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Original Research Article

Disparity in prehospital scene time for geriatric trauma patients

Alexander J. Ordoobadi [a,b,1], Gregory A. Peters [a,c,1], Maggie L. Westfal [a,d], Cassandra M. Kelleher [a,d], David C. Chang [a,d,*]

[a] Harvard Medical School, 25 Shattuck Street, Boston, MA, 02115, USA
[b] Department of Surgery, Brigham and Women's Hospital, 75 Francis Street, Boston, MA, 02115, USA
[c] Department of Emergency Medicine, Brigham and Women's Hospital, 75 Francis Street, Boston, MA, 02115, USA
[d] Department of Surgery, Massachusetts General Hospital, 55 Fruit Street, Boston, MA, 02114, USA

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ABSTRACT

Background: Geriatric patients face disparities in prehospital trauma care. We hypothesized that geriatric trauma patients are more likely to experience prolonged prehospital scene time than younger adults.

Methods: Retrospective analysis of the 2017 National Emergency Medical Services Information System. Patients who met anatomic or physiologic trauma criteria based on national triage guidelines were included (n = 16,356). Geriatric patients (age≥65, n = 3594) were compared to younger adults (age 18–64). The primary outcome was prolonged scene time (>10 min). Multivariable logistic regression was performed, controlling for patient demographics, on-scene treatments, and injury severity.

Results: Geriatric patients were more likely to experience prolonged scene time than younger adults after controlling for other factors (OR 1.78, 95% CI 1.57–2.04, $p < 0.001$). The likelihood of prolonged scene time reached OR 2.29 (95% CI 1.85–2.84) for patients age 70–79 and OR 2.66 (95% CI 2.07–3.42) for patients age 80–89, relative to age 18–29.

Conclusions: Geriatric trauma patients are more likely than younger adults to have prolonged prehospital scene time. This disparity may be caused by delayed recognition of injury severity or age-related cognitive biases.

1. Background

Multiple factors can affect the duration of scene time. Some of these factors lie outside of the control of EMS personnel, such as urbanicity,[1,2] the level of EMS care (i.e. advanced life support [ALS] vs. basic life support [BLS]),[3] and the need to perform extrication or mitigate on-scene hazards. However, the overall duration of scene time can be independently influenced by EMS personnel. For example, the EMS clinician's decision to perform procedures on-scene,[4] perception of clinical severity,[5,6] knowledge of local protocols,[7] and sense of urgency can all affect the duration of scene time.

Geriatric patients with traumatic injuries are at higher risk for mortality and morbidity than younger adults.[8–12] Despite their increased risk, disparities in the care of geriatric trauma patients have been demonstrated in both hospital and prehospital settings.[13,14] For example, EMS personnel are less likely to transport geriatric patients with traumatic injuries to trauma centers than younger patients.[13,15–18] Identifying disparities in care for this patient population may serve as a first step toward quality improvement initiatives to improve outcomes for geriatric trauma patients. For this reason, this study was undertaken to determine whether there is a difference in the duration of scene time between geriatric and younger adult patients with traumatic injuries.

2. Methods

2.1. Data source

Data were extracted from the 2017 National EMS Information System (NEMSIS) Public-Release Research Dataset, administered by the NEMSIS Project (NEMSIS Technical Assistance Center, University of Utah School of Medicine, Salt Lake City, Utah). This dataset is generated from voluntary submissions of patient care report data from EMS agencies across the nation and made available to the public in a de-identified form. This study was reviewed by the Harvard Longwood

* Corresponding author. Department of Surgery, Massachusetts General Hospital, 165 Cambridge Street, Suite 403, Boston, MA, 02114, USA.
E-mail addresses: aordoobadi@bwh.harvard.edu (A.J. Ordoobadi), GPETERS3@mgh.harvard.edu (G.A. Peters), mwestfal@partners.org (M.L. Westfal), CKELLEHER3@mgh.harvard.edu (C.M. Kelleher), dchang8@mgh.harvard.edu (D.C. Chang).
[1] These authors contributed equally to this work.

