

Use of 911 for Rapid Re-Triage of Critical Trauma Patients

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Abbreviations:

ED: emergency department
EMS: Emergency Medical Services
IFT: inter-facility transfer
ISS: injury severity score
LA: Los Angeles
TC: trauma center
TEMIS: Trauma and Emergency Medical Information System

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Abstract

Objectives: The objective of this study was to evaluate the effectiveness of a 911 trauma re-triage protocol implemented at a new community hospital in a region with a high volume of trauma and frequent transports by private vehicle.

Methods: This retrospective cohort study included all trauma patients ≥ 15 years old transferred via 911 trauma re-triage from a new community hospital over a 10-month period from August 2015 through April 2016. Criteria for 911 trauma re-triage were developed with input from local Emergency Medical Services (EMS) and trauma experts. An educational module, along with the criteria and implementation steps, was distributed to the emergency department (ED) personnel at the community hospital. Data were abstracted from the regional trauma registry, and the EMS patient care records were reviewed. Primary outcomes were: (1) median total transport time; and (2) proportion of patients who met the 911 re-triage criteria.

Results: During the study period, 32 patients with traumatic injuries were transferred via 911 re-triage to the closest trauma center (TC). The median age of patients was 31 years (IQR 24–45 years) with 78% male and 66% suffering from a penetrating mechanism. The median prehospital provider scene time was 10 minutes (IQR 8–12 minutes) and transport time was seven minutes (IQR 6–9 minutes). Median total transport time was 17 minutes (IQR 15–20 minutes). Seventeen patients (53%) met 911 re-triage criteria as determined by study investigators. The most common criteria met was “penetrating injury to the head, neck, or torso” in 14 cases.

Conclusion: This study demonstrated that 911 re-triage was a feasible strategy to expeditiously transfer critical trauma patients to a TC within a mature trauma system in an urban-suburban setting with a median total transport time of 17 minutes.

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Introduction

Trauma is a major public health concern and leading cause of death in the United States for those aged one to 44 years old.¹ Los Angeles (LA) County (California USA) has not been immune to this problem with an overall trauma center (TC) volume in 2008 of approximately 19,000, which increased to over 23,000 in 2017 across 15 TCs.² For patients with critical injury, it has been well-established in current literature that treatment at a designated TC improves overall outcomes.^{3–6} While Emergency Medical Services (EMS) systems have been designed to identify trauma patients for direct routing to TCs, patients with traumatic injuries may also present to a non-TC via private vehicle or due to EMS under-triage. In these cases, secondary transportation to a TC is required to ensure optimal patient outcomes.

Typically, inter-facility transfers (IFTs) are coordinated between individual hospitals, often involving a transfer center, and require identification of an accepting physician at the receiving center. Private ambulance transport is then arranged by the sending facility. In trauma systems, delays in IFTs often stem from difficulties in identification of a receiving facility, preparation of documentation, successful completion of physician-to-physician communication, and/or arrangement of timely ambulance transportation.^{7–10} While this traditional process of IFT may be effective for stable patients, delays in IFTs cause harm to patients experiencing time-critical emergencies.⁷ In particular, for critical trauma patients at local community hospitals who require expeditious transport to definitive care for emergent interventions, this process is inappropriately lengthy. Use of an established 911 system offers a rapid alternative for effective IFTs for these trauma patients.^{8,11}

9-1-1 TRAUMA RE-TRIAGE

Determine if patient meets 9-1-1 Trauma Re-triage Criteria:

Perfusion:

- Persistent signs of poor perfusion
- Need for immediate blood replacement therapy

Respiratory Criteria:

- Intubation required

GCS / Neurologic Criteria:

- GCS <9
- GCS deteriorating by 2 or more during observation

Anatomic Criteria:

- Penetrating injuries to head, neck, chest, or abdomen
- Extremity injury with neurovascular compromise or loss of pulses

Provider Judgment:

- Patients, who in the judgment of the evaluating emergency physician, have a high likelihood of requiring emergent life- or limb-saving intervention within 2 hours

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Figure 1. 911 Trauma Re-Triage.

