

Effectiveness Of Telemedicine In EMS System: A Systematic Review

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Abstract

Background:

Telemedicine (TM) describes the usage of information technology to share precise information for diagnosis, management, and prevention of diseases. TM provides prompt access to healthcare, remote treatment options, and a significant decrease in needless ER visits and hospital stays. Due to the increase in patients, resource constraints, and the complexity of cases that present to acute care settings, the global burden of emergency medical services (EMS) is still increasing. Thus, the application of TM in EMS may be able to lessen the workload of EMS and increase its effectiveness.

Aim:

To assess the effectiveness of TM implemented in emergency medical service (EMS) by reviewing the previous studies concerned with this subject.

Methods:

The relevant articles were obtained through an online search on scientific websites using relevant terms. The eligible articles were original ones written in the English language, providing quantitative analysis regarding the effectiveness of TM in EMS.

Results:

Eight studies met the determined criteria and were included. The studies assessed TM effectiveness through assessing the number of admissions, calls, and missions of EMS, and studying the hours and number of patients.

Conclusion:

TM was effective in the EMS system, which would reduce the burden on EMS while improving its efficiency. TM showed its effectiveness in EMS in almost six aspects to improve EMS service and quality.

Keywords: TM, Effectiveness, EMS.

Introduction:

Telemedicine (TM) describes the provision of remote healthcare service using communication and information modalities [1]. TM involves using such technologies to share precise information for diagnosis, management, and prevention of diseases. TM also supports evaluation, research, and continued education of healthcare providers; thus, it aims to improve both the community and individual health outcomes [2].

TM offers opportunities to provide care remotely, timely medical access, a considerable reduction in unnecessary emergency visits, and hospital admissions. This, in turn, can optimize emergency service resources, improve healthcare accessibility, and enhance patient satisfaction by emphasizing appropriate and efficient care delivered to patients with no need for inpatient services [3].

The use of TM is considered an organizational response to several challenges, such as epidemiological challenges related to aging, the elevation of patient frequencies suffering from chronic illness, demographic challenges with unequal distribution of healthcare providers, economic challenges, and crises such as the COVID-19 pandemic. Also, TM can be implemented as a response to challenges faced by the healthcare service, especially in the emergency department (ED) [3].

ED is one of the most sensitive and critical sections of the hospital, and how it functions has a considerable impact on the other departments and patient satisfaction. The performance of ED is a key measure in the evaluation of the role of hospitals in providing service to the population [1].

The global burden of ED continues to rise, and this is driven by the elevation in the number of patients, limitations of resources, and complexity of cases presenting to the acute care settings. Additionally, overcrowding of ED is a well-documented problem leading to delayed treatment, prolonged waiting times, and in some cases, adverse outcomes for the patients [4].

It was stated that TM implementation in ED is able to help in reducing ED overcrowding, providing specialized services to paramedics, reducing time between accidents and patient arrival at hospitals, and providing better management of crisis [1]. TM for emergency medical service (EMS) may be useful in rural communities due to the paramedic shortage [5]. Therefore, this systematic review was established to assess the effectiveness of TM implemented in EMS.

Method and search strategy:

The checklist of PRISMA [6] was the guidance for writing this review. The electronic databases of "PubMed, Science Direct, Google Scholar, and Scopus" were explored to obtain all possible related articles, and using relevant terms, including "TM, Effectiveness, EMS, Implementation, Outcomes, Benefits, and Advantages". The searching procedure was restricted to articles published from 2016 to the present, resulting in a duration of ten years of publication. The titles produced from the searching process were revised thoroughly to avoid missing potential studies.

Eligibility criteria:

The relevant articles that focused on TM and its implementation in EMS were enrolled for further refining, whereas those articles that focused on TM in other healthcare settings, or focused on pediatric EMS, were excluded. Also, all duplicate articles were precluded to avoid duplication of data and findings. Furthermore, any article published before 2016 and appeared coincidentally, and any article based on qualitative analysis, were excluded. The second stage was more refining of the remaining articles by the inclusion of original articles and exclusion of non-original ones, such as systematic reviews, meta-analyses, and others. English language articles were eligible and considered for inclusion. All full-text articles were eligible, and those that provided complete data, whereas those available for abstracts only and/or provided incomplete data were excluded. The detailed illustration of the eligibility criteria is shown in figure 1.

