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Variation in Prehospital Use and Uptake of the National Field Triage Decision Scheme

Andy S. Barnett, MD, N. Ewen Wang, MD, Ritu Sahni, MD, MPH, Renee Y. Hsia, MD, MSc, Jason S. Haukoos, MD, MSc, Erik D. Barton, MD, MS, MBA, James F. Holmes, MD, MPH, Craig D. Newgard, MD, MPH, and the WESTRN Investigators

Abstract

Background. The Field Triage Decision Scheme is a national guideline that has been implemented widely for prehospital emergency medical services (EMS) and trauma systems. However, little is known about the uptake, modification, or variation in field application of triage criteria between trauma systems. **Objective.** To describe and compare the use of field triage criteria by EMS personnel in six regions, including the timing of guideline uptake and the use of nonguideline criteria. **Methods.** This was a retrospective cohort study of injured children and adults transported by 48 EMS agencies to 105 hospitals (trauma centers and non–trauma centers) in six Western U.S. regions from 2006 through 2008. We used probabilistic linkage to match patient-level prehospital information from multiple sources, including EMS records, base-hospital phone communication records, and trauma registry data files. Triage criteria were evaluated individually and grouped by "steps" (physiologic, anatomic, mechanism, and special considerations). We used descriptive statistics to compare the frequency of triage criteria use (overall and between regions) and to evaluate the timing of guideline uptake across multiple versions of the guidelines. **Results.** A total of 260,027 injured patients were evaluated and transported by EMS over the three-year study period, of whom 46,414 (18%) met at least one field triage criterion and formed the primary sample for analysis. The three most common criteria cited (of 33 in use) were EMS provider judgment (26%), age <5 or >55 years (10%), and Glasgow Coma Scale (GCS) score <14 (9%). Of the 33 criteria in use, five (15%) were previously retired from the guidelines and seven (21%) were never included in the guidelines. 11,048 (24%) patients had more than one criterion applied (range 1–21). There was large variation in the type and frequency of criteria used between systems, particularly among the nonphysiologic triage steps. Only one of six regions had translated the most recent guidelines into field use within two years after release. **Conclusion**. There is large variation between regions in the frequency and type of field triage criteria used. Field uptake of guideline revisions appears to be slow and variable, suggesting opportunities for improvement in dissemination and implementation of updated guidelines. **Key words:** triage; trauma; injuries and wounds; emergency medical services; guideline adherence

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Introduction

While field trauma triage has played an integral role in military conflicts since the late 1700s, the first civilian trauma triage tool was developed in 1976 by the American College of Surgeons Committee on Trauma (ACS-COT).[1,2] The field triage guidelines (i.e., the Field Triage Decision Scheme) were revised in 1987 to the stepwise, algorithmic format similar to the scheme widely used by many emergency medical services (EMS) and trauma systems today.[1] The current decision scheme (most recently revised in 2011[3]) contains four main "steps" (physiologic, anatomic, mechanism, and special considerations), each containing multiple

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Address correspondence and reprint requests to: Craig D. Newgard, MD, MPH, Department of Emergency Medicine, Center for Policy and Research in Emergency Medicine, Oregon Health & Science University, 3181 SW Sam Jackson Park Road, Mailcode CR-114, Portland, OR 97239–3098. e-mail: newgardc@ohsu.edu

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different triage criteria. The triage steps have been modified with each subsequent revision (1990, 1993, 1999, 2006, and 2011), with addition and deletion of different individual criteria based on updated research and expert opinion. Although the general triage decision scheme has been implemented in the majority of U.S. trauma systems to better concentrate seriously injured patients in major trauma centers and thereby improve survival,[4–13] knowledge of actual field use of the decision scheme by EMS personnel at the patient level is limited.

It is assumed that trauma and EMS systems update their field triage protocols soon after each revision and that most systems use the same general set of triage guidelines, though there is little research directly testing this assumption. With multiple revisions of the decision scheme, there is sparse information on the uptake and implementation of each revised set of guidelines. Similarly, whether there is variation in using specific triage criteria (including those previously removed from the guidelines) between trauma systems remains largely unknown. One study of state-level triage guidelines suggested variation in state-level uptake of new field triage guidelines.[14] Other evidence suggests that implementation of national guidelines for prehospital care can take between one and two years.[15] If variation exists in the practice of field triage by EMS providers, including implementation and use of different versions of the guidelines (or use of nonguideline criteria), such variation may explain some of the differences in outcomes between trauma centers in different regions[16–19] and offer insight into the translation of national EMS policy at the field level.

In this study, we describe and compare the use of individual field trauma triage criteria between six different trauma systems in the Western United States, including assessment of previously retired criteria, criteria never included in the guidelines, and approximation of the time required for uptake of new guidelines at the field level. Importantly, this study focuses on the process of field trauma triage, rather than an outcome-based assessment of the decision scheme, which has previously been assessed in these regions.[20] While previous studies have looked at the translation of published guidelines at the state and agency levels, translation at the field provider and patient levels remains unclear. This study uses patient-level data to evaluate the end point of knowledge translation for a national EMS guideline.

METHODS

Study Design

This was a multiregion retrospective cohort study. Fourteen institutional review boards at six regions approved this protocol and waived the requirement for informed consent.

Setting

The study included injured children and adults evaluated and transported by 48 EMS agencies to 105 hospitals (including 12 level I, five level II, three level III, four level IV, one level V, and 80 community/private/federal hospitals) in six regions across the Western United States over a three-year period (January 1, 2006, through December 31, 2008). The six regions included Portland, Oregon/Vancouver, Washington (four counties); King County, Washington; Sacramento, California (two counties); San Francisco, California; Santa Clara, California (two counties); and Denver County, Colorado. These regions are part of the Western Emergency Services Translational Research Network (WESTRN) and were defined using a prespecified geographic "footprint" corresponding to EMS agency service areas. Regions consisted of a central metropolitan area (urban) and the surrounding region (suburban with some outlying rural areas).

Selection of Participants

The study sample included all injured patients (children and adults) for whom the 9–1–1 EMS system was activated within the six predefined geographic regions with patient transport to acute care hospitals (trauma centers and non–trauma centers). Injured patients were identified within each participating EMS agency by EMS provider impression of "injury" or "trauma" (per the EMS patient care report). Specifying the sample in this manner allowed for a population-based, out-of-hospital injury cohort of patients with both minor and serious injuries, as perceived by EMS providers, and representing the denominator to whom the field triage guidelines are routinely applied. The primary sample for analysis was the subgroup of patients specified as field-based "trauma activations" (patients meeting at least one field-based trauma triage criterion, as determined by EMS providers). We excluded patients undergoing interhospital transfer without initial contact with EMS; EMS runs listed as "cancelled," "no patient found," and "stand by"; nontransported patients; and patients who died in the field.

