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Original Contributions

OLD AGE WITH A TRAUMATIC MECHANISM OF INJURY SHOULD BE A TRAUMA TEAM ACTIVATION CRITERION

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☐ **Abstract—Background: Age is not a standard trauma team activation (TTA) criteria recommended by the Committee on Trauma. However, there is concern that vital signs in elderly patients are often unreliable. In addition, elderly patients are at risk after moderate trauma. At our institution, age ≥ 70 years with traumatic mechanisms of injury has been a TTA criterion for more than 15 years. Objective: Our aim was to determine whether age ≥70 years as a TTA criterion appropriately identifies patients in need of additional resources without significantly impacting overtriage rates. Methods: We conducted a retrospective trauma registry study of TTAs for age ≥ 70 years from January 2012–December 2016. Demographics, injury data, Injury Severity Score (ISS), procedures, emergency department (ED) disposition, and hospital data were collected. Primary outcome was mortality, secondary outcomes were intensive care unit (ICU) and hospital lengths of stay. Patients were stratified into meeting standard criteria (TTA-S) or activated based on age alone (TTA-A). TTA patients with ISS > 15, ED intubation, ICU admission, immediate operating room or catheter-based intervention, and mortalities were appropriately triaged. Results: During the study, there were 5436 total TTAs. Seven hundred and thirty-nine TTAs in patients aged ≥ 70 years, of which 198 (26.8%) were TTA-S and 541 (73.2%) were TTA-A. In the TTA-A group, 49 (9%) patients died, 149 (27.5%) had ISS > 15, 65 (12%) underwent immediate intervention, 72 (13%) had ED intubations, and 306 (56.6%) required admission to the ICU. The overtriage rate in the TTA-A group was 39.6%. Conclusions: Elderly patients with severe trauma patients often do not meet the standard TTA criteria, resulting in potentially dangerous undertriage. Addition of age (≥70 years) criterion for TTA reduces undertriage and does not result in excessive overtriage.** © 2019 Elsevier Inc. All rights reserved.

☐ **Keywords—trauma team activation; geriatric; overtriage**

INTRODUCTION

Age is not included in the standard trauma team activation (TTA) criteria recommended by the American College of Surgeons Committee on Trauma (ACS COT) (1). However, vital signs in elderly trauma patients are often unreliable. Many severely injured elderly patients can have normal vital signs initially, only to deteriorate rapidly a short time later (2,3). This undertriage may affect outcomes (4). In addition, elderly patients are an at-risk population even after fairly moderate trauma (5,6). Our facility adopted age ≥ 70 years with traumatic mechanism as a TTA criteria in 2000, with follow-up research identifying improved outcomes (7).

The data in this manuscript are the original work of the authors and were presented as a poster at the 77th Annual Meeting of the American Association for the Surgery of Trauma, September 26, 2018, San Diego, CA.

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Due to the increasing geriatric proportion of the U.S. population, this expanded criterion could create a large overtriage burden for the trauma team. The purpose of this study was to determine whether this TTA criterion appropriately identifies patients in need of additional resources without significantly impacting overtriage rates.

MATERIALS AND METHODS

We conducted a retrospective review of the trauma registry at a large, urban, ACS-verified level I trauma center. The study included all trauma patients that were TTA and aged ≥ 70 years during a 5-year period (January 1, 2012–December 31, 2016). Ground-level falls were excluded. After obtaining approval from the University of Southern California Institutional Review Board, we queried our local trauma database based on inclusion and exclusion criteria. The registry is prospectively maintained by trained trauma registrars. The quality of the data entry is controlled by the Los Angeles County Department of Health Services, Emergency Medical Services. Registry data collected included demographics, mechanism of injury, vital signs at the scene and on admission, Injury Severity Scores (ISS), as well as catheter-based interventions and operations performed, time of procedures and operations, mortality, disposition after leaving the emergency department (ED), and discharge disposition. Charts were reviewed to clarify any missing fields.

