Chapter 11
Telemedicine in the Practice of Emergency Medicine: Telemergency

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Introduction

Rapid communication and consultation with advanced clinical specialists at the time of a medical emergency can potentially mean the difference between life and death. Telemedicine offers the promise of immediate connectivity to board-certified emergency physicians and other specialists in these acute circumstances. However, unlike other areas of telemedicine that focus on one type of specialty or medical condition, the broad nature of the practice of telemergency in the evaluation of the undifferentiated patient requires greater flexibility in engagement and has added challenges of timing and logistics. However, the growing volume of patients served and the great disparity in emergency care in many communities in the United States suggest that the use of telemedicine in the emergency department (ED) also presents a major opportunity for an impact on outcomes in the management of time-sensitive events.

What Is Telemergency?

A medical emergency is defined as an acute condition that without immediate intervention would result in the loss of life, limb, or a permanent disability. Almost every medical discipline from cardiology to dermatology has clinical scenarios in which such emergent interventions are required in a time-sensitive framework. While

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emergency physicians are trained to recognize and stabilize most common emergency conditions, specialists with advanced expertise are sometimes required to provide additional definitive care (e.g., cesarean delivery for an acute placenta abruption). While the resources and spectrum of specialties that are available at most large urban EDs allow for the state-of-the-art management of most emergency conditions, the lack of such means in rural and smaller community hospitals presents a significant challenge when they are presented with acute medical conditions [1]. Telemergency is a process in which the disparities in expertise typically found in smaller hospital EDs can be ameliorated through the use of telemedicine technologies, a team of trained and supported advanced practice providers, and robust clinical resources at a "hub" site responsible for provision of telemergency [2]. The recommended general components, structure, and process of practice for such a telemergency system is outlined in Text Box 11.1 and based on more than 15 years of experience at the University of Mississippi Medical Center (UMMC).

Text Box 11.1 Telemergency Medicine Standards and Guidelines

A physician practicing telemergency in a Level I or Level II Trauma Center and functioning in a collaborative/consultative role shall observe the following protocols and standards:

- Emergency medicine physicians –the emergency medicine physician practicing telemergency medicine and functioning in a collaborative/consultative role should be board-certified in emergency medicine
- Hub site emergency medicine physician staffing – the emergency department of the level i or level ii trauma center (the "hub site") shall be continually staffed, 24 hours a day, 7 days a week, with board-certified emergency medicine physician(s). The telemergency program shall have a medical director who is board-certified in emergency medicine and shall serve as the director of the advanced practice provider training program.
- Hub site availability of specialists — the emergency medicine physician shall have access to the on-site specialists who are normally available at a level i trauma center. These specialists shall include, but not be limited to: neonatologists, pediatric intensivists, obstetricians, and trauma surgeons. They should be available for a consult within 30 minutes.
- It staff – the hub site shall be supported by information technology (it) specialists who are available to proactively monitor, address, and resolve technical issues at both the hub site and distant sites. Prior to the initiation of telemergency medicine, the medical director of the telemergency program shall review and approve a plan for prompt it responses to technology issues and problems. Any page shall be answered in less than 10 minutes and unless there is a network outage, the problem shall be resolved in less than 4 hours.
- Telestroke services – the hub site shall be staffed with emergency medicine physicians who meet the requirement stated above, and who are able and willing to assess for and recommend time-critical medications (e.g.,

