

UCSF

UC San Francisco Previously Published Works

Title

The role of telehealth in pediatric emergency care

Permalink

<https://escholarship.org/uc/item/55v6406z>

Journal

Journal of the American College of Emergency Physicians Open, 4(3)

ISSN

2688-1152

Authors

Saidinejad, Mohsen

Barata, Isabel

Foster, Ashley

et al.

Publication Date

2023-06-01

DOI

10.1002/emp2.12952

Copyright Information

This work is made available under the terms of a Creative Commons Attribution-NonCommercial-NoDerivatives License, available at


<https://creativecommons.org/licenses/by-nc-nd/4.0/>

Peer reviewed

SPECIAL CONTRIBUTION

Pediatrics

The role of telehealth in pediatric emergency care

Mohsen Saidinejad MD, MS^{1,2}  | Isabel Barata MD, MS³ | Ashley Foster MD⁴ | Timothy K. Ruttan MD⁵ | Muhammad Waseem MD^{6,7} | Douglas K. Holtzman MD⁸ | Lee S. Benjamin MD⁹ | Sam Shahid MBBS, MPH¹⁰ | Kathleen Berg MD⁵ | Dina Wallin MD¹¹ | Shireen M. Atabaki MD, MPH¹² | Madeline M. Joseph MD¹³ | On behalf of the ACEP Pediatric Emergency Medicine Committee¹

¹The Lundquist Institute for Biomedical Innovation at Harbor UCLA, Torrance, California, USA

²David Geffen School of Medicine at UCLA, Los Angeles, California, USA

³Donald and Barbara Zucker School of Medicine at Hofstra/Northwell, Northwell Health, Manhasset, New York, USA

⁴Harvard Medical School, Massachusetts General Hospital, Boston, Massachusetts, USA

⁵Dell Medical School at the University of Texas, Austin, Texas, USA

⁶Lincoln Medical Center, Bronx, New York, USA

⁷Weill Cornell Medicine, New York, USA

⁸Summerville Medical Center, Summerville, South Carolina, USA

⁹Trinity Health St. Joseph Medical Center, Ann Arbor, Michigan, USA

¹⁰American College of Emergency Physicians, Irving, Texas, USA

¹¹University of California, San Francisco, San Francisco, California, USA

¹²The George Washington University, School of Medicine, Children's National Hospital, Washington, District of Columbia, USA

¹³University of Florida, Jacksonville, Florida, USA

Correspondence

Mohsen Saidinejad, MD, MS, The Lundquist Institute for Biomedical Innovation at Harbor UCLA, David Geffen School of Medicine, Torrance, California, USA
Email: mohsenmd@gmail.com

Funding and support: By *JACEP Open* policy, all authors are required to disclose any and all commercial, financial, and other relationships in anyway related to the subject of this article as per ICMJE conflict of interest guidelines (see www.icmje.org). The authors have stated that no such relationships exist.

Abstract

In 2006, the Institute of Medicine published a report titled “Emergency Care for Children: Growing Pains,” in which it described pediatric emergency care as uneven at best. Since then, telehealth has emerged as one of the great equalizers in care of children, particularly for those in rural and underresourced communities. Clinicians in these settings may lack pediatric-specific specialization or experience in caring for critically ill or injured children. Telehealth consultation can provide timely and safe management for many medical problems in children and can prevent many unnecessary and often long transport to a pediatric center while avoiding delays in care, especially for time-sensitive and acute interventions. Telehealth is an important component of pediatric readiness of hospitals and is a valuable tool in facilitating health care access in low resourced and critical access areas. This paper provides an overview of meaningful applications of telehealth programs in pediatric emergency medicine, discusses

Supervising Editor: Henry Wang, MD, MS.

This is an open access article under the terms of the [Creative Commons Attribution-NonCommercial-NoDerivs](https://creativecommons.org/licenses/by-nc-nd/4.0/) License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2023 The Authors. *JACEP Open* published by Wiley Periodicals LLC on behalf of American College of Emergency Physicians.

the impact of the COVID-19 pandemic on these services, and highlights challenges in setting up, adopting, and maintaining telehealth services.

KEYWORDS

COVID-19, patient portal, pediatric emergency medicine, pediatric telehealth, tele-consultation, tele-psychiatry, virtual visit

1 | INTRODUCTION

Shortages in the pediatric health care workforce continue to affect the care that children receive in the United States. In addition to this, significant disparities exist in the quality of care that children in rural and in low-resource urban areas receive.¹ Several factors contribute to this, including an increase in the number of children with chronic conditions and technology dependence, lack of adequate compensation and incentives for primary care pediatricians, and underdeveloped infrastructure for pediatric care outside of large urban pediatric medical centers. Telehealth encompasses the provision of health care via telecommunication and information technologies, including clinical care and education services.² It provides an excellent opportunity to optimize current resources in providing more equitable care, regardless of geography.³

Although the overall structure and process of telehealth are similar between adult and pediatrics, the epidemiology and potential impact of telehealth are different for children. A great majority of critically ill and injured children present to general emergency departments (ED), where timely access to expertise and pediatric-specific experience is less available.⁴ To ensure good health care outcomes for these children, access to specialists through telehealth is critical in bridging the health care gap in rural and low-resourced areas. During COVID, pediatric specialists temporarily expanded their scope of practice age limit, which affected telehealth services.⁵

We provide an overview of the role of telehealth in pediatric emergency care.