Patients were stratified into those meeting standard criteria (TTA-S) and those that were only a TTA for age (TTA-A). Standard TTA criteria included systolic blood pressure (SBP) < 90 mm Hg, heart rate > 120 beats/min, Glasgow Coma Scale score < 9, gunshot wound to the neck or trunk, and any transfer requiring blood products to maintain vital signs. Overtriage rates were calculated utilizing a modified Cribari method. Center-specific criteria were chosen to identify patients with "major injury," which would likely benefit from the trauma team's rapid response. These criteria included ISS > 15, mortalities, ICU admission, ED intubation, need for immediate operating room and catheter-based intervention (Figure 1). The criteria and methods here are based on the *Resources for the Optimal Care of the Injured Patient* published by the ACS COT (1).

RESULTS

During the study period, 739 patients were identified that met age criteria for inclusion, constituting 13.5% of the total TTAs (n = 5436). Median age was 79 years (interquartile range 75–85 years; range 70–105 years), and 425 (57.5%) were male. The most common mechanisms of injury were automobile vs. pedestrian (41.4%), fall from a height (25.7%), and motor vehicle collision (14.4%).

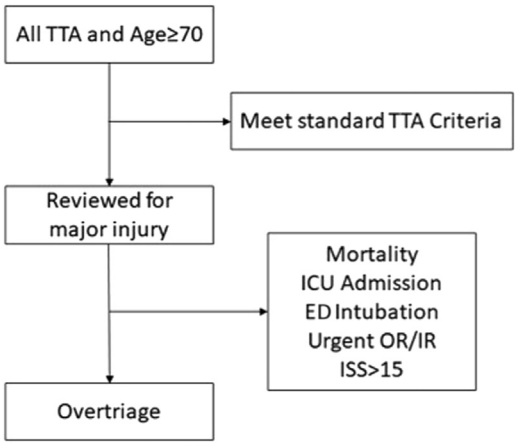

Figure 1. Determination of overtriage by center-specific criteria. ED = emergency department; ICU = intensive care unit; IR = interventional radiology; ISS = injury severity score; TTA = trauma team activation; OR = operating room.

Patients were divided into cohorts, 198 TTA-S and 541 TTA-A (Table 1). Overall mortality was 22.9%. Mortality was significantly worse for TTA-S (60.1%) compared to TTA-A (9.1%) ($p < 0.0001$). Despite this lower mortality, TTA-A patients still represented a significantly injured population. In the TTA-A cohort, there were 149 (27.5%) patients with an ISS > 15, 63 (11.6%) with an ISS > 25, and 306 (56.6%) required ICU admission. Only 50% of the TTA-A patients were discharged home, 22.2% required rehabilitation placement, and 15.9% required skilled nursing facility placement.

In the TTA-A group, 40 (7.4%) underwent immediate operation. The most commonly performed emergency operations in this group of patients was abdominal (33 patients, 6.1%), followed by extremity/soft-tissue operations (17 patients, 3.1%). Craniotomy was performed in 8 (1.5%) patients.

Overtriage analysis was performed on the overall cohort utilizing the modified Cribari method. The overtriage rate was 30% for all patients included in the study. The TTA-A and TTA-S cohorts were then analyzed separately. Among TTA-A patients: 49 (9.1%) died, 149 (27.5%) had an ISS >15, 306 (56.6%) patients were admitted to the ICU, 72 (13.3%) required intubation in the ED, and 65 (12%) required immediate operating room or catheter-based intervention. After applying these criteria, and accounting for patients that met multiple categories, an overtriage rate of 39.6% was calculated for TTA-A patients. In the TTA-S patients, the overtriage rate was 4% (Table 2).