Abbreviation: GCS, Glasgow Coma Scale.

In 2015, a new community hospital opened in LA County in an area with a high trauma burden, where frequent transports by private vehicle were anticipated. In response, the LA County EMS system developed a pilot program to activate the established 911 system for rapid transport of these patients to the closest TC. The primary objective of this study was to describe the effectiveness of 911 trauma re-triage with regard to timeliness of IFTs. A secondary objective was to assess protocol adherence by the sending hospital.

Methods

This was a retrospective cohort study utilizing data from the regional trauma registry and individual patient care records. The study was reviewed and approved by the Institutional Review Board at the Lundquist Research Institute (Torrance, California USA; protocol ID # 042614).

The LA County EMS Agency oversees a regional trauma system serving over 10 million residents with 30 fire-based public provider EMS agencies and one law enforcement agency transporting patients to 14 designated TCs and covering LA County's 4,085 square miles. In 2015, a new 131-bed community hospital was opened in LA serving an urban/suburban region of approximately 1.3 million predominantly black and Hispanic residents. Four years after opening, the emergency department (ED) volume at this community hospital was estimated at approximately 90,000 patients per year. The nearest designated TC was located just under three miles away. Historically, inter-facility trauma transfers in LA County were coordinated by a centralized transfer center and required identification of an accepting physician at the receiving TC. Private ambulance transport was then arranged by the sending facility. Given the high trauma burden in the selected area and anticipation of injured patients arriving by private vehicle, the LA County EMS Agency implemented a 911 trauma re-triage policy to allow for rapid transport of trauma patients from the community hospital to the nearest TC with unconditional acceptance.

The 911 re-triage protocol was developed based on recommendations from a state EMS workgroup along with input from local experts at the LA County EMS Agency and regional TCs.¹² Per protocol, IFTs to the TC were conducted via the public fire-based EMS provider who was the sole 911 provider serving this region. Prior notification of the transfer was provided, as able; however, acceptance of the transfer was based on prior agreement between the centers and did not require direct physician-to-physician communication. In advance of implementation, an educational module, along with the criteria and implementation steps, were distributed to ED providers and staff at the community hospital.

Patients included were 15 years or older who sustained a traumatic injury and were transported via 911 re-triage from the community hospital to the nearest designated TC. Patients transported by private ambulance for routine IFTs and those transported to other TCs were excluded. Data were routinely submitted by TCs in LA County to the EMS Agency on all trauma victims with at least one ICD-9 injury diagnostic code within the range of 800-959.9 or ICD-10 S00-S99 or T79.A1-T71.A9 and maintained in LA County's Trauma and Emergency Medical Information System (TEMIS). Data received from all trauma centers are verified by an epidemiologist based at the LA County EMS Agency for completeness, logical consistency, duplication, and formatting. Data completeness is maintained at >90% for all fields. Identified deficiencies and errors are sent back to the TC for correction, and updated information is automatically uploaded to TEMIS every 24 hours. Quarterly reports are generated and disseminated to the system for use in quality improvement. This study was a retrospective analysis of patient data contained in the TEMIS.

Data were downloaded to an Excel file (Microsoft Corporation; Redmond, Washington USA) from TEMIS from August 1, 2015 through May 31, 2016 by a registered nurse working within her normal job duties, blinded to the study hypothesis and outcomes. Variables abstracted included age, sex, race/ethnicity; mechanism of injury; injury severity score (ISS); EMS times (response time, scene time, and transport time); TC treatments; disposition from the ED (admission, and to what level of care, or discharge); and patient outcome (lived/died) at discharge from the TC. All variables were defined based on the TEMIS data dictionary available to the investigators.¹³ Time values were recorded by prehospital providers via the Computer-Aided Dispatch system and automatically transmitted to the electronic patient care record for upload into TEMIS. Total transport time was defined as EMS arrival at the transferring hospital to arrival at the TC (ie, inclusive of scene time and transport time). Total transfer time was defined as EMS response to arrival at the TC (ie, inclusive of EMS response time, scene time, and transport time).

