deployment of inpatient telemedicine is feasible across diverse settings as a response to the COVID-19 pandemic.

Key words: information technology; inpatient telemedicine, virtual rounding, telerounding, technology implementation; COVID-19, pandemic, infection control, PPE use

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Background and Significance

While workforce integrity is a key component of a pandemic response, health care personnel are at higher risk for contracting SARS-CoV-2 (COVID-19) through the workplace.[1,2] Personal protective equipment (PPE) can help prevent nosocomial transmission, but persistent supply shortages have left health care workers worldwide vulnerable.[2–4] Such shortages also place non-COVID-19 inpatients at risk. Faced both with PPE supply constraints and the residual risk even with proper use, health systems have been forced to find additional ways to protect their workers and patients.

During previous outbreaks such as Ebola, H1N1, SARS-CoV, and MERS-CoV, telemedicine appeared to be a potentially useful tool for delivering health care.[5] Yet again, telemedicine has emerged as a potent protective tool,[6–9] and the relaxation of federal privacy restrictions and increased reimbursement in the setting of the nationwide emergency has temporarily lifted key barriers to widespread use.[10]

Traditionally employed to overcome geographic distances,[11] virtual communication has rapidly spread to the closer quarters of the inpatient wards because it allows patients and providers to interact without infection risk.[12,13] Under names like "virtual rounding", "telerounding" or "video rounding,"[15,16] prior work in non-outbreak situations has suggested this type of telemedicine is acceptable to both patients and providers[15–19] and may increase efficiency and task-based communication.[20] However, descriptions of telemedicine in the acute care setting used for infection control have been limited to the emergency department setting,[21] and evaluative literature is lacking.

Objective

To reduce pathogen exposure, conserve PPE, and facilitate health care personnel work participation in the setting of the COVID-19 pandemic, three affiliated institutions rapidly and independently deployed inpatient telemedicine programs during March 2020. We describe key features and early learnings of these programs in the hospital setting.

METHODS

Setting

Stanford Health Care (Stanford, California, USA) is a large academic medical center encompassing two adult acute care hospitals, emergency care, and outpatient primary and specialty clinics. The health system is closely affiliated with Stanford Children's Health (Palo Alto, California, USA), which includes Lucille Packard Children's Hospital. The County of Santa Clara Health System (San Jose, California, USA) is a safety net institution made up of three acute care hospitals (combined adult and pediatric), emergency care and outpatient clinics. Each of these three health systems is an independent organization, with its own electronic health records (EHRs) and information technology (IT) systems, though medical student and resident trainees affiliated with Stanford University rotate across all institutions.

Implementation of inpatient telemedicine across three organizations

In response to COVID-19, leadership within each of the three organizations independently evaluated and deployed inpatient telemedicine as an informatics response in March 2020. Their respective IT teams worked to rapidly deploy this capability across high priority sites within two weeks in anticipation of a surge in COVID-19 cases. Relevant clinical and operational leadership within each institution shared key features and learnings from the deployments during a learning meeting, and the summative analysis was re-circulated for clarification and approval. This project was given a non-research determination by both Stanford's Institutional Review Board (Protocol #56061) as well as the County of Santa Clara Health System's Institutional Review Board (Protocol #20-011EX).

RESULTS

All three institutions faced strong time pressures to standup the new systems while still maintaining a high security standard. Differences across patient demographics and technological capabilities led to some variation among the three health systems, but key technical considerations were largely similar, including target population, workflow, privacy, hardware, software, integration with the EHR, and security (Table 1). A short developmental narrative is provided for each system.

Implementation of inpatient telemedicine at Stanford Health Care

Leadership convened a multi-stakeholder task force to build a new inpatient telemedicine program. The task force revamped a planned inpatient telemedicine solution that had not yet been deployed. The new plan accelerated the timeframe and widened the previously planned capabilities. After a systematic evaluation of potential deficiencies and risks, the solution was trialed in mid-March 2020 and then broadly implemented.