Thrombolysis) when appropriate. Additionally, the hub site shall have immediate availability of stroke specialists.
- Transportation resources – the hub site shall maintain adequate resources to transport a patient from any distant site to the hub site within 60 minutes, or to transport an emergency medicine physician to the patient, if necessary.
- It hardware/software – the telemergency technology shall include telehealth equipment with high resolution capability, far end camera control and peripheral devices (stethoscope, otoscope, dermascope). Internet bandwidth shall be sufficient to have a seamless audio/video experience.
- Training program for advanced practice providers – the medical director at the hub site or the physician who serves as chief quality officer at the level i or level ii trauma center shall review and approve a formal training program for advanced practice providers who staff the distant partner sites. This will be a formalized course of training specific to the practice of telemergency medicine that includes simulation, skills and practical training, didactic training, and hands-on practical rotations at the hub site. Additionally, the training program will include an annual skills assessment of advanced practice providers for clinical procedures (suturing, intubation, chest tube placement, etc.)
- Continuous quality improvement – the hub site shall monitor and regularly analyze data to ensure continuous quality improvement and consistent outcomes in telemergency medicine.

Why Is There a Need for Telemedicine in Emergency Medicine?

According to the US Centers for Disease Control (CDC), there are approximately 136 million ED visits in the United States each year [3]. Of these visits almost 40 million are injury related (29%). Additionally, more than 12 million (9%) of the overall patients are hospitalized for protracted management, and of these, 1.5 million are admitted to intensive care units (ICUs). Around 2.2% of patient visits result in a transfer to a hospital with higher levels of care. Most of these transfers are from rural and smaller community hospitals.

To provide further context, an analysis of healthcare workforce needs reported that 20% of the US population resides in a rural setting, while only 9% of the physician workforce lives and works in these same areas and a majority of these are primary care practitioners [4]. For emergency care, Carr et al. found that living in a rural area is "a key variable in access to ED care," and noted profound association between rurality and overall access to emergent care [5]. Nationally it has been noted that the demand for board-certified emergency medicine (EM) trained

physicians significantly exceeds the available supply [6]. So, as is the case with other specialists, rural hospitals struggle to recruit EM-trained physicians, with a large portion of ED care being provided by physicians trained in other specialties [7, 8]. In fact, the likelihood of receiving care from a board-certified emergency physician decreases fivefold as rurality increases [7, 8].

This is important because it has been demonstrated that both quality and timeliness of care with critical interventions is best achieved when emergency care is administered by EM board-certified physicians as compared to non-EM physicians [9–11]. The importance of this rural disparity is amplified when considering the numerous research studies that suggest that timely appropriate medical interventions are the critical determinant of outcomes in many emergent conditions such as ST-elevation myocardial infarctions (STEMI), traumatic shock, and acute ischemic stroke [12, 13]. Telemedicine support for non-specialist emergency providers practicing in rural and small community hospitals has been considered one potential pathway to improving the quality of emergency care in rural and underserved settings [2, 11].

History of Telemergency

The Telemergency Program at UMMC began as a pilot project with 3 hospitals in October 2003 [14]. The program was initially started with the assistance of private foundation funding acquired by Richard L. Summers, MD, and was conceptualized and organized by Robert L. Galli, MD, and Kristi Henderson, DNP, NP-BC [2, 14]. The program was born from a consensus within the UMMC Department of Emergency Medicine that there was a serious need to improve emergency care in Mississippi. At that time, UMMC frequently received poorly managed trauma and critical patients in transfer to our tertiary care ED from critical access hospitals in small rural communities where there were no physicians available with emergency expertise. Often these EDs were covered by local physicians who were also actively practicing in their clinics or they were being supported by nurse practitioners with a family medicine orientation. Recruiting board-certified EM physicians to cover these small EDs was financially unfeasible, but closure of these hospitals would place enormous burdens on their communities and require hours of travel to find the first available hospital for emergency services in already underserved population. Many other states confront similar issues.

We developed a strategy that combines EM-trained advanced practice providers and telemedicine connections to provide EM expertise to these struggling medical communities. Since 2003 the UMMC telemergency program has grown to include 17 rural hospital EDs and has serviced more than 600,000 patients in that 15-year period. With this system, we have assisted in leading cardiac resuscitations, delivering babies, and many other forms of acute care management in real time [11]. From this platform, we have launched air transport from the telemedicine

consultation room for emergency transports and sent an emergency physician to distant sites in a time of disaster. We also support telemedicine sites on oil rigs in the Gulf of Mexico for emergent consultations. Since this initial program, similar successful models for telemergency have developed in other locations throughout the United States.

