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Deciphering the Use and Predictive Value of “EMS Provider Judgment” in Out-of-Hospital Trauma Triage: A Multi-site, Mixed Methods Assessment

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Abstract

Background—“EMS provider judgment” was recently added as a field triage criterion to the national guidelines, yet its predictive value and real-world application remain unclear. We

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examine the use and independent predictive value of EMS provider judgment in identifying seriously injured persons.

Methods—We analyzed a population-based retrospective cohort, supplemented by qualitative analysis, of injured children and adults evaluated and transported by 47 EMS agencies to 94 hospitals in 5 regions across the Western U.S. from 2006–2008. We used logistic regression models to evaluate the independent predictive value of EMS provider judgment for ISS ≥ 16 . EMS narratives were analyzed using qualitative methods to assess and compare common themes for each step in the triage algorithm, plus EMS provider judgment.

Results—213,869 injured patients were evaluated and transported by EMS over the 3-year period, of whom 41,191 (19.3%) met at least one of the field triage criteria. EMS provider judgment was the most commonly used triage criterion (40.0% of all triage-positive patients; sole criterion in 21.4%). After accounting for other triage criteria and confounders, the adjusted odds ratio (OR) of ISS ≥ 16 for EMS provider judgment was 1.23 (95%CI 1.03-1.47), although there was variability in predictive value across sites. Patients meeting EMS provider judgment had concerning clinical presentations qualitatively similar to those meeting mechanistic and other special considerations criteria.

Conclusions—Among this multi-site cohort of trauma patients, EMS provider judgment was the most commonly used field trauma triage criterion, was independently associated with serious injury and was useful in identifying high risk patients missed by other criteria. However, there was variability in predictive value between sites.

Keywords

trauma; triage; judgment; serious injury

INTRODUCTION

The guidelines for field trauma triage were originally developed by the American College of Surgeons Committee on Trauma (ACSCOT) in 1976,¹ with periodic revisions over the past three decades, most recently in 2006.^{2,3} Because these guidelines serve as the basis for field triage in the U.S. and have been widely implemented by trauma systems, modifications to the triage algorithm are noteworthy and carry a large impact on out-of-hospital care. One of the criteria added to the 2006 revised guidelines was “EMS provider judgment,”³ though literature demonstrating the utility of provider judgment has been mixed.⁴⁻¹² Previous studies have suggested that EMS provider judgment can improve the sensitivity of field triage,^{5-7,9,10,12} enhance the accuracy of other triage criteria,¹¹ or have no effect on triage accuracy.^{4,8} A recent review of the literature found “no clear evidence supporting paramedic judgment as an accurate triage method,” but noted that variability in outcome measures and research methodology limited definitive conclusions.⁴

One of the challenges with evaluating the independent predictive value of EMS provider judgment is that this factor likely affects the interpretation and application of all other triage criteria. That is, EMS provider judgment is a term representing field provider cognitive reasoning, rather than a single, explicit triage criterion. While the triage guidelines are algorithmic and assume that field providers follow a step-wise approach to identifying and triaging seriously injured patients, recent research suggests that out-of-hospital triage is rapid, dynamic, heuristic, non-algorithmic and driven largely by provider judgment.¹³ Although provider judgment may be central to the decision-making process of triage, the frequency of use and value of EMS provider judgment remain unclear.

In this study, we examine the use and independent predictive value of EMS provider judgment in identifying patients with serious injuries or requiring specialized trauma resources among a broad multi-site cohort of trauma patients treated by multiple EMS agencies and hospitals in the Western U.S.

MATERIALS and METHODS

Study Design

This was a multi-site, population-based retrospective cohort study, supplemented by qualitative analyses (i.e., a mixed-methods study).

Study Settings

This study included patients evaluated by 47 EMS agencies and transported to 94 hospitals (8 Level I trauma centers, 3 Level II trauma centers, 3 Level III hospitals, 4 Level IV hospitals, 1 Level V hospital and 75 non-trauma hospitals) over a 36-month period (January 2006 – December 2008) in 5 sites across the Western U.S. Sites included: Portland, OR/ Vancouver, WA (4 counties); King County, WA; Sacramento, CA (2 counties); San Francisco, CA; and Santa Clara, CA (2 counties). The sites are part of the Western Emergency Services Translational Research Network (WESTRN), a consortium of geographic regions, EMS agencies and hospitals linked through Clinical and Translational Science Award (CTSA) centers. Each site consists of a pre-defined geographic “footprint” typically including a central metropolitan area and surrounding territories, defined using EMS agency service areas. Most sites are urban and suburban, although some rural and frontier areas are also included. All sites have established trauma systems, use standardized trauma triage protocols¹⁴ based on the ACSCOT Field Triage Decision Scheme to guide patient identification and transport decisions by EMS, and use a variety of EMS system structures and response types. Site demographics, EMS system structures and hospitals are summarized in Table 1. Twelve Institutional Review Boards at the 5 sites reviewed and approved this protocol.