2 | HISTORY OF TELEHEALTH

Telehealth has been in use for many years. The American Recovery and Reinvestment Act⁶ and Health Information Technology for Economic and Clinical Health⁷ acts of 2009 helped accelerate the advancement of technology and Internet-connected health. Shortly thereafter, the Meaningful Use Act and the Affordable Care Act⁸ accelerated the use of digital health care in the United States. In 2016, Centers for Medicare and Medicaid Services began allowing payment for telehealth services, including services to rural health care centers.⁹ The COVID-19 pandemic¹⁰ further accelerated telehealth use and payment through the COVID Aid, Relief, and Economic Security Act.

The American Academy of Pediatrics section on Telehealth Care and the American Telemedicine Association describe pediatric telehealth use for long-distance education (tele-education),^{11,12} remote special-

ist consultations (tele-consultation),¹² and clinician-to-clinician and clinicians-to-patient communication (tele-practice).^{11,13,14} Impactful use of telehealth in neonatology and chronic care have also been described.¹⁵ Additionally, telehealth has been used to remotely recruit children for research studies.¹⁶ The COVID-19 pandemic caused a surge in video-based pediatric virtual office visits, allowing telehealth clinicians to engage in timely and definitive routine as well as follow-up care for children during the “stay in home” orders.¹⁷

3 | TELEHEALTH IN PEDIATRIC EMERGENCY MEDICINE

Telehealth provides timely and efficient access to pediatric specialists in managing children with complex chronic and acute care problems. Although the elements and the process of creating a telehealth system are similar in adult medicine and pediatrics, telehealth is particularly impactful in bringing pediatric-specific expertise to bedside in rural and low resourced areas, where these skills and expertise are not immediately available. This includes children who are technology dependent, as well as children with high medical complexity. Telehealth in these situations accelerates assessment and care, reduces cost and need for unanticipated hospitalization, and significantly improves patient and family experience.¹⁸ Some of the examples of how telehealth can overcome health disparities and inequities include the following.

3.1 | Prehospital transport

Timely access to specialists to help facilitate transport decisions significantly improves care, reduces costs, and increases staff and patient safety.¹⁹ When a distant general hospital seeks to transport a child requiring specialty care to another facility, a pediatric specialist at the destination hospital can remotely provide advice, including assistance with transport logistics and specific care needs during the interfacility transport.

3.2 | Tele-triage

A pediatric specialist can use video or phone telehealth triage and assess for acuity and level of service needed for infants and children. Data show that remote triaging has great concordance with in-person triage.²⁰ On-site tele-triage also helps reduce ED wait times for children whose level of illness can be underestimated. Despite its

advantage, until the COVID-19 pandemic, the use of tele-triage in pediatrics was limited.²¹

3.3 | Tele-consultation

General EDs transfer children more often than adults, due to less availability of pediatric specialists and lack of comfort and experience with ill children.^{22–25} Tele-consultation has great impact in diagnosing skin rashes and respiratory illness, as well as determination of intervention need (lacerations, fractures). Tele-consultation also provides great value in hospital destination decisions for trauma, complex medical problems, and psychiatric care.^{26–29} The interobserver reliability of tele-consultation compared to in-person assessment is 80%–100%.^{26,28,29} Telehealth has helped decrease school absenteeism from minor illnesses.^{30–32} Other uses of tele-consulting include patient follow-up,³³ electrocardiogram (ECG) interpretation,³⁴ and review of radiographic images.^{35–38} With COVID-19 travel restrictions, telehealth has become a vital alternative to an in person visit.³⁹ Health care systems have accelerated telehealth for screening, triage,⁴⁰ diagnosis, treatment, and ED follow-up of children.⁴¹

3.4 | Telehealth for child and adolescent psychiatry (tele-psychiatry)

Given the severe national shortage of pediatric mental health professionals⁴² and significant disparities in timely access to a trained and licensed child psychiatry professional, tele-psychiatry has been transformative in bridging this gap at a level that would otherwise have not been possible. Video tele-psychiatry provides an effective and cost-efficient way for EDs to consult with a psychiatry specialist at a distant site. One of the most important uses of tele-psychiatry is screening for suicidality in children and adolescents. Currently, suicide is the second leading cause of death in children aged 10–14 years.⁴³ Prevalence of pediatric suicide is particularly high in rural and critical access areas, where access to a mental health professional is extremely limited.⁴⁴ Ability to provide timely screening and assessment for a child who is at high risk of suicide is critical, and availability of a telehealth program can be the difference between life and death in many cases.