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2.2. Study population

Incidents involving patients age 18 years or older who were identified by EMS personnel as meeting the national field triage guidelines[19] for physiologic criteria (systolic blood pressure [SBP] <90; respiratory rate [RR] < 10 or >29 breaths per minute or need for ventilatory support; Glasgow Coma Scale [GCS] score ≤13) or anatomic criteria (penetrating injuries to the head, neck, torso, and extremities proximal to elbow or knee; chest wall instability or deformity; two or more proximal long-bone fractures; crushed, degloved, mangled, or pulseless extremity; amputation proximal to the wrist or ankle; pelvic fractures; open or depressed skull fracture; paralysis) were selected for inclusion in the study.

Incidents were excluded if there was any form of documented on-scene delay that was deemed outside the control of EMS personnel (e.g., due to extrication, hazardous materials, triage/multiple patients, vehicle failure, etc.). Incidents with scene times greater than 60 min were also excluded because this extreme duration of scene time likely represents some form of on-scene delay that was not recorded in the database. To exclude interfacility transports, all incidents that were not labeled as a 911 scene response were excluded. Incidents where the patient was not treated and transported by the same unit were excluded for two reasons. First, a prolonged scene time is outside of the control of EMS personnel if a transport-capable unit is not available on scene (e.g., if medical care is provided on-scene by fire department personnel while waiting for a transport-capable ambulance to arrive). Second, because NEMSIS is an incident-level database rather than a patient-level database (i.e. more than one EMS response may be logged for a single patient), there could be multiple records per patient if multiple units responded to the same incident. Since each patient can only be transported from the scene once, the focus on records where the patient was treated and transported by the same unit would exclude records from other responding but non-transporting units.[20] Incidents that were managed by a BLS unit only (roughly 10% of initially included incidents) were excluded from the primary analysis because ALS units can provide a much wider range of on-scene procedures, resulting in collinearity between the level of EMS care (i.e. ALS vs. BLS) and the number and type of on scene procedures in the multivariable logistic regression model.

2.3. Statistical analysis

Patients were separated into two age groups: geriatric (age 65 and older) and younger adults (age 18–64). The primary outcome was a binary variable indicating whether prehospital scene time was greater than 10 min. The 10-min cutoff for prolonged scene time was selected because multiple large EMS systems have recommended 10 min as the target maximum duration of scene time for patients with traumatic injuries,[21–23] and it has also been suggested as a national quality measure for prehospital trauma care.[24] The secondary outcomes were a binary variable indicating scene time greater than 15 min and the actual scene time as a continuous variable.

Along with patient demographics, multiple covariates were identified within the dataset that could affect the duration of scene time. The patient's revised trauma score (RTS) was calculated from recorded vital signs and Glasgow Coma Scale (GCS) and then grouped into RTS greater than or less than or equal to 6. RTS values less than or equal to 6 have been used in previous studies to describe more severe traumatic injuries.[25] On scene procedures were identified as those occurring between the time of EMS arrival and the time of transport initiation. Seven types of on-scene procedures were recorded: establishing intravenous (IV) access, establishing intraosseous (IO) access, intubation, tourniquet application, spinal immobilization, splinting, and needle decompression thoracostomy (NDT). The total number of procedures that were performed on-scene was also computed.

Unadjusted analysis was performed using a chi square test for categorical variables and a two-sided Student's t-test for continuous variables. Multivariable logistic regression was performed for the primary outcome of scene time greater than 10 min, controlling for patient sex, incident urbanicity, revised trauma score, trauma activation criteria (i.e. the specific anatomic and physiologic trauma triage criteria identified by EMS personnel), and number and type of on-scene procedures performed. Subgroup analyses were performed by repeating the same regression model for 17 different subpopulations of the total sample to assess the consistency of our findings. We also performed a subgroup analysis on patients treated and transported by BLS units to determine whether there were differences in the likelihood for prolonged scene time between patients treated by BLS and ALS units. To compare differences in risk factors for prolonged scene time between adult and geriatric patients, the regression model was also repeated for these groups and the odds radios of each covariate were compared between the adult and geriatric groups. All statistical analyses were performed using Stata version 15.0 (StataCorp, College Station, TX). A P-value ≤ 0.05 was considered statistically significant.

