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Review Article

Clinical Applications of Telemedicine in Paediatric Emergency Care: A Systematic Review Study

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ABSTRACT:

Background: Access to timely and specialized care is critical in pediatric emergencies, yet many rural and underserved areas lack pediatric emergency medicine (PEM) specialists. Telemedicine (TM) offers a potential solution by enabling real-time consultation and decision support remotely.
Objective: To evaluate the effectiveness of telemedicine in managing critically ill pediatric patients in emergency settings, with a focus on improving access in rural and resource-limited environments
Materials and Methods: A narrative literature review was conducted using PubMed, Scopus, Web of Science, and Google Scholar. Studies published from January 2014 to June 2023 were screened for relevance. Twenty-five studies were included, covering various telemedicine modalities and outcomes related to pediatric emergency care.
Results: The findings suggest that TM improves access to pediatric specialists, enhances triage and diagnostic accuracy, reduces unnecessary interfacility transfers, and provides cost-effective alternatives to conventional care. Studies also highlighted implementation barriers, including provider resistance, infrastructure limitations, and variability in adoption
Conclusion: Telemedicine demonstrates clear benefits in pediatric emergency care, particularly in underserved settings. Despite challenges, TM is a promising adjunct to traditional emergency systems. Broader adoption and further outcome-based research are needed to optimize its role in improving pediatric emergency care delivery.

Keywords: telemedicine, pediatric emergency, rural healthcare, tele-triage, critical care, healthcare access.

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INTRODUCTION:

Pediatric emergencies require rapid assessment and specialized care, particularly for critically ill children whose conditions may deteriorate quickly. However, in many rural and resource-limited settings, geographic and logistical barriers restrict access to pediatric emergency medicine (PEM) specialists. These disparities in healthcare access often lead to delays in diagnosis, inappropriate referrals, and suboptimal outcomes for vulnerable pediatric populations [1].

Telemedicine (TM), defined as the remote diagnosis and treatment of patients through telecommunications technology, has emerged as a potential solution to these challenges [2]. Recent global events, particularly the COVID-19 pandemic, have accelerated the adoption of telehealth services across healthcare systems [2]. By enabling real-time consultations, video assessments, and data exchange between community providers and pediatric specialists, TM has the capacity to bridge the gap between patients and expert care, regardless of location [3].

In the context of pediatric emergencies, this shift has provided a unique opportunity to evaluate the effectiveness of telemedicine in real-world, high-pressure scenarios [4]. Studies conducted across diverse healthcare environments—from urban hospitals in the United States to rural facilities in low- and middle-income countries—have highlighted TM's potential to improve triage accuracy, reduce unnecessary patient transfers, and support timely, life-saving interventions [5]. Despite promising findings, concerns remain about the integration of TM into emergency workflows, provider readiness,

infrastructure limitations, and the quality of care delivered remotely. Evaluating the effectiveness of telemedicine in these contexts is crucial for guiding clinical.

Purpose Statement (in narrative form)

The purpose of this paper is to evaluate the effectiveness of telemedicine in delivering timely and appropriate care to critically ill children in emergencies, with a particular focus on underserved and rural areas where access to Specialized pediatric emergency care may be limited.

Objectives

To review and synthesize current evidence on the role of telemedicine in pediatric emergency care.

To assess the impact of telemedicine on clinical outcomes, decision-making, and time to intervention for critically ill children.

To explore how telemedicine helps bridge the gap in access to pediatric emergency expertise in rural and resource-limited settings.

To identify common challenges and limitations associated with the implementation of telemedicine in these scenarios.

To highlight best practices and future directions for optimizing telemedicine use in pediatric emergencies.

MATERIALS AND METHODS:

Study Design: This review employed a narrative-literature-review design to evaluate the effectiveness of telemedicine in delivering care to critically ill pediatric patients in emergency settings. The focus was particularly on rural and underserved areas where access to pediatric emergency expertise is often limited.