DISCUSSION

TTA criteria have been used to identify, at the time of admission, patients who are at high risk of death and

Table 1. Demographic Characteristics

Characteristics	All TTA ≥ 70 years (n = 739)	TTA-A (n = 541)	TTA-S (n = 198)
Age, years, median (IQR)	79 (75–85)	79 (74–84)	79 (75–85)
Male, n (%)	425 (57.5)	306 (56.6)	119 (60.1)
ISS, median (IQR)	10 (5–22)	9 (2–17)	25 (10–29)
ISS > 15, n (%)	279 (37.8)	149 (27.5)	130 (65.7)
Mechanism, n (%)			
Blunt	707 (95.7)	520 (100.0)	187 (94.4)
Penetrating	32 (4.3)	0 (0.0)	32 (16.2)
Initial vital signs, median (IQR)			
Heart rate	86 (72–100)	84 (72–95)	97 (71–120)
SBP, mm Hg	149 (126–169)	151 (131–169)	138 (96–170)
GCS	15 (10–15)	15 (14–15)	6 (3–12)

GCS = glasgow coma scale; IQR = interquartile range; ISS = injury severity score; SBP = systolic blood pressure; TTA = trauma team activation; TTA-A = trauma team activation based on age; TTA-S = trauma team activation based on standard criteria.

complications. The outcomes in this group of patients can be improved by the early presence in the ED of a trauma team under the leadership of an expert trauma surgeon. These patients also benefit from high priority with regard to radiology and laboratory investigations, ICU admission, and operating rooms (7). On the other hand, liberal TTA criteria may result in unnecessary use of limited resources and increased costs. For these reasons, the ACS has introduced a list of TTA criteria based on vital signs, level of consciousness, anatomy, and mechanism of injury. Age alone is not included in the standard TTA criteria.

In addition to the standard criteria, the ACS recommends that individual trauma centers add additional criteria in an effort to optimize overtriage and undertriage rates at their individual facility. These criteria should be created with special emphasis on high-risk patients who are not captured by the existing national guidelines.

The initial evaluation and management of the elderly trauma patients pose major challenges. The initial vital signs can be misleadingly "normal," despite serious injury. Tachycardia may not be present despite significant blood loss because of the inability of the cardiovascular system of the elderly patient to launch a normal physiologic response to trauma, or due to common medications, such as β-blockers or angiotensin-converting enzyme inhibitors. In a normally hypertensive elderly patient, the standard definition of normal blood pressure as SBP > 90 mm Hg can be misleading. This concept has been studied, and Brown et al. have suggested that SBP < 110 mm Hg be utilized for geriatric patients to avoid excessive undertriage (3). This study highlights these concerns, identifying a mortality rate of 61% once elderly patients meet standard criteria. Furthermore, elderly trauma patients tolerate blood loss poorly because of the inability of the atherosclerotic vessels to constrict and maintain blood pressure. In addition, some elderly are chronically dehydrated because of diuretic use and poor fluid intake. Finally, because of the poor physiologic reserves, elderly patients decompensate easily and often without warning, even with fairly minor or moderate injuries. In the present study, the overall mortality in patients with an ISS ≤ 15

Table 2. Overtriage Analysis and Outcomes

Variable	All TTA ≥70 Years (n = 739)	TTA-A (n = 541)	TTA-S (n = 198)
Overtriage analysis, n (%)			
Mortality	169 (22.9)	49 (9)	120 (60.6)
ICU admission	457 (61.8)	306 (56.6)	151 (76.3)
ED intubation	218 (29.5)	72 (13.3)	146 (73.7)
Immediate OR	98 (13.3)	40 (7.4)	58 (29.3)
Catheter intervention	34 (4.6)	25 (4.6)	9 (4.5)
ISS > 15	279 (37.8)	149 (27.5)	130 (65.7)
Hospital outcomes, median (IQR)			
ICU LOS (days)	4 (3–9)	4 (3–8)	4 (3–9)
Ventilator days	3 (1–8)	3 (1–10)	3 (1–6)
Hospital LOS (days)	3 (1–9)	3 (1–9)	3 (1–9)
Discharge disposition, n (%)			
Home	293 (39.6)	274 (50.6)	19 (9.6)
Rehabilitation center	147 (19.9)	120 (22.2)	27 (13.6)
SNF	115 (15.6)	86 (15.9)	29 (14.6)