3.5 | Telehealth for sexual abuse/assault evaluation

Telehealth provides a vital remote link to a child abuse expert consultant to help EDs with recognition of signs of abuse, proper examination, timely evidence collection, and appropriate documentation in real time, before transfer to a tertiary center, reducing patient anxiety at a vulnerable moment.⁴⁵

3.6 | Tele-practice

Distance communication including paramedic base station contact and clinician-to-patient communication has been critical to increas-

ing the quality and timeliness of care and improving pediatric care outcomes. It has also reduced medication dosing errors.^{46,47} Remote monitoring (tele-monitoring) has facilitated data sharing for time-sensitive conditions such as cardiac arrhythmias, seizure events, and respiratory distress, by alerting receiving facility clinicians of a potential emergency.^{48–52} Telehealth allows assisting with decisions related to airway and oxygen therapy, intravenous fluid administration, antimicrobial recommendations, interpretation of laboratory results, and other life-saving interventions via a remote video monitor. In addition to this, tele-practice in primary care pediatrics has also experienced an increase in use, as numerous in-person pediatrician visits were canceled due to COVID-19 safety precautions. With clinics closed, many children received vital health maintenance visits by telehealth.

3.7 | Telehealth regionalized care support

Telehealth can connect trauma expertise from regional pediatric trauma centers to rural and low-resource EDs⁵³ leading to reduced diagnostic and medication errors.⁵⁴ Telehealth can also assist with timely and effective local pediatric trauma and burn care, as well as determination of need for interfacility transport. Similarly, a remotely located pediatric specialist can provide help with managing children with complex care needs, including care of technology-dependent children and complex metabolic and genetic conditions. at a distant ED, decreasing unnecessary transfers, and reducing morbidity and mortality.^{55,56}

3.8 | Tele-learning

Bringing scientific evidence to community and rural practice through tele-education, such as Project ECHO (Extension for Community Health Outcome) helps disseminate best practices and improves clinical care confidence and experience.⁵⁷ The great majority of ill and injured children present to community EDs with low pediatric volumes and less familiarity and comfort with pediatric care in such settings.⁴ Telehealth education is an important mechanism to disseminate pediatric-specific best practices to these community EDs. In addition to this, the use of telehealth for ED aftercare education for children is also increasing in prevalence,^{58–61} as are virtual reality gaming, simulation, video conferencing, and interactive learning modules.^{62–66}

4 | ADDITIONAL APPLICATIONS OF TELEHEALTH IN PEDIATRIC EMERGENCY MEDICINE

Telehealth can address specialist shortages by leveraging centralized assets for rural and low resourced communities. A single pediatric emergency medicine (PEM) subspecialist from the “hub” tertiary pediatric hospital can conduct patient assessment and initiate treatment

TABLE 1 Practice of telehealth: Clinicians, nurses, and patients.

| Health Care Clinician | Role |
|---|---|
| <i>Physicians</i> <ul style="list-style-type: none"> • Primary care pediatricians • Pediatric emergency physicians • Pediatric specialists and sub-specialists | <ul style="list-style-type: none"> • Provide a telephone or video visit • Provide consultation and determine need for transfer to another facility • Provide online specialty care recommendations |
| <i>Advanced practice practitioners (APPs)</i> <ul style="list-style-type: none"> • Nurse practitioners (NPs) • Physician assistants (PAs) | <ul style="list-style-type: none"> • NP: can initiate a consultation, give medical advice, order labs, write prescriptions, and interpret most imaging and tests. • PA: practice parameters are approved by the PA licensing board, and scope of practice may vary greatly by state |
| <i>Nurses (RNs)</i> | <ul style="list-style-type: none"> • Tele-triage • Preoperative and preprocedural patient check-in; discussion of discharge or admission instructions • Post-visit follow-up and appointment reminders • Home monitoring, tele-triage |
| <i>Patients and their caregivers</i> | <ul style="list-style-type: none"> • Initiate appointments and consultations. • Request medication refills • Initiate virtual visits |

of a patient at a remote facility (the “spoke”).⁶⁷ Prearranged agreements between the hub and a spoke hospital improve access to care⁶⁸ and eliminate unnecessary transport.⁶⁹ Telehealth can also provide for simultaneous involvement of a team of clinicians in patient care. A video telehealth consultation allows the specialist to better visualize and evaluate the patient,⁷⁰ which improves diagnostic accuracy. Telehealth visits can be integrated into the child’s electronic medical record (EMR) for billing and medico-legal purposes and can be provided various health care clinicians and even patients and families (Table 1). Telehealth empowers patients to be more engaged in their own health care. EMR patient portals allow patients not only to access their own health records but can allow communication with health care team, appointment scheduling, and medication request. A specific consideration for children and adolescents of the age of assent is information privacy and ability to determine and limit access by a proxy (caregiver), for issues that are protected by state and federal law. Lastly, telehealth is a valuable tool for educating trainees as well as patients and caregivers.⁷¹