2.4. Missing data

Several variables had missing data, including urbanicity (5.8% missing), RTS (7.6% missing), number and type of procedures (27% missing), and race (64.1% missing). Given the high proportion of missing data for race, it was not included as a covariate in the adjusted analysis but was evaluated in the subgroup analysis. Multiple imputation using the multivariate normal model was performed to impute missing data within the urbanicity, RTS, and number of procedures variables. These imputed variables were then rounded to the nearest integer to convert them into categorical variables. The results of the adjusted analysis performed on the multiple imputation dataset are presented in a supplemental table (Supplemental Table 1). The primary adjusted analysis in the results section was performed on incidents with complete data because these estimates of the likelihood of prolonged scene time were more conservative than those obtained through multiple imputation.

3. Results

A total of 16,356 incidents were included in the study (Fig. 1). The majority of these incidents involved younger adult patients (78.0%), while geriatric patients comprised the remaining 22.0% of incidents. Patients were predominantly male (69.1%) and white (58.3%) (Table 1). Most incidents occurred in an urban area (81.8%). The most common indications for trauma center referral were GCS≤13 and penetrating injuries to the head, neck, torso, and proximal extremities (Table 1). Most patients had a revised trauma score (RTS) greater than 6 (i.e. less severe). At least one unique procedure was performed on-scene in 78.0% of incidents. The most common procedures that were performed on-scene were establishing IV access (56.1%) and spinal immobilization (39.7%).

There were demographic differences between incidents involving adult and geriatric patients (Table 1). Younger adult patients were predominantly male, while sex was more evenly distributed among the geriatric patients. Geriatric patients were predominantly white, while there was greater racial and ethnic diversity among the younger adult patients. Incidents involving younger adult trauma patients occurred more frequently in urban areas than incidents involving geriatric patients. Penetrating injuries were less common in geriatric patients, while pelvic fractures were more common in this age group. Geriatric patients were more likely to have RTS greater than 6 compared to younger adult patients. IV access was performed at similar rates in the two groups (56.2% vs. 56.9%, $p = 0.484$), while spinal immobilization was performed more frequently in younger adult patients than in geriatric patients (40.7% vs. 36.2%, $p < 0.001$).

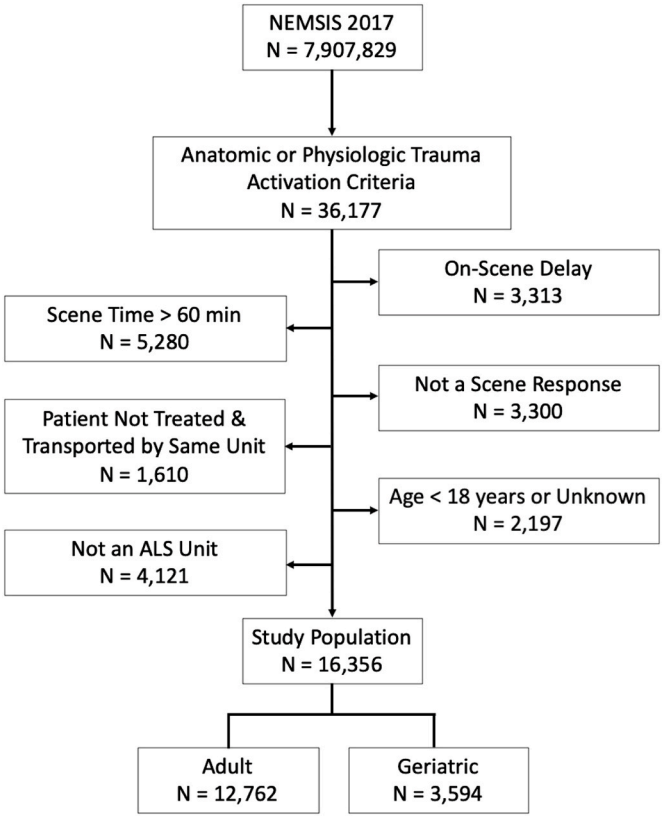

Fig. 1. Selection criteria for incidents included in the study.
Abbreviations: NEMSIS, National Emergency Medical Services Information System; ALS, Advanced Life Support.