Search Strategy:

A comprehensive literature search was conducted using electronic databases including PubMed, Scopus, Web of Science, and Google Scholar. The search was limited to studies published between January 2014 and June 2023 to capture recent developments, particularly in the wake of increased telehealth adoption during the COVID-19 pandemic.

The following keywords and combinations were used:

"Telemedicine" OR "telehealth"

"Pediatric emergency" OR "pediatric critical care"

"Remote consultation" OR "Tele-triage"

"Rural healthcare" OR "underserved populations"

Boolean operators (AND/OR) and filters for English language and human subjects were applied.

Inclusion and Exclusion Criteria:

Inclusion Criteria: Studies focused on pediatric emergency care using telemedicine.

Articles that evaluated telemedicine effectiveness, accessibility, triage, or implementation. Peer-reviewed articles, reviews, retrospective and prospective studies, randomized trials, and

qualitative studies. Studies have been conducted in rural, urban, or mixed settings globally.

Exclusion Criteria:

Non-English articles, Editorials, Commentaries, and letters without original data. Studies not involving emergency or urgent pediatric care

Study Selection and Data Extraction:

Two independent reviewers screened the titles and abstracts of retrieved records. Full texts were then assessed for eligibility based on the inclusion criteria. Disagreements were resolved through discussion and consensus. For each included study, the following data were extracted: First author and year;/region of study; Study design and sample size; Duration and setting; Type of telemedicine intervention; Objectives and key findings.

The extracted data was compiled and summarized in a comprehensive comparison table, categorizing the studies by design, geographic region, population, and outcomes.

Table 1: The characteristics summary of the included studies reported in

First Author	Year & Country	Publication Journal	Study design	Sample & Duration	TM Modality	Study goals	Key Findings
Mateus LA, et al. [15]	**2023,** Canada	Frontiers in digital health.	Mixed methods pilot study.	**31 participants**	Peds-TECH interviews /surveys	Evaluate TM in pediatric ED care	High acceptance among caregivers and physicians
Rahim MJ, et al. [12]	2023, USA	BMC Health Services Research	Cross-sectional survey	597 guardians (3 months)	Guardian-reported telehealth use	Identify TM barriers and benefits	Improved access; key barriers noted
Marcin JP, et al. [10]	2023, USA	JAMA Network	RCT	696 children (16 months)	Teleconsultation vs. phone consults	Compare transfer outcomes	TM reduced unnecessary transfers
Saidinejad M, et al. [2]	**2023,** USA	Journal of the american college of emergency Physicians	Observational	Not specified	TM post-COVID overview	Explore infrastructure needs	TM improved experience, reduced cost
Boggs KM, et al. [22]	**2023,** USA	Telemedicine and e. Health vol.29, N.4	A National survey.	237 EDs	A nine-question of ED TM survey	Understand barriers	Assimilation challenges highlighted.
Totten AM. et al. [4]	**2022,** USA	Journal of Telemedicine and Telecare 2022	A systematic review	97 studies	Provider-to-provider TM	Assess effectiveness	TM supports rural health equity
Beyer A, et al. [6]	**2022,** Germany	Journal Pone. 0269058	Concordance analysis	266 patients (4.5 years)	Video conferencing triage	Assess remote triage validity	Effective in low-access regions
Weidner K, et al. [18]	**2022,** Spain	American Journal of Speech-Language Pathology	Descriptive retrospective	182 consults (3 months	Twitter-based TM	Use Twitter as triage tool	TM improved triage time and access
Rowther AA, et al. [24]	**2022,** Pakistan	SSM - Qualitative Research in Health Volume 2, December 2022, 100150	Qualitative	20 stakeholders (8 months)	Teleconsultation Interview questions	Explore clinician views	Redefined roles; perceived as useful.