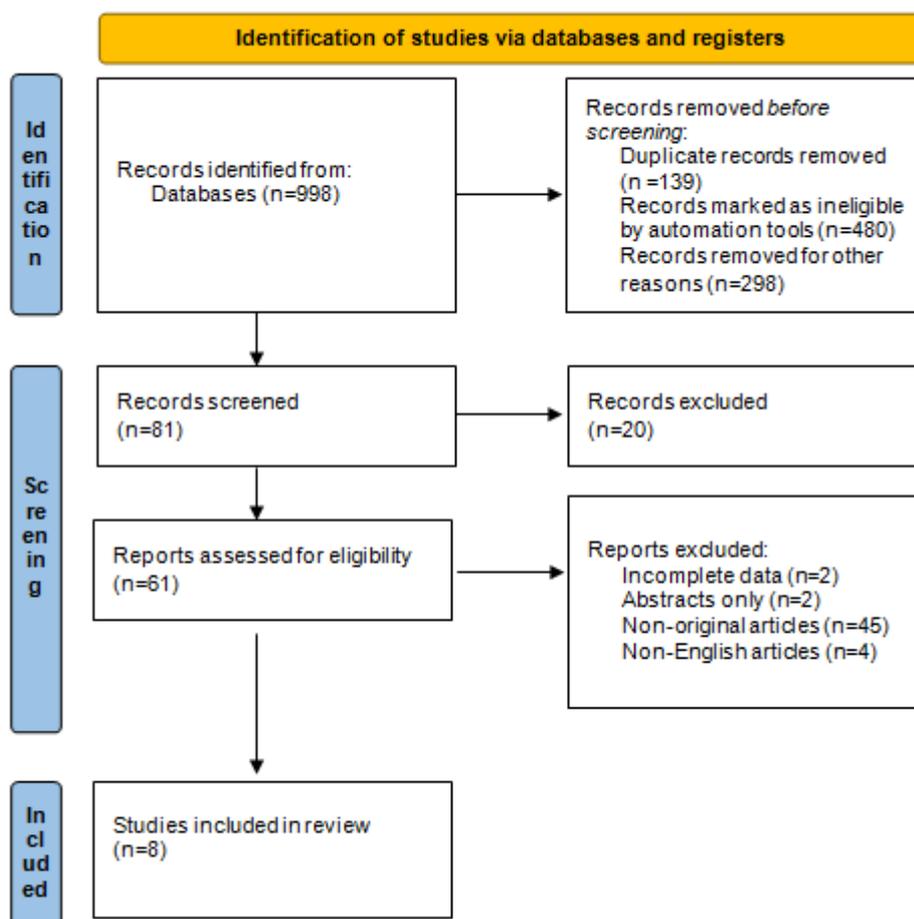


Fig 1: Eligible criteria scheme

Data review and analysis:

The first stage in this phase was reviewing each abstract of the included articles to determine the data of interest and important for our review. The second step was the extraction of data from each included article via a precise review of each article and the extraction of data using a specially designed Excel sheet. The data after extraction was revised and then transferred to a pre-designed table for summarization.

Results:

There were eight studies [3, 7-13] that fulfilled the eligibility criteria and were enrolled in this review (Table 1). The studies were of different designs, including prospective [7, 3], prospective observational [8, 11], retrospective [9], cross-sectional [10], cohort [12], and observational [13].

The studies displayed great variations regarding the population under study, as some focused on the number of admissions [7, 13], calls [8], EMS missions [9], patients [3, 10, 11], and hours [12]. One study included 1424 admissions and categorized them based on TM implementation into the admissions based on TM-EMS physician treatment and those received EMS treatment on site [7]. The other study involved 2662 first ED admissions, which had the availability of TM, and categorized them into those who used TM consultation and those who didn't despite the availability of TM [13]. One study included 8680 calls by patients who were managed by the integrated medical center and revealed a mean of 24 calls per day [8]. One study enrolled 229384 EMS missions during seven years [9], whereas another study included 652 screening hours and categorized them into those performed via TM and those via standard screening at ED [12]. Regarding the remaining three studies, which enrolled patients, one study

included 400 patients who consulted EM and categorized them into those who used TM during follow-up after discharge from EM and those who received standard care after discharge [3]. The second study was based on surveying 319 patients to identify the EMS overload [10]. The last study included 100 patients and divided them into those who used TM in dermatology by sending their photos to an emergency physician and then assessed by dermatologists, and those who were recruited by dermatologists [11].

