Prehospital Emergency Care

Telehealth Impact on Primary Care Related Ambulance Transports

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Abstract

Introduction: Telehealth has been used nominally for trauma, neurological, and cardiovascular incidents in prehospital emergency medical services (EMS). Yet, much less is known about the use of telehealth for low-acuity primary care. We examine the development of one telehealth program and its impact on unnecessary ambulance transports. **Objective:** The objective of this study is to describe the development and impact of a large-scale telehealth program on ambulance transports. **Methods:** We describe the patient characteristics and results from a cohort of patients in Houston, Texas who received a prehospital telehealth consultation from an emergency medicine physician. Inclusion criteria were adults and pediatric patients with complaints considered to be non-urgent, primary care related. Data were analyzed for 36 months, from January 2015 through December 2017. Our primary dependent variable was the percentage of patients transported by ambulance. We used descriptive statistics to describe patient demographics, chi-square to examine differences between groups, and logistic regression to explore the effects with multivariate controls including age, gender, race, and chief complaint. **Results:** A total of 15,067 patients were enrolled (53% female; average age 44 years ± 19 years) over the three-year period. The 3 primary chief complaints were based on abdominal pains (13% of cases), nausea/vomiting/diarrhea (NVD) (9.4%), and back pain (9.3%). Ambulance transports represented 11.2% of all transports in the program, while alternative taxi transportation was used in 75.6%, and the remainder were self- or no-transports. Taxi transportation to an alternate, affiliated clinic (versus ED) was utilized in 5% of incidents. After multivariate controls, older age patients presenting with low-risk, non-acute chest pain, shortness of breath, and dizziness were much more likely to use ambulance transport. Race and gender were not significant predictors of ambulance transport. **Conclusions:** We found telehealth offers a technology strategy to address potentially unnecessary ambulance transports. Based on prior cost-effectiveness analyses, the reduction of unnecessary ambulance transports translates to an overall reduction in EMS agency costs. Telehealth programs offer a viable solution to support alternate destination and alternate transport programs. **Key words:** emergency medical services; telemedicine; transportation of patients

Introduction

Emergency medical services (EMS) are responsible for prehospital treatment and transport of an estimated 240 million 9-1-1 callers nationwide each year (1). There is a growing concern that many of these are non-urgent, medically unnecessary transports (2). One study found an increase of 31% in non-urgent EMS transport during a recent 10-year period (3). Similarly, between 1996 and 2006, emergency department (ED) usage increased from 34.1 to 40.5 visits per 100 persons (4). Therefore, over 25% of ED visits were deemed non-emergency care and resulted in unnecessary resource utilization in the health care system (5).

Patients' motivation for seeking emergency care has been linked to multiple factors. Studies have found ED users attributed their decision to a perceived need for immediate evaluation, barriers to accessing outpatient services, being referred by a health care professional, and for other financial considerations (6, 7). While underlying motivations are likely multifactorial, the increasing non-urgent utilization of EDs has consistently been linked to increased healthcare costs approaching $4 billion annually (5). Increased non-urgent ED utilization has also been associated with increased wait times, added stress on staff, and lower continuity of care (8).

The American College of Emergency Physicians and the National Association of EMS Physicians have concluded that transportation to alternative destinations or non-transportation may be suitable

for non-urgent patients (9). Some studies have suggested that between 33–50% of all ambulance transports are medically unnecessary (10). Pairing this concept with telemedicine technology has been proven to reduce rates of transportation to EDs from a short-term correctional facility, with comparable rates of return to the ED within 7 days following consultation with no negative outcomes (11).

In an effort to improve productivity of EMS resources and to more appropriately manage patient volumes, the Houston Fire Department (HFD) initiated an alternative model that integrates telehealth technology, non-ambulance-based transportation, and expanded paramedic roles to triage non-urgent patients to more appropriate primary care settings. To our knowledge, this is the largest prehospital telehealth system in the country.

The objective of this study is to analyze a cohort of the first 3 years of patients and to assess changes in resulting ambulance transports. In addition, we sought to describe the patient characteristics, trends, and chief complaints of patients that have gone through the program.

Methods

Study Design

We performed an observational study using data from January 2015 to December 2017 for all patients that were triaged by telehealth in the ETHAN program. We compared differences in chief complaints, race, gender, and age between those patients that were transported by ambulance versus taxi or self-transport. All data used were de-identified, and the study was approved by the institutional review board at the University of Texas Health Science Center at Houston.