Variables

We defined field-based "trauma activation" by the presence of any of the following factors: EMS provider–documented "trauma system entry" (or similar charting, depending on local terminology); EMS-recorded trauma identification number (used at some regions as a mechanism for tracking injured patients

entered into the trauma system); matched records from the local trauma registry specifying "scene" (EMS-identified) origin; or matched phone records from the regional base hospital in regions requiring EMS personnel to call in for all trauma activations prior to hospital arrival. For field-based trauma activations, we also captured all individual triage criteria prospectively specified by EMS personnel (rather than by post hoc chart review) from all the above data sources (EMS charts, trauma charts, and base hospital trauma activation phone records). Patients not identified as trauma activations using the above process were considered triage-negative, nontrauma patients. To merge all data sources, we used probabilistic linkage[21,22] (LinkSolv version 8.2, Strategic Matching, Inc., Morrisonville, NY). The record linkage process included merging multiple EMS records for the same patient (in regions where multiple EMS agencies care for the same patient), base hospital phone records, and trauma registry records. The use of probabilistic linkage to create this data set has been rigorously evaluated and described in a separate publication.[23]

Data Analysis

We used descriptive statistics to characterize and compare trauma triage criteria use overall and within and between regions. We grouped triage criteria by step (physiologic, anatomic, mechanism, and special considerations), as organized in the Field Triage Decision Scheme. As a proxy for calculating the duration of time required to uptake new triage criteria and retire "old" criteria at the field level, we compared criteria use by regions through December 31, 2008, with that for the year in which they appeared in (or were removed from) the guidelines. For the majority of analyses, missing values for triage criteria were considered absent, to provide a consistent denominator. However, we did assess the proportion of patients known to be trauma activations by EMS personnel, but without any specific criteria recorded (missing values for triage criteria). Finally, we also evaluated the number of triage criteria applied per patient, separated by triage step. In the majority of analyses, the patient is the unit of analysis. However, we also describe use of different triage criteria by region (i.e., with regional trauma system as the unit of analysis). Database management and all analyses were performed using SAS version 9.2 (SAS Institute, Inc., Cary, NC).

RESULTS

There were 260,027 injured persons evaluated and transported by 48 EMS agencies to 105 hospitals during the study period, of whom 46,414 (17.8%) were field-based trauma activations and formed the primary sample for analysis. Characteristics of the six study regions, including region-specific sample sizes, are listed in Table 1. There were 33 different individual triage criteria used between the six regions during the study period.

Changes to the Field Triage Decision Scheme over the five revisions since 1987 (1990, 1993, 1999, 2006, and 2011) are illustrated in Figure 1, including the proportion of regions using each criterion by 2008 (the end of the study period). The current (2011) Field Triage Decision Scheme is included in Appendix 1 (available online).[3] Of the 33 criteria in use during the study period, five (15%) were previously retired from the guidelines and seven (21%) were never included in the guidelines. Three physiologic criteria (Glasgow Coma Scale [GCS] score <14, systolic blood pressure [SBP] <90 mmHg, and respiratory rate >29 or <10 breaths/min) had the most consistency in use, with all six regions using these criteria. For the anatomic criteria, there was more variation in use, particularly among criteria added in the 1999 and 2006 versions of the guidelines. Only one region used "crushed, degloved, or mangled extremity" (added in 2006), with the first documented use in 2008. Two regions used "open or depressed skull fracture" (added in 1999). Study regions used the majority of mechanism criteria, including previously retired criteria. For example, six of six regions continued to use the rollover and extrication time criteria through 2008 (both criteria were removed in the 2006 guidelines). Five of the six regions used criteria never included in the guidelines, with four regions using two nonguideline criteria and one region using four nonguideline criteria. Three of four new criteria added in the 2006 guidelines (crushed, degloved, or mangled extremity; vehicle telemetry data; and time-sensitive extremity injury) were not in use by five of six regions by the end of 2008, while EMS provider judgment (also added in 2006) was used by the majority (5/6) of regions during the study period.

Figure 2 illustrates the overall frequency of criteria used, separated by triage step. Because multiple criteria could be used for the same patient, the proportions in Figure 2 represent total frequency of use and therefore add to more than 100%. The most commonly used criteria (in order) were: EMS provider judgment (25.7%), age (9.7%), GCS (8.7%), energy (6.7%), passenger space intrusion (6.2%), and penetrating injury (6.1%). The least commonly used criteria came primarily from the anatomic step: crushed, degloved, or mangled extremity (0.1%); amputation (0.2%); burns (0.3%); pelvic fracture (0.4%); pregnancy >20 weeks (0.5%); flail chest (0.6%); and two or more long-bone fractures (0.8%). Most of the other criteria that were rarely used (e.g., cardiopulmonary resuscitation [CPR], environment, steering wheel deformity, Revised Trauma Score [RTS], heart rate, and airway) had not been included in previous triage guidelines and were used in a minority of regions. When criteria were