Hardware was deployed using a hub and spoke model. Computer workstations with video capability or full-size tablets (Apple, Cupertino, California, USA) mounted on wheels served as "hubs" that were centrally located in the ward. The "spokes" were full-sized tablets mounted on wheels (Figure 1), which remained in individual patient rooms and were disinfected as a part of standard rooming processes between patients. Both the tablet and mounts were deployed in lock-step with the health system's placement of patients with COVID-19 and expanded in parallel. In mid-March 2020, deployment began with 25 tablets on wheels in the first COVID-specific isolation. During the following two weeks, an additional 104 tablets on wheels were deployed to the adult and pediatric emergency departments. By mid-April, a total of 417 tablets were deployed, covering all inpatient and emergency areas.

Given the need for rapid deployment, priority was given to optimize existing solutions; therefore, custom modifications were minimized. A video conferencing vendor (Zoom, San Jose, California, USA) that facilitated enterprise-level management was selected. It offered HIPAA-compliant communication, met minimum audio and visual quality specifications, and permitted a "hub and spoke" configuration whereby the "spoke" tablets based in patient rooms automatically answered "hub" calls in a unidirectional format. In addition, the hub device could be used to facilitate patient connection to outside family members.

Technical managers worked with clinical champions alongside clinical managers to document pre-existing clinical workflows and inpatient telemedicine needs and opportunities. These teams developed new workflows and an implementation plan for each unit. Clinical champions worked alongside the informatics education

Table 1. Deployment of inpatient telemedicine across three health systems: considerations and solutions

Consideration	Stanford Health Care *Academic medical center*	Stanford Children's Health *Pediatric health system*	County of Santa Clara Health System *Safety net county health system*
Targeted patient demographic	Patients with confirmed or suspected COVID-19 in the emergency department or inpatient setting Immunocompromised patients	All inpatients	Patients with confirmed or suspected COVID-19 in the emergency department or inpatient setting Immunocompromised patients Patients who meet "Tablet Readiness" criteria (Table 2)
Patient privacy	Initial courtesy audio call with existing nurse call system followed up with video call on bedside tablet upon patient's permission; automated device answer	Adult proxy in the room opts in to answer a video call, sometimes with bedside nursing assistance	Patient in the room opts in to answer a video call, sometimes with bedside nursing assistance
Patient hardware	Tablet mounted on moveable stands with wheels	Pre-existing wall-mounted tablets previously used for entertainment	Miniature tablet handheld or mounted on moveable stands with wheels
Provider hardware and access	Available on dedicated tablets and desktop workstations located centrally in each ward; unavailable from home or provider work room	Available on desktop workstations with video EHR capability located in provider work rooms Available on enabled computers on wheels outfitted with built in camera and outfitted with omnidirectional USB plug & play microphone Available from home	Available on personal or county-issued smart phones as well as "pooled" provider and staff tablets located in each unit Additional participants can be added by users active on the video call
Software & EHR integration	Web-based videoconferencing (Zoom) linked in a "hub and spoke" configuration whereby a "hub" device on the unit level makes unidirectional calls to a "spoke" device in the patient room that automatically answers No direct EHR integration	Direct patient communication: web-based videoconferencing (Webex) with perpetually active virtual room assigned to each patient, with electronic links embedded in the medical record Team communication: web-based videoconferencing (Webex) with an 18-hour recurring daily meeting assigned to each multi-disciplinary team	Device-based videoconferencing (FaceTime) with a patient's unique device identification entered into the EHR Unidirectional video calls initiated directly from the EHR mobile application customized plug-in
Capabilities – inpatient perspective	Tablet functionality otherwise blocked	Wall-mounted tablet with pre-existing entertainment choices	Web browsing capabilities that wipe clean after 60 seconds of non-use Patients can call out to friends and family if receiver has a device of the same brand
Capabilities – family perspective	Compassionate use available for end-of-life care with family members on the unit, facilitated by nurses from the hub device	Compassionate use available for end-of-life care with on-site or remote family members, facilitated by nurses Can accept incoming calls from family	Compassionate use for end-of-life care with on-site or remote family members, facilitated by nurses Can accept incoming calls from family
Security	Local control and lock-down capability through mobile device management Video stream password protected Hub device acts as gatekeeper to facilitate remote calls	Web conference access launched from secure EHR	Device-based videoconference technology encrypted end-to-end Access launched from secure EHR Mobile Device Management system wipes data after inactivity

NOTE. EHR – electronic health record

team to rapidly foster engagement. Clinical rounding teams decided whether all team members would be remote during the encounter or if certain representatives could enter the room.