Study Setting

The study took place in the city of Houston which has a population of more than 2.3 million people within the city limits and 4.5 million across the broader metropolitan statistical area. The cohort of patients studied were participants in the Emergency Telehealth and Navigation (ETHAN) program operated by the Houston Fire Department (HFD) in Houston, Texas. The Houston Fire Department responds to all 9-1-1 callers and is the primary fire-based EMS department operating over 60 ambulances, 90 engines, 39 ladder trucks, and 35 medic response vehicles located at 93 fire stations across the 600 square mile region. HFD manages nearly 300,000 medical emergencies per year and is one of the largest EMS agencies in the country. ETHAN is an ongoing program incorporating telehealth triage with alternate transportation and follow-up social services to support different dispositions to more appropriate levels of care.

Study Protocol and Enrollment

This program was facilitated through telemedicine technologies utilized by emergency physicians at a centralized location to triage patients. On-scene paramedics determined eligibility for the program. First responders, including emergency medical technicians (EMT) and paramedics, arrived to meet the patient at the scene and were responsible for determining the status of the patient's condition. Patients were eligible to be enrolled in the program if they had non-life-threatening or mild illnesses and also met the following inclusion criteria: full history and physical with no emergency; age > 3 months; capable of communicating in English; vital signs within normal limits; afebrile if chronically ill or over 65 years of age; ability to care for self; and the ability to be transported in a passenger vehicle. Patients were excluded from the study if any of the following symptoms were present upon examination: acute, high-risk chest pain likely of cardiac origin post-electrocardiogram (ECG); temperature greater than 100.3 degrees; or specified neurological deficits.

If patients consented to a telehealth consultation, they were connected through an online call button on the paramedics' tablet (initiating a face-to-face conversation) with one of 16 board-certified emergency physicians. Typically, one or 2 physicians were online during the weekdays between 8:00 am and 5:00 pm. Telehealth was facilitated through a HIPAA-compliant and secure video conferencing software in which the physician and patient were able to interact with each other. In addition to the synchronous interaction with the patient, the physician had access to the patient's on-scene medical record, including the patient's chief complaint, demographics, medical history, allergies, vital signs, and medications. If the physician determined a patient did not need immediate medical attention, a same or next day referral for follow-up care at an affiliated federally qualified health center (FQHC) would be provided. This intervention protocol has been further described by Langabeer and colleagues (12).

Variables

Patient data were electronically extracted from the electronic patient care record (PCR) database (ImageTrend, Lakeville, MN) for all study

TABLE 1.   Characteristics of patients in the ETHAN program

Demographics	With ETHAN intervention ($n = 15,067$)	No ETHAN intervention ($n = 647,320$)
Age, mean (std)	44.1 (19)	48.4 (22.5)
<18, n (%)	799 (5.3)	49,844 (7.7)
18–35, n (%)	4,776 (31.7)	159,241 (24.6)
36–65, n (%)	7,548 (50.1)	280,937 (43.4)
>65, n (%)	1,944 (12.9)	157,298 (24.3)
Gender, % female	52.9%	51.5%
Race		
Black/African American, n (%)	8,483 (56.3)	302,298 (46.7)
Caucasian, n (%)	2,682 (17.8)	168,303 (26.0)
Hispanic, n (%)	2,456 (16.3)	161,183 (24.9)
Asian, n (%)	1,235 (8.2)	14,241 (2.2)
Other, n (%)	211 (1.4)	1,295 (0.2)

TABLE 2.   Frequency of modes of transportation for patients in the ETHAN program

Transport type, outcome	Telehealth intervention ($n = 15,067$)
Ambulance transports, n (%)	1,687 (11.2)
Taxi transport, n (%)	11,390 (75.6)
Self or no-transport, n (%)	1,990 (13.2)

participants. The primary dependent variable was whether patients were transported by ambulance. We also extracted for each incident the chief complaint type, disposition information (clinic or ED), patient's race, gender, and age.

Data Analysis

Data were extracted from the Houston Fire Department's electronic patient care record for the first 36 months of the program's inception. We used descriptive analyses to determine frequencies and central tendencies and compared univariate differences between groups using chi-square analyses. Logistic regression was used to explore differences for those patients who were transported by ambulance (vs. all others) to explore if effects persist after multivariate controls. We generally selected variables as the referent group, which were most prevalent or had the largest number of observations. Statistical significance was defined as $p < .05$. SPSS was utilized to perform all data analyses (SPSS Statistics, version 25, Armonk, NY: IBM Corp.).