Gray = in use White = not in use	Versions of the Field Triage Decision Scheme						Regions Using in 2008[†]
	1987	1990	1993	1999	2006	2011[*]	
Step 1 - Physiologic criteria:							
GCS <14[‡]	■	■	■	■	■	■	6/6
SBP <90 beats/min	■	■	■	■	■	■	6/6
RR <10, >29 breaths/min	■	■	■	■	■	■	6/6
Airway intervention[§]						■	2/6
Revised Trauma Score <11		■	■	■			1/6
Pediatric Trauma Score <9[¶]		■	■				0/6
Step 2 - Anatomic criteria:							
Proximal penetrating injury	■	■	■	■	■	■	6/6
Two or more long-bone fractures	■	■	■	■	■	■	6/6
Flail chest	■	■	■	■	■	■	5/6
Burns[**]	■	■	■	■	■	■	3/6
Pelvic fracture		■	■	■	■	■	4/6
Limb paralysis		■	■	■	■	■	6/6
Proximal amputation		■	■	■	■	■	5/6
Open or depressed skull fracture				■	■	■	2/6
Mangled extremity					■	■	1/6
Step 3 - Mechanism criteria:							
Falls >20 feet[††]	■	■	■	■	■	■	6/6
High-speed auto crash[‡‡]	■	■	■	■	■	■	3/6
Intrusion >12 inches[§§]	■	■	■	■	■	■	5/6
Ejection of patient from vehicle	■	■	■	■	■	■	6/6
Rollover	■	■	■	■			6/6
Death of same-car occupant	■	■	■	■	■	■	6/6
Pedestrian hit by car[¶¶]	■	■	■	■	■	■	6/6
Motorcycle crash[***]		■	■	■	■	■	5/6
Extrication >20 minutes		■	■	■			6/6
Vehicle telemetry data					■	■	0/6
Step 4 - Special considerations criteria:							
Age <5, >55 years[†††]	■	■	■	■	■	■	6/6
Cardiac or respiratory disease	■	■	■	■			5/6
Medically complicated[‡‡‡]		■	■	■			
Anticoagulation, bleeding disorder		■	■	■	■	■	
ESRD requiring dialysis					■		
Pregnancy			■	■	■	■	5/6
EMS provider judgment					■	■	5/6
Time-sensitive extremity injury					■		0/6
Criteria never included in national guidelines:							
Heart rate >140 beats/min							1/6
Cardiopulmonary resuscitation							2/6
Steering wheel deformity							1/6
Environment							2/6
Energy							2/6
Intoxication							2/6

grouped by triage step, frequency of use proceeded in reverse order of the triage algorithm: step 4—special considerations (50.7%), step 3—mechanism (33.1%), step 2—anatomic (14.0%), and step 1—physiologic (12.6%).

Figure 3 (A–D) details the interregion variation in the use of individual triage criteria, separated by triage step. Among the physiologic criteria (Fig. 3A), the GCS criterion was used more commonly and consistently between regions than SBP <90 mmHg or respiratory rate criteria. Heart rate, RTS, and need for airway/ventilator support were used rarely by a small number of regions. For anatomic criteria (Fig. 3B), penetrating torso injury was most commonly used, particularly among patients in regions A and D. With the exception of the skull fracture criterion use in one region, all other anatomic criteria were rarely used. There was substantial variation in the use of the mechanism criteria (Fig. 3C), particularly for motor vehicle criteria (e.g., passenger space intrusion, pedestrian-vs.-automobile collision, motorcycle crash at speed >20 mph, ejection, high-speed automobile crash, and rollover). Conversely, falls from a height >20 feet, extrication time, death of another occupant, and steering wheel deformity were uncommonly used. For the special considerations criteria (Fig. 3D), EMS provider judgment was most frequently used among the majority of regions employing this criterion. The one region not using EMS provider judgment (region A) had a high frequency of use of the energy criterion (44%), whereas other regions used this criterion rarely or never. The age criterion was also commonly used by all regions, except in region A. Region D had the least frequent of use of the EMS provider judgment criterion, but the most frequent use of the age and medical/comorbidities criteria.

When the frequency of criteria use for each site (Fig. 3A–D) is compared with mechanism of injury and patient demographic data among trauma activations at these sites (Appendix 2, available online), some of the site variation in triage appears consistent with site-specific incidence of certain injury mechanisms. For example, the high percentage of motor vehicle criteria used in site F is consistent with site F's having the highest portion of motor vehicle crashes. There are similar findings for penetrating injury criteria use in site A. However, variations in the use of other triage criteria (e.g., age, fall, and ejection criteria) do not directly correspond to site-specific differences in the mechanism of injury and patient demographics.

The number of criteria applied per patient, as separated by triage step, is demonstrated in Figure 4. There was a range of one to 21 criteria applied per patient, with 27% of patients known to be trauma activations having missing values for specific criteria. Forty-nine percent of the patients met a single triage criterion and 24% of the patients met two or more triage criteria. The majority of patients meeting anatomic, mechanism, or special considerations criteria (i.e., steps 2, 3, and 4) had triage criteria listed from a single step. In contrast, almost 80% of patients meeting physiologic triage criteria (step 1) also had triage criteria listed from another step in the triage algorithm. Patients meeting special considerations (step 4) criteria were least likely to also meet criteria from another triage step.

DISCUSSION

In this study, we demonstrate substantial variation in the use of individual field triage criteria and implementation of national trauma triage guidelines at the field level across EMS and trauma systems. There were a number of criteria still in use that had previously been retired from the algorithm or had never been included in the guidelines. There was also variable use of the 2006 triage guidelines (the most recent guideline

FIGURE 1. Summary of changes to the Field Triage Decision Scheme (the national triage guidelines) over time and regions using each individual criterion by the most recent year of data collection (2008). *Triage criteria from the most recent version of the guidelines (2011) are included for completeness of comparison with previous versions of the decision scheme; however, the most recent year of data collection for this project was 2008 (prior to the release of the 2011 guidelines). †The primary study sample includes data for the three years up to the year 2008, and this column reflects the regions using the 2006 version of the guidelines as of that time. ‡Glasgow Coma Scale (GCS) score increased from <13 to <14 in 1993. §2011 definition: includes "need for ventilatory support." ¶Pediatric Trauma Score <9 was removed in 1999. **In combination with other trauma. 1987 definition: >15% total body surface area (TBSA). 1990 definition: >10% TBSA or inhalational. 1993 definition: combination trauma with burns. 1999 definition: added "major burns." 2006 definition: moved from step 2 (anatomic) to step 4 (special Considerations), with recommendation for direct transport to a burn facility if no other trauma. ††2006 guidelines included children who fell >10 feet or 2–3 times the height of the child. ‡‡1987 definition: crash speed ΔV (change in velocity) >20 mph, 30-inch vehicle deformity, or rearward displacement of the front axle. 1990 definition: initial speed >40 mph, ΔV >20 mph, auto deformity >20 inches. 2006 definition: removed vehicle exterior deformation. 2011 definition: changed to "high risk" and removed speed criteria, reintroduced exterior deformation (18 inches). §§2011 definition: intrusion of >12 inches into the occupant site, or 18 inches into any site. ¶¶Changed from >20 mph to >5 mph in 1990, with the inclusion of "pedestrian thrown or run over." Speed of collision removed in 2006 and reintroduced (>20 mph) in 2011. ***>20 mph or with separation of rider and bike (separation removed in 2006). †††2011 definition: removed age <5 years and included statement "Should be triaged preferentially to pediatric capable trauma centers." Included comments for adults >55 years being at increased risk of injury/death. ‡‡‡1990 definition: diabetics on insulin, cirrhosis, malignancy, obesity, or psychotics taking medication. 1993 definition: added immunosuppressed patients. 1999 definition: added immunosuppressed, removed malignancy. End-stage renal disease (ESRD) requiring dialysis added in 2006. In this sample, there were no EMS agencies that subdivided these comorbidity categories, so they are presented as a group. ESRD = end-stage renal disease; GCS = Glasgow Coma Scale score; RR = respiratory rate; SBP = systolic blood pressure.