Preliminary data available on the utilization of the videoconferencing software at Stanford Health Care suggests adoption amongst clinicians and patients. During the one-month period since the launch of inpatient telemedicine (3/18/2020-4/20/2020), 6,017 connections were documented system wide in the inpatient and emergency settings. For the 631 of inpatient video calls that lasted between two minutes and two hours, the average (standard deviation) duration was 16.5 (19.6) minutes. We note the duration of calls skewed heavily towards a high frequency of short calls. Utilization data was not readily available for the other two health systems described below due to variation in product capabilities.

Implementation of inpatient telemedicine at Stanford Children's Health

COVID-19 considerations in the pediatric hospital differed from those in the adult hospitals. While COVID-19 infection in children does not typically cause severe disease, children can be asymptomatic carriers and infect health care workers or immunocompromised patients.[22] Therefore, the primary goal in this setting revolved around promoting physical distancing between staff members,

Figure 1. Hardware display at Stanford Health Care (photo courtesy of Stanford Health Care).

patients and families, and conserving PPE, while maintaining high-quality, family-centered care with a partially remote workforce.

All pediatric beds in the main children's hospital building were already equipped with wall-mounted full-sized tablets (Apple, Cupertino, California, USA) available for entertainment purposes for both the patient and family. The deployment team capitalized on this by adding a HIPAA compliant video conferencing application (Cisco Webex, Milpitas, California, USA) with its own account on each tablet. A hyperlink to the perpetually active video conference personal room for each device was available in the patient's EHR (Epic Systems Corporation, Verona, Wisconsin, USA). Staff could then directly engage with patients and families inside the room via videoconferencing from elsewhere in the hospital or remote locations by accessing the link through the electronic medical record. In this model, the patient or family member receive an instructional telephone call letting them know they should enter the video conferencing application from the wall-mounted tablet. Additionally, tablets were all provisioned with FaceTime (Apple, Cupertino, California, USA) so that patients can connect with outside friends and family members. Tablets located in units for patients confirmed with or under investigation for COVID-19 were prioritized for required software updates in late March 2020. However, all tablets were updated to meet the new standard within the following two weeks. Additional tablets were procured, similarly provisioned, and assigned to the remaining obstetric and pediatric rooms on units outside the main building during the first two weeks in April 2020.

Additionally, the health system recommended social distancing for staff and minimized staff entry into patient areas for non-essential purposes. To continue the system's multidisciplinary, family-centered rounds, the system also utilized readily-available computer workstations on wheels for 10 inpatient medical teams. Hardware consisted of a large screen and computer audio speakers with a built-in camera. Due to poor microphone quality on the standard computer, an additional omnidirectional USB "plug and play" microphone (MXL, Torrance, California, USA) was installed. Most members of the multidisciplinary rounding team (physicians, advance practice providers, pharmacists, case managers, dieticians) remained remote and logged into the video conference. One or two providers physically moved the computer on wheels with the multidisciplinary team hosted on the video conference platform to the threshold of each patient room, where they held rounding discussions with the patient, family member, and a bedside nurse. The

Table 2. "Tablet Readiness" screen assessment

- Is the patient/in-room proxy alert and oriented?
- Is the patient/in-room proxy able to use their hands? (i.e. able to answer a FaceTime call?)
- Can the patient/in-room proxy see, hear and speak? (i.e. able to participate in a FaceTime call?)

-OR-

- Is the device being used for compassionate/palliative use? For example, for a patient who is intubated, or dying, the device would allow family to spend time with this patient, even if the patient cannot interact.

N.B. To be considered "tablet ready", a "yes" response to all questions was required, although the patient's anxiety level and behavioral issues were also taken into consideration.

computer on wheels was not typically brought beyond the threshold of the doorway and was regularly sanitized between patient encounters to minimize environmental transmission. To minimize the logistical burden of new video conference entry for each patient, each multidisciplinary rounding team had its own recurring video conference URL that was used throughout rounds. The URLs to these videoconference streams were listed securely on an electronic bulletin board hosted on the hospital intranet to enable easy reference for the team.