Rationale for transport was determined from review of the corresponding prehospital care report for each patient, including the narrative summary of events. Two investigators, board certified in Emergency Medicine and EMS and trained on the 911 re-triage policy, independently reviewed the prehospital patient care report to determine: (1) whether the patient met 911 re-triage criteria by policy (Figure 1); and (2) whether the investigator agreed with the decision for 911 trauma re-triage. Investigators were blinded to the treatment and outcome at the TC. In the case of disagreement, a third senior EMS physician investigator, also trained on the 911 re-triage policy, reviewed the case to determine the final decision.

The primary outcome was median total transport time. Secondary outcomes were the proportion of patients meeting

Characteristics	n	%
Gender		
Female	7	22%
Male	25	78%
Race/Ethnicity		
Non-Hispanic Black	13	39%
Hispanic	14	45%
Non-Hispanic White	1	3%
Other or Undocumented	4	13%
Age in Years (median, IQR)	31	24-25
Mechanism		
Blunt	11	34%
Penetrating	21	66%
Injury Severity Score (median, IQR)	4	1-10
Time (median, IQR)		
EMS Response Time (minutes)	4	2-5
Scene Time (minutes)	10	8-12
Transport Time (minutes)	7	6-9
Total Transport Time (minutes) ^a	17	15-20
Total Transfer Time (minutes) ^b	21	18-25

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Table 1. Patient Characteristics and Transfer Times (n = 32)
Abbreviation: EMS, Emergency Medical Services.

^aTotal transport time includes scene time and transport time.

^bTotal transfer time includes response time, scene time, and transport time.

re-triage criteria and whether investigators agreed with the decision for 911 trauma re-triage. Each case was also reviewed to determine whether the patient would have met field trauma triage criteria for direct transport to a TC, based on LA County trauma triage policy.¹²

Data were maintained in Microsoft Excel and uploaded into SAS 9.4 (SAS Institute; Cary, North Carolina USA) for statistical analysis. Descriptive statistics were calculated with median and inter-quartile range (IQR) or frequencies and proportions, as appropriate.

Results

During the study period, 32 patients with traumatic injuries were transferred via 911 re-triage to the nearest TC. Patient characteristics are shown in Table 1. Twenty-five (78%) were male; 39% black, 45% Hispanic, 13% other or undocumented race/ethnicity, and 3% white. The median age was 31 years old (IQR 24-45 years). Twenty-one (66%) had a penetrating mechanism of injury. Median injury severity score (ISS) was four (IQR 1-10).

Overall response and transport times were short. The median 911 prehospital provider response time was four minutes (IQR 2-5 minutes), median prehospital provider scene time was 10 minutes (IQR 8-12 minutes), and median transport time was seven minutes (IQR 6-9 minutes). The median total transfer time via 911 was 21 minutes (IQR 18-25 minutes; Table 1).

Seventeen patients (53%) met 911 re-triage criteria as determined by study investigators (Table 2). Agreement between investigators was 97% (31 of 32 cases). Investigators concurred with the decision to utilize 911 re-triage for the same 17 patients; investigator agreement 91% (29 of 32 cases). In cases of disagreement, final classification was determined by a third investigator.

The most common criteria met was “penetrating injury to the head, neck, or torso” in 14 cases. Two patients, by investigator judgment, met the criteria “high likelihood of requiring emergent life- or limb-saving intervention within two hours,” both had sustained a gunshot wound to the buttock. “Intubation required” and “extremity injury with neurovascular compromise” were present in one patient each (Table 2 and Table 3). Twenty-seven patients (84%) would have met EMS trauma triage criteria for primary transport to a TC as delineated by LA County trauma triage policy.¹²

Overall, 22 (69%) patients were admitted to the TC, including seven to the operating room and four to the intensive care unit. Three patients required packed red blood cell transfusions. All patients survived to hospital discharge.