State of the Practice of Telemergency

The Telemergency Practice Model

A telemergency system functions as a virtual ED on a 24/7 basis with a board-certified EM physician stationed in the telemedicine operations center ready to answer all incoming requests [2]. Experience has taught us that the operations center should be contiguous with the Hub's ED to best allow for the utilization of additional resources and expertise when needed. Emergency consultations are typically available for any patient who arrives at one of the partner sites as determined by the provider at that location. However, minor conditions often do not require consultation and can be handled locally. A mutually acceptable protocol with consulting criteria can help guide this decision-making with a requirement for engagement with the telemergency consulting service for all higher acuity patients [15]. Such a triaged practice allows for the telemergency system to accommodate multiple EDs at the same time, while oversight is provided through consultation with an EM specialist. Ancillary technical and information technology (IT) support is also required 24/7 for a successful program. Access to the local electronic health record, electrocardiography, and radiology platforms are all important pieces of a telemergency program as this broader information is often needed for the consultation. Any prospective model of telemergency should be compliant with state laws and consistent with the policies of the state board of medical licensure. An example of standards that are commonly utilized is included at the end of this chapter.

Role for the Advanced Practice Provider

While telemergency consultation services can be provided to any ED that is not staffed with an EM physician, it is often found that supporting a qualified advanced practice provider offers the best utilization of resources in small rural communities with few emergency visits [16]. It has been our experience that a program that provides some specialty training in emergency skills such as intubations and chest tube placements enables confidence and integrity for the system. The scope of practice determined for these providers should be in agreement with the state's medical licensure boards for medicine and nursing.

Criteria for Telemergency Consultation

It is important to establish workflows and specific criteria for consultation in any telemedicine system. The criteria currently used in our telemergency program at UMMC were developed over years of experience [2, 14, 16]. Initially, all patients were required to be treated and evaluated by both the advanced practice provider and the collaborating consultant EM physician through telemedicine. However, the experience of the program was that this comprehensive process was unwieldy in the evaluation of non-urgent patients and increased the wait time for minor complaints. We created a set of guidelines to identify specific patients whom the advanced practice providers could assess and treat primarily, as well as those patients requiring immediate consultation and transfer. These detailed guidelines are provided in Tables 11.1, 11.2, and 11.3 and are divided into 3 categories: (1) does not require consultation, (2) does require consultation, and (3) does require consultation and probable transfer. These categories are based on decision points of emergencies needing advanced expertise and also the potential need for transfer. While these guidelines serve as a baseline for telemergency consultation, they may not precisely cover every situation and clinical venue. Further research is needed to assess the risks and benefits of such guidelines and their implementation as well as potential adaptations to meet needs in other clinical contexts.

Telemedicine Equipment

Telemedicine equipment mounted on a mobile cart allows for two-way audio and visual communication between the patient or distant provider and the EM physician in the ED-based operations center. The technology allows for a remote, yet thorough exam including peripheral devices that enable the ability to auscultate the heart and lungs, and to examine the inner ear, nose, and skin. Technology can be utilized to complete any portion of the exams as if in-person except for those involving smell and touch. There are also mechanisms in place for the electronic downloading and surveillance of radiographic images, laboratory data, and electrocardiograms from the distant site.