Patient Population

The study sample included all patients (children and adults) for whom the 9-1-1 EMS system was activated within the 5 geographic regions, EMS provider(s) recorded a primary impression of “injury” or “trauma,” and who were transported to an acute care hospital (either a trauma or non-trauma center). Specifying the sample in this manner allowed for a broad, population-based, out-of-hospital injury cohort defined through the lens of EMS providers and a sample representative of the denominator to whom the field trauma triage guidelines are routinely applied, including patients with mild and severe injuries, meeting and not meeting field triage criteria. Interhospital transfers without an initial EMS response were excluded, although all injured patients within the study regions who were initially transported by EMS were included regardless of subsequent transfer to another hospital. EMS records listed as “cancelled,” “no patient found,” “stand by” (calls without patient contact), deaths in the field, and non-transported patients were excluded.

Variables

We recorded up to 5 triage criteria per patient (as cited by EMS personnel), including “EMS provider judgment.” We also recorded criteria from previous versions of the decision scheme still in local use (e.g., rollover motor vehicle crash). Because trauma triage criteria may not be recorded in every EMS chart for patients deemed by EMS providers to meet criteria (e.g., due to missing information), we took several steps to assure comprehensive identification of all triage-positive patients and the triage criteria used. Triage-positive

patients were defined as those with trauma triage criteria specified in the EMS chart; EMS provider documented “trauma system entry” (or similar documentation); EMS-recorded trauma identification number (used at some sites); a matched record from the local trauma registry specifying “scene” origin; or other EMS charting terminology specific to each region identifying triage-positive patients. In regions where multiple EMS agencies care for the same patient (and therefore generate multiple EMS records), we matched and compiled all available EMS records to assure comprehensive capture of information from the scene. Triage information available in matched trauma registry records and base hospital databases was used to supplement information captured in EMS charts when triage information was missing. We also collected information on patient demographics (age, gender), field procedures (e.g., intravenous line placement), hospital destination and type, EMS chart narratives and outcomes (detailed below).

Outcomes

The primary outcome was an Injury Severity Score (ISS) 16. Using this injury severity measure allows comparison to several other triage studies and identifies a patient population likely to benefit from trauma center care.¹⁵⁻¹⁷ Secondary outcomes included an Abbreviated Injury Scale (AIS) score 3¹⁶ and specialized trauma resource use (non-orthopedic major operative interventions^{18,19} or in-hospital mortality). Non-orthopedic surgical interventions included abdominal, thoracic, spine, brain, neck, vascular or interventional radiology procedures. In-hospital deaths were integrated into the resource definition to account for high-need patients who may not have otherwise met the definition for serious injury (e.g., death before undergoing surgical procedures or prior to diagnostic studies necessary to calculate an accurate ISS).

In order to track outcomes for patients transported to a broad spectrum of hospitals, we used probabilistic linkage (LinkSolv v8.2, Strategic Matching, Inc., Morrisville, NY)^{20,21} to match EMS records to multiple sources of hospital records (local trauma registries, state discharge databases and emergency department data). All hospital data sources had standardized processes to ensure consistent and reliable hospital data collection. Because AIS and ISS are not collected in state discharge or emergency department databases, we used a mapping function (ICDPIC module for Stata v11, StataCorp, College Station, TX) and ICD9 diagnosis codes to generate injury severity measures.²² Previous studies have validated software for mapping administrative diagnosis codes to anatomic injury scores.^{23,24} Procedure codes were used to capture and categorize procedural-related resource use. Probabilistic linkage methodology has been used to link EMS data to hospital records in previous studies²¹ and has been validated for matching ambulance records to trauma registry data.²⁵