TABLE 1. Description of Regions, EMS Systems, and Hospitals in the Six Regions

Region	No. Injured Patients Transported by EMS	No. (%) Trauma Activations	EMS Service Area Population*	Population Density (persons per square mile)	Service Area Description	No. EMS Agencies	Type of EMS Response	No. Hospitals	No. Level I Hospitals	No. Level II Hospitals
A	46,158	5,223 (11.3%)	610,345	3,989	Urban/suburban	1	Tiered response, BLS/ALS	11	4	2
B	57,737	9,866 (17.1%)	2,082,318	570	Primarily urban/suburban, some rural	10	Single tier, dual ALS	16	2	1
C	58,683	19,435 (33.1%)	2,503,631	1,439	Urban/suburban	2	Single tier, dual ALS	20	3	1
D	3,973	1,152 (29.0%)	744,041	16,175	Urban	1	Tiered response, BLS/ALS	12	1	0
E	78,075	8,725 (11.2%)	1,916,441	901	Primarily urban/suburban, some rural	32	Tiered response, BLS/ALS	18	1	0
F	15,401	2,013 (13.1%)	549,644	438	Primarily urban/suburban, some rural	2	Tiered response, BLS/ALS	28	1	1
Total	260,027	46,414 (17.8%)	8,406,420	23,512	—	48	—	105	12	5

*2009 population estimates, except region D (2006 estimate).
ALS = advanced life support; BLS = basic life support; EMS = emergency medical services.

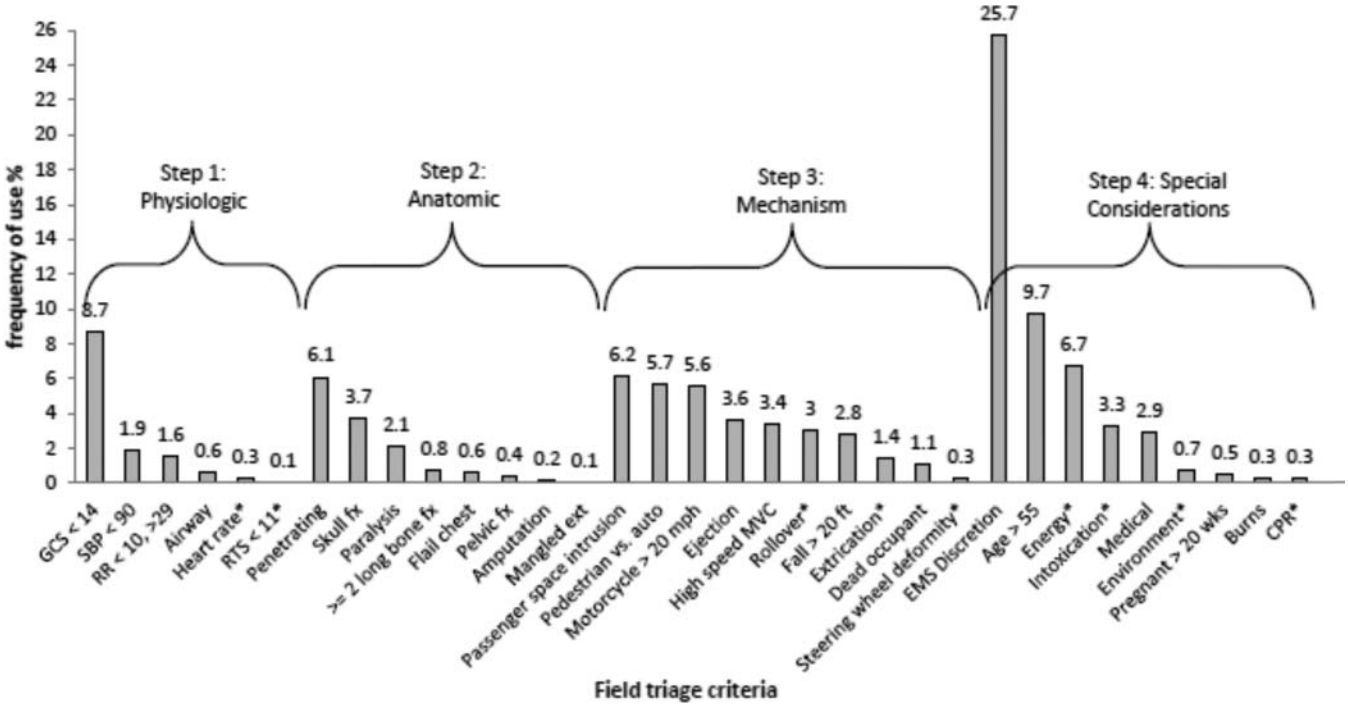


FIGURE 2. Overall use of triage criteria among trauma activations, by step ($n = 46{,}414$). The proportions were calculated by overall frequency of use, including patients for whom more than one criterion was applied. "EMS discretion" = "EMS provider judgment." *Criteria retired or never included in the Field Triage Decision Scheme. CPR = cardiopulmonary resuscitation; EMS = emergency medical services; ext = extremity; fx = fracture; GCS = Glasgow Coma Scale score; MVC = motor vehicle collision; RR = respiratory rate; RTS = Revised Trauma Score; SBP = systolic blood pressure.

revision at the time of the study) at the patient level within a two-year period. Although there are likely multiple factors contributing to variation in the use of triage criteria between regions, our findings suggest that field triage is practiced and implemented differently between trauma systems.

