

Cross-sectional Study of the Ambulance Transport Between Healthcare Facilities With Medical Support via Telemedicine: Easy, Effective, Low-cost, and High-security Tool

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Keywords: Telemedicine, Ambulances, Emergencies, Emergency Service, Hospital, Admitting Department, Hospital

Posted Date: September 9th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-70084/v1>

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Abstract

Background: Feasibility and safety of ambulance transport between healthcare facilities with medical support exclusively via telemedicine is unknown.

Methods: This was a retrospective study with a single telemedicine center reference for satellite emergency departments of the same hospital. Study population was all critically ill patients admitted to one of the peripheral units, from November 2016 to May 2020, and who needed to be transferred to the main building. Telemedicine-assisted transportation was performed by an emergency specialist. For inclusion, the criteria demanded the patients above the age of 15 years and initial stabilization be performed at the emergency department. Unstable, intubated, ST-elevation myocardial infarction, and acute stroke patients were excluded. The primary endpoint was the number of telemedicine-guided interventions during transport.

Results: 2840 patients were enrolled. The population was predominantly male (53.2%) with a median age of 60 years. Sepsis was the most prevalent diagnosis in 28% of patients, followed by acute coronary syndromes (8.5%), arrhythmia (6.7%), venous thromboembolism (6.1%), stroke (6.1%), acute abdomen (3.6%), respiratory distress (3.3%), and heart failure (2.5%). Only 22 (0.8%) patients required telemedicine-assisted support during transport. Administration of oxygen therapy and analgesics were the main remotely-oriented interventions. There were no communication problems in the telemedicine-assisted group.

Conclusions: Telemedicine-assisted ambulance transportation of stabilized critically ill patients can effectively and safely substitute an onboard physician on most transfers between same-institution locations.

1. Background

Health-system capillarization is associated with greater efficiency in care, mainly by facilitating access to face-to-face care [1]. However, the organization of decentralized emergency services is expensive and complex [2]. Life-threatening cases that are initially stabilized at a satellite community's emergency department (ED) must be transported to a hospital for complete treatment [3]. Transportation of critically ill patients between hospitals usually requires a highly specialized ambulance team, which includes a trained driver, paramedics or nurses, and a medical doctor [4]. Keeping a physician available to assist in such transportation, however, is expensive, expanding on idleness and occupational hazard [5]. Brazil's legislation states that advanced support ambulances must provide medical support [6].

Telemedicine (TM) is an easy, universal, and low-cost tool to solve health-related problems [7]. There exists evidence to suggest that teleconsultation assessment benefits virtually all medical scenarios, including ambulance transportation [8]. In a prehospital setting, the support TM lends to the ambulance team is associated with a reduction in ED referral [9]. Video communication between the ambulance and the ED may boost the local staff's perception of clinical status and jump-start triage [10]. Remote patient interviews and the interpretation of the conducted tests positively alter disposition patterns [11]. Wireless media communication between the ambulance staff and remote specialists can be made possible during ongoing transportation [12]. Despite this evidence, no studies have been conducted on the feasibility and safety of ambulance patient transportation with only a remote physician.

Thus, this study aimed to analyze the profile, feasibility, and outcomes of the ambulance transfer of patients who have been stabilized in a satellite ED to the main hospital with ongoing medical support only via TM.

2. Methods

This was a retrospective and descriptive study with a single TM center (Hospital Israelita Albert Einstein, São Paulo—Brazil) reference for four satellite EDs of the same hospital. Study population was all critically ill patients admitted to one of the peripheral units, from November 2016 to May 2020, and who needed to be transferred to the main building. TM-assisted transportation was performed using a standard 4G-network-enabled tablet and free video-conferencing software. Communication was established with the aid of a tablet held by plastic support and a Bluetooth headset accompanied by a nurse. TM emergency specialists were available 24/7, and for each transportation, there was always contact at the beginning and end; there was ongoing contact if necessary. Ambulance routes were standardized and 4G-signal availability checked before departure. The distance between the satellites and the main unit varied from 7 to 25 km, with the transport time varying from 10 to 30 minutes. Transport data were electronically recorded in the inpatient medical record. For inclusion, the criteria demanded the patients be teenagers or adults above the age of 15 years and initial stabilization be performed at the ED. Unstable, intubated, ST-elevation myocardial infarction, and acute stroke patients were excluded along with

patients without complete data. The primary endpoint was the number of TM-guided interventions during transport. The diagnosis and characterization of the interventions were compiled. The Shapiro-Wilk test was performed to normality analysis. Patient age was described as the median and quartiles and other categorical variables as absolute numbers and percentages. The statistics were only descriptive, and no comparisons were made.

3. Results

From 2976 eligible patients, 2840 were enrolled as study participants (75 were excluded for STEMI, 53 for ongoing stroke, 6 for mechanical ventilation or persistent instability, and 2 for the absence of data).

The population was predominantly male (53.2%) with a median age of 60 years, with 25% aged 42 years and 75% aged 67 years.