Telemergency Business Models

The need for sustainable business models is pervasive in telehealth. For telemergency, there are two common business models that can achieve this goal: contractual services or fee-for-service. Presently, the simplest approach is to provide the service under a contractual arrangement with the hospital receiving telemergency services. Such an agreement could provide for a prespecified fee assessed for each documented tele-encounter or be a global charge for coverage on an hourly/daily/monthly basis. In our experience, a global charge approach is preferable since it empowers rural providers to have a low threshold for requesting a consult and

Table 11.1 Conditions that do not require telemergency consultation

Abdominal pain: stable vitals, no significant physical examination findings, age < 50 years
Allergic reactions not associated with shortness of breath, wheezing, or hypotension
Animal bites not involving the hand or face
Cerumen removal
Chronic peripheral vascular disease
Conjunctivitis
Constipation/diarrhea
Contact dermatitis
Dental pain
Dizziness: vital signs stable, no significant physical examination findings, age < 50 years
Fatigue without associated symptoms
Follow-up wound check, cast check, or suture removal
Foreign body removal (uncomplicated and not involving the eye)
Gastritis: suspected food poisoning, no associated dehydration with limited duration
Gynecologic disorders: vaginitis, insignificant abnormalities in menstruation, cramps
Hemorrhoids
Hypertension that is asymptomatic and accompanied by a diastolic pressure < 120 mm Hg
Incision and drainage of simple abscess not involving rectal area
Intravenous hydration/antibiotics >8 years old
Low back pain that is chronic and not associated with neurologic findings
Migraines: typical migraine, stable vital signs, afebrile, normal examination, no trauma
Minor burns
Minor eye injury: corneal abrasion
Minor lacerations or abrasions
Nausea/vomiting
Otitis media, otitis externa, ear pain >3 months old
Pharyngitis: no sign of abscess or airway compromise
Pregnancy without bleeding, pain
Prescription refills: non-narcotic or controlled substance until next business day
Puncture wounds not requiring exploration
Sexually transmitted diseases, excluding pelvic inflammatory disease
Skin rashes, pruritus
Sprains/strains
Swollen lymph nodes
Uncomplicated hepatitis or exposure to hepatitis
Upper respiratory infection, congestion, cough, flu
Urinary tract infections >6 months old
Work releases
Wound care
Any of the above conditions with the presence of a complex medical history or at the discretion of the nurse practitioner may require consultation.

Table 11.2 Conditions that require telemergency consultation

Abdominal pain: all patients with acute pain or >50 years old
Abnormal vital signs: SBP < 100 or >180 mm Hg, pulse rate <50 or >110 bpm, RR > 24 bpm, temperature >101.5 °F
Age <1 or >75 years (all patients)
Alcohol or drug withdrawals
Allergic reaction with shortness of breath, wheezing, or hypotension
Arrhythmias
Bleeding: significant bleeding from any orifice
Burns: any 3°; 2° >10% BSA; burns to face, hands, feet, perineum, electrical or inhalation
Chest pain: all patients
Coma or change in mental status
Complicated lacerations
Drug overdose
Fever, <6 months old
Fever and toxic appearance or of unknown origin, < 1 year old
Foreign body of the eye
Fractures with vascular impairment or displacement
Significant head trauma
Headache associated with neurologic findings, fever, or meningeal signs
Hypothermia, temperature <35 °C (95 °F); hyperthermia, temperature >40.5 °C (105 °F)
Hypertension: diastolic blood pressure of >120 mm Hg
Intravenous hydration/antibiotics in children <8 years old
Neurologic deficits
Severe pain management
Patient with complex medical history
Pelvic inflammatory disease
Postoperative-related problems
Postpartum pelvic pain
Pregnancy complications (i.e., abdominal pain, bleeding, fever)
Psychiatric patients with abnormal findings
Puncture wounds requiring exploration
Seizures
Shock
Shortness of breath
Sickle cell crisis
Testicular pain
Upper abdominal pain not clearly of gastrointestinal origin (possible cardiac)
Urinary tract infection/dysuria/hematuria in children <4 months old
Vaginal bleeding: saturation of full-size pad 1 or more per 2 hour
Any symptom that the provider is concerned about requires consultation *Any patient with the following laboratory tests ordered requires consultation:* *EKG, computed tomography scan, cardiac enzymes, lumbar puncture, cervical-spine X-rays.*