There is a relatively large body of triage research assessing the predictive value of different triage criteria for identifying patients with serious injury (or resource need), though there is little published work on how triage criteria are actually used and translated from national guidelines into practice. In our study, there were notable differences overall and between regions in the frequency of individual triage criteria use at the patient level. "EMS provider judgment" was the most common triage criterion cited by EMS personnel across all regions, being used almost three times as often as the next most commonly cited criterion, even though one region (region A) did not use the criterion at all. The use and independent predictive value of EMS provider judgment in identifying patients with serious injuries[24] and the integral role of provider judgment in out-of-hospital cognitive processing for field triage[25] have been previously detailed. Closer evaluation of the one region not using the EMS provider judgment criterion revealed that the same region had disproportionate use of the energy criterion. This finding suggests that regardless of the trauma system, EMS personnel encounter a substantive portion of high-risk patients who may not meet standard criteria (i.e., non–EMS provider judgment, non–energy criteria). For other triage steps, the GCS and penetrating injury criteria were commonly used, though other physiologic and anatomic criteria were infrequently cited. Among the mechanism criteria, there was large variation in use between regions, particularly among vehicular factors. This finding suggests differences between regions in mechanisms of injury, provider practice patterns, or recurring use of specific criteria based on provider familiarity and experience. Criteria from steps 2, 3, and 4 were also more commonly used in isolation (i.e., within the same step), whereas step 1 criteria were frequently combined with criteria from other steps to identify high-risk patients.

While minor local modifications to field triage criteria and some variation in use are expected based on inherent differences in trauma populations and local needs, our findings suggest more variation than would be explained by such differences. There were four- to fivefold differences in frequency of use for several criteria between regions. Combined with nonguideline criteria and the number of previously retired criteria still in use, this variation suggests that triage is practiced differently in different systems, which may explain some of the variation in under- and overtriage estimates between regions.[20] In addition, because the

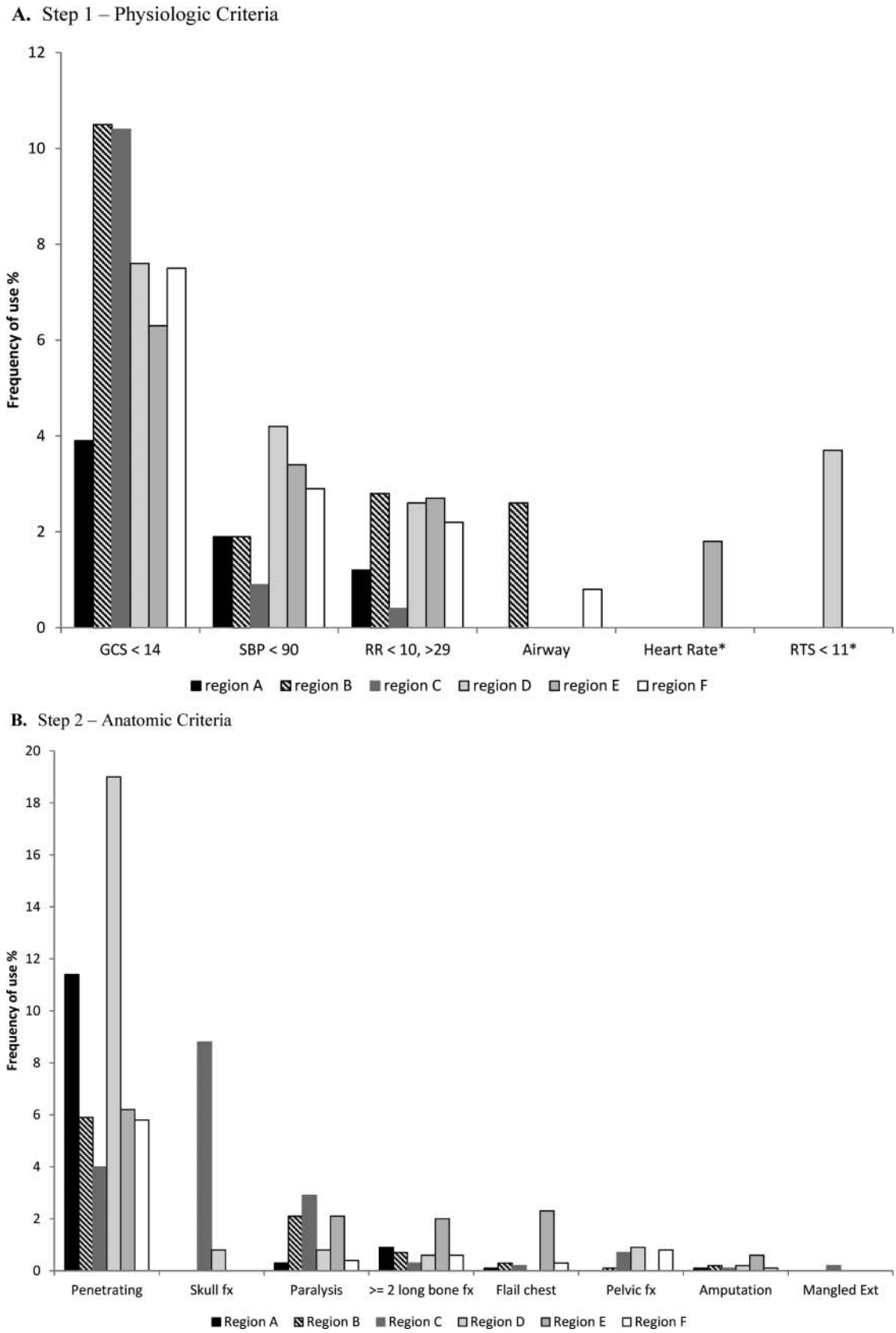
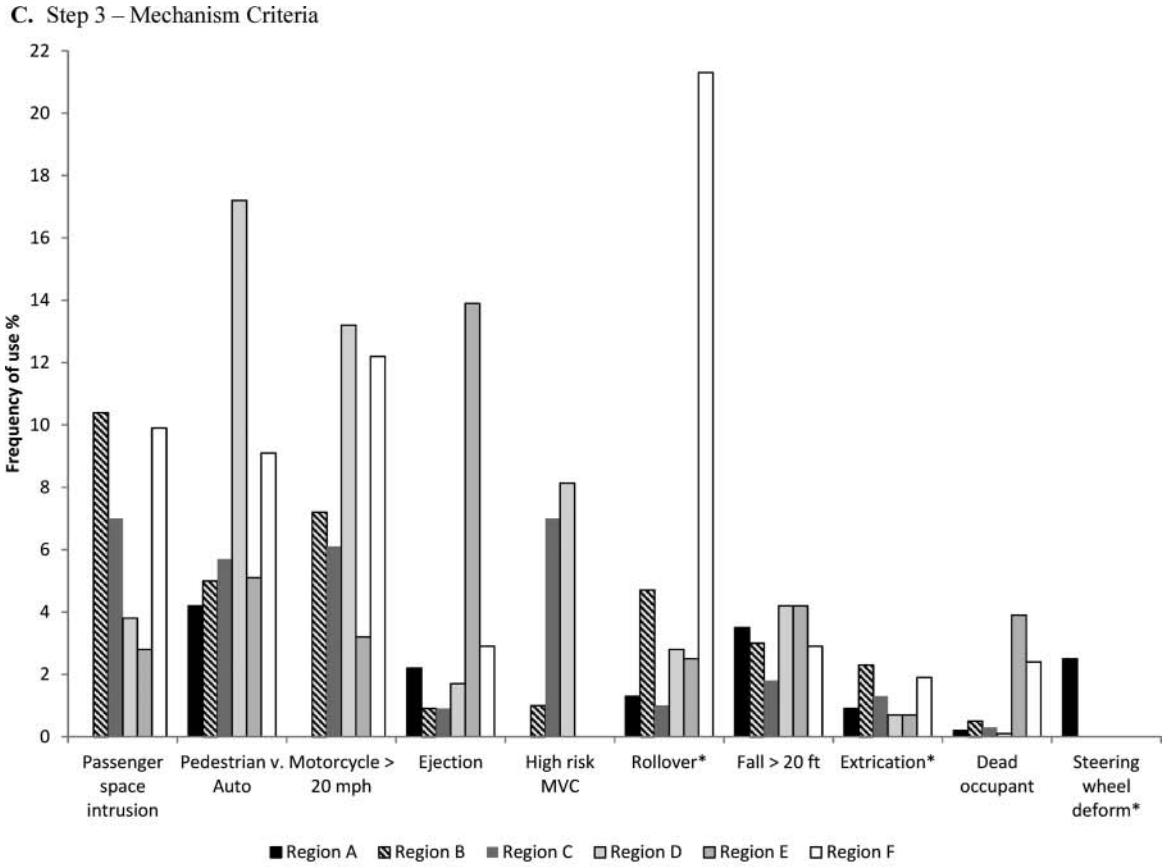