Mitra A, et al.[11]	**2021** USA	Journal of Telemedicine and Telecare	Systematic review	Multiple studies	Synchronous & asynchronous TM	Assess TM on outcomes |.	Improved accuracy, faster disposition, cost savings
Flaherty KE, et al.[7]	**2021,** Haiti	American Journal of Tropical Medicine and Hygiene	Cost effectiveness analysis	819 patients (9 months)	TM medication delivery	Compare TMDS to hospital emergency	TMDS cost-effective in rural settings
Rosenthal JL. [13]	**2021,** USA	Telemedicine and e-Health	Quality improvement	403 transfers (12 months)	ED-specialist teleconsults	Implement pediatric TM transfers.	Supported implementation strategies
Severini RD, et al. [14]	**2021**, Brazil	Jornal de Pediatria.	Descriptive Retrospective study	140 patients (3 months)	Low-cost TM	Pandemic implementation	High guardian satisfaction
Schinasi DA et al. [19]	**2021,** USA	Current Problems in Pediatric and Adolescent Health Care Volume 51, Issue 1	Descriptive qualitative	Not specified	Physician-specialist TM	Overcome access barriers	Improved access, minimized transfers
Varma S et al. [1]	**2020**, USA	The journal of pediatrics. Original article volume 230, P126-132.E1, MARCH 2021	Retrospective cohort study	1,733 transfers (2 years)	Telemedicine in lieu of transfer	Identify TM-useful cases.	TM reduced some interfacility transfers
Sauers Ford HS, et al. [17]	**2019**, USA	Published in final edited form as: Acad Emerg Med. 2019 Sep; 26	Qualitative study	16 interviews (2 months)	Provider interviews	Identify TM barriers	Highlighted provider bias, workflow issues
Kim JW, et al. [9]	**2019,** USA	Published in Pediatric emergency care Journal, New York.	Comparative qualitative	18 ED providers	Provider interviews	Explore provider experience.	Identified limitations and concerns
Waltzman ML, et al. [21]	**2018**, USA	Emergency Medicine and critical care An open access peer reviewed journal Online ISSN 2631-5432	Cross-sectional survey	53 patients (2 years)	Mobile TM to PICU.	Link between community hospital (ED) providers and tertiary PICU specialists.	Improved care; workflow challenges noted
Sheikhtaheri A, et al. [25]	**2018,** Iran	Health Management and Economics Research Center, Iran University of Medical Sciences. With Open Access by IOS Press.	Systematic review	2000–2016 literature	General pediatric TM	Evaluate TM applications	Limited outcome evidence; more research needed
Du Toit M, et al. [20]	**2017**, Australia	Journal of Telemedicine and Telecare 2019, Vol. 25(1) 3–16!	Systematic review and Meta-Analysis	**2532 records**	Remote TM for non-critical ED	Manage non-urgent cases	Telehealth programs May reduce unnecessary ED transfers

Murtha TD, et al. [5].	**2017,** USA	PCC Medicine (MT Bigham and J Giuliano, Section Editor)	Mixed-methods	Not specified	Remote video consultations	Diagnostic / triage support	Helped overcome training, distance issues.
Harvey JB, et al. [3].	**2017,** USA	Official journal of the Society of Critical Care Medicine and the World Federation of Pediatric Intensive and Critical Care Societies	Retrospective analysis	52 rural EDs (4 years)	PCC teleconsults	Improve triage decision	TM improved provider accuracy
Siew L, et al. [16].	**2016, USA**	Pediatrics, American Academy of Pediatrics	Prospective observational	**277 children**	Live-streamed video	Compare remote vs. bedside eval	TM reliable for febrile/respiratory assessment
Gattu R, et al. [8].	2016, USA	Pediatric Emergency Care Journal, Volume 32 - Issue 2	Systematic reviews	Multiple studies.	PEM-focused literature.	Review PEM TM applications	Clinical potential; more outcome data needed.
Uscher-Pines L, et al. [23].	**2014,** USA	Telemedicine Journal and e - Health.	Survey	25 sites (4 months)	PET phone survey	Assess PET program status	Identified barriers, success factors

Abbreviations:

T.M. Telemedicine
T.H. Telehealth
PRISMA Preferred Reporting Items for Systematic Reviews and Meta-Analyses
ED Emergency Department
PED Paediatric Emergency Department
PEM Paediatric Emergency Medicine
PET Pediatric Emergency Telemedicine
TMDS Telemedicine and medication delivery service
HEM Hospital Emergency Medicine
ETP Emergency Telemedicine Programs.
PER Paediatric Emergency Room
PCC Pediatric Critical Care
RCT Randomized Crossover trial Analyses.