The mean (SD) scene time across all patient groups was 14.5 (7.9) minutes. Geriatric patients had a significantly longer mean scene time than younger adult patients (16.7 (8.0) vs. 13.9 (7.8), $p < 0.001$). On unadjusted analysis, a greater proportion of incidents involving geriatric patients had scene times greater than 10 min and 15 min than those involving younger adults (Table 1).

On multivariable analysis, controlling for patient sex, urbanicity of the incident, RTS, trauma activation criteria, and on-scene procedures, geriatric patients were more likely to have a scene time greater than 10 min than younger adult patients (OR 1.79, 95% CI 1.57–2.04, $p < 0.001$) (Table 2). When the multivariable analysis was repeated with age grouped into 10-year increments, the likelihood of scene time greater than 10 min increased with increasing age, in all age groups relative to patients age 18–29 (Fig. 2). The risk of prolonged scene time reached OR 2.29 (95% CI 1.85–2.84) for patients age 70–79 and OR 2.66 (95% CI 2.07–3.42) for patients age 80–89, relative to patients age 18–29. Other covariates that were independently associated with scene time greater than 10 min included female sex, incidents in non-urban areas, and pelvic fractures. Conversely, greater injury severity, penetrating trauma, and amputations were independently associated with decreased likelihood of scene time greater than 10 min.

Subgroup analysis performed for a variety of trauma activation criteria, patient demographics, injury severity, and procedures performed on-scene demonstrated qualitatively similar results, with geriatric patients experiencing prolonged scene time in almost every patient subpopulation (Fig. 3). A subgroup analysis was also performed on incidents where patients were treated and transported by a BLS unit only. Geriatric patients treated by BLS units were more likely to have prolonged scene time than younger adults (OR 1.97, 95% CI 1.19–3.06, $p = 0.007$), a similar result to the primary analysis involving patients treated by ALS units.

To identify specific contributors to scene delays among geriatric patients, the analysis was further performed on geriatric patients only, and the results were compared to the same stratified analysis with younger adult patients only. Pelvic fractures were associated with increased likelihood of prolonged scene time in geriatric patients (OR 1.74, 95% CI 1.09–2.80, $p = 0.022$) but not in adult patients (OR 1.18, 95% CI 0.89–1.57, $p = 0.254$). Conversely, penetrating trauma was associated with decreased odds of prolonged scene time in younger adult patients (OR 0.48, 95% CI 0.41–0.56, $p < 0.001$) but not in geriatric patients (OR 0.87, 95% CI 0.56–1.34, $p = 0.523$). Female sex and non-urban setting were consistently associated with increased odds of prolonged scene time in both geriatric and younger adult patients.

4. Discussion

Prolonged scene time has been associated with increased mortality in patients with traumatic injuries.[1,20,26,27] As a result, EMS systems seek to reduce scene time to improve the quality of prehospital trauma care.[21,22,24] Given this focus on scene time as a quality metric, we evaluated whether there were differences in the duration of scene time between adult and geriatric patients. We found that geriatric trauma patients have longer prehospital scene times than younger adult patients. This association persisted after controlling for a variety of patient, incident, and treatment factors, isolating age as a major contributor to the observed gap in scene time. As we control for confounders and eliminate rational explanations for differences in scene time, the possibility remains that unconscious cognitive processes may be driving this pattern of care.

When EMS clinicians arrive on the scene of an injured patient, they must decide whether to take the patient to a trauma center. This decision must be made rapidly to avoid prolonged scene time and accurately to avoid under- or over-triage. Although triage decisions are designed to be made based on the national trauma field triage guidelines,[19] Newgard et al. demonstrated that they are primarily driven by the EMS clinician's "gut feeling" about the patient.[28] This gut feeling is formed before EMS personnel perform a physical exam or obtain a complete set of vital signs and is largely based on two key factors: the patient's mechanism of injury and initial presentation (e.g., general appearance, visible injuries, and mental status).[28] This initial provider impression is vulnerable to cognitive biases, which are decision making shortcuts that can result in errors.[29] These cognitive biases may result in prolonged scene time for geriatric patients by resulting in delayed recognition of serious injuries and a decreased sense of urgency to initiate transport to the trauma center.