Regarding TM implementation, TM revealed various implementation in EMS, including its implementation in pre-hospital diagnosis for EMS management [7], TM implementation via CMI for the management of patients without accessing to ED [8], TM involvement in EMS missions for consultation [9], TM adoption for the follow-up of patients after discharge from ER [3], TM involvement in reducing EMS overload [10], its implementation for dermatological emergency patients [11], in screening [12], and for the management and clinical outcomes of the trauma patients [13].

There was great heterogeneity in the findings of the included studies due to the variations in the objectives and characteristics of each included study. Therefore, the findings can be presented as follows:

One study revealed the effectiveness of TM in diagnosis, where no variations were found between tele-EMS and EMS physician diagnosis ($P=0.8$). However, EMS diagnosis was more accurate, where the number of cases in which pre-hospital diagnosis matched discharge diagnosis was higher for EMS compared to tele-EMS ($P=0.01$), and EMS physicians recorded more diagnoses compared to tele-EMS physicians ($P<0.001$) [7]. Another study focused on diagnosis in dermatology emergencies revealed that agreement in diagnosis between tele-evaluation and clinical evaluation was 100% with considerably less treatment time for tele-dermatology patients compared to controls ($P<0.001$) [11].

The utilization of TM via the CMI model resulted in managing 71.9% of patients with no need to access the ED, and of those patients, 78.2% were managed through TM only, and 21.8% with TM and dispatch of the HRRT, with a high satisfaction level of the patients (9.1/10) [8].

TM increased the performance in EMS as implementation of TM resulted in increased EMS missions by 8.5% with a reduction in call duration for tele-consultation from 12.07 to 9.42 min [9].

TM following ED discharge led to a reduction in the number of patient consultations compared to those who visited the ER ($P=0.004$), an increase in treatment adherence of TM users ($P=0.01$), and higher satisfaction of TM users (90%) compared to non-users (37.5%) [3].

TM was also helpful in reducing the overload of EMS as TM implementation resulted in a potential reduction in patients who intended to visit ED, but didn't use it after receiving the service via TM ($P<0.01$), via Sehha app (24.4%), or medical call center (9.6%) ($P<0.01$) [10].

The implementation of TM in screening resulted in almost a similar time to in-person screening, and higher order for analgesia by tele-screener, but in-person screening was better regarding the lower number of patients who LWBS. However, TM was better in screening compared to in-person in terms of reducing the rate of patients who LWBS compared to the previous year (difference 20.7) and providing standardized care to those with chest pain better than in-person screening [12].

TM was effective in reducing the initial ED LOS and the rapid rate of inter-hospital transfer (aOR 1.2), but it was also linked with increased total ED LOS and scans using computed tomography (aOR 1.6) [13].