Implementation of inpatient telemedicine at County of Santa Clara Health System

The County of Santa Clara Health System command center quickly recognized that an inpatient telemedicine solution was urgently needed to reduce transmission of COVID-19 and PPE usage. Given its socioeconomically diverse patient population, ease of use of the telemedicine platform was a major consideration. After assessing device and technical infrastructure, and reviewing multiple web- and device-based teleconferencing solutions, an inpatient telemedicine working group decided to move forward with a popular device-based solution (FaceTime through Apple, Cupertino, California, USA) in mid-March 2020. The platform was chosen for its ease of use as it most closely resembled a standard phone call, allowing patients and their families to communicate, and allowing patients to decide if they wanted to accept a video call or not. The technical team worked with developers from both the device and EHR vendor (Epic Systems Corporation, Verona, Wisconsin, USA) to streamline device setup and develop basic EHR integration. Within one and a half weeks, 200 patient and 40 provider iPads were rolled out to all three county-owned hospital sites including emergency departments and designated COVID-19 units.

Devices were deployed in a decentralized, point-to-point model. Providers could make FaceTime video calls to patients using either a personal or a county-issued smart phone. Additionally, "pooled" tablets were deployed on each COVID-19 unit for staff or providers who did not have access to a FaceTime-capable device. For security and privacy reasons, patient access was limited to a FaceTime application only as well as a private internet browser that auto-closed and wiped its history after 60 seconds of non-use, leveraging the institution's mobile device management (MDM) software (Intelligent Hub, VMware, Palo Alto, USA). Automatic wiping of the browser history obviated the need to reset devices between patients, which would have required additional personnel resources to address two-factor authentication.

Given considerations of patient privacy and the desire to optimize patient choice, the system elected to allow patients the option to answer or dismiss incoming video calls. Thus, patients needed to have the cognitive, psychological and functional capacity to accept video call. Patients (or an in-room proxy, such as an adult for a pediatric patient) were assessed for appropriateness for utilization of the tablet system (Table 2). Appropriate candidates were provisioned a tablet and given a tip sheet on how to use the device, which was translated into seven languages. The nurse entered the device's ID into a flowsheet row in the individual patient's EHR. The EHR-device integration then automatically generated a standard FaceTime URL that was linked to the device and EHR. This setup minimized the manual burden of setting up new accounts while also allowing FaceTime video calls to be made directly from the patient's chart in the EHR mobile application. Instructional designers created a standard set of user instructions and tips for providers and staff. Clinical champions and the technical team worked together to demonstrate the system, and weekly teleconferences were held to resolve challenges and share benefits and best practices across sites within the health system.

Shared priorities

While technical criteria and workflows were developed for each health system, informatics leaders had to consider a broad range of priorities. For example, all health systems identified their relationships with their vendors as an important component of success. The identification and rapid procurement of consumer grade hardware, whether a tablet or an accessory, that could be deployed in an enterprise setting was also a core element for each successful deployment. The compatibility between the enterprise mobile device management system and off-the-shelf hardware was heavily weighted when making these choices. Strong teamwork amongst technical support members to enable software configuration options and reliability that the systems would be correctly deployed were also required. One of the health systems had to specifically consider internet bandwidth constraints in choosing software. In addition, understanding how to decontaminate equipment during room turnover and keeping equipment charged were also priorities.

Health systems also had to identify their key goals and objectives for deployment. For pediatric populations, where COVID-19 hospitalization rates were low, there was an emphasis on reducing the risk of hospital staff spreading infection. Focus was given to enable clinical workflows where eligible providers were able to contribute to team-based care remotely, even for non-isolated patients. On the other hand, adult patient populations are both at greater risk for transmitting infection to and from health care workers. With concern that hospital capacity would eventually be overrun by COVID-19 patients, inpatient telemedicine resources were deployed to match where isolation cases were already located and expanded in parallel with the growth of these cases.

Rapid deployment relied on existing consumer-facing technology

All three institutions were able to deploy inpatient telemedicine capability to their target population within a two-week period in mid-March 2020. Across all three systems, hardware and software solutions relied on products that were already available to the general public, rather that solutions specific to health care enterprises. The decision around hardware was dominated by the need for rapid deployment with minimal training of patients and personnel. Patients and clinicians alike were able to use technology they were already familiar with in settings outside the hospital. The relatively low price point when compared with enterprise solutions and flexibility in capabilities (e.g. outgoing calls, web browsing capabilities) also contributed to the selection of commodity solutions.