4.1 | Infrastructure needed for implementation of telehealth in pediatric emergency medicine

It is critical to support the initial cost of equipment setup, connectivity, software and hardware maintenance, payment for service, and credentialing across health care facilities and local, state, and national boundaries. Understanding the benefits of telehealth in improving safety and quality of health care, particularly in rural and low-resourced communities, will help with overcoming some of the barriers to telehealth implementation including cost. In addition, it is important to engage clinicians and nurses in performing new work modalities and to look for best practices to better integrate telehealth into their daily ED operations. Providing adequate resources to avoid

ED workflow interruptions⁷² is very important in the implementation of telehealth and to avoid clinicians seeing telehealth technology as complicated and overwhelming.^{73,74} Dedicated staffing and correct billing for telehealth are needed to generate payment to be able to provide such services. In addition, children and families may see in-person encounters as having higher value than telehealth visits.⁷⁵ Therefore, educating families about the benefits and appropriate use of telehealth in PEM is very important for ensuring patient satisfaction.

Optimizing billing for telehealth services provided by pediatric specialists and subspecialists is important as telehealth may be seen as a potential lost revenue⁷⁶ for clinicians whose compensation is based on relative value units, where in-person patient care may generate a higher compensation. This potential barrier must be addressed preemptively during the rollout of a telehealth program, contemplating alternative ways to reward effective telehealth use. Similarly, a perceived lack of incentive to integrate telehealth into practice among health care team members can affect buy-in⁷⁷⁻⁸⁰ and, as with patients and families, can be addressed with education on the myriad of proven benefits of telehealth.

Another consideration for telehealth is the age limit that defines subject matter expertise for pediatrics. In 1988, the American Board of Pediatrics (ABP) published a statement making the upper age limit for a pediatric patient 21 years.⁸¹ This statement was reaffirmed in 2012, but in recognizing this to be an arbitrary number, it allowed for exceptions for ABP-certified pediatricians to care for young adults over 21 years when the physician and family agree. Examples include special needs and complex care patients, as the number of these patients who grow to be adults is increasing. Payors as well as various practices in each state also set age limits, which affects telehealth practice. In making the decision to extend pediatric care beyond 21 years, the agreement of the family, the physical and psychological needs of the patient, and the ability for

the pediatric telehealth clinicians to meet these needs should be considered.⁸²

4.2 | Future directions and research gaps

Although pediatric telehealth has transformed patient care resources in the community, many research questions remain to be answered. Whether access to telehealth and dissemination of best practice resources in the community translates into better pediatric care practices and ultimately patient care outcomes is still not well understood. Further research is needed to assess the ongoing impact of telehealth services and direct impact and improved equity in care outcomes in the community, particularly where in rural and low-resourced communities with disparities in pediatric care.

4.3 | Summary of telehealth considerations

Important considerations in pediatric emergency telehealth include the following:

1. Although most critically ill children present to non-pediatric hospital EDs, many of the clinicians and staff at these hospitals do not feel comfortable caring for these patients and in many cases lack adequate space, resources, and pediatric-specific training needed to provide effective and timely care. This often leads to unnecessary transfers and delays in ultimate care.
2. Telehealth is a valuable resource for timely triage, history and a limited physical exam, and initial assessment and treatment for acutely ill or injured children in the community where pediatric expertise and specialty services are limited. Telehealth brings the pediatric expertise to remote locations where it is needed for care of many children who have complex medical and trauma care needs, including technology-dependent children and those with chronic medical problems.
3. Tele-consultation, particularly tele-psychiatry is vital in timely screening and assessment of a child with suicidal ideation. Given the extreme shortage of pediatric mental health professionals, prearranged telehealth service agreements are critical in the community, where ED clinicians lack space and resources to identify high-risk patients and those who require urgent mental health services.
4. Regional and local agreements with emergency medical services for children and base station communication about destination decision and coordination of transport for a child requiring urgent treatment at a pediatric ED must be preestablished.
5. Pediatric telehealth practice requires several unique elements, including determination of pediatric age criteria as defined by state medical boards, medical licensing authority, and local laws. Additional attention must be paid to pediatric medico-legal considerations, including privacy rights, assent, and data security for sensitive medical information. This type of patient bill of

rights is critically important when providing pediatric telehealth services.