Table 1: Summary of the data

Author and Publication year	Design	Characteristics	Tele-Application	Results and main findings
Hess et al 2025 [7]	Prospective, randomized interventional, controlled, open-label, two-arm, parallel-group sequential trial	-N=1424 admissions *Tele-EMS physician treatment=447 *On-site EMS physician treatment=977	TM was implemented in pre-hospital diagnosis for EMS treatment	*There were no significant differences between tele-EMS physicians and EMS physicians regarding the admission diagnoses (P=0.877). *The number of cases in which at least one pre-hospital diagnosis matched the discharge diagnosis was significantly higher for EMS physicians than for tele-EMS physicians (P=0.019) *EMS physicians recorded two diagnoses significantly more often than tele EMS physicians (P< 0.001).
Cortellaro et al 2025 [8]	Prospective observational	-N=8680 calls managed by CMI *Mean of calls=24 calls per day	CMI TM-based care model	*71.9% of the patients were managed without ED access, of whom 78.2% patients were managed through TM evaluation only, and 21.8% with TM evaluation and dispatch of the HRRT. *The population treated by the HRRT exhibited a higher age. *The mean satisfaction score was 9.1/10.
Schroder et al, 2024 [9]	Retrospective	-N=229384 EMS missions during 7 7-year period	Implementing the tele-EMS system in EMS missions	*At the end of the study, the total frequency of EMS missions increased by 8.5%. *A tele-EMS physician was consulted on 10.1% missions. *The proportion of telemedicine missions increased from 8.6% at the beginning to 12.9% at the end of the study. *The call duration for tele-consultation decreased from 12.07 min to 9.42 min.
Soltane et al, 2024 [3]	Prospective randomized controlled	-N= 400 patients consulting the EM *TM group=200 *Control group=200	TM implemented for following up patients discharged from the ER	* Patients in the TM group tended to consult less in the month following their initial ER visit (P=0.004). *There was a significant difference in treatment adherence between the TM group and the controls (P=0.014). *The satisfaction with TM was higher than satisfaction with regard to an in-person consultation at the emergency department (90% versus 37.5%).
Alfaleh et al, 2022 [10]	Cross-sectional	-N=319 patients underwent a survey	TM implementation to reduce EMS overload	* There were 53 (33.33%) of 159 (49.8%) of patients who had the intention to visit the ED but did not go to the ED after using TM services (P< 0.01).

				*9.6% of patients who used the medical call center and 24.4% who used Sehha as TM services had changed their mind concerning visiting the ED after taking the medical advice (P< 0.01).
Villa et al 2020 [11]	Prospective observational pilot	-N=100 patients *Tele-dermatology=50 *Control=50	TM implementation for dermatological emergency patients in the emergency department	* The agreement in suspected diagnosis between tele-dermatological evaluation and clinical evaluation of the same physician in the tele-dermatology group was 100%. *The mean time for treatment of the control group was 151±71 minutes, and that of the teledermatology group was 43±38 minutes (P< 0.001).
Rademacher et al, 2019 [12]	Cohort	-N=652 screening hours *Tele-screening=315 hours *Standard screening at ED=337 hours	TM implementation in screening	*In-person screeners evaluated 1933 patients over 337 hours (5.7 patients per hour), whereas tele-screeners evaluated 1497 patients over 315 hours (4.9 patients per hour) (difference=0.8). *There were fewer patients who LWBS during in-person screening than during telescreening (2.6% vs 3.8%; difference=-1.2). *In comparison to the previous year, tele-screening reduced the rate of patients with LWBS (difference=20.7). *Analgesia was ordered more frequently by tele-screeners than by in-person screeners (difference=19.6). *There was no difference in standard care received by patients with chest pain between tele-screening and in-person screening (difference=7.0%).
Mohr et al 2017 [13]	Observational	-N=2662 first ED admission and individuals available for TM *TM consulted=291 *TM not consulted=2371	TM implementation for the management and clinical outcomes of trauma patients	*TM utilization was linked with reduced initial ED LOS. *TM availability was linked with an elevation in the probability of inter-hospital transfer (aOR 1.2) and increased total ED LOS, and computed tomography scans (aOR 1.6).

EMS; Emergency medical service, TM; Telemedicine, CMI; Integrated Medical Center, ED; Emergency department, HRRT; Home Rapid Response Team, ER; Emergency room, CIPs; Critically ill patients, LWBS; Left without being seen, LOS; Length of stay.

Discussion:

TM introduction in healthcare settings offers solutions by triaging patients before they arrive at ED, facilitating remote consultation, and enabling real-time specialist input for complex cases [14]. In the EMS system, TM technology has displayed promise in providing remote specialist consultations, supporting decision-making processes for triage, and monitoring critical patients [15]. Therefore, this work was established to identify the effectiveness of TM implemented in EMS.