FIGURE 3. Field triage criteria use in six regions, separated by triage steps 1 to 4 (n = 46,414). *Criteria retired or never included in the Field Triage Decision Scheme. †Proportions were calculated by frequency of use at the region level using all trauma activations at a given region as the denominator. "EMS Discretion" = "EMS provider judgment." CPR = cardiopulmonary resuscitation; EMS = emergency medical services; ext = extremity; fx = fracture; GCS = Glasgow Coma Scale score; MVC = motor vehicle collision; RR = respiratory rate; RTS = Revised Trauma Score; SBP = systolic blood pressure.



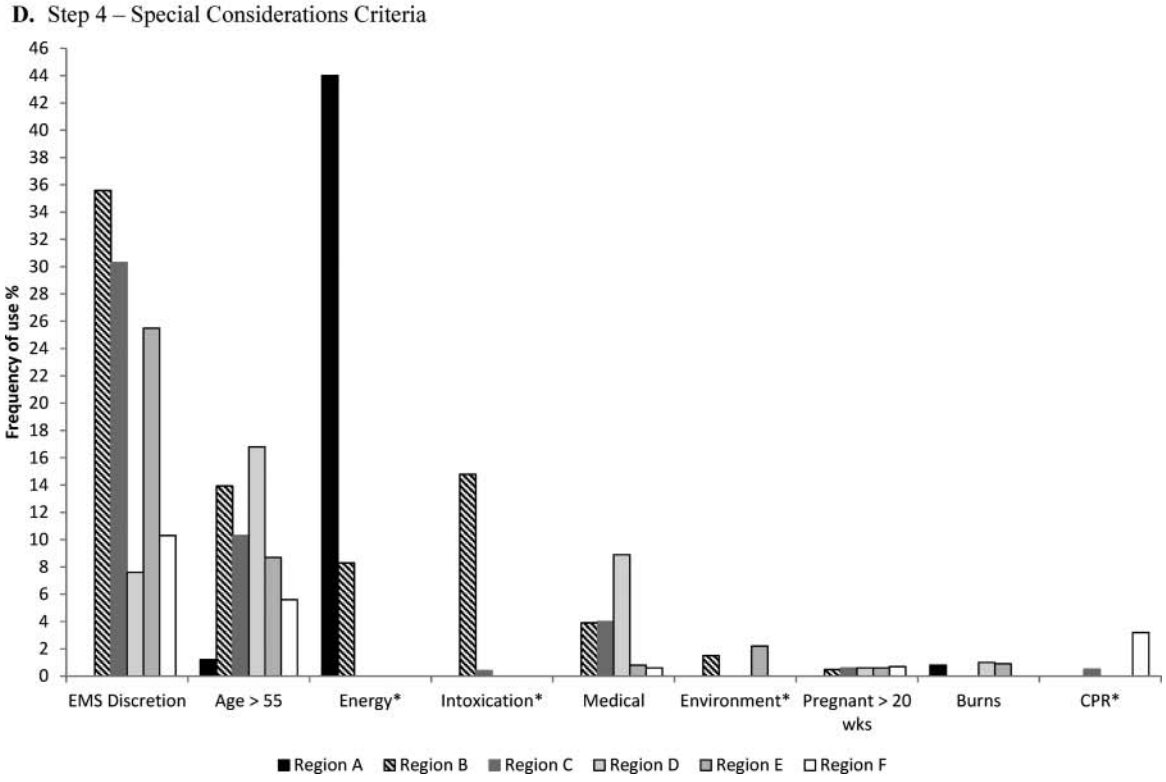


FIGURE 3. *Continued*

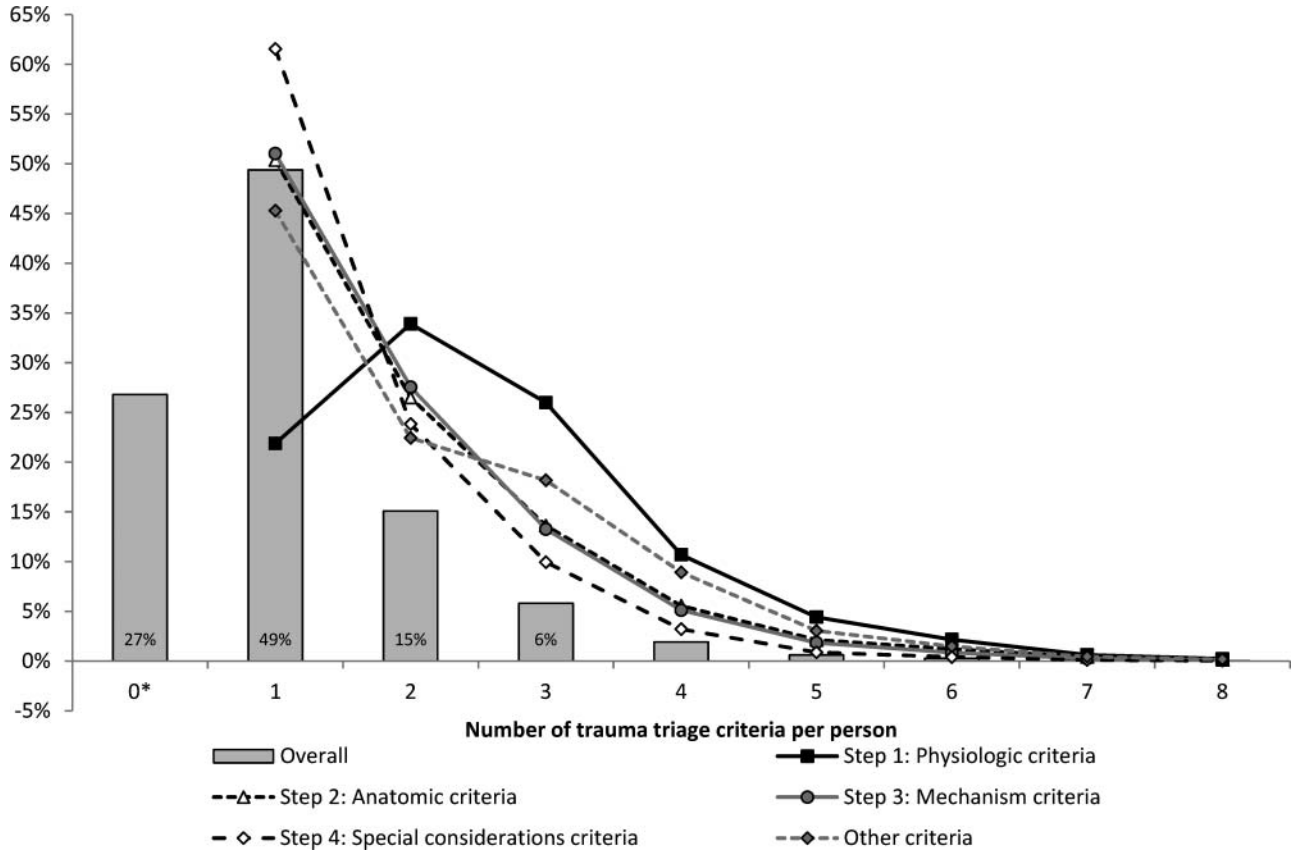


FIGURE 4. Number of criteria used per patient, overall and separated by triage step ($n = 46{,}414$). *Twenty-seven percent of patients known to be trauma activations by emergency medical services (EMS) providers did not have specific criteria listed (missing values). "Other criteria" include triage criteria never included in the decision scheme and therefore not assigned to a specific triage step.

study sample was regional (Western United States) and included established trauma systems, there may be greater variation if studied on a national level and including a wider range of trauma systems.

The Field Triage Decision Scheme represents one of few national EMS practice guidelines implemented in EMS systems throughout the United States. Previous research has examined knowledge translation in EMS, primarily with regard to delayed implementation of the 2005 American Heart Association guidelines for the management of out-of-hospital cardiac arrest[15] and roadblocks that led to the delays.[26] Variation in state-level uptake of new field triage guidelines has also been evaluated.[14] Our study was unique in evaluating translation of the national field triage guidelines to the patient level among multiple trauma systems, demonstrating substantial variation in implementation of revised guidelines. The uptake of national guidelines at the EMS provider level is a complex, multifactorial task that has unique challenges. Delays in guideline use and implementation may occur at many points along the knowledge translation pathway. In many settings, such guideline changes must first be agreed upon and implemented at state and regional levels before implementation at the local EMS agency and provider level. Agreeing to these changes may require input from multiple stakeholders, policymakers, hospitals (e.g., different trauma centers), and committees. Once agreed upon, implementing revised guidelines often requires changing multiple EMS agency triage protocols and retraining field providers. After these processes are complete, changing field provider practice patterns to actually use the updated triage protocols may add additional time until such revisions are measureable at the patient level. Consistent with the multitude of steps, our findings suggest that current implementation processes for revisions in national triage guidelines at the field level are slow and variable, with opportunities for improvement in both dissemination and implementation.