Regarding the diagnosis, sepsis was the most prevalent among the enrolled patients (28%), followed by acute coronary syndromes in patients presenting without persistent ST-segment elevation (8.5%), arrhythmia (6.7%), venous thromboembolism (6.1%), stroke not eligible for thrombolysis (6.1%), acute abdomen (3.6%), multiple causes of respiratory distress (3.3%), and heart failure (2.5%). A small portion of the study population was suffering from poisoning (2%), airway disease (1.9%), and convulsion (0.9%). Very few patients were transported for trauma, serious orthopedic and obstetric problems, vertigo, toxic-metabolic problems, anaphylaxis, and other conditions (Table 1).

Table 1
Demographic data and diagnosis

Variable	Description
	(N = 2840)
Age (years), median (Q25, Q75)	60 (42, 67)
Gender	
Female, n (%)	1329 (46.8)
Male, n (%)	1511 (53.2)
Diagnosis	
Sepsis, n (%)	795 (28)
Non-ST-elevation ACS, n (%)	241 (8.5)
Arrhythmia, n (%)	190 (6.7)
Venous thromboembolism, n (%)	173 (6.1)
Stroke not eligible for thrombolysis, n (%)	172 (6.1)
Acute abdomen, n (%)	102 (3.6)
Respiratory distress, n (%)	94 (3.3)
Heart failure, n (%)	71 (2.5)
Poisoning, n (%)	57 (2)
Airway disease, n (%)	54 (1.9)
Convulsion, n (%)	26 (0.9)
Trauma, n (%)	25 (0.9)
Orthopedic, n (%)	13 (0.5)
GO conditions, n (%)	12 (0.4)
Vertigo, n (%)	11 (0.4)
Anaphylaxis, n (%)	11 (0.4)
Metabolic conditions, n (%)	10 (0.4)
Other, n (%)	773 (27.2)
ACS, acute coronary syndrome; GO, gynecological and obstetrical	

Only 22 (0.8%) patients required TM-assisted support during transport. Administration of oxygen therapy and analgesics were the main remotely-oriented interventions in 3 (13.6%) patients, intravenous (IV) hydration by hypotension in 2 (9.1%), and antihypertensive treatment in 2 (9.1%). In the other 12 cases, TM was triggered for monitoring evaluation, and there was no guidance on drug intervention.

Among the TM-assisted patients, 8 (36.3%) were observed to be suffering from severe clinical deterioration immediately after arriving at the main unit, and among the non-assisted patients, only 5 (0.2%). Just 9 (0.3%) transports experienced partial communication between the ambulance staff and TM (detected in standard communication of arrival at the hospital). There were no communication problems in the TM-assisted group (Table 2).

Table 2
– Telemedicine-assisted transport data

Variable	Description
	(N = 2840)
TM-assisted support, n (%)	22 (0.8)
TM-guided interventions	
Monitoring evaluation, n (%)	12 (54.5)
Oxygen, n (%)	3 (13.6)
Analgesic, n (%)	3 (13.6)
IV saline solution, n (%)	2 (9.1)
Antihypertensive, n (%)	2 (9.1)
Clinical deterioration after arriving	
TM-assisted support, n/n (%)	8/22 (36.3)
Non-TM-assisted support, n/n (%)	5/2818 (0.2)
Communication difficulties	
TM-assisted support, n/n (%)	0/22 (0)
Non-TM-assisted support, n/n (%)	9/2818 (0.2)
IV, intravenous	

4. Discussion

Interhospital transportation is a common event in a decentralized health network, and the ambulance transport of critical patients is associated with increased complications [13]. Safety transport needs basic non-human conditions such as appropriate equipment and vehicle and direct handover. However, the ambulance staff plays the most important role in patient support through intensive monitoring, early red flag recognition, and on-time stabilization [14].

Despite the conceptual importance of experienced staff, novice ED personnel are normally used in ground transport as well as other hospital doctors upon request [15]. The high cost of maintaining fixed high-quality professionals for transportation, mainly with idle periods and short trips, justify this organization [16]. These new professionals, usually tired and with interruptions in their activity and commute to help with transport, probably have field practice limitations. The temporary absence of these professionals during duty is also associated with crowding in the ED [17].¹⁷ In parallel, there is evidence to suggest that paramedics (which can be extrapolated to nursing in our country) have discernment in recognizing stable and critically ill patients and can abort transport if there is a high risk of instability. Presumably, these professionals screen for safer transportation situations, implying a low chance of medical intervention on the way [18, 19].

Some studies show that up to 15% of the patients transported in ambulances arrive at another hospital presented with hypotension or hypoxia, and a part of them have already experienced these changes at the beginning of the transport and not been diagnosed. In part, the reason can be attributed to the characteristics of the medical team that performs this type of transport, being mostly done by doctors with little experience [20].

It is noteworthy that the occupational risk is also greater in ambulance transport, especially when there is a need to provide care with vehicle movement [21]. Furthermore, approximately 40% of transport is unnecessary, suggesting the need for strict protocols before the patient can board the ambulance [22, 23]. Such evidence presumably supports the low probability of medical intervention during transport. The presence of more experienced physicians is an effective measure to ensure transport safety both in the initial assessment and in the handling of possible complications on the way [20]. In this study, the TM physician on duty had experience with critically ill patients, was working with low mental stress conditions, and the aid to transport had little impact on the care routine. This

data initially supports the cost-effectiveness of the strategy, with a positive impact on the ED teams who keep their doctors in situ. Furthermore, no impairment was found in TM activity.