SBP systolic blood pressure, *bpm* beats per minute, *BSA* body surface area, *EKG* electrocardiogram

Table 11.3 Conditions that require telemergency consultation and probable transfer

Acute head injury
Advanced airway management: intubation
All resuscitations
Burn management
Dizziness with unstable vital signs
Multisystem trauma evaluation and resuscitation
Serious or complex medical emergencies (i.e., DKA)
Shock of any cause
Transfer of these patients should not be delayed because of the telemedicine consultation, but these consults should be used for the stabilization of these patients. Definitive treatment of these patients should not occur in the outlying emergency departments. Referral should be made to the closest appropriate facility capable of providing the services needed.

DKA diabetic ketoacidosis

mitigates the risk of missing patients who might benefit from telemergency consultation. The global model is also consistent with numerous medical professional contracts for conventional care in which the consultant is paid for "on call" time, thus ensuring availability even without utilization.

As healthcare systems grow and evolve, telehealth has become increasingly mainstream. Thus, third-party payers often reimburse for telehealth services, albeit with substantial variation at the state level and across commercial insurers. An important future direction is educating third-party payers with regard to the potential improvements in quality and cost associated with a telemergency program. Research regarding the changes in ED length of stay, tests ordered, transfers to other facilities, and general outcomes resulting from telemergency consultations will be important in providing evidence to obtain third-party payers' support.

Specific Clinical Scenarios and Telemergency

While telemergency services are intended to be broad and encompass all potential emergent conditions, there are at least four clinical contexts in emergency care that warrant further consideration. Sometimes an area of specialty expertise is needed that is beyond the typical scope of the consulting EM physician. Layering these specialty services on the backbone of a robust telemergency system is a practical solution to optimize certain specialty consults.

Telestroke

Treatment with thrombolytic therapy for the treatment of nonhemorrhagic acute stroke events substantially improves patient outcomes, and thus this emergency practice is standard of care in neurology. However, a national shortage of neurologists

has placed a strain on the stroke specialists providing oversight for this evaluation and treatment on a 24/7 basis. Since most acute stroke patients first present to an ED, there is a compounded burden placed on facilities where neurologists are not readily available to provide for management oversight. Telestroke programs in which a neurologist can remotely consult with underserved EDs through telemedicine technologies have become a mainstream solution [17]. However, the stroke neurology workforce is quickly becoming overwhelmed with the variety of potential stroke candidates and stroke mimics that are identified by the nonemergency personnel for neurology consultation in the rural and small community hospitals. A hybrid system integrates telestroke services on the backbone of an established telemergency program in which EM physician specialists first triage the patients from the perspective of an undifferentiated emergency and then connect the partner site to a stroke specialist video-conferenced into the telemedicine consultation when appropriate [18].

Telepsychiatry

Mental health services are currently in great demand throughout the United States. Because of inadequate access to mental health services, many mentally ill patients seek care in EDs. Telepsychiatry expertise in the assessment of these patients before transfer to an acute care setting can greatly facilitate the disposition of these patients and significantly reduce overutilization of acute care systems. Therefore, telepsychiatry is becoming one of the most important aspects of a telemergency system. While the telemergency specialists can provide for a triage with metabolic and toxicology screening for these patients, the system that has access to further input by psychiatric specialists has significant advantages for initial mental health stabilization and triage decision making among this vulnerable patient population.

Teletrauma

It is usually considered that rural communities experience proportionately similar amounts of trauma as urban centers though the types of trauma may differ. However, because the populations of these communities are so small, the total number of trauma patients coming to rural EDs is much less than that seen in urban centers [19]. As with any area of medical practice, a reduced number of overall trauma encounters limits the experience of these ED personnel in dealing with certain types of severe injuries. It is thought that a telemedicine-assisted evaluation of trauma patients provides for a more comprehensive assessment and management of these patients and facilitates early transfers [13]. This is particularly important for the most severely injured patients with time-sensitive conditions requiring surgical and/or specialty interventions.