Geriatric patients are more likely to be seriously injured from less severe mechanisms of injury than younger adults,[30,31] so the EMS clinician's initial evaluation of the patient's mechanism of injury could lead to delayed recognition of serious injuries in geriatric patients[32] and contribute to prolonged scene time. For example, EMS clinicians may initially discount the possibility that a geriatric patient is severely injured when the mechanism of injury is a ground level fall or other similar, low-velocity event. In our study, pelvic fractures, which can occur from ground level falls and other less-severe mechanisms of injury in geriatric patients,[33,34] were independently associated with prolonged scene time in geriatric patients but not in younger adults. In such cases, EMS personnel are less likely to recognize serious injury until a more complete patient assessment has been performed, thereby prolonging scene time. While delayed recognition may play a role in explaining the scene time disparity for some incidents, it does not fully explain the age-related disparity. For example, within the subset of incidents involving penetrating trauma, where the need for trauma center referral should be both easily and rapidly identified, the disparity in scene time persisted.

Another possible explanation for the scene time disparity is that EMS clinicians may feel less of a sense of urgency to rapidly initiate transport in geriatric trauma patients than in younger adults. Healthcare workers have been shown to underestimate older adults' preferences for

Table 1
Characteristics of included incidents.

	All Patients		Adult Patients (n = 12,762)		Geriatric Patients (n = 3594)		
Incident Characteristic	n	%	n	%	n	%	*P* value
Patient Sex							
Female Patient	5042	30.9	3267	25.7	1775	49.5	<0.001
Race/Ethnicity of Patient							<0.001
White	3422	58.4	2422	52.0	1000	82.8	
Black	1327	22.6	1249	26.8	78	6.5	
Hispanic	951	16.2	850	18.3	101	8.4	
Asian	75	1.3	55	1.2	20	1.7	
Other	90	1.5	81	1.7	9	0.8	
Urbanicity							<0.001
Urban	12,607	81.8	10,099	84.3	2508	73.1	
Suburban	957	6.2	666	5.6	291	8.5	
Rural	1498	9.7	988	8.3	510	14.9	
Wilderness	353	2.3	230	1.9	123	3.6	
Revised Trauma Score of Patient							<0.001
>6	12,845	85.0	9944	84.4	2901	87.2	
≤6	2268	15.0	1841	15.6	427	12.8	
Physiologic Trauma Center Referral Criteria							
GCS ≤13	6699	41.0	4991	39.1	1708	47.5	<0.001
RR < 10 or >29 or need for ventilatory support	1335	8.2	1094	8.6	241	6.7	<0.001
SBP <90	1043	6.4	801	6.3	242	6.7	0.322
Anatomic Trauma Center Referral Criteria							
Amputation proximal to wrist or ankle	568	3.5	493	3.9	75	2.1	<0.001
Crushed, degloved, mangled, or pulseless extremity	988	6.0	851	6.7	137	3.8	<0.001
Chest wall instability or deformity	661	4.0	528	4.1	133	3.7	0.24
Open or depressed skull fracture	1349	8.3	1070	8.4	279	7.8	0.232
Paralysis	387	2.4	303	2.4	84	2.3	0.897
Pelvic fractures	1224	7.5	598	4.7	626	17.4	<0.001
Penetrating injuries	3994	24.4	3609	28.3	385	10.7	<0.001
Two or more proximal long-bone fractures	966	5.9	779	6.1	187	5.2	0.043
Scene Time							
Scene time >10 min	11,150	68.2	8271	64.8	2879	80.1	<0.001
Scene time >15 min	6289	38.5	4457	34.9	1832	51.0	<0.001

Abbreviations: GCS, Glasgow coma score; RR, respiratory rate; SBP, systolic blood pressure.

Table 2
Multivariable logistic regression model[a] for scene time >10 minutes.