EMS is not alone in facing the challenges of knowledge translation. Studies have demonstrated that this issue is widespread across many health specialties.[27–29] While there are many steps along the knowledge translation pathway, the transition from clinical guideline to clinical practice was the focal point of our study. This final translational step can be further broken down into adoption of principle, early implementation, and persistence of implementation.[30] We believe that trauma and EMS communities in the

United States have adopted the principle of field triage and have generally proceeded with early implementation. However, persistence of implementation (including updates to the national guidelines) appears highly variable between systems. An expert panel in 2007 addressed the issue of knowledge translation in EMS, breaking it down into two critical components: "getting the evidence straight" and "getting the evidence used."[31] According to this paradigm, the evidence-based, regular updates to the Field Triage Decision Scheme fulfill the first component. Our study explored the second component. The most recent version (2011) of the Field Triage Decision Scheme[3] offers another opportunity to study the translation of current trauma triage knowledge into field practice, as well as assessment of the barriers and facilitators to this translation.

LIMITATIONS AND FUTURE RESEARCH

Our study was limited to six regions in the Western United States and therefore may not be generalizable to all EMS systems. Each of the study regions has a well-developed trauma system, which may have introduced bias toward higher levels of guideline implementation and compliance; the true magnitude of variation may be much greater than presented in this study. Also, the study used a retrospective cohort study design, with the inherent limitations of retrospective research. However, we did employ several strategies to increase study rigor, including population-based sampling, inclusion of the broad group of injured patients served by EMS, multiple EMS agencies, and triangulation of data to maximize capture of triage criteria.

While we demonstrate variation in the use of individual triage criteria between regions, our data did not allow us to directly assess whether such variation was due to inherent differences in patient populations versus variation in application of the criteria. Comparison of our triage criteria findings to mechanism of injury and demographic data in the sample suggest that differences in trauma populations do not completely explain the variation, and that the same type of patient may have different criteria applied by field providers in different trauma systems. However, this question will require further investigation.

