Injury, Int. J. Care Injured 47 (2016) 19–25

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Improving early identification of the high-risk elderly trauma patient by emergency medical services

Craig D. Newgard [a,*], James F. Holmes [b], Jason S. Haukoos [c,d], Eileen M. Bulger [e], Kristan Staudenmayer [f], Lynn Wittwer [g], Eric Stecker [h], Mengtao Dai [i], Renee Y. Hsia [j,k]
The Western Emergency Services Translational Research Network (WESTRN) Investigators

[a] Center for Policy and Research in Emergency Medicine, Department of Emergency Medicine, Oregon Health & Science University, Portland, OR, United States
[b] Department of Emergency Medicine, University of California at Davis, Sacramento, CA, United States
[c] Department of Emergency Medicine, Denver Health Medical Center, Denver, CO, United States
[d] Department of Epidemiology, Colorado School of Public Health, University of Colorado School of Medicine, Aurora, CO, United States
[e] Department of Surgery, University of Washington, Seattle, WA, United States
[f] Department of Surgery, Stanford University, Palo Alto, CA, United States
[g] Clark Regional Emergency Services Agency, Vancouver, WA, United States
[h] Division of Cardiology, Department of Internal Medicine, Knight Cardiovascular Institute, Oregon Health & Science University, Portland, OR, United States
[i] Intermountain Injury Control Research Center, University of Utah, Salt Lake City, UT, United States
[j] Department of Emergency Medicine, University of California, San Francisco, United States
[k] San Francisco General Hospital, San Francisco, CA, United States

ARTICLE INFO

Article history:
Accepted 18 September 2015

Keywords:
Emergency medical services
Trauma
Triage
Elderly
Trauma systems

ABSTRACT

Study objective: We sought to (1) define the high-risk elderly trauma patient based on prognostic differences associated with different injury patterns and (2) derive alternative field trauma triage guidelines that mesh with national field triage guidelines to improve identification of high-risk elderly patients.
Methods: This was a retrospective cohort study of injured adults ≥65 years transported by 94 EMS agencies to 122 hospitals in 7 regions from 1/1/2006 through 12/31/2008. We tracked current field triage practices by EMS, patient demographics, out-of-hospital physiology, procedures and mechanism of injury. Outcomes included Injury Severity Score ≥ 16 and specific anatomic patterns of serious injury using abbreviated injury scale score ≥3 and surgical interventions. In-hospital mortality was used as a measure of prognosis for different injury patterns.
Results: 33,298 injured elderly patients were transported by EMS, including 4.5% with ISS ≥ 16, 4.8% with serious brain injury, 3.4% with serious chest injury, 1.6% with serious abdominal-pelvic injury and 29.2% with serious extremity injury. In-hospital mortality ranged from 18.7% (95% CI 16.7–20.7) for ISS ≥ 16 to 2.9% (95% CI 2.6–3.3) for serious extremity injury. The alternative triage guidelines (any positive criterion from the current guidelines, GCS ≤ 14 or abnormal vital signs) outperformed current field triage practices for identifying patients with ISS ≥ 16: sensitivity (92.1% [95% CI 89.6–94.1%] vs. 75.9% [95% CI 72.3–79.2%]), specificity (41.5% [95% CI 40.6–42.4%] vs. 77.8% [95% CI 77.1–78.5%]). Sensitivity decreased for individual injury patterns, but was higher than current triage practices.
Conclusions: High-risk elderly trauma patients can be defined by ISS ≥ 16 or specific non-extremity injury patterns. The field triage guidelines could be improved to better identify high-risk elderly trauma patients by EMS, with a reduction in triage specificity.

Introduction

Injuries in older adults are common and often involve use of emergency medical services (EMS) [1,2]. Current field trauma triage processes fail to identify a large proportion of seriously injured older patients, many of whom are transported to non-trauma hospitals (termed "under-triage") [3–8]. This mismatch

* Corresponding author at: 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, United States. Tel.: +1 503 494 1668; fax: +1 503 494 4640.
E-mail address: newgardc@ohsu.edu (C.D. Newgard).

http://dx.doi.org/10.1016/j.injury.2015.09.010
0020–1383/

between patient need and hospital capability is a disparity in care that can result in worse clinical outcomes [9,10]. As the population of older adults in the U.S. continues to increase, under-triage and resulting disparities in trauma care are likely to become further exaggerated unless system-level changes are implemented. While the national field triage guidelines have been modified in an effort to close this gap [11], little evidence exists that these changes have been successful and out-of-hospital research on injured older adults remains sparse.

Elderly trauma patients are unique compared to younger patients. They can incur life-threatening injuries from low velocity mechanisms (e.g., ground-level fall [12,13]) and have a much higher prevalence of comorbid conditions and frailty compared to younger patients. Older adults take more medications (including medications potentially worsening injury [14,15]) and have different physiologic responses to injury [16,17]. They often have more complex medical and surgical decision-making than younger patients [18], including end-of-life considerations. Thus, the one-size-fits-all approach to field triage guidelines may be inadequate for injured elderly patients. Previous studies have explored elderly-specific triage criteria [19–21], although there is a need to pull these modifications together in a manner that allows integration with the current national triage guidelines and to compare with current triage processes. Defining "serious injury" in older adults also remains unclear, as definitions used for younger populations may not be appropriate.