ED = emergency department; ICU = intensive care unit; IQR = interquartile range; ISS = Injury Severity Score; LOS = length of stay; OR = operating room; SNF = skilled nursing facility; TTA = trauma team activation; TTA-A = trauma team activation based on age; TTA-S = trauma team activation based on standard criteria.

was 23.6%. The mortality in this group of patients and in the absence of any of the standard TTA criteria was 3%; however, the need for ICU admission was 44.4%. This should highlight the dangerous potential for undertriage, which can potentially delay treatment.

Lane et al. highlighted that this undertriage effect begins in the prehospital environment (8). Their review of the Pennsylvania trauma system identified a significantly lower proportion of severely injured (ISS > 15) elderly trauma patients triaged appropriately to a trauma center. Similar results were demonstrated in the California state trauma system by Hsia et al. during a 10-year period, where patients over the age of 65 years had a significantly lower rate of trauma center care (odds ratio 0.35; 95% confidence interval 0.3–0.41) (9). Even if taken to a trauma center, these patients are not always TTA. In our series, 149 (27.5%) patients ≥ 70 years with severe injuries (ISS > 15) and 63 (11.6%) patients with critical injuries (ISS > 25) did not meet TTA criteria and would have been undertriaged. Undertriage has been associated with poor outcomes in several studies (10,11).

Our center adopted age ≥ 70 years, with traumatic mechanism, as a TTA criteria in the year 2000. Subsequent research from our facility demonstrated that the early evaluation and intervention that this provides does improve mortality (7). However, with the increasingly elderly U.S. population, there exists the possibility of a significant overtriage rate. This could negatively impact a trauma center's ability to provide high-quality and cost-effective care to all of its patients. Earlier work by Goodmanson et al. reviewed the Pennsylvania state trauma registry, and estimated a 38% increase in annual admissions, per trauma center, if age 70 years was considered a mandatory criterion for trauma center triage (12). This 38% increase would be a significant resource burden on any trauma center. If all of these patients were TTA, and a large proportion of these patients were overtriaged, this would compound the effect.

This analysis utilized center-specific criteria suggested in the *Resources for the Optimal Care of the Injured Patient*, as a method to evaluate for overtriage (1). This publication also recommends overtriage rates between 25% and 35% as acceptable. The overtriage rate after application of center-specific criteria was 39.6% for TTA-A patients.

Limitations

This study does have the standard limitations of all databank-based studies. In particular, patients that would have upgraded in care based on emergency physician judgment are not captured, this is an accepted TTA-S criterion. This could artificially increase the overtriage rate in our study.

CONCLUSIONS

Elderly trauma patients, even those with severe injuries, often do not meet the standard ACS COT–recommended TTA criteria. The present study supports that older age should be considered as a TTA criterion, irrespective of vital signs, if the mechanism of injury is traumatic and not a ground-level fall. This approach reduces undertriage and does not lead to excessive overtriage.

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ARTICLE SUMMARY

1. Why is this topic important?

Elderly trauma patients are particularly at risk due to unreliable vital signs and poor outcomes after even moderate trauma. Age is not a standard criteria for trauma team activation, despite these risk factors.

2. What does this study attempt to show?

This study examines the feasibility of adding age to the standard trauma team criteria. The study evaluates the impact this would have on overtriage rates.

3. What are the key findings?

The overtriage rate in a group of patients that were trauma team activations based solely on age was 39.6%. Within this patient population 27.5% had Injury Severity Scores > 15, 12% required immediate operative interventions, and 56.6% required ICU admissions. All of these patients would have been undertriaged if age was not a criterion.

4. How is patient care impacted?

This study suggests that age should be added to the standard trauma team activation criteria. This would decrease undertriage rates and provide timely care to this vulnerable group.