DISCUSSION:

This review highlights the growing body of evidence supporting the use of telemedicine (TM) in pediatric emergency care, particularly in improving access, enhancing clinical decision-making, and reducing disparities in rural or underserved areas.

1. Improved Access to Pediatric Emergency Expertise; Many studies demonstrated that telemedicine facilitates timely access to pediatric subspecialists, enabling local healthcare providers to manage critically ill children without delay. For instance, teleconsultation significantly reduced unnecessary inter-facility transfers, allowing children to be managed safely within community hospitals [10]. Similarly, telemedicine helped maintain care within local communities while enhancing provider confidence and decision-making [19].
2. Enhancement of Triage and Clinical Accuracy; Several studies provided evidence that remote triage and assessment using live video platforms yielded clinical judgments comparable to bedside evaluations. This suggests that telemedicine can be a reliable tool for the initial assessment of pediatric

patients, particularly those presenting with febrile illness or respiratory distress [6, 16].

3. Cost-Effectiveness and Resource Optimization;
4. In resource-limited settings, telemedicine has shown cost benefits. One confident study reported that a nighttime TM medication delivery service in Haiti was more cost-effective than traditional emergency care models [7]. Similarly, **a** study described a low-cost telemedicine model in Brazil that provided high satisfaction and safety during the COVID-19 pandemic [14].
5. Barriers to Implementation; Despite telemedicine benefits, implementation challenges persist, certain studies highlighted barriers such as provider hesitation, workflow integration issues, and lack of training or infrastructure [9,17]**.** Further study confirmed that even among EDs that had adopted pediatric telemedicine, assimilation remained uneven and limited by logistical concerns [22].
6. Gaps in Evidence: While the overall trend favors telemedicine, specific reviews emphasized the need for further research to assess the impact of TM on measurable clinical outcomes. This gap is especially relevant in determining long-term effects on morbidity and mortality, and in validating telemedicine as a replacement for physical consultation in high-stakes emergencies [8, 25].
7. Limitations and Strengths of the study:

The potential methodological limitations of this systematic review are as follows: the possibility of missing a study cannot be excluded. Even though our search criteria allowed for the inclusion of studies from different countries, most included studies were conducted in USA and "high-income countries", telemedicine use in high-income and low-income countries may be different, and the results of this review should be viewed as results from high-income countries.

This review included studies with different follow-up periods and patient populations (various health conditions and age groups); therefore, there may have been several inconsistencies between the results of each study.

The potential methodological strengths of this systematic review are as follows: This review studies only included research that was published last 10 years in peer-reviewed journals; moreover, the earliest study was published in 2014, and it is likely that earlier studies were not missed. Although this systematic studies in English, on the other hand from all countries were eligible for this review. Furthermore, this review used multiple databases (PubMed, Google Scholar, and Medscape) to conduct the literature search.

CONCLUSION:

Telemedicine has emerged as a valuable tool in enhancing pediatric emergency care, particularly for critically ill children in rural and underserved settings. Across diverse clinical environments, evidence from recent studies suggests that TM can improve access to pediatric expertise, support accurate and timely triage, reduce unnecessary patient transfers, and offer cost-effective alternatives to traditional emergency services. Its utility is especially pronounced in areas with limited access to pediatric specialists, where timely intervention can be critical to patient outcomes. However, while the benefits are clear, challenges related to provider adoption, infrastructure, and integration into clinical workflows must be addressed to ensure sustainable implementation. Additionally, studies that are more robust are needed to quantify the long-term impact of TM on clinical outcomes, including morbidity and mortality. Overall, telemedicine holds strong promise as a complement to traditional pediatric emergency care. With thoughtful implementation, appropriate training, and supportive policies, TM can play a pivotal role in closing gaps in emergency healthcare delivery for children, especially where the need is greatest.

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