Discussion

This study demonstrated that implementation of a 911 trauma re-triage protocol for patients with critical injuries initially presenting to a non-TC was a feasible approach for timely transfer to definitive care at a designated TC. Furthermore, after a brief initial training, local community hospital providers were able to effectively utilize this 911 re-triage protocol to appropriately transfer trauma patients in more than 50% of the cases. Through rapid transfer to definitive care, this may improve outcomes for select patients needing time-sensitive interventions not available within the community hospital setting.

To date, only two prior studies have assessed 911 re-triage for critically injured trauma patients; both took place within urban/suburban centers in California. Kuncir, et al conducted a retrospective study assessing 911 re-triage in Orange County, California from 2014 through 2015, where a 911 trauma re-triage policy has been in effect to move all trauma patients to the TC since the mid-2000s. They noted a median total transfer time in that system of 122.5 minutes (defined as time of patient arrival at the transferring hospital to time of arrival to the TC).⁸ This differs from the current study because the time interval was assessed starting from time of patient arrival at the non-TC, which allowed inclusion of decision time prior to initiation of patient transfer, and patients mostly suffered from blunt trauma. Della Valle, et al undertook a retrospective observational study in the San Francisco Bay Area from 2013 through 2015, comparing 911 re-triage to conventional IFT. The authors found a decrease of 81 minutes in median total transfer time (defined as time of patient arrival at the transferring hospital to time of arrival at the TC) between 911 re-triage and conventional IFT (172 minutes versus 258 minutes, respectively).⁹ Patients with penetrating trauma had a much shorter median transfer time via 911, 96 minutes, in comparison to blunt trauma via 911 at 198 minutes, suggesting the decision time may be longer for patients with a blunt traumatic mechanism.

In the current study, the median total transfer time from initiation of the 911 response at the transferring hospital to arrival at the TC was 21 minutes. By defining the total transfer time as beginning with EMS activation, this better quantifies the burden on the 911 system and removes the variability of the decision-making process at the transferring center in regards to activating the transfer process. Unfortunately, the differing definitions of total transport/transfer times between the aforementioned studies and this investigation prevent direct comparison of time values. Yet overall, these reports collectively demonstrate the feasibility of 911 re-triage systems as a means to expeditiously move trauma

Patient	Age	Gender	Met Criteria	Specific 911 Re-Triage Criteria Met	Description of Patient, Mechanism of Injury, and Rationale for Transfer if did not meet 911 Re-triage Criteria	Disposition and Level of Care
1	31	M	Yes	Penetrating injury to torso		Discharged home from ED
2	43	M	No		Wrist laceration with rotary saw with concern for arterial injury; hemostasis achieved and documented normal neurologic exam and perfusion to extremity	Admitted to ward
3	24	M	Yes	Penetrating injury to head		Discharged home from ED
4	29	M	No		Auto vs Pedestrian with no evidence of trauma and complaint of foot numbness	Admitted to ward
5	38	F	No		Assault with blunt head trauma and intracranial hemorrhage on CT head; stable vital signs, GCS 15, normal neurological exam	Admitted to ICU
6	19	F	No		Motorcycle accident with clear discharge from nares; ambulatory on arrival, GCS 15, normal neurological exam	Discharged home from ED
7	23	M	Yes	Penetrating injury to torso		Taken directly to OR
8	49	M	No	NA	Fall from height with hip and flank pain; stable vital signs	Admitted to ward
9	36	M	Yes	Neurovascular compromise, high likelihood of requiring emergent life- or limb-saving intervention		Taken directly to OR
10	25	M	Yes	Penetrating injury to torso		Discharged home from ED
11	50	M	Yes	Penetrating injury to torso		Admitted to ward
12	25	M	Yes	Penetrating injury to neck		Taken directly to OR
13	29	M	No		Stab wound to thigh; stable vital signs, hemostasis achieved	Taken directly to OR
14	53	M	No		Assault with blunt head trauma and intracranial hemorrhage on CT head; stable vital signs, GCS 15, normal neurological exam	Admitted to ICU
15	28	F	Yes	Penetrating injury to torso		Taken directly to OR
16	32	M	Yes	Penetrating injury to torso		Discharged home from ED
17	47	M	Yes	Penetrating injury to torso		Admitted to ward
18	19	M	No		Gunshot wound to forearm; stable vital signs, hemostasis achieved, normal neurological exam and perfusion to extremity	Admitted to ward
19	34	M	Yes	Penetrating injury to torso, Intubation required		Taken directly to OR
20	23	M	Yes	Penetrating injury to torso		Admitted to ward
21	30	M	Yes	High likelihood of requiring emergent life- or limb-saving intervention		Discharged home from ED
22	40	M	Yes	High likelihood of requiring emergent life- or limb-saving intervention		Admitted to ward