Data Analysis

We used descriptive statistics to characterize the sample, use of EMS provider judgment and patient outcomes. To maintain the population-based sampling design, we used the full sample (including patients who did and did not match to a hospital record) to describe use of EMS provider judgment. However, outcome-based analyses assessing the value of EMS provider judgment were restricted to patients with matched hospital records. We constructed multivariable logistic regression models to assess the independent association between EMS provider judgment and serious injury, adjusted for the presence of other trauma triage criteria, patient demographics, field procedures, hospital type and site. Because many of the triage criteria are used rarely (e.g., proximal amputation, flail chest) or only in certain sites (e.g., high velocity mechanism), we collapsed criteria into triage steps 1 through 4, plus EMS provider judgment (removed from step 4). To minimize bias in the analysis, we intentionally omitted variables that had collinearity with triage criteria (e.g., SBP,

respiratory rate, GCS, field intubation). The primary dependent variable was ISS ≥ 16 . Secondary analyses were used to assess additional dependent variables (AIS ≥ 3 , resource use). To test effect modification of EMS provider judgment by age, we assessed age $\times$ EMS provider judgment as an interaction term in the models, plus analyses stratified by children (0 - 17 years), adults (18 - 54 years) and elders (≥ 55 years). All analyses were conducted using SAS (v 9.2, SAS Institute, Cary, NC).

To reduce bias and preserve study power, we used multiple imputation²⁶ to handle missing values. We have demonstrated the validity of multiple imputation for imputing missing out-of-hospital values and trauma data under a variety of conditions.^{27,28} We used flexible chains regression models for multiple imputation (IVEware, Survey Methodology Program, Survey Research Center, Institute for Social Research, University of Michigan, MI)²⁹ with generation of 10 multiply imputed datasets, analyzed independently and combined using Rubin's rules to appropriately account for the within- and between-dataset variance.²⁶ Because outcome analyses were restricted to patients with matched hospital records (a potential source of bias), we re-analyzed all models using a fully imputed sample (including patients with and without matched hospital records) in a sensitivity analysis.

Finally, to better understand the use of EMS provider judgment in the context of other triage criteria, we analyzed EMS chart narratives (available from 2 sites) using standard qualitative methods.^{30,31} While chart narratives are often long, detailed, and not amenable to quantitative analysis, they provide rich contextual information from the scene. Chart narratives were separated into the 4 triage steps, EMS provider judgment and patients not meeting any criteria. Patients meeting multiple triage criteria in different steps of the algorithm were assigned to the lowest numeric (i.e., highest risk) step in the algorithm. Three investigators (MK, MN and JH) reviewed and coded all chart narratives for patients meeting triage criteria, plus a random sample of narratives from non-criteria patients equivalent to the volume of narratives from other triage categories. We coded key ideas, phrases, and recurrent themes for patients meeting each of the triage steps, then compared and contrasted precipitating themes to see how they interacted with and influenced each other. Illustrative quotes and phrases were selected to demonstrate relevant ideas within and between the triage steps.

RESULTS

Quantitative Results

There were 213,869 injured patients evaluated and transported by EMS over the 3-year period, including 24,341 (11.4%) children. There were 41,191 (19.3%) patients that met at least one trauma triage criterion. Among triage-positive patients, EMS provider judgment was the most commonly cited criterion overall (40.0%) and sole criterion (21.4%). When assessed by site, use of EMS provider judgment varied from 8.0% – 47.1% among triage-positive patients (Figure 1). Characteristics of patients meeting the EMS provider judgment criterion, meeting other triage criteria, and meeting no criteria are listed in Table 2. There were 80,918 (37.8%) patients with matched hospital records, among whom 5.9% had ISS ≥ 16 , 17.7% had AIS ≥ 3 and 6.0% required specialized trauma resources. Among the sample with matched outcomes, EMS provider judgment was the most commonly cited triage criterion overall (40.8%) and sole criterion (20.4%).

Estimates for the unadjusted and adjusted associations between EMS provider judgment and metrics for serious injury are presented graphically in Figure 2 and numerically (overall and by site) in Table 3. There was a positive association between EMS provider judgment and ISS ≥ 16 in both the unadjusted and adjusted analyses. For AIS ≥ 3 , there was an unadjusted association with provider judgment, which diminished after accounting for other triage

criteria. For specialized trauma resource use, EMS provider judgment had a significant unadjusted association, but an inverse relationship after accounting for other triage criteria. Step 1 and 2 criteria had larger associations with serious injury, particularly when assessed for resource use (Figure 2). Findings were qualitatively similar when the full sample (including multiply imputed outcomes for patients without a matched hospital record) was analyzed and when additional variables were added (e.g., SBP, GCS, intubation) or removed (Level I/II hospital).