Furthermore, wiring within hospital rooms must remain within strict accreditation requirements, as loose wires increase the risk of falls or other hazards. Therefore, mounting telemedicine capabilities inside the room was not feasible within the desired time frame.

Remaining gaps in translation services, fleet management, security

Integrating translation services was among the most pressing gaps acknowledged by all three institutions. At one institution, a makeshift solution included calling interpreter services on a separate application and device, which presented sub-optimal audio quality and lack of three-party video capability. Another institution still required in-person translator services that reduced translators' ability to work remotely.

Seamless fleet management consisting of equipment maintenance was also cited as a gap. Given that some devices were local to the unit, adjustment required IT personnel to physically go to these units to troubleshoot concerns, increasing the need for personnel resources that had to be diverted from other initiatives.

Finally, cybersecurity risk remained a concern, even though security was held as a top priority throughout each deployment. Widespread use of web and device-based video conference in the inpatient setting may make this technology vulnerable to cyberattacks despite varying combinations of HIPAA-compliance, encryption, and password protection offered by these solutions.[23,24] The health systems took measures to ensure that video conference streams are not exposed to the public or vulnerable to attacks and continue to actively explore solutions to these challenges.

Pandemic as a catalyst for long-term change

The threat of an imminent surge of COVID-19 patients drove all three institutions to act quickly to develop an inpatient telemedicine solution. Aspects that facilitated this rapid shift were executive-level engagement, prioritization of COVID-19 response above other priorities, and positive relationships with vendors that prioritized health care customer needs above others. Requests to vendors that may have otherwise been put into a queue were prioritized due to imminent clinical need. In addition, frontline staff willingness to engage and accept new telemedicine workflows was considerably higher than with non-pandemic technology rollouts given the imperative need to decrease exposure for themselves, their colleagues, and patients.

The intention of clinical informatics leadership within the three health systems is to sustain inpatient telemedicine capability going forward, both as a response to a pandemic curve that has flattened but may be prolonged, as well as for non-COVID-19 purposes in the future. Leadership from the three institutions discussed the resources that would be required to maintain this network into the future. Additional dedicated field service workers to troubleshoot problems was cited as a critical need, as their efforts had been temporarily pulled from other activities during deployment. The solutions will also need to be adapted as national and state regulations related to patient privacy and reimbursement in the acute care setting continue to evolve.

DISCUSSION

Strong case for inpatient telemedicine in the infectious disease outbreak setting

These three health systems and others[21] have each independently recognized the potential for telemedicine capability in the acute care setting to respond to an infectious diseases outbreak. They seem to have uncovered 'common sense' intuition that health systems have not been pressed to acknowledge before this pandemic. Previously, the role of inpatient telemedicine as an infection control strategy was indirectly recognized in the design and implementation of a customized EHR system built to manage Ebola.[25] However, the current epidemic has broken new ground by making inpatient telemedicine a pivotal part of the overall infection control plan. Current hospital accreditation programs necessitate that a range of infrastructural standards, such as availability of negative pressure rooms, be met to reduce risk of infection transmission.[26] Our national strategic preparedness for pandemics may also benefit from the incorporation of standards for inpatient telemedicine in future accreditation guidelines.

Expanding the definition and role of telemedicine

Prior to the COVID-19 pandemic, the definitions of telehealth and telemedicine from US federal agencies used for reimbursement purposes focus on *remote* interaction.[14,27] Is a telemedicine interaction between a patient and clinician outside the patient's door or down the hallway still considered remote? Such questions have yet to be fully addressed and may necessitate an expansion of the definitions of telehealth and telemedicine.

Following the declaration of a state of emergency in the U.S. as a result of the COVID-19 pandemic, federal payers issued regulatory waivers allowing clinicians to complete a majority of inpatient and outpatient medical services via telemedicine, with full parity in reimbursement as the equivalent in-person services would have received.[12,28–30] It remains to be seen whether these changes will last beyond the resolution of the pandemic and what role this will have on the use of telemedicine, particularly for inpatient services.