5 | CONCLUSION

Telehealth plays a critical role in filling the gap in care for acutely ill and injured children in the community, bringing much needed pediatric specialists virtually to rural and areas with low resources and allowing timely, effective, and patient-centered care to areas where such expertise is lacking. PEM telehealth has expanded over the last decade and substantially accelerated during COVID-19 pandemic. Credentialing, connectivity, data privacy, and payment are significant barriers to wide-scale adoption of telehealth, although with shortages in pediatric subspecialists in communities and widening disparities in quality of care, telehealth is essential in providing safe and equitable emergent care for acutely ill or injured children. Boxes 1–5 provide examples of specific applications of pediatric telehealth.

Case examples of the breadth of pediatric telehealth services

Box 1: Example case of base physician determination of most suitable destination of care

A 5-year-old female with paramedic-estimated 20% body surface area burn is being transported by emergency medical services. The paramedic team calls from the scene to the base station ED. The receiving base station is not a pediatric burn center, but the transport to the urban pediatric burn center is approximately 18 miles away. Base physician asks the paramedic to securely transmit pictures of the burn and determines whether the additional transport time to the pediatric burn center is reasonable.

Box 2: Video tele-triage to provide screening and treatment of low acuity patients in the ED

With a recent surge in pediatric respiratory viral illness, local EDs are facing a crisis in space and resources to care for children. One local ED is considering a video tele-triage system, where low acuity patients can be screened, treated, and released. Candidates for low acuity triage include children who have an emergency severity index score of 4 or 5, who are 2 years or older, and who have no underlying chronic medical conditions.

Box 3: Pediatric telepsychiatry for timely initiation of assessment and treatment

An adolescent presents to a community ED with suicidal ideation and a plan to overdose. She has no prior psychiatric diagnosis and is not currently taking any medications. Although she sees a therapist weekly through school for feeling depressed, the wait time for her region's only pediatric psychiatrist is over 6 months. Children typically wait 3–14 days in this ED to be transferred to inpatient psychiatric facilities that treat pediatric patients. She is calm and cooperative in the ED, and her parents appreciate the gravity of the situation. The emergency physician would like to consult with a pediatric psychiatrist by telehealth for evaluation and potential initiation of treatment.

Box 4: Telehealth for remote consultation to a pediatric specialist for critical care

A rural community ED with a pediatric daily volume of 5–10 children has a standing consult and transfer agreement with a regional children's hospital approximately 150 miles away. On a cold winter evening, a toddler in significant respiratory distress is brought to the rural ED by the parents. The ED staff is extremely concerned that the child needs specialty care immediately and plans for endotracheal intubation. The ED clinician also video conferences with the PEM physician at the children's hospital requesting endotracheal intubation and transport.

Box 5: Telehealth for participation in a regional or national pediatric quality improvement collaborative

A rural ED has identified an improvement opportunity for management of children needing painful procedures. The ED currently does not have a pediatric anxiolysis or sedation policy. The ED identifies a small team to join a national collaborative on pediatric painful procedure management in the general and low pediatric volume EDs. Pediatric pain and sedation experts and PEM physicians assist teams in building a procedural sedation checklist and developing training and education material. All training sessions, including live webinars, virtual office hours, and individual coaching sessions, are provided by telehealth. The goal of this collaborative is to help build a standardized pediatric painful procedure management tool, informed by best practices and subject matter experts.

AUTHOR CONTRIBUTIONS

Each author listed in this manuscript has provided sufficient input in terms of literature review, content writing, editing, and meeting attendance to be eligible to be listed as author in this manuscript.

ACKNOWLEDGMENTS

We would like to thank and acknowledge the contribution of the American College of Emergency Physicians Telehealth Section, and the review and feedback by Dr. Aditi Joshi, chair of the ACEP Telehealth Section, and Dr. Joyce Li, member of the ACEP Pediatric Emergency Medicine Committee, for reviewing and providing feedback on this manuscript.

CONFLICT OF INTEREST STATEMENT

None of the authors have any conflict of interest to declare.