The interaction between age $\times$ EMS provider judgment was highly significant for ISS ≥ 16 ($p < .0001$) and resource use ($p = .007$), but not for AIS ≥ 3 ($p = 0.99$). In analyses stratified by age (Table 4), EMS provider judgment was associated with ISS ≥ 16 , AIS ≥ 3 (except elders) and resource use (except children). In multivariable analyses, EMS provider judgment was positively associated with serious injury only among patients 55 years and older (adjusted OR for ISS ≥ 16 : 1.50, 95% CI 1.15 – 1.96). As with other multivariable model results, there was an inverse association between EMS provider judgment and resource use.

Qualitative Results

EMS chart narratives were available from two sites ($n = 12,433$), including: 1,441 patients meeting physiologic criteria; 996 meeting anatomic criteria; 2,684 meeting mechanistic criteria; 1,676 meeting special considerations; 2,948 meeting the EMS provider judgment criterion; and 2,688 randomly selected patients not meeting any triage criteria. Recurrent themes among patients within each step are detailed below, with sample quotes from each triage step listed in Table 5.

Step 1: Physiologic Criteria—Recurrent themes of patients meeting step 1 (physiologic) criteria included obvious physical distress, altered mentation and respiratory difficulty. Terms frequently used in chart narratives for such patients included: “apneic,” “respiratory distress,” “unconscious,” “sluggish/lethargic” and “unresponsive to verbal and/or painful stimuli.” Most patients incurred mechanisms of considerable force and severity, with details about the mechanism and event generally being relayed by a witness or bystander, rather than by the patient. Examples of such mechanisms included: high-impact motor vehicle crashes, multiple gunshot wounds, multiple stab wounds, and blunt head trauma. Alcohol intoxication was common in this category. Patients meeting step 1 criteria frequently also met criteria for steps 2 (anatomic) and 3 (mechanistic). By the narrative descriptions, there was little difficulty among field providers in clinically distinguishing patients meeting physiologic criteria.

Step 2: Anatomic criteria—Patients meeting anatomic criteria were generally conscious and able to relay a chief complaint and history by themselves. Gunshot wounds and stabbings were common in this category, with the triage criterion “penetrating injuries to head, neck, torso, and proximal extremities” being repeatedly mentioned. Of the remaining step 2 patients, suspicion for spine injury was the next most commonly mentioned criterion, with narratives often describing “numbness,” “tingling,” and “loss of feeling” in limbs (frequently as a result of motor vehicle crashes or falls). Other anatomic criteria were uncommonly mentioned. As with step 1 patients, there was little difficulty among field providers in clinically distinguishing patients meeting anatomic criteria, as the potential for serious injury was often externally apparent.

Step 3: Mechanism criteria—Multiple mechanisms were cited for patients meeting step 3 criteria, most commonly falls, motor vehicle crashes (often involving intrusion, ejection, or death in the same auto compartment), motorcycle crashes, auto versus pedestrian/bicyclist

and assaults. Most patients were conscious and had no or minimal visible anatomic injury. Descriptions of patients and scenes for step 3 patients were very similar to and often indistinguishable from patients meeting the step 4 and EMS provider judgment criteria (detailed below).

Step 4: Special Considerations—Common themes among step 4 patients included low-level falls, low-speed motor vehicle crashes and auto versus pedestrian events (particularly among older adults). Additional common scenarios included assaults and motorcycle crashes involving young adults. Age criteria were commonly used, though provider discretion appeared common when triaging young and older age groups. Physical findings were uncommonly described. Descriptions of patients entered under the “burn” and “pregnant > 20 weeks” criteria were rare. When mentioned, burn patients generally presented following fires associated with motor vehicle crashes and pregnant patients were involved in low-speed motor vehicle crashes or falls.

EMS Provider Judgment (Step 4 criterion)—Patients meeting only the EMS provider judgment criterion typically did not fit any other explicit triage criteria in the algorithm. These patients generally had unwitnessed low-level falls, assaults, low-speed motor vehicle crashes, auto versus pedestrian events and mechanisms involving a witnessed period of unconsciousness prior to EMS arrival. Also included were patients with drug intoxications, where the presence of serious injury could not be adequately assessed. Overall, these patients had very similar contextual and scene descriptions to patients meeting steps 3 and 4, and were distinct from patients meeting step 1 and 2 criteria. Most patients listed under the EMS provider judgment criterion had potentially concerning aspects of their presentation (e.g., loss of consciousness, abdominal pain, subtle altered mentation), often with lower velocity mechanisms, that didn’t clearly fit other triage criteria.