The implementation of telemergency services in rural EDs in Mississippi was found by Duchesne et al. to improve the initial trauma evaluation and provide for more rapid transfer of severely injured patients to the trauma center [13]. This resulted in a significant overall reduction in mortality. Total hospital costs and lengths of stay were also reduced in this process. An analysis of trauma registry patients in North Dakota demonstrated decreases in length of ED stay for transferred trauma patients, with an implication of improved evaluations for those patients who were not transferred. However, this analysis noted that there was not an overall decrease in the transfer rate for trauma patients from the rural hospitals in which telemedicine was being utilized. This is not unexpected as it is usually the most severely injured patients who are transferred regardless of the capacity for evaluation by the local ED and due to lack of available advanced specialty services such as orthopedics or plastic surgery in rural settings. Perhaps the greatest benefit of connectivity to a telemergency system for trauma and other time-sensitive conditions is that if helicopter or other transfer transport is required, there is more immediate access to the Level I facility for acceptance of the patient and making the transfer arrangement.

Critical Care Support Through Telemedicine

Timely, quality care in life-threatening conditions is particularly challenging in rural areas due to the lack of specialty services and advanced experience in managing critical illness (Sterling SA. Critical Care Utilization in TelEmergency. Society of Academic Emergency Medicine abstract: in submission.) This consideration has been a major driver for the adoption of telemergency services among rural hospitals. A standardized approach to guiding any engagement with specialists through telemergency (as outlined in Tables 11.1, 11.2, and 11.3) is important to providing safe quality care.

In a recent analysis of 3946 consults in a mature telemergency program, 13.5% of the consults had ≥1 critical care diagnoses [20]. The top four critical care diagnoses were as follows: significant traumatic injury (16.9%), cardiopulmonary arrest (CPA 15.8%), myocardial infarction (15.6%), and cerebrovascular accident (10.9%). An inter-hospital occurred for 79.3% of the telemergency consults, with the outcome of death in the ED in 12.6% of the cases. Transfer hospital data show a median transfer distance of 62.3 miles with an estimated transfer time of 60 minutes by ground transport. These data support the implicit need for telemergency services among rural hospitals.

With regard to CPA specifically, a recent report by Summers et al. compared survival between urban patients with CPA managed via standard ED code teams and those in rural hospitals managed via telemedicine, and found no statistically significant difference between the groups. Of the 459 urban patient records examined, 114 patients survived (24.8%) CPA as compared to the 8 of 39 total rural patients (20.5%) [21]. These findings suggest that resuscitation guided by telemedicine

consultation with emergency specialists can achieve survival rates among rural patients with CPA comparable to those of urban hospitals. Thus, narrowing the gap between the level of care found in rural and urban hospitals should be a major goal of any telemergency program.

EMS and Telemedicine

There are a variety of innovative possibilities for using telemedicine technologies in the prehospital setting [22]. As concerns for early differentiation, emergent treatment and appropriate routing of patients become more important for conditions such as stroke and trauma, a deeper engagement of EMS personnel with emergency experts will be important. In rural settings, the transport of critical individuals to advanced care centers may take longer than the typical "golden hour" considered for these patients [23]. Audiovisual and other electronic connectivity of telemergency support services to ambulances may provide life-saving decision support.

Epidemics, Bioterrorism, and Disaster Telemedicine

Emergent public health epidemics and bioterrorism attacks may first appear as sentinel events in the ED environments. Syndromic biosurveillance attached to telemergency services can provide a means for the early detection and response to these events [24]. In times of a major disaster, it is also often difficult to provide timely specialty expertise to the scene of the event [25]. Telemergency support has already been found to be useful in our program during disaster circumstances such as post-natural disaster medical support (e.g., hurricane and tornado) and during a Gulf of Mexico oil spill disaster. We may also see the future implementation of drone and GPS technologies in prehospital settings to support the response to telemergency disaster management.