TM is already a reality in health services, being useful in reducing the time for medical intervention and with a high rate of accuracy in diagnosis and cost-effectiveness [24]. The broad public, professional caregivers, and patients reported a positive attitude toward TM for emergency treatment during ambulance transportation and chronic care at home. These results support further improvement of TM solutions in these domains [25]. Adjusting for health status, socioeconomic status, and provider availability reduced the quartile 1 versus quartile 4 difference in ambulance transport rates. Geographic variability in ambulance use is large and associated with the variation in patient health status and their socioeconomic status [16].

In this study, ambulance transport was considered safe, with low rates of complications, contrary to what is shown in the literature, and little need for medical intervention. There are two key points in this finding: 1) the checklist made by the nursing staff who removed extremely unstable patients from this transport modality and 2) the nursing's ability to recognize a threatening situation, activate TM, and follow recommendations. It is noteworthy that in the study population, only 4.5% of the patients were eligible for the criteria to abort transfer without an onboard doctor. The extremely low rate of patients who became unstable on arrival at the main unit reinforces the effectiveness of the two key points. The vast majority of communications between the ambulance and remote physicians were effective, and there was no compromise in understanding any important recommendation. During transport, only 22 patients needed TM-support intervention, 12 being the only interpretation of data obtained in monitoring. The others had increased oxygen supply, administration of symptomatic drugs, IV hydration, or use of hypotensive agents. About one-third of the patients were found to be unstable when they arrived at the central unit, a situation recognized by changes in vital signs. There was no clear association of these changes with the lack of adequate support in transport; on the contrary, the patients maintained changes similar to the exit from the satellite unit: 3 cases of sepsis with borderline blood pressure, 2 cases of sustained hypertension, and 3 cases of non-critical hypoxemia. This emphasizes the very low number of patients in this situation and without a clear implication of the worst prognosis associated with transport. Although TM is already widespread, there are a few reports in the literature demonstrating the functioning of the interhospital transport system in partnership with TM.

This study demonstrated that telehealth offers a technology strategy to address the potentially unnecessary ambulance transports. Based on prior cost-effectiveness analyses, the reduction of unnecessary ambulance transports translates into an overall reduction in Emergency Medical System agency costs. Telehealth programs offer a viable solution to support alternate destinations and alternate transport programs [27].

The use of telehealth in transport allows qualified doctors to provide support to several ambulances, reducing the costs for the health-care system and optimizing team time management; however, it should be noted that there is a need for a well-prepared team (e.g., a qualified nurse). The interventions can be guided, when necessary, via TM without prejudice to the patient. There is already evidence of patients with low clinical severity and non-emergent conditions, and telehealth avoids inappropriate referrals in more than half of the cases. Presumably, these patients will not experience any complications during transportation [27].

The interhospital ambulance transportation is very common nowadays, and despite the assumed association of the need for hospitalization with greater severity, the vast majority of the patients stabilized in satellite units were transported uneventfully to the central unit. The very few cases that required any intervention during transport were properly guided by a TM-experienced doctor. A checklist before transportation can exclude the cases that need a doctor on board, such as patients with ST-elevation myocardial infarction, ongoing stroke, and intubates.

There are some limitations to this study. First, it is a retrospective cohort based on institutional care routine; second, some life-threatening situations have not been contemplated for, and finally, no comparison was drawn with similar groups transported with onboard doctors. With respect to the strength of this study, it reflects real-life practice with 2840 patients with prevalent conditions who were transported safely and with a better cost ratio.

5. Conclusion

TM-assisted ambulance transportation of stabilized critically ill patients can effectively and safely substitute an onboard physician on most transfers between same-institution locations. A simple 4G-network-enabled tablet held by plastic support and a Bluetooth headset is enough for effective communication considering the urban environment.

List Of Abbreviations

ED, emergency department

IV, intravenous

TM, telemedicine

Declarations

- Ethics approval and consent to participate: This work was approved by the Research Ethics Committee of Hospital Israelita Albert Einstein - reference number 34955620.0.0000.0071.
- Consent for publication: Not applicable.
- Availability of data and material: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.
- Competing interests: The authors declare they have no conflicts of interest related to the present manuscript.
- Funding: None.
- Authors' contributions: Conception, planning, analysis, and interpretation of data: Tarso A. D. Accorsi; Carlos H. S. Pedrotti. Data collection: Carlos H. S. Pedrotti; Jose R. de O. Silva Filho. The writing of the article or its critical intellectual review: Tarso A. D. Accorsi; Renata A. Morbeck; Karine De Amicis Lima. Responsibility for the final approval for publication: Tarso A. D. Accorsi; Karine De Amicis Lima; Eduardo Cordioli.
- Acknowledgements: The authors would like to thank the Telemedicine center IT team and the Emergency Transportation Unit of the Hospital Israelita Albert Einstein for the information technology support and the relevant services provided.

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