Patients not meeting any triage criteria—Common themes for injured patients not meeting any field triage criteria were sporting injuries, isolated orthopedic injuries to extremities, physical and sexual assaults, exacerbations of pre-existing injury conditions, history of chronic pain and suicide attempts. Patients were generally alert, awake, non-intoxicated, with no external signs of injury. EMS providers consistently used statements such as “no obvious visible signs of trauma” and “no loss of consciousness.” These patients generally had less concerning mechanisms of injury, normal vital signs and mentation, and were able to talk and relay the history themselves.

DISCUSSION

In this study, we demonstrate the independent predictive value of “EMS provider judgment” as a field triage criterion for identifying seriously injured patients. Our qualitative results suggest that patients meeting only the provider judgment criterion have similar clinical and situational presentations to patients meeting mechanistic (step 3) and other special considerations (step 4) criteria. While previous studies have had mixed results regarding the utility of EMS provider judgment in trauma triage,⁴⁻¹² we show that the cognitive reasoning processes encapsulated in this criterion can help identify seriously injured patients potentially missed by other triage criteria. However, our data also illustrate that the predictive value of this criterion varies between EMS systems, with strong predictive value in some systems and no apparent value in others. This inter-site variability may help explain some of the differences in previous research. These findings support the inclusion and retention of EMS provider judgment in the field trauma triage guidelines, though also suggest the need to explore reasons for the variability in predictive value between sites.

Our results are important in further clarifying the value of EMS cognitive reasoning in triage. Since 1987, when the original triage scheme was revised into the present-day format, trauma triage has been developed and taught as a highly structured, algorithmic process that begins with the highest yield predictors and ends with those presumed to have the lowest yield.³² We recently described the cognitive processing involved in field triage, demonstrating that such decision-making is driven largely by EMS provider “gut feeling” (i.e., judgment), a rapid process that simultaneously integrates dispatch information, early visual cues from the scene and provider experience.¹³ Findings from this previous study suggest that field provider cognition is not as linear and algorithmic as the triage algorithm suggests.¹³ The current study provides quantifiable support that such rapid, heuristic, time-sensitive cognitive processing strategies can be used to identify seriously injured patients potentially missed by other triage criteria and add credence to the concept that field providers learn to think like experienced clinicians in diagnostic acumen.

These findings also allow a comparative assessment of EMS provider judgment to other steps of the triage algorithm. The physiologic step had strong associations with serious injury and resource use, similar to previous triage studies.^{18,33} The independent predictive value of the anatomic and mechanistic steps varied by outcome. After accounting for other triage criteria, provider judgment was most useful for identifying patients with ISS ≥ 16 . For resource use, the direction of effect for provider judgment changed from positive to negative after adjusting for other variables. This finding may be a reflection of strong confounding by step 1 and 2 criteria, effectively neutralizing and reversing the association between provider judgment and resource use in the multivariable model. In addition, EMS providers have little control over hospital treatment decisions (e.g., surgery) and in-hospital mortality can have multiple reasons, so resource use may not be a fair outcome for field providers to predict. We believe this finding should not be construed to suggest that EMS provider judgment is “protective” for patients with resource use, but rather that the ability of field providers to predict surgical intervention or death is driven largely (though not exclusively) by physiologic and anatomic criteria.

While the quantifiable value of EMS provider judgment was clear in some sites, it appeared to have little demonstrable role in identifying seriously injured patients in others. There are multiple potential reasons for this variability. First, the application and use of the judgment criterion is likely to be inherently different between EMS systems. Second, the likelihood of recording EMS provider judgment when it is used also likely differs between sites, with some sites citing the judgment criterion in all (or most) instances where it is used and other sites reserving use for instances where no other criteria apply. Such selective recording of triage criteria may underestimate the true value of provider judgment. Third, provider judgment was only recently added to the national guidelines for field triage,^{2,3} which may impact experience with (and therefore predictive value) of the criterion in certain sites. Finally, individual EMS provider experience may impact the value of the criterion. It is conceivable that in systems where field providers tend to have greater experience and longer tenure in the field, the judgment criterion takes on greater predictive value, however we did not specifically address these hypotheses.

The qualitative findings in this study provide further insight into the type of patients meeting each step in the triage algorithm. Our results suggest that patients meeting the physiologic and anatomic steps are clinically distinct and readily identifiable as “major trauma patients,” while patients meeting step 3 and 4 criteria (including EMS provider judgment) are less obvious in their potential for serious injury. While step 3 criteria include multiple high risk mechanisms, there are clearly many permutations of and differing injury scenarios that step 3 criteria do not explicitly cover.