Future of Telemergency

The future of telemedicine in general is one of rapid growth and dramatic changes in the landscape of healthcare enabled by significant advances in technology. There are many possibilities surrounding augmented reality instruments, remote-controlled robots, drones, and numerous other emerging technologies. Augmented reality is the use of computer-generated perceptual information in an immersive interactive experience in order to enhance the conditions and components of the real-world environment. The interactions can occur across multiple sensory modalities and could include visual, auditory, haptic, somatosensory, and olfactory experiences. Since a

large part of the practice of medicine includes the skill of the physical examination, platforms that augment the telemedicine experience can provide valuable additional sensory information regarding the patient's condition to the teleprovider. For instance, if the emergency physician or surgeon providing the telemergency service can virtually palpate the abdomen through augmented technology to determine the characteristics of relative rigidity and tenderness, this may enable better management decisions and resultant impacts on triage decisions and related outcomes. Augmented reality technologies are rapidly being developed for military and entertainment uses. There is an expectation that they will also find uses in the practice of telemedicine. Since medical emergencies require time-sensitive decision-making, these innovations may find their greatest impact in the arena of telemergency.

Research in Telemergency

Telemedicine will likely be key to the survival of the rural and small community practice of EM. While we can make intuitive conclusions concerning the impact of these changes on patient outcomes, objective research will be critically important to validate the methods and practice of telemedicine. The two greatest challenges to doing robust outcomes-based research in telemergency are the episodic nature of the ED patient-physician relationship and the problems associated with complete data capture for the encounter across two distinct and distant locations [26]. The nearly ubiquitous utilization of electronic health records and the development of statewide health information exchange networks will greatly facilitate patient encounter data capture in the future.

Operational Metrics

Additional evidence supporting the value of the practice of telemergency on ED and hospital operational metrics continues to emerge. An analysis of data from our telemergency systems has demonstrated significant 20.1% increase in inpatient admissions locally at the rural facility and a 10.9% increase in appropriate patient transfers to a hospital with a higher level of care or specialty care unavailable at the rural hospital [11, 27]. The median change in death prevalence rates decreased 3.7% ($p = 0.88$), and there was a significant decrease in the prevalence rate of those who left without treatment (LWT) or left against medical advice (AMA) after a telemergency program implementation.

An evaluation of the routine use of the telemedicine system revealed that more than 54% of the rural providers used the telemedicine system for an audio/visual consultation every shift and more than 91% collaborated with the telemergency physician multiple times during their shift. This constant physician availability

through telemedicine increased the frequency of consultations by 86.4% during the evaluation period. The nurse practitioners were comfortable with the use of the equipment (100%), and all were satisfied or very satisfied with the telemergency program. Operational and satisfaction metrics are important for the continued support of telemergency programs and should be routinely tracked.

Teleconsenting

The ED is often a point of recruitment for clinical research studies [28]. Teleconsenting allows a researcher to remotely video conference with a potential study participant and guide them through the informed consent document, going step-by-step until all required documentation is complete. Although teleconsenting is not meant to be used as the sole mode of enrollment for studies, it is a useful tool in a clinical researcher's recruitment arsenal, and can help overcome difficulties in meeting study number enrollment and diversity goals, particularly in rare disease cohorts. With the advent of new technology including free, secure sites such as doxy.me and the vast majority of US adults (77%) now owning smartphones, teleconsenting can take place in some of the most geographically remote locations such as rural EDs, saving researchers' time, decreasing study costs, and bringing forth valuable scientific developments more rapidly. Randomized, controlled trials show that participants are just as satisfied, in some cases more so, with the experience of teleconsenting, and have practically identical levels of research consent comprehension compared to standard face-to-face consenting [28, 29]. Teleconsenting will help advance research by increasing the potential reach of researchers without increasing costs, thereby aiding in recruitment and increasing inclusivity, diversity, and study power, while conserving regulatory requirements and participant satisfaction and comprehension.

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