ORCID

Mohsen Saidinejad MD, MS  <https://orcid.org/0000-0002-4782-0597>

REFERENCES

1. Basco WT, Rimsza ME. Pediatrician workforce policy statement. *Pediatrics*. 2013;132(2):390-397.
2. Sikka N, Gross H, Joshi AU, et al. Defining emergency telehealth. *J Telemed Telecare*. 2019;1357633x19891653.
3. Marcin JP, Rimsza ME, Moskowitz WB. The use of telemedicine to address access and physician workforce shortages. *Pediatrics*. 2015;136(1):202-209.
4. Gausche-Hill M, Ely M, Schmuhl P, et al. A national assessment of pediatric readiness of emergency departments. *JAMA Pediatr*. 2015;169(6):527-534.
5. Somekh I, Somech R, Pettoello-Mantovani M, et al. Changes in routine pediatric practice in light of coronavirus 2019 (COVID-19). *J Pediatr*. 2020;224:190-193.
6. American Recovery And Reinvestment Act of 2009: Law, Explanation and Analysis: P.L. 111-5, as Signed by the President on February 17, 2009. Chicago, Ill.: CCH; 2009.
7. Recovery Act-Funded Programs Archived 2013-05-14 at the Wayback Machine. Information Technology (IT) section Archived 2013-05-14 at the Wayback Machine, also known as HIT. HHS.gov/Recovery; 2009.
8. Oberlander J. Long time coming: why health reform finally passed. *Health Aff (Millwood)*. 2010;29(6):1112-1116.
9. CMS Rural Health Strategy. May 8, 2018. Accessed March 26, 2023. <https://www.cms.gov/About-CMS/Agency-Information/OMH/Downloads/Rural-Strategy-2018.pdf>
10. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. *JAMA*. 2020;323(13):1239-1242.
11. Doolittle GC, Spaulding AO, Williams AR. The decreasing cost of telemedicine and telehealth. *Telemed J E Health*. 2011;17(9):671-675.
12. Munoz RA, Burbano NH, Motoa MV, et al. Telemedicine in pediatric cardiac critical care. *Telemed J E Health*. 2012;18(2):132-136.
13. Hall-Barrow J, Hall RW. Telemedicine and neonatal regionalization of care - ensuring that the right baby gets to the right nursery. *Pediatr Ann*. 2009;38(10):557-561.
14. Lim D, Oakley AM, Rademaker M. Better, sooner, more convenient: a successful teledermoscopy service. *Australas J Dermatol*. 2012;53(1):22-25.