RESULTS

There were 15,067 participants in the telehealth program from a total 865,000 EMS incidents during the study period from January 1, 2015 to December 31, 2017. This represents a 2% overall EMS volume

triaged by the ETHAN program. They were majority female (53% female), average age 44 years ± 19 years over the three-year period. Table 1 presents the patient characteristics relative to all other EMS incidents that were non-traumatic in nature. The 3 primary chief complaints were based on abdominal pains (13% of cases), nausea/vomiting/diarrhea (9.4%), and back pain (9.3%). Ambulance transports represented 11.2% in the telehealth program, while alternative taxi transportation was used in 75.6% of the cases. Of these, 5.0% of patients went by taxi to alternate, affiliated clinic instead of the emergency department. After multivariate controls, older age patients presenting with low-risk, non-acute chest pain, shortness of breath, and dizziness were much more likely to use ambulance transport. Race and gender were not significant. Table 2 presents the frequency of each mode of transportation.

To assess the types of complaints patients presented within the intervention, we employed a process of manual annotation and natural language processing (NLP) techniques to analyze the free text for chief complaint. The most common chief complaints were abdominal pain (in over 16% of all cases), followed by general pain and NVD. In examining differences between mode of transport (ambulance vs. non-ambulance), we found more patients were likely to be transported by ambulance for abdominal pain, low-risk chest pain, shortness of breath, and dizziness. As can be seen in Table 3, certain complaints such as shortness of breath and non-acute chest pain were significantly more likely to result in transport. Table 3 presents the frequency of each complaint type and the statistical differences for each complaint for those transported by ambulance compared to non-ambulance.

We applied a logistic regression model to control for multiple covariates including age, gender, race, and chief complaints. Only older age persisted as a significant demographic factor associated with use

TABLE 3.   Top 10 chief complaints experienced by patients in the ETHAN program

Complaint category	Total ($n = 8091$)	Non-Ambulance ($n = 7002$)	Ambulance ($n = 1079$)	p-value
Abdominal Pain, n (%)	2,484 (16.4)	2,143 (16.0)	331 (19.6)	<.001
General Pain/Weakness, n (%)	1,162 (8.4)	1,011 (7.6)	151 (8.9)	<.05
NVD, n (%)	981 (9.4)	872 (6.5)	109 (6.5)	ns
Lower Extremity Pain, n (%)	875 (6.3)	817 (6.1)	58 (3.4)	<.001
Back Pain, n (%)	860 (5.7)	780 (5.8)	80 (4.7)	ns
Chest Pain (low-risk), n (%)	458 (3.3)	318 (2.4)	140 (8.3)	<.001
Shortness of Breath, n (%)	399 (3.0)	311 (2.3)	88 (5.2)	<.001
Dizziness, n (%)	313 (2.1)	251 (1.9)	62 (3.7)	<.001
Low Grade Fever, n (%)	288 (1.9)	256 (1.9)	32 (1.9)	ns
Anxiety or Depression, n (%)	271 (1.9)	243 (1.8)	28 (1.7)	ns

ns = not significant.

TABLE 4.   Multivariate logistic regression model results

	Ambulance transport	
Patient characteristics	OR (95% CI)	p-value
Age	1.014 (1.005–1.023)	<.001
Female (ref: male)	1.091 (.972–1.210)	ns
Race		
Caucasian (ref)		ns
Black/African American	1.223 (.922–1.624)	ns
Hispanic/Latino	1.131 (.872–1.473)	ns
Asian	1.354 (.994–1.791)	ns
Other	1.703 (.982–2.962)	ns
Chief Complaint		
Abdominal Pain (ref)		<.001
General Pain/Weakness	.844 (.674–1.062)	ns
NVD	.793 (.613–1.031)	ns
Lower Extremity Pain	.392 (.284–.544)	<.001
Back Pain	.640 (.488–.840)	<.001
Chest Pain, (low-risk)	2.544 (1.973–3.279)	<.001
Shortness of Breath	1.567 (1.149–2.138)	<.05
Dizziness	1.658 (1.181–2.327)	<.01
Low Grade Fever	.888 (.564–1.396)	ns
Anxiety or Depression	.723 (.458–1.143)	ns

ns = not significant.

of ambulance transport. With regard to complaint type, the odds ratio (OR) for patients with low-risk chest pain was 2.54 (95% CI: 1.97–3.27). Thus, patients in this group were ×2.5 more likely to use ambulance transports, followed by patients with dizziness (1.6×) and patients with shortness of breath (1.5×) when compared with patients triaged by ETHAN with abdominal pain- the most common chief complaint. Complaints of lower extremity pain and back pain were significantly less likely to use ambulance transport. Table 4 presents the regression results for likelihood of ambulance transport.