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Table 2. Criteria/Rationale for Transfer and Disposition Outcome by Individual Patient (*continued*)

Patient	Age	Gender	Met Criteria	Specific 911 Re-Triage Criteria Met	Description of Patient, Mechanism of Injury, and Rationale for Transfer if did not meet 911 Re-triage Criteria	Disposition and Level of Care
23	25	F	No		Motor vehicle accident with right lower quadrant pain, seatbelt injury and extremity injuries; stable vital signs, GCS 15	Discharged home from ED
24	22	M	No		Gunshot wound to upper arm with reported retained bullet in extremity; stable vital signs, hemostasis achieved, normal neurological exam and perfusion to extremity	Admitted to ICU
25	22	M	No		Assault with blunt head trauma and basilar skull fracture on CT scan; stable vital signs, GCS 15, normal neurological exam	Admitted to ward
26	64	F	No		Motor vehicle accident with reported face and abdominal trauma (LUQ ecchymosis on exam); stable vital signs, GCS 15	Admitted to ward
27	40	M	No		Assault with blunt head trauma and reported scalp lacerations and blurry vision; stable vital signs, GCS 15, normal neurological exam	Admitted to ward
28	57	M	Yes	Penetrating injury to torso		Taken directly to OR
29	20	F	Yes	Penetrating injury to head		Discharged home from ED
30	21	F	Yes	Penetrating injury to torso		Discharged home from ED
31	56	M	No		Auto vs Pedestrian with bilat mandible fractures on CT scan; combative, GCS 14 - oriented to person, stable vital signs	Discharged home from ED
32	52	M	No		Motor vehicle accident with spleen injury on CT scan; stable vital signs, GCS 15	Admitted to ICU

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Table 2. (continued). Criteria/Rationale for Transfer and Disposition Outcome by Individual Patient
Abbreviations: CT, computed tomography; ED, emergency department; GCS, Glasgow Coma Scale; ICU, intensive care unit; OR, operating room.

Persistent Signs of Poor Perfusion	0
Need for Immediate Blood Replacement Therapy	0
Intubation Required	1
Glasgow Coma Scale less than 9	0
Glasgow Coma Scale Deteriorating more than 2 Points during Observation	0
Penetrating Injuries to Head, Neck, and Torso	14
Extremity Injury with Neurovascular Compromise or Loss of Pulses	1
High Likelihood of Requiring Emergent Life- or Limb-Saving Intervention within 2 Hours	2

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Table 3. Frequency of Each Re-Triage Criteria
Note: Patients could meet more than one criterion.

patients to definitive care within a developed regional trauma system. In comparison, transfer times for trauma patients utilizing the standard IFT process range from two hours to greater than four hours in some studies, though varying definitions of transport/transfer time were used.^{7,9,10,14} It is well-described in current literature that timely treatment at a TC, ideally via direct transport to a TC or secondarily via rapid transfer to a TC from a non-TC, results in reduced morbidity and mortality for trauma patients.^{3,4,7,15,16} Though 911 re-triage is not a replacement for direct routing, it can minimize delays to definitive care for critically injured patients who arrive at a non-TC, with a median total transfer time from EMS notification to arrival at the TC of 21 minutes in this cohort. Furthermore, Kuncir, et al demonstrated similar mortality rates for transfer patients utilizing 911 trauma re-triage compared with direct transport of trauma patients within their system.