15. Marcin JP, Nesbitt TS, Kallas HJ, et al. Use of telemedicine to provide pediatric critical care inpatient consultations to underserved rural Northern California. *J Pediatr*. 2004;144(3):375-380.
16. González-Espada WJ, Hall-Barrow J, Hall RW, et al. Achieving success connecting academic and practicing clinicians through telemedicine. *Pediatrics*. 2009;123(3):e476-e483.
17. Curfman AL, Hackell JM, Herendeen NE, et al. Telehealth: improving access to and quality of pediatric health care. *Pediatrics*. 2021;148(3).
18. Ferro F, Tozzi AE, Erba I, et al. Impact of telemedicine on health outcomes in children with medical complexity: an integrative review. *Eur J Pediatr*. 2021;180(8):2389-2400.
19. de la Piedra A, Braeken A, Touhafi A, et al. Secure event logging in sensor networks. *Comput Math Appl*. 2013;65(5):762-773.
20. Beyer A, Moon K, Penndorf P, et al. Triage through telemedicine in paediatric emergency care-Results of a concordance study. *PLoS One*. 2022;17(5):e0269058.
21. Brova M, Boggs KM, Zachrisson KS, et al. Pediatric telemedicine use in United States Emergency Departments. *Acad Emerg Med*. 2018;25(12):1427-1432.
22. Jindal A, Velmahos GC, Rofougaran R. Computed tomography for evaluation of mild to moderate pediatric trauma: are we overusing it? *World J Surg*. 2002;26(1):13-16.
23. Li J, Monuteaux MC, Bachur RG. Interfacility transfers of noncritically ill children to academic pediatric emergency departments. *Pediatrics*. 2012;130(1):83-92.
24. Osen HB, Bass RR, Abdullah F, et al. Rapid discharge after transfer: risk factors, incidence, and implications for trauma systems. *J Trauma*. 2010;69(3):602-606.
25. Pillai SB, Bethel CA, Besner GE, et al. Fall injuries in the pediatric population: safer and most cost-effective management. *J Trauma*. 2000;48(6):1048-1050. discussion 50-1.
26. Farook SA, Davis AK, Sadiq Z, et al. A retrospective study of the influence of telemedicine in the management of pediatric facial lacerations. *Pediatr Emerg Care*. 2013;29(8):912-915.
27. Heffner VA, Lyon VB, Brousseau DC, et al. Store-and-forward teledermatology versus in-person visits: a comparison in pediatric teledermatology clinic. *J Am Acad Dermatol*. 2009;60(6):956-961.
28. McConnochie KM, Connors GP, Brayer AF, et al. Differences in diagnosis and treatment using telemedicine versus in-person evaluation of acute illness. *Ambul Pediatr*. 2006;6(4):187-195. discussion 96-97.
29. Smith AC, Kimble R, Mill J, et al. Diagnostic accuracy of and patient satisfaction with telemedicine for the follow-up of paediatric burns patients. *J Telemed Telecare*. 2004;10(4):193-198.
30. McConnochie KM, Wood NE, Herendeen NE, et al. Telemedicine in urban and suburban childcare and elementary schools lightens family burdens. *Telemed J E Health*. 2010;16(5):533-542.
31. McConnochie KM, Wood NE, Kitzman HJ, et al. Telemedicine reduces absence resulting from illness in urban child care: evaluation of an innovation. *Pediatrics*. 2005;115(5):1273-1282.
32. Van Dillen C, Silvestri S, Haney M, et al. Evaluation of an off-the-shelf mobile telemedicine model in emergency department wound assessment and management. *J Telemed Telecare*. 2013;19(2):84-88.
33. Fox KC, Somes GW, Waters TM. Timeliness and access to health-care services via telemedicine for adolescents in state correctional facilities. *J Adolesc Health*. 2007;41(2):161-167.
34. Sable CA, Cummings SD, Pearson GD, et al. Impact of telemedicine on the practice of pediatric cardiology in community hospitals. *Pediatrics*. 2002;109(1):E3.
35. Bengner JR, Noble SM, Coast J, et al. The safety and effectiveness of minor injuries telemedicine. *Emerg Med J*. 2004;21(4):438-445.
36. Ferrero A, Garavaglia G, Gehri R, et al. Analysis of the inter- and intra-observer agreement in radiographic evaluation of wrist fractures using the multimedia messaging service. *Hand (N Y)*. 2011;6(4):384-389.
37. Lambrecht CJ. Telemedicine in trauma care. *Telemed Today*. 1998;6(1):25.
38. Tachakra S, Lynch M, Newson R, et al. A comparison of telemedicine with face-to-face consultations for trauma management. *J Telemed Telecare*. 2000;6(Suppl 1):S178-S181.
39. Kim JW, Lame M, Szalay L, et al. Telemedicine surge for pediatric patients in response to the COVID-19 pandemic in New York city. *Telemed J E Health*. 2021;27(10):110-51110.
40. North SW, McElligot J, Douglas G, et al. Improving access to care through the patient-centered medical home. *Pediatr Ann*. 2014;43(2):e33-e38.
41. Kim JW, Friedman J, Clark S, et al. Implementation of a pediatric emergency telemedicine program. *Pediatr Emerg Care*. 2020;36(2):e104-e107.
42. Findling RL, Stepanova E. The workforce shortage of child and adolescent psychiatrists: is it time for a different approach? *J Am Acad Child Adolesc Psychiatry*. 2018;57(5):300-301.
43. Underlying Cause of Death 1999-2020. National Center for Health Statistics Mortality Data. CDC WONDER: U.S. Department of Health & Human Services; 2020.
44. Tolliver M, Polaha J, Williams SL, et al. Evaluating the prevalence of child psychosocial concerns in rural primary care. *Rural Ment Health*. 2020;44(2):96-105.
45. Latifi R, Weinstein RS, Porter JM, et al. Telemedicine and telepresence for trauma and emergency care management. *Scand J Surg*. 2007;96(4):281-289.
46. Dharmar M, Kuppermann N, Romano PS, et al. Telemedicine consultations and medication errors in rural emergency departments. *Pediatrics*. 2013;132(6):1090-1097.
47. Nesbitt TS, Dharmar M, Katz-Bell J, et al. Telehealth at UC Davis—a 20-year experience. *Telemed J E Health*. 2013;19(5):357-362.
48. Benbadis SR, LaFrance WC Jr, Papandonatos GD, et al. Interrater reliability of EEG-video monitoring. *Neurology*. 2009;73(11):843-846.
49. Benbadis SR, O'Neill E, Tatum WO, et al. Outcome of prolonged video-EEG monitoring at a typical referral epilepsy center. *Epilepsia*. 2004;45(9):1150-1153.
50. Day HW. Preliminary studies of an acute coronary care area. *J Lancet*. 1963;83:53-55.
51. Drew BJ, Califf RM, Funk M, et al. Practice standards for electrocardiographic monitoring in hospital settings: an American Heart Association scientific statement from the councils on cardiovascular nursing, clinical cardiology, and cardiovascular disease in the young; endorsed by the International Society of Computerized Electrocardiology and the American Association of Critical-Care Nurses. *Circulation*. 2004;110(17):2721-2746.
52. Zartner PA, Toussaint-Goetz N, Photiadis J, et al. Telemonitoring with implantable electronic devices in young patients with congenital heart diseases. *Europace*. 2012;14(7):1030-1037.
53. Ward MM, Jaana M, Natafqi N. Systematic review of telemedicine applications in emergency rooms. *Int J Med Inform*. 2015;84(9):601-616.
54. Hicks LL, Boles KE, Hudson ST, et al. Using telemedicine to avoid transfer of rural emergency department patients. *J Rural Health*. 2001;17(3):220-228.
55. Steinhubl SR, Muse ED, Topol EJ. The emerging field of mobile health. *Sci Transl Med*. 2015;7(283):283rv3.
56. Swan M. The quantified self: fundamental disruption in big data science and biological discovery. *Big Data*. 2013;1(2):85-99.
57. McBain RK, Sousa JL, Rose AJ, et al. Impact of project ECHO models of medical tele-education: a systematic review. *J Gen Intern Med*. 2019;34(12):2842-2857.
58. Arora S, Peters AL, Burner E, et al. Trial to examine text message-based mHealth in emergency department patients with diabetes (TEXT-MED): a randomized controlled trial. *Ann Emerg Med*. 2014;63(6):745-754.
59. Donat JF. Long-term EEG monitoring for difficult seizure problems. *J Child Neurol*. 1994;9(Suppl 1):S57-S63.