DISCUSSION

In this large regional cohort of patients utilizing a telehealth intervention, we report several findings. First, we found that the percent of ambulance transports was only 11%. Most of these patients were still referred to the hospital ED; however, they were offered alternative transportation following telehealth triage. Although the EMS agency will forgo payment for a transported patient, allowing alternative transportation to the ED permits paramedic units to immediately be put back into service and respond to emergent events. This represents a cost-savings from the payer perspective and possibly to the healthcare system as EMS responds to more appropriate levels of care. Second, patients who participated in the ETHAN program were more likely to be African American and female between 36 and 64 years of age. Third, patients presenting with specific chief complaints are more likely to be referred for non-ambulance transportation, such as lower extremity and back pain. Chest pain in this study was considered to be non-acute or low risk following an ECG and evaluation by the physician in the telehealth setting; however, this persisted as a factor supporting the use of ambulance. More acute forms of chest pain, involving abnormal rhythms or ST-elevation myocardial infarction, would have immediately been transported to the ED. In addition, dizziness and shortness of breath most commonly were transported by traditional ambulance after adjusting for demographic differences. Therefore, the lower rates of ambulance transports associated with certain complaint types, such as back pain, seem to be more aligned with reduced ambulance transports. Changing the inclusion criteria around these complaint types could help to further reduce the need for transport for this program, as well as other agencies adopting similar initiatives.

In a prior cost-effectiveness analysis, the estimated cost impact for a prehospital telehealth intervention is roughly $103 less than the traditional EMS care, primarily through productivity savings generated from returning physical assets and personnel to service faster (13). The majority of the savings, inclusive of ladder trucks and other resource intensive supplies, are derived from allowing

paramedics to return to work faster to respond to emergent events. This program had a significant impact on reducing ambulance transports. Generalizing these findings suggests significant opportunities to improve EMS agency productivity, which is especially important in busy, resource-constrained agencies. Additional research will have to consider how to incorporate alternate destinations (beyond the ED), since in this study we found only a minority of patients (5%) accepted referrals to clinics rather than the ED.

Although there have been several research studies examining telehealth, there has not been any which explore telehealth impact on ambulance transport (14). Prior studies on telehealth have largely focused on neurological emergencies, acute myocardial infarction, and traumatic events and only a few studies have explored primary care related EMS telehealth incidents (15). The data presented examine the relationship between ambulance transport and telehealth utilization from a large metropolitan agency. These findings should be used to inform health policy and reimbursement practices at the state and national level and to guide other EMS agencies with their quality improvement initiatives for large-scale non-ambulance transportation. Other studies are beginning to examine the acceptability of alternatives to the standard transport option (16, 17). We found many patients are willing to accept alternatives. While there are significant cost savings from reducing ambulance utilization, there are also additional costs that an agency would have to consider. Reimbursement mechanisms, which incentivize ambulance transports to an ED, will continue to be a problem until health policy and reimbursement practices change. Funding alternative taxi transportation requires a different operational mindset about finances, that is, cost reductions in one area can fund investment in others. As a result, our findings suggest that a reduction in ambulance transports coupled with increased use of alternative taxi transportation, will yield a substantial improvement in operational costs. This study was partially funded by the Texas Medicaid 1115 waiver program known as the Delivery System Reform Incentive Payment Program, which encouraged innovation in care delivery to fund new programs. Without such funding, other agencies would need to consider how to operationalize a similar program in their own service.

It is interesting to note telehealth consultations between the physician and patient were effective at reducing ambulance transports but did not produce significant effects of changing the eventual destination. Most patients still preferred the ED, even if they went by taxi instead of ambulance. One of the

long-term objectives for telehealth utilization should be to reduce both ambulance transports and unnecessary ED visits. This study as designed left the disposition decision with the patient, although the choice of transport rested with the EMS agency and physician.

There are several opportunities for future research. First, there might be certain geographical areas where patients who appeared to meet the criteria might not have been referred to ETHAN based on provider compliance or cultural issues. We aim to explore this further in a subsequent analysis. Second, there is an opportunity to identify a control group that more closely meets the sample characteristics, including demographic, geographic, and patient factors.

Our study had several limitations. First, we were limited that all data were extracted from the agency's PCR system. As with most prehospital PCRs, there were concerns regarding data quality and accuracy despite efforts at validation and cleansing prior to analyses. A second limitation was the lack of longitudinal information about the patient after the initial EMS incident. Future studies will consider the impact of other non-EMS healthcare utilization, using the health information exchange for example, to explore outcomes after the telehealth consultation. A final limitation was participation in the ETHAN program was dependent upon first responder recognition and initiation. This may have been higher in some areas due to organizational culture, motivation of the workforce, or training.

CONCLUSION

In a three-year cohort of patients in a telehealth study, we found prehospital utilization of telehealth has the potential to reduce unnecessary ambulance transports for primary care related incidents. In addition, there are significant variables that were associated with the use of ambulance in this program. Based on prior cost-effectiveness analyses, a reduction in ambulance transports offered less resource intensive alternative transportation. We found this telehealth program to support alternate destination and transport for patients seeking prehospital primary care related care.

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