Finally, there has been concern that EMS provider judgment may increase rates of over-triage. While our results do not specifically address this issue, a recent study from the same sites does not support this concern.³⁴ When assessing the cumulative sensitivity and specificity of each step in the triage algorithm, the addition of step 4 criteria increased over-triage from 25% to 37% with a reduction in under-triage from 29% to 13%.³⁴ As EMS provider judgment represents just one of the step 4 criteria, the increase in over-triage directly attributable to this single criterion is likely much less.

The primary limitation of this study is the retrospective study design, although we applied rigorous strategies for population-based sampling, comprehensive capture of triage criteria, and tracking injury severity regardless of hospital destination. As a function of the comprehensive sampling, outcomes were not available for all patients. However, analyses restricted to patients with matched records versus use of multiple imputation to include all patients were qualitatively similar. Recording the EMS provider judgment criterion was left to EMS providers, so it is possible that there were differences between actual and recorded use of this criteria. Furthermore, we did not capture metrics for provider experience, content and consistency of field triage training for EMS providers, system culture and philosophy, and were therefore unable to account for such factors.

The qualitative analysis was based on narrative information recorded in EMS charts, which may have therefore omitted or skewed certain details. We believe these possibilities were minimized by reviewing a large volume of records from multiple EMS providers at different sites. In addition, we organized the qualitative analysis by steps of the triage algorithm, although some patients met criteria from multiple steps.

In this multisite sample, EMS provider judgment was commonly used as a triage criterion for pediatric and adult trauma patients and was independently associated with serious injury, although not consistently across all sites. Our results demonstrate the value of field provider cognitive reasoning in identifying seriously injured patients, particularly among persons not clearly meeting other triage criteria.

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Figure 1. Frequency of using the “EMS Provider Judgment” criterion among triage-positive patients, by site (n = 41,191).

Figure 2.

Unadjusted and adjusted odds ratios for serious injury and specialized trauma resource use among each of the triage steps and EMS provider judgment ($n = 80,918$).

*Unadjusted odds ratios were generated using bivariable logistic regression, including triage step and the outcome, without adjustment for other triage criteria or confounders. †Adjusted odds ratios were generated from multivariable logistic regression models including: triage criteria categories (physiologic, anatomic, mechanism, special considerations), EMS provider judgment, age, gender, field intravenous line placement, hospital type and site.

Site demographics, EMS systems and hospitals.

Table 1

Site:	EMS service area population *	Geographic area (sq miles)	Population density (persons per sq mile)	Service area description	EMS agencies †	Type EMS response‡	Hospitals	Level I hospitals	Level II hospitals	Level III hospitals	Level IV hospitals
A	2,082,318	3,655	570	Primarily urban/suburban, some rural	10	Single tier, dual ALS	16	2	1	0	0
B	2,503,631	1,740	1,439	Urban/suburban	2	Single tier, dual ALS	20	3	1	0	0
C	1,916,441	2,126	901	Primarily urban/suburban, some rural	32	Tiered response, BLS/ALS	18	1	0	3	5¶
D	549,644	1,254	438	Primarily urban/suburban, some rural	2	Tiered response, BLS/ALS	28	1	1	0	0
E	744,041	46	16,175	Urban	1	Tiered response, BLS/ALS	12	1	0	0	0
Total	7,796,075	8,821	884	-	47	-	94	8	3	3	5

* 2009 population estimates, except site E (2006 estimate). EMS = emergency medical services.

† The number of EMS agencies included in the study. In several sites, additional first responder, non-transport agencies participate in the EMS system.

‡ BLS = basic life support; ALS = advanced life support.

¶ Includes one Level V hospital.

Table 2

Characteristics of injured patients transported by EMS, separated by the “EMS provider judgment” criterion (n = 213,869).