This study adds to the prior literature demonstrating both the effectiveness (in regards to transfer time) and the appropriateness of 911 use (in regards to protocol adherence) after implementation of a 911 trauma re-triage protocol. Della Valle, et al evaluated a similar set of criteria in the San Francisco Bay area, however, the authors did not evaluate protocol adherence as an outcome.⁹ In this study, all injuries identified at the non-TC necessitating 911 trauma re-triage according to protocol were due to penetrating trauma, most often to the head, neck, or torso. Of those transferred that did not satisfy 911 re-triage criteria, the majority suffered from blunt trauma or penetrating trauma isolated to an extremity. All had stable vital signs documented by the 911 provider.

In this study, investigators agreed that 911 transport was not appropriate in all cases that did not meet the 911 re-triage criteria, thus supporting the existing re-triage criteria. Although not all trauma patients will require 911 re-triage, transfer may still be appropriate for some trauma patients via standard transfer procedures as evidenced by the rate of admission in this cohort (69%). Patients may also benefit from subspecialty consultation not available at the non-TC. However, these transfers should be conducted on a non-emergent basis, thus reducing the burden on the 911 system.

Critics of 911 re-triage practices cite concerns over limited prehospital resources and risk of exceeding paramedic scope of practice, as well as the potential for over-use. As evidenced by this study and others, these transfers can be conducted efficiently with time intervals consistent with published average prehospital trauma response times.^{11,17} In a study by Eckstein, et al, IFTs made up 0.1% of all ambulance transports.¹¹ Additionally, in cases where interventions or treatments performed at the referring hospital require continued management that exceeds paramedic scope of practice (eg, infusion of blood products or monitoring of a chest tube), it may be feasible in some instances for hospital personnel to accompany paramedics. Alternatively, where appropriate, the specific interventions may be temporarily discontinued for transport.¹¹ In the current study, no patients required any additional personnel from the referring hospital to accompany the paramedics due to interventions exceeding paramedic scope of practice. In the case of the intubated patient, paramedics were able to manually ventilate during the transport.

Finally, concerns of over-use must be weighed against the risk of under-triage. Despite evidence of over-triage in this small pilot study, this degree of over-triage (25%–35%) is acceptable according

to the American College of Surgeons Committee on Trauma (Chicago, Illinois USA) in order to prevent dangerous under-triage.¹⁸ Of note, the vast majority of patients transferred in this study met field trauma triage criteria for direct transport to a TC within the same regional system.¹² Additionally, given that this was a relatively novel protocol implemented in a new ED, it is conceivable that with increased protocol familiarity and quality improvement, apparent over-use of the 911 re-triage system would decrease over time. Future analyses are planned to evaluate the level of over-triage subsequent to adapting the 911 trauma re-triage policy system-wide.

Limitations

This study has several limitations. First, the retrospective nature of the study and lack of a comparison group limits what can be inferred from patient outcomes. This protocol was implemented upon the opening of the local community hospital, and as such, there were no prior data on trauma transfers via the standard process against which to compare. Although data from the EMS providers and TCs were available, it was not possible to obtain records from the community hospital; therefore, the rationale for transport is based on the injuries as documented by transporting EMS providers. The time of arrival at the community hospital is also unknown, so the total time to transfer could not be calculated from patient arrival. Although EMS activation times and transport times were relatively short, this study does not attempt to further quantify the burden on the 911 system, including delays in responding to primary 911 calls or need to bring resources in from surrounding areas. Finally, this study took place between one referring and one receiving institution in an urban region within a mature trauma system and significant prehospital resources. As such, study findings may not be generalizable to dissimilar settings including rural areas or regions with developing trauma systems.

Conclusions

This pilot study demonstrates the feasibility and effectiveness of 911 re-triage protocols for rapid transfer of critical trauma patients to a TC in an urban region with a mature trauma system, with a median transport time of 17 minutes. This study serves as a foundation for other regions to develop trauma-centered 911 re-triage protocols, as well as for future studies in the Los Angeles County to assess the on-going county-wide efficacy of this protocol.

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