ED provides urgent healthcare for the patients; however, some conditions aren't critical and can be managed outside the ED. This leads to a great number of admissions to the ED, which in turn reduces the time spent by the healthcare providers with the patients, leading to more medical errors. Also, higher admissions to ED increase waiting time for treatment, leading to ED overcrowding and the delay in managing some urgent cases [1]. In our review, we found that TM was effective in reducing ED admissions and access while increasing ED performance. TM was effective in reducing the need to access ED [8], reducing the number of consultations following discharge from ED [3], and was helpful in reducing the overload of EMS [10]. Such findings indicate the effectiveness of TM in reducing the burden on EMS by reducing overload; this, in turn, would save resources and save time for the most critical cases that require urgent care, and finally would lead to improvement in the efficiency of the healthcare provided. Additionally, TM increased EMS missions, which combined with a reduction in call duration [9]. This indicates that TM was effective in increasing EMS performance and mission achievements with time saving.

However, there are concerns regarding the reliability of remote diagnosis via TM [16]. There were only two studies focused on TM effectiveness in diagnosis in this review, and we discovered that TM was effective in diagnosis, and no variations were found between tele-EMS and EMS physician diagnosis [7]. Also, in dermatology emergencies, the agreement in diagnosis between tele-evaluation and clinical evaluation was perfect, with a rate of 100% with less treatment time required for those of the TM group, revealing high accuracy of diagnosis [11]. However, EMS diagnosis was more accurate regarding the match between pre-hospital and discharge diagnosis, and EMS physicians recorded more diagnoses compared to tele-EMS ones [7]. Such findings indicate that TM was effective in diagnosis in EMS settings; however, it may be perfect and more appropriate for specific specialties and conditions compared to others. Therefore, there is a need to investigate the best effectiveness and performance of TM in diagnosis regarding several conditions in the ED.

A previous analysis included ten trials compared telehealth to face-to-face care; five trials concerned telephone care, and one study focused on telephone and video care. It was found that there was no difference between telehealth and face-to-face for visits to ED, hospitalizations up to 12 months, deaths, or other adverse events [17]. However, in our review, we found that the time of treatment for tele-evaluation in dermatology emergencies was less compared to the clinical one [11]. Also, we found that TM was effective in reducing initial ED LOS and rapid inter-hospital transfer [13].

A total of 28 studies were enrolled in a previous review, and it was found that TM increased the accuracy of assessment of patients in pre-clinical settings, guided referring ED physicians in performing appropriate life-saving interventions, improved time-to-disposition, and led to cost savings when compared to regular care [18]. In a previous systematic review that enrolled only clinical trials focused on TM in ED settings, a total of six trials were included. Similar to our findings, it was found that TM improved the diagnostic accuracy, enhanced treatment adherence, and reduced re-consultation rates. Additionally, high diagnostic concordance with in-person assessments was discovered, especially in non-critical cases [19].

In a previous review, it was reported that several studies reported higher patient satisfaction with TM compared to traditional care [19]. Similarly, we found high patient satisfaction regarding TM despite the insufficient studies reporting patient satisfaction [8, 3].

One review included 15 records revealed that remotely guided ultrasound by tele-emergency physicians displayed an overall high diagnostic accuracy in simulations [20]. In contrast, in our review, one study

revealed that TM was linked with increased scans using computed tomography [13]. However, this finding can't be emphasized as only one study reported that finding, and no other study reported scans by ultrasound or computed tomography.

A previous review studied the benefits of TM in ED, which included 18 studies, deducing that there was strong evidence suggesting that the utilization of TM positively influenced patient care. Nonetheless, it was also reported that there is still a need for better quality of evidence to emphasize TM feasibility in the ED [1]. Based on our findings, stronger evidence on the effectiveness of TM in several aspects of EMS is also needed.

Conclusion:

TM was found to be effective in an EMS system that would improve the efficiency of ED service and reduce the burden on that service. TM showed its effectiveness in EMS in several aspects, including accurate diagnosis, increased performance and achievement of EMS, reduced access to ED, reducing overload, saving time required for diagnosis, and reducing LOS.

Limitations, strengths, and recommendations:

The limitations of this review include the retrospective design of some studies and the great heterogeneity of the included studies. However, the main strength of this review is that we identified the effectiveness of TM in EMS regarding several aspects. Therefore, further studies are highly recommended for stronger evidence of TM effectiveness in EMS and regarding different aspects.

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