Each patient or room should have telemedicine capability

We note that some telemedicine systems described for inpatient rounding have been situated upon mobile, robotic platforms that allow the device to move from room to room.[15,31] Setting aside resource limitations, our experience suggests that the optimal setup in response to an infectious disease outbreak is inpatient telemedicine capability within each room or a device assigned to each patient. With SARS-CoV-2 and other infectious pathogens, environmental transmission poses significant risk,[32] particularly through mobile fomites that robotically-based technologies represent.

Inpatient telemedicine may also have the capability of preventing transmission of more common nosocomial pathogens to certain patients, such as those who are immunocompromised, even outside of the context of a pandemic. In addition, inpatient telemedicine may be used for other purposes, including virtual "sitters" to monitor patients, facilitating visitor interactions, clinician convenience, and clinician efficiency.[33] As the role of inpatient telemedicine expands, alternate team configurations and rounding workflows will no doubt continue to be explored.

Potential to reduce PPE use

Early data on the use of inpatient telemedicine to facilitate rounding activities suggests ongoing clinician and patient adoption in a large academic medical center. The potential for video calls to diminish PPE use and/or influence the number of clinician-patient interactions has yet to be formally evaluated. Nonetheless, evidence of adoption may suggest the likelihood of decreased PPE use.

Impact on medical education

During an infectious disease outbreak, the primary drivers of patient care and staff safety may supersede the clinical education mandate in academic settings. The negative impact that the COVID-19 and other pandemics have had on medical education is well recognized.[34] Inpatient telemedicine platforms may enable academic medical centers to incorporate trainees into clinical rounds in high risk settings, allowing these institutions to continue to meet their commitment to ongoing trainee education.

Limitations and future considerations

We recognize the need for ongoing investigation into several aspects of the use of inpatient telemedicine as an infection control and PPE-reduction measure. Gaps in understanding how these telemedicine solutions are integrated into clinical workflow across various settings remain. A key clinical priority will be to determine if the presence of a telemedicine video option during rounding changes clinician behavior in ways that compromise patient care. In particular, clinicians reacting out of fear of contracting a communicable disease may inappropriately reduce aspects of the daily inpatient physical exam and thereby miss clinically relevant findings that would shift the course of care. The components of an inpatient clinical encounter that can be appropriately captured via telemedicine versus in person are also poorly understood. The psychological impact on patients must also be explored, as the lack of regular physical human interaction may contribute to feelings of isolation and depression. Finally, the role of inpatient telemedicine as it relates to family and caregivers, including during end-of-life inpatient care, also needs attention.

Our experience is limited to the Northern California area, which was recognized as an early hot-spot for COVID-19 cases. We acknowledge the threat of an impending surge of COVID-19 cases contributed to high motivation across all levels of each organization to innovate, while the fact that this surge had not yet fully materialized gave us additional capacity to implement these innovations. Any early successes described here have much to do with circumstances beyond our control. This underscores the importance of future preparedness initiatives. Understanding the impact that inpatient telemedicine has on disease spread and material resources may inform health system planning to better prepare for future infectious and non-infectious use cases.

CONCLUSION

The COVID-19 pandemic has propelled the growth of telemedicine. The rapid deployment of a technology across multiple settings within a health system is a major undertaking. We note here the general success each institution had, despite different circumstances of legacy systems, hardware, software, patient population, and clinical workflows. Their experience shows that rapid deployment of inpatient telemedicine is feasible in diverse settings as a response to the COVID-19 pandemic. The newly developed systems were designed to reduce pathogen transmission and PPE-use, and facilitate ongoing health care personnel work participation despite home quarantine orders. Matching the technical configurations and programmatic deployment to local needs and resources facilitated progress towards those goals. While the role of inpatient telemedicine during the pandemic and beyond remains to be seen, it seems likely that inpatient telemedicine in some form is here to stay.

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CONFLICT OF INTERESTS

The authors report no conflicts of interest.

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AUTHOR CONTRIBUTIONS

S.V. and B.P. conceived of the presented idea. C.S., N.P., P.S., S.A. contributed to and supervised the findings. S.V., B.P., R.R. analyzed data. S.V. took the lead writing manuscript while B.P., W.C., M.H., E.S. authored subsections of the manuscript. All authors discussed the results and contributed to the final manuscript.

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