Using a large multi-site cohort of injured adults $\geq$65 years transported by EMS, we sought to: (1) define the high-risk injured older adult using prognostic differences associated with different injury patterns; and (2) derive alternative field trauma triage guidelines that mesh with current national guidelines to improve identification of high-risk elderly trauma patients. This study builds upon recent work developing triage guidelines specific to injured older adults [19–21]. Sixteen Institutional Review Boards at 7 sites approved this protocol and waived the requirement for informed consent.

Materials and methods

Study design

This was a multi-site retrospective cohort study.

Study setting

The study included injured older adults who were evaluated by 94 EMS agencies transporting to 122 hospitals (including 15 Level I, 8 Level II, 3 Level III, 4 Level IV, 1 Level V and 91 community/private/federal hospitals) in 7 regions across the Western U.S. from January 1, 2006 through December 31, 2008. The 7 regions included: Portland, OR/Vancouver, WA (4 counties); King County, WA; Sacramento, CA (2 counties); San Francisco, CA; Santa Clara, CA (2 counties); Denver County, CO; and Salt Lake City, UT (4 counties). Regions were based on EMS agency service areas, typically including a central metropolitan region and some surrounding rural areas.

Selection of participants

The study sample included all injured adults $\geq$ 65 years transported by EMS to an acute care hospital (trauma and non-trauma centres) with a matched hospital record available. This cohort of patients approximates the group of older adults to whom field triage guidelines are routinely applied and includes patients with mild, moderate and serious injuries of all types. We restricted the sample to patients $\geq$ 65 years due to the high rate of under-triage in this age group [4,5,8], large trauma-related mortality [22,23], high prevalence of comorbidities and medication use, and previous research suggesting that the importance of individual triage criteria changes when older adults are defined as $\geq$65 years versus $\geq$55 years [19]. We excluded inter-hospital transfers without an initial EMS presentation, non-transported patients and deaths in the field.

Measurements

We included the following out-of-hospital variables in the analysis: age; sex; initial out-of-hospital physiology (Glasgow Coma Scale [GCS] score, systolic blood pressure [SBP], respiratory rate and heart rate); need for assisted ventilation (bag-valve mask ventilation, intubation, supraglottic airway or cricothyrotomy); 23 field trauma triage criteria currently in use at these sites; mechanism of injury (15 categories); hospital destination; and EMS reason for selecting a particular hospital. We also captured a composite, dichotomous measure of field triage to reflect actual triage practices by EMS personnel. To minimize misclassification bias, field triage status was compiled from multiple data sources, including EMS charts, matched trauma registry records and matched EMS phone records from base hospitals. For purposes of the analysis, we collapsed EMS reason for hospital selection to a dichotomous term of patient choice versus other reasons, based on previous research suggesting that patients requesting particular hospitals may have better prognosis [24]. We categorized acute care hospitals as major trauma centres (Level I and II trauma hospitals) based on American College of Surgeons accreditation status and state designation versus non-trauma hospitals.

Outcomes

We used Abbreviated Injury Scale (AIS) scores [25] to create 5 definitions of "serious injury" (AIS $\geq$ 3) and considered in-hospital mortality as a marker of prognosis to compare definitions. The definitions included: Injury Severity Score (ISS) $\geq$ 16 [26]; serious traumatic brain injury (TBI, maximum head AIS $\geq$ 3 or any intracranial procedure); serious chest injury (maximum thoracic AIS $\geq$ 3 or thoracic surgery); serious abdomen-pelvic injury (maximum abdominal-pelvic AIS $\geq$ 3, therapeutic laparotomy or pelvic surgery); and serious extremity injury (maximum upper or lower extremity AIS $\geq$ 3 or orthopaedic surgery on the extremities). Surgical procedures in each of the body regions were included to account for major interventional procedures reflecting serious injuries, in addition to standard AIS scoring. The region-specific surgical procedures were coded based on ICD9-CM procedure codes in the brain, thoracic, abdominal-pelvic and extremity regions that indicated invasive operative management. In addition, operative procedures captured through standardized trauma registry data fields and mapped to these anatomic regions were used to supplement ICD9-CM procedure codes for surgical interventions. For each of the anatomic regions, we also evaluated isolated serious injury (defined as an AIS $\geq$ 3 and/or major surgical intervention for a single anatomic region, but with an ISS $<$ 16).

Hospital records from trauma registries, emergency department (ED) databases and discharge databases were used to generate injury severity measures, surgical procedures and in-hospital mortality. These records were matched to EMS records using probabilistic linkage (LinkSolv v8.2, Strategic Matching, Inc.). We have validated the use of record linkage methodology for matching ambulance records to trauma registry data [27] and have rigorously evaluated and described use of these methods in the current database [28]. Because ISS is not included in administrative data sources, we used a mapping function (ICDPIC .ado Stata module) to generate ISS from ICD-9-CM diagnosis codes [29],