	Patients meeting only the EMS Provider Judgment criterion n = 8,867		Patients meeting EMS Provider Judgment criterion (with or without other triage criteria) n = 16,430		Patients meeting other triage criteria n = 24,761		Patients not meeting any triage criteria n = 172,678	
Demographics:								
Age – mean (years)		46.1		42.8		42.4		48.9
< 18 years (%)	1,038	(11.7%)	2,092	(12.7%)	3,208	(13.0%)	19,041	(11.0%)
18 – 54 years (%)	4,823	(54.4%)	9,610	(58.5%)	14,237	(57.5%)	84,774	(49.1%)
55 years (%)	3,007	(33.9%)	4,728	(28.8%)	7,316	(29.6%)	68,863	(39.9%)
Women (%)	3,835	(43.2%)	6,424	(39.1%)	9,379	(37.9%)	90,006	(52.1%)
Out-of-hospital physiology and procedures:								
SBP (mmHg) – mean		136.1		134.9		132.3		136.9
SBP 90 mmHg	251	(2.8%)	602	(3.7%)	1,345	(5.4%)	4,513	(2.6%)
GCS – mean		14.5		14.3		13.9		14.6
GCS 8 (%)	85	(1.0%)	429	(2.6%)	1,432	(5.8%)	621	(0.4%)
Respiratory rate (breaths/minute) – mean		18.7		18.9		19.0		18.1
Intubation attempt (%)	72	(0.8%)	461	(2.8%)	856	(3.5%)	187	(0.1%)
Intravenous line placement (%)	5,241	(59.1%)	11,081	(67.4%)	15,627	(63.1%)	37,436	(21.7%)
Field Triage Criteria:								
Physiologic criteria (%)	0	(0%)	3,469	(20.9%)	4,819	(19.5%)	-	-
Anatomic criteria (%)	0	(0%)	2,158	(13.1%)	6,700	(27.0%)	-	-
Mechanism of injury criteria (%)	0	(0%)	3,319	(20.2%)	13,021	(52.6%)	-	-
Special considerations criteria (%)	0	(0%)	4,066	(24.5%)	6,854	(27.7%)	-	-
Mechanism of Injury:								
Gunshot wound (%)	84	(0.9%)	254	(1.5%)	748	(3.0%)	672	(0.4%)
Stabbing (%)	187	(2.1%)	414	(2.5%)	1,288	(5.2%)	3,650	(2.1%)
Assault (%)	635	(7.2%)	925	(5.6%)	1,029	(4.2%)	12,439	(7.2%)

	Patients meeting only the EMS Provider Judgment criterion	Patients meeting EMS Provider Judgment criterion (with or without other triage criteria)	Patients meeting other triage criteria	Patients not meeting any triage criteria
	n = 8,867	n = 16,430	n = 24,761	n = 172,678
Fall (%)	2,783 (31.4%)	4,252 (25.9%)	6,051 (24.4%)	75,913 (44.0%)
Motor vehicle crash (%)	2,003 (22.6%)	5,571 (33.8%)	9,646 (38.9%)	40,913 (23.7%)
Other (%)	3,175 (35.8%)	5,014 (30.5%)	5,999 (24.2%)	39,091 (22.6%)
Hospital Measures* :				
Injury Severity Score – mean	4.6	6.2	6.8	2.7
ISS >= 16 (%)	523 (7.8%)	1,631 (12.1%)	2,587 (13.2%)	574 (1.2%)
Maximum AIS – mean	1.2	1.5	1.6	0.9
AIS >=3 (%)	1,252 (18.6%)	3,142 (23.3%)	5,324 (27.2%)	5,859 (12.3%)
Resource use (%)	348 (5.2%)	1,001 (7.4%)	2,232 (11.4%)	1,622 (3.4%)
Non-orthopedic surgery (%)	305 (4.5%)	878 (6.5%)	1,809 (9.2%)	1,181 (2.5%)
Orthopedic surgery (%)	1,048 (15.5%)	2,091 (15.5%)	3,292 (16.8%)	9,295 (19.5%)
In-hospital mortality (%)	56 (0.8%)	182 (1.4%)	657 (3.4%)	529 (1.1%)

* Hospital measures were calculated among patients with matched hospital records (n = 80,918). SBP = systolic blood pressure (mmHg); GCS = Glasgow Coma Scale score; ISS = Injury Severity Score; AIS = Abbreviated Injury Scale score.

Table 3

Unadjusted and adjusted odds ratios for “EMS provider judgment” using different definitions of serious injury, by site (n = 80,918).*

Site	ISS 16				AIS 3				Resource use			
	Unadj OR	95%CI	Adj OR	95%CI	Unadj OR	95%CI	Adj OR	95%CI	Unadj OR	95%CI	Adj OR	95%CI
A	1.95	(1.75-2.18)	1.24	(1.06-1.44)	0.70	(0.64-0.76)	0.80	(0.71-0.90)	0.69	(0.60-0.79)	0.66	(0.56-0.79)
B	1.04	(0.53-2.04)	0.50	(0.18-1.39)	1.29	(0.67-2.49)	0.80	(0.35-1.81)	1.09	(0.80-1.50)	0.65	(0.40-1.05)
C	4.56	(4.01-5.19)	1.96	(1.66-2.32)	3.55	(3.11-4.06)	2.95	(2.51-3.45)	2.29	(1.97-2.65)	1.07	(0.88-1.30)
D	1.08	(0.36-3.22)	0.70	(0.20-2.44)	1.62	(0.49-5.32)	1.00	(0.33-3.01)	1.26	(0.48-3.33)	0.72	(0.22-2.36)
E	2.70	(1.06-6.93)	2.21	(0.65-7.55)	1.36	(0.54-3.43)	1.10	(0.33-3.68)	1.94	(0.82-4.57)	1.59	(0.54-4.74)
Overall	2.79	(2.27-3.44)	1.23	(1.03-1.47)	1.53	(1.19-1.97)	1.06	(0.86-1.29)	1.32	(1.13-1.54)	0.75	(0.62-0.90)