Factor	Odds Ratio	95% CI	*P* value
Age (reference: age 18–64)			
Geriatric (age ≥65)	1.79	1.57–2.04	<0.001
Sex (reference: male)			
Female	1.38	1.24–1.54	<0.001
Incident Urbanicity (reference: urban)			
Suburban	1.59	1.29–1.97	<0.001
Rural	1.69	1.41–2.01	<0.001
Wilderness	1.38	0.98–1.95	0.062
Revised Trauma Score (reference: >6)			
≤6	0.60	0.53–0.69	<0.001
Physiologic Trauma Criteria			
GCS	0.77	0.68–0.88	<0.001
SBP	0.99	0.81–1.20	0.898
RR	0.64	0.54–0.76	<0.001
Anatomic Trauma Criteria			
Penetrating trauma	0.49	0.43–0.57	<0.001
Long bone fractures	0.80	0.65–0.98	0.032
Pelvic fractures	1.34	1.06–1.69	0.016
Paralysis	1.50	1.04–2.15	0.029
Skull fracture	0.80	0.67–0.95	0.012
Chest trauma	1.02	0.80–1.31	0.862
Mangled extremity	0.76	0.63–0.93	0.009
Amputation	0.53	0.41–0.67	<0.001

Abbreviations: GCS, Glasgow coma score; SBP, systolic blood pressure; RR, respiratory rate.

[a] Also controlled for number and type of procedures performed on scene.

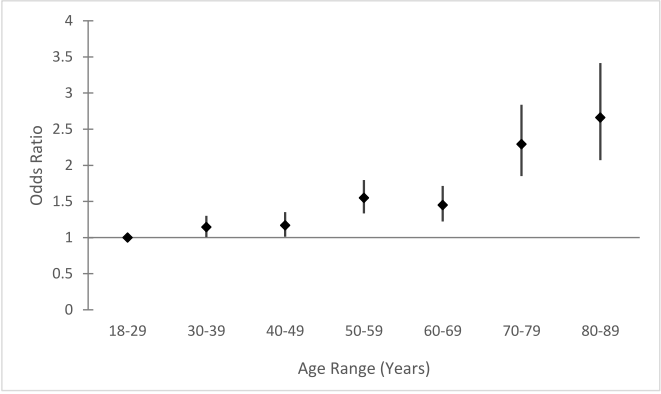

Fig. 2. Secondary analysis demonstrating the odds of scene time greater than 10 min by age groups. These odds ratios were obtained by repeating the multivariable logistic regression in Table 2 with ages grouped into 10-year increments with age 18–29 serving as the reference group.

aggressive care,[35] and this could contribute to a decreased sense of urgency among EMS clinicians caring for geriatric trauma patients, resulting in prolonged scene time. Similarly, the high base rate of medical comorbidities among older adults could cause EMS clinicians to initially attribute vital sign abnormalities to a medical condition that would benefit from on-scene treatment rather than due to traumatic injuries that would warrant expedited transport to a trauma center. Importantly, cognitive biases are not related to intelligence or cognitive ability and are present in healthcare providers across all levels of training, including among physicians caring for older adult patients admitted to the hospital with traumatic injuries.[14,29,36]

Delayed injury recognition and unconscious age bias point to areas for improvement within both trauma systems and EMS training courses. Cultural factors within trauma systems can exacerbate unconscious age biases. Surveys of EMS clinicians have demonstrated that subtle cues