60. Isetta V, León C, Torres M, et al. Telemedicine-based approach for obstructive sleep apnea management: building evidence. *Interact J Med Res.* 2014;3(1):e6.
61. Saidinejad M, Zorc J. Mobile and web-based education: delivering emergency department discharge and aftercare instructions. *Pediatr Emerg Care.* 2014;30(3):211-216.
62. Binks S, Bengler J. Tele-education in emergency care. *Emerg Med J.* 2007;24(11):782-784.
63. Jain A, Agarwal R, Chawla D, et al. Tele-education vs classroom training of neonatal resuscitation: a randomized trial. *J Perinatol.* 2010;30(12):773-779.
64. Mahadevan S, Muralidhar K, Shetty D. Tele-education service using telemedicine network in healthcare industry. *Telemed J E Health.* 2012;18(9):699-702.
65. Nelson C. A telemedicine case conference to teach medical students in a pediatrics setting. *Acad Med.* 2001;76(5):570.
66. Van Gaalen JL, Hashimoto S, Sont JK. Telemanagement in asthma: an innovative and effective approach. *Curr Opin Allergy Clin Immunol.* 2012;12(3):235-240.
67. Mikrogianakis A, Kam A, Silver S, et al. Telesimulation: an innovative and effective tool for teaching novel intraosseous insertion techniques in developing countries. *Acad Emerg Med.* 2011;18(4):420-427.
68. Lorch SA, Myers S, Carr B. The regionalization of pediatric health care. *Pediatrics.* 2010;126(6):1182-1190.
69. Varma S, Schinasi DA, Ponczek J, et al. A retrospective study of children transferred from general emergency departments to a pediatric emergency department: which transfers are potentially amenable to telemedicine? *J Pediatr.* 2021;230:126-132.e1.
70. Rush KL, Howlett L, Munro A, et al. Videoconference compared to telephone in healthcare delivery: a systematic review. *Int J Med Inform.* 2018;118:44-53.
71. Lee JA, Holland-Hall C. Patient portals for the adolescent and young adult population: benefits, risks and guidance for use. *Curr Probl Pediatr Adolesc Health Care.* 2021;51(11):101101.
72. Blocker RC, Heaton HA, Forsyth KL, et al. Physician, interrupted: workflow interruptions and patient care in the emergency department. *J Emerg Med.* 2017;53(6):798-804.
73. Dayal P, Hojman NM, Kissee JL, et al. Impact of telemedicine on severity of illness and outcomes among children transferred from referring emergency departments to a children's hospital PICU. *Pediatr Crit Care Med.* 2016;17(6):516-521.
74. Lintern G, Motavalli A. Healthcare information systems: the cognitive challenge. *BMC Med Inform Decis Mak.* 2018;18(1):3.
75. Lapointe L, Rivard S. Getting physicians to accept new information technology: insights from case studies. *CMAJ.* 2006;174(11):1573-1578.
76. Schwamm LH, Holloway RG, Amarenco P, et al. A review of the evidence for the use of telemedicine within stroke systems of care: a scientific statement from the American Heart Association/American Stroke Association. *Stroke.* 2009;40(7):2616-2634.
77. Douglas MD, Xu J, Heggs A, et al. Assessing telemedicine utilization by using medicaid claims data. *Psychiatr Serv.* 2017;68(2):173-178.
78. Hatcher-Martin J, Anderson ER, Factor S. Patient acceptance and potential cost-savings of teleneurology in an academic outpatient movement disorders practice (P1.022). *Neurology.* 2016;86(16 Supplement):1-22.
79. Russo JE, McCool RR, Davies L. VA telemedicine: an analysis of cost and time savings. *Telemed J E Health.* 2016;22(3):209-215.
80. Scott Kruse C, Karem P, Shifflett K, et al. Evaluating barriers to adopting telemedicine worldwide: a systematic review. *J Telemed Telecare.* 2018;24(1):4-12.
81. American academy of pediatrics council on child and adolescent health: age limits of pediatrics. *Pediatrics.* 1988;81(5):736.
82. Hardin AP, Hackell JM. Age limit of pediatrics. *Pediatrics.* 2017;140(3). e20172151.

How to cite this article: Saidinejad M, Barata I, Foster A, et al. The role of telehealth in pediatric emergency care. *JACEP Open.* 2023;4:e12952. <https://doi.org/10.1002/emp2.12952>