* Adjusted odds ratios were generated from multivariable logistic regression models including: triage criteria categories (physiologic, anatomic, mechanism, special considerations), EMS provider judgment, age, gender, field intravenous line placement, hospital type and site.

Table 4

Unadjusted and adjusted odds ratios for “EMS provider judgment” using different definitions of serious injury, by age strata (n = 80,918).*

Site	ISS 16				AIS 3				Resource use			
	Unadj OR	95%CI	Adj OR	95%CI	Unadj OR	95%CI	Adj OR	95%CI	Unadj OR	95%CI	Adj OR	95%CI
0 – 17 yrs	2.53	(1.82-3.52)	1.07	(0.77-1.48)	2.00	(1.48-2.70)	0.87	(0.66-1.15)	1.28	(0.87-1.90)	0.57	(0.34-0.95)
18 – 54 yrs	2.43	(1.83-3.22)	1.14	(0.96-1.35)	2.28	(1.67-3.11)	1.22	(0.99-1.50)	1.33	(1.08-1.64)	0.68	(0.54-0.86)
55 years	3.48	(2.99-4.06)	1.50	(1.15-1.96)	1.12	(0.92-1.37)	1.12	(0.90-1.40)	1.41	(1.22-1.64)	0.91	(0.75-1.11)

* Adjusted odds ratios were generated from multivariable logistic regression models including: triage criteria categories (physiologic, anatomic, special considerations), EMS provider judgment, age, gender, field intravenous line placement, hospital type and site.

Table 5

Illustrative quotes from EMS chart narratives describing patients meeting each triage step, plus “EMS provider judgment”.

Triage Step	
Step 1: Physiologic	“Pt was in a parking lot on our arrival and appeared to be DOA. Closer examination found the pt to be breathing at 12 times per minute.”
	“Pedestrian hit by a car, @ ALS arrival pt unconc/unresp/agonal resp 8.”
Step 2: Anatomic	“On scene pt is found laying on his right side with a GSW noted to the left lower back no exit wound. Pt is AO 4/4 GCS 15.”
	“Pt reports being stabbed with an unknown type/length knife in the city.”
Step 3: Mechanism	“Pt is involved in truck vs. guardrail MVC at speeds of approx 45 MPH. Pt has a GCS of 15 but does appear to be confused about the accident itself.”
	“Pt fall approx 50 ft from 6th floor balcony brief loc, then pt woke up. AO x 3 w/p/d in minimal distress etoh on breath.”
	“Pt GCS 15. Pt was an un-helmeted bicyclist who was struck by a vehicle traveling at approx 30mph. Pt has dried blood around his nare, +missing 3 upper teeth, abrasion to L elbow.”
Step 4: Special Considerations	“Pt fell from moving skateboard to pavement. Pt was being towed ... behind car decelerating from 15 mph.” (child)
	“MVA. Per pt he was seated in the back seat behind the driver...Pt c/o abd pain upon palpation.” (child)
	“Pt in mild distress laying supine on bathroom floor s/p unwitnessed fall. Pt states fall was from standing to ground level, pt unknown LOC, pt poor hist.” (elder)
EMS Provider Judgment	“Pt was snow sledding down a hill into a parking lot. Pt struck a tree with his head at the bottom of the hill. Pt had a LOC lasting up to five minutes.”
	“Pt AOX4 GCS 15 sitting in the street post assault. Per pt he was assaulted by 2 people with a baseball bat. Pt found to have 2 large hematomas to L parietal/occipital lobe neg crepitus. Pt also had 4-5 cm lac to rt zygoma.”
No Criteria Met	“Pt states he was struck in the mouth with a fist, c/o R sided lip pain. States teeth feel in correct position, is oriented to event, day, month, year and place.”
	“Pt states she was sexually assaulted ... has some left side neck pain from a scratch were she was grabbed. Pt denies loc, states no complaints otherwise.”
	“Pt punched the wall inside his home. He is c/o 9/10 pain to right hand with deformity and decreased range of motion.”