Finally, it was not possible to evaluate whether differences in local use of triage criteria resulted in better or worse outcomes for injured patients. Many other factors affect the ability to concentrate seriously injured patients in major trauma centers, including patient preference, geography, hospital proximity, provider experience, local protocols, resource availability, and ambulance diversion patterns. Our findings suggest that not all EMS and trauma systems employ field triage similarly, resulting in the potential for nonuniformity in determining which patients are transported to major trauma centers. It is plausible that trauma systems not yet optimized in the ability to concentrate seriously injured patients in major trauma centers could have worse patient outcomes compared with systems that have optimized practices, though our study was not designed to test this hypothesis.

CONCLUSION

Field-level use of individual trauma triage criteria is highly variable between regions, with substantive differences in the uptake and retention of criteria from revisions to the national Field Triage Decision Scheme. In five of the six regions studied, uptake of the new triage guidelines had not occurred at the field level within two years after dissemination. Despite broad, collaborative, national efforts to periodically update national triage guidelines, translation of these guidelines at the field level appears generally slow and inconsistent. Our findings suggest that there are opportunities for improvement in dissemination, implementation, and translation of national field triage guidelines into practice.

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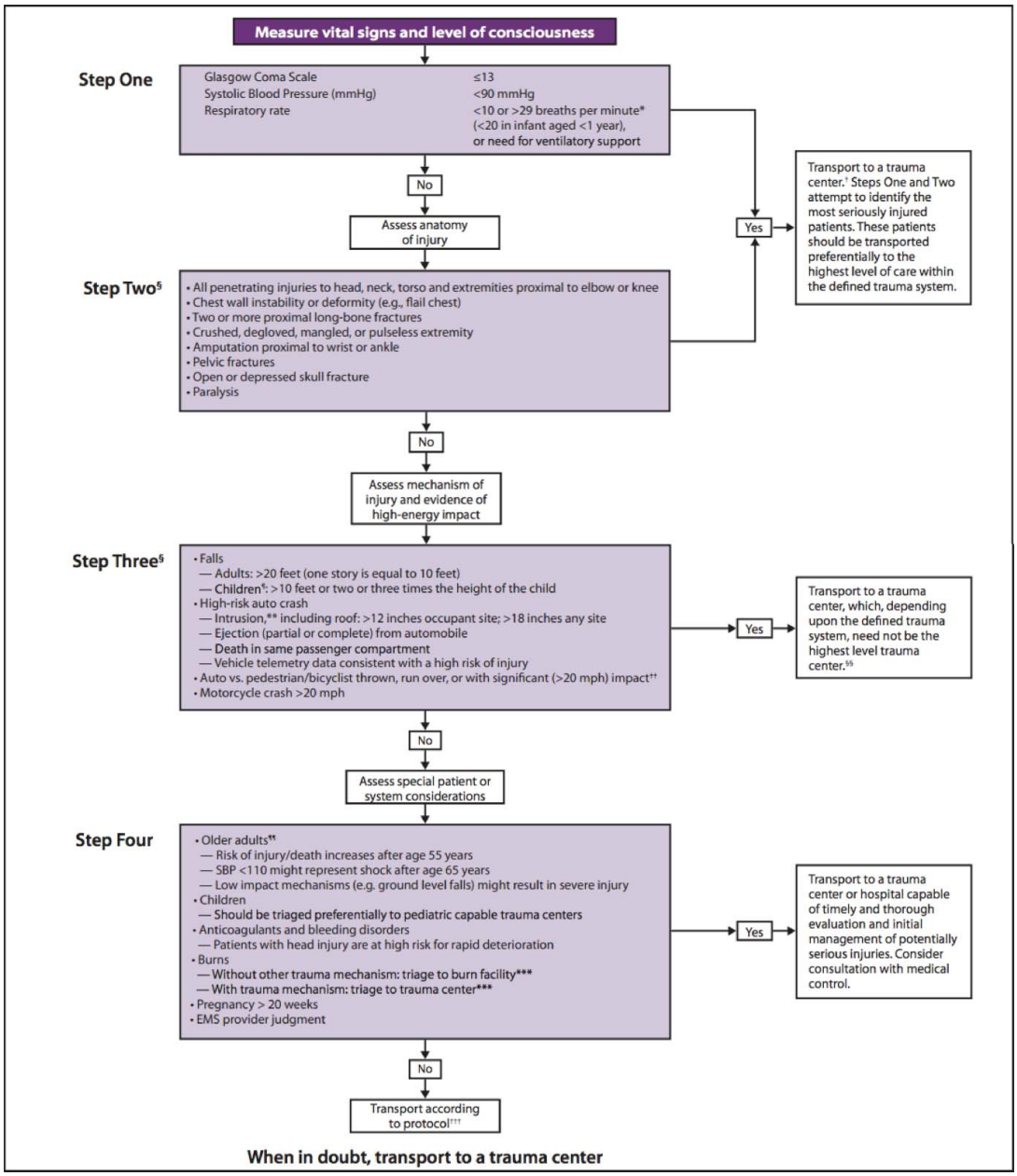
APPENDIX 1.

2011 Field Triage Decision Scheme. From: Sasser SM, Hunt RC, Faul M, et al. Guidelines for field triage of injured patients: recommendations of the National Expert Panel on Field Triage, 2011. MMWR. 2012;61:1–20. EMS = emergency medical services; SBP = systolic blood pressure.



APPENDIX 2.

Mechanism of Injury and Patient Age for Trauma Activations, by Region ($n = 46{,}414$)

	Region					
	A	B	C	D*	E	F
Mechanism:						
Gunshot	6.5%	1.1%	1.7%	—	3.1%	2.3%
Stabbing	9.5%	5.3%	3.3%	—	4.6%	4.5%
Burn	1.2%	0.3%	0.2%	—	1.9%	0.3%
Assault/rape	18.5%	0.5%	6.5%	—	6.1%	3.7%
Fall	22.5%	31.3%	23.4%	—	44.1%	9.9%
Motor vehicle	33.8%	43.5%	42.3%	—	21.1%	56.6%
Bicycle	0	1.3%	4.3%	—	3.1%	7.0%
Pedestrian	6.8%	0.6%	5.9%	—	5.6%	9.1%
Other	1.2%	16.0%	12.5%	—	10.6%	6.8%
Patient age:						
Age—median (IQR), yr	34 (23–49)	37 (22–55)	38 (22–58)	37 (26–55)	46 (27–67)	30 (20–48)

*Region D did not have mechanism of injury data available beyond those captured in the triage criteria.
IQR = interquartile range.