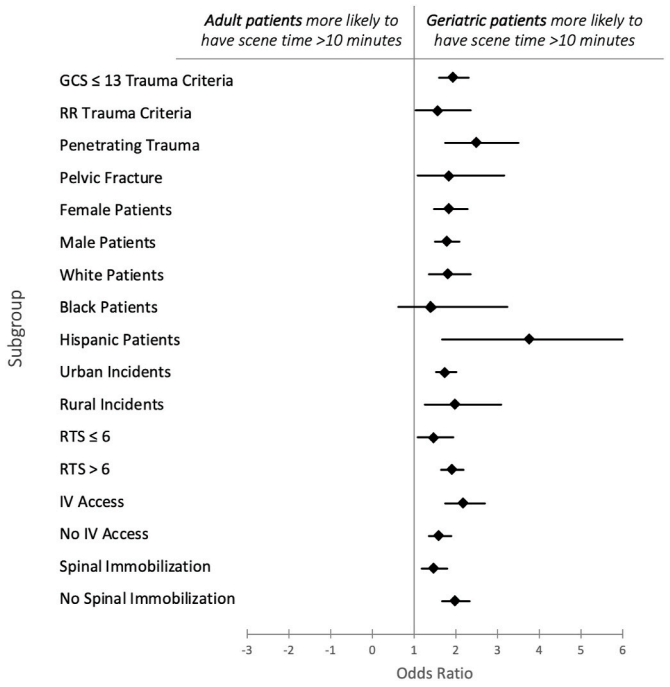

Fig. 3. Subgroup analysis for odds of scene time greater than 10 min for geriatric patients compared to adult patients.
Abbreviations: GCS, Glasgow coma score; RR, respiratory rate; RTS, revised trauma score; IV, intravenous.

from receiving trauma center personnel, including eye rolling and grumbling,[28] may cause them to question their triage decisions about older adult trauma patients.[13] Furthermore, it is rare for EMS clinicians to receive formal feedback and follow up from trauma centers about patients they transported. Such follow-up would allow paramedics to learn from each call and would reinforce the concept that older adults can be severely injured from less significant mechanisms of injury than younger adults. A lack of dedicated training on geriatrics within emergency medical technician (EMT) and paramedic training courses may also contribute to delayed recognition of injuries in older adults.[37]

This study has several limitations. We do not have patient outcomes data because the dataset is deidentified, preventing linkage with hospital records. However, prolonged scene time has been shown in prior studies to be associated with increased mortality in adult and geriatric trauma patients,[1,20,26,27] and several large EMS systems have identified scene time as an important quality metric for prehospital trauma care.[21–24] This study is also limited by the fact that the data source is a convenience sample generated from voluntary submission of EMS patient care data, and thus may or may not be representative of the population.[38] However, the inclusion of nearly 8 million EMS activations from more than 4000 agencies across 35 states and territories suggests that these data are likely generalizable to many settings in the US. In addition, we have only included incidents where the EMS unit both treated and transported the patient to mitigate the risk of duplicate records. We acknowledge that some procedures performed by other units prior to the arrival of the transporting unit may have been unintentionally excluded, but we expect that most of these procedures would be included in the transporting unit's patient care report given that all prehospital procedures must be reported to the receiving facility by the transporting unit. Finally, our data source allowed us to account for penetrating trauma as the mechanism of injury, but we were unable to account for the presence of blunt trauma due to limitations of the dataset. This approach controls for the fact that penetrating trauma is rapidly recognized and is associated with reduced prehospital times, but we acknowledge that a more direct assessment of mechanism of injury would be helpful. Future studies that directly account for mechanism of injury would be helpful to deepen insight into how it factors into scene time across age groups. Nevertheless, our study also benefits from several strengths. The dataset includes a broad set of variables, enabling a comprehensive multivariable regression approach to control for multiple factors that can affect scene time. In addition, the dataset draws upon nationwide data that are submitted by a diverse set of agencies and regions.

Our study has important implications. Interventions to reduce the scene time disparity for older adults should target the possibility of delayed recognition of injuries and age-related cognitive biases. Changes to EMS trauma triage protocols could speed recognition of severe injuries among older adults. One promising intervention is the identification of more sensitive physiologic trauma triage criteria for geriatric trauma patients to compensate for higher average baseline blood pressure in these patients.[39] Improved EMS education, including the widespread implementation of geriatric educational modules and unconscious bias training,[40,41] could address both delayed recognition of injuries and age-related biases. In addition, trauma centers should provide feedback and patient follow-up to EMS crews who transport geriatric trauma patients. Together, these interventions to reduce age-related disparities in scene time may serve as one approach to improve outcomes for geriatric trauma patients, who are known to be at higher risk for mortality and morbidity than younger adults with similarly severe injuries.[8,9]

Meeting presentations

This manuscript has not been presented at any meetings.

Authorship statement

All authors were involved with study design. AJO and GAP were responsible for literature review, data analysis, data interpretation, and drafting the article. MLW, CMK, and DCC contributed to the interpretation of the data and critically revised the article.

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Declaration of competing interest

The authors declare no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjsurg.2021.10.031.

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