ORIGINAL ARTICLE

Undertriage of Elderly Trauma Patients to State-Designated Trauma Centers

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Objective: To determine whether age bias is a factor in triage errors.

Design: Retrospective analysis of 10 years (1995-2004) of prospectively collected data in the statewide Maryland Ambulance Information System followed by surveys of emergency medical services (EMS) and trauma center personnel at regional EMS conferences and level I trauma centers, respectively.

Patients: Trauma patients were defined as those who met American College of Surgeons physiology, injury, and/or mechanism criteria and were subjectively declared priority I status by EMS personnel.

Main Outcome Measure: Undertriage, defined as when trauma patients were not transported to a state-designated trauma center.

Results: The registry analysis identified 26 565 trauma patients. The undertriage rate was significantly higher in patients aged 65 years or older than in younger patients (49.9% vs 17.8%, $P<.001$). On multivariate analysis, this decrease in trauma center transports was found to start at age 50 years (odds ratio, 0.67; 95% confidence interval, 0.57-0.77), with another decrease at age 70 years (odds ratio, 0.45; 95% confidence interval, 0.39-0.53) compared with patients younger than 50 years. A total of 166 respondents participated in the follow-up surveys and ranked the top 3 causal factors for this undertriage as inadequate training, unfamiliarity with protocol, and possible age bias.

Conclusions: Even when trauma is recognized and acknowledged by EMS, providers are consistently less likely to consider transporting elderly patients to a trauma center. Unconscious age bias, in both EMS in the field and receiving trauma center personnel, was identified as a possible cause.

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EVIDENCE-BASED CLINICAL practice guidelines strongly recommend that elderly trauma patients be treated as aggressively as nonelderly patients. For example, the Eastern Association for the Surgery of Trauma says that "all other factors being equal, advanced patient age, in and of itself, is not predictive

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of poor outcomes following trauma, and therefore should not be used as the sole criterion for denying or limiting care in this patient population" and that "with the exception of patients who are moribund on arrival, an initial aggressive approach should be pursued with the elderly trauma patient, as the majority will return home, and up to 85% will return to independent functions."[1]

However, some studies have suggested that age bias may still exist in trauma care, even in the prehospital phase of that care. For example, in a previous analysis of Maryland ambulance data, it was found that elderly trauma patients were less likely than similarly injured nonelderly patients to be transported to designated trauma centers (TCs).[2] The possibility of age bias has been discussed in many other medical fields[3-8] and sometimes in trauma surgery,[9] but it is unknown whether this disparity in prehospital transport may be another example of age bias in health care.

The objective of this study was to determine if age bias plays a role in the undertriage of elderly trauma patients to TCs. We expanded the analysis beyond patient conditions as recorded by emergency medical services (EMS) forms to include an examination of the providers and their reasoning for and judgment of their transport decisions.

METHODS

This was a 2-part study. The first was a retrospective analysis of the statewide Maryland Ambulance Information System database under-

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taken by the Geriatric Emergency Medical Services Advisory Committee for the Maryland Institute for Emergency Medical Services System. We performed the analysis following normal data access approval at Maryland Institute for Emergency Medical Services System and institutional review board approval at Johns Hopkins Hospital. The data are derived from all ambulance forms in the state of Maryland. These forms are completed by the EMS providers at the time of the incident or shortly thereafter and contain questions with lists of predefined answer choices. The present analysis included 10 calendar years, starting with 1995, which was the year of an earlier study in the literature,[2] through the end of 2004.

We identified trauma patients from the database by screening for those with at least 1 injury. However, not all injured patients require treatment at a designated TC. Without exact diagnosis in the prehospital setting, we identified potential major trauma patients by applying 2 criteria concurrently. We first applied the American College of Surgeons (ACS) trauma triage criteria,[10] which includes 3 broad objective categories: presenting physiology, injury pattern, and mechanism of the injury. We then added the judgment of the prehospital providers in terms of their assignment of priority level to the case. According to Maryland EMS regulations, priority level I should be assigned to a patient who is "critically ill or injured" and "requires immediate attention" and in whom "a delay in treatment may be harmful." We thus defined major trauma patients to be those who not only met ACS criteria but who were also declared to be priority I by the EMS.

Undertriage was defined as occurring when a trauma patient, as defined, was not transported to 1 of 8 designated TCs in Maryland (2 level I centers, both in Baltimore; 4 level II centers, with 2 in Baltimore and 2 in the suburbs around Washington, DC; and 2 level III centers). These TCs are designated by the state of Maryland using a modified version of the ACS criteria.

Patients who were being transferred between hospitals were excluded from the analysis to avoid double counting. Patients who were transported to a non-Maryland hospital were also excluded to avoid differences in TC designation criteria in other states.

The second part of the study involved surveys of providers after presentations of the registry findings at 4 EMS conferences and at a surgery grand rounds in a level I TC in Maryland between 2004 and 2006. For these presentations, information from a preliminary analysis of 1995-2001 data was used. The survey was based on discussions from the first 2 EMS conferences and was subsequently administered at the third and fourth EMS conferences and at the level I TC. The surveys asked the respondents to rank the different causal factors by estimating the percent weight each factor contributed to the overall problem of undertriage in elderly trauma patients. This technique is similar to the concept of Selective Evaluation of Individualized Quality of Life, in which respondents are asked to indicate, by changing the size of slices on a wheel, how much each factor contributes to their quality of life.[11] In analysis, weights that added up to more than 100% were recalculated proportionally so that the sum would be equal to 100%. Weights that did not add up to 100% were left alone and not recalculated. Statistical analysis was performed in Stata, version 9.2 (Stata Corp, College Station, Texas), with statistical significance defined as $P < .05$.

RESULTS

From 1995 through 2004, a total of 728 567 injured patients were identified in Maryland. Among them, 126 172 patients met at least 1 of the ACS trauma criteria; and among that group, 26 565 were declared to have priority I status by the EMS providers. The following discussion pertains to this group of 26 565 patients. Nevertheless, it should be noted that the findings are similar when the analysis was performed on all of the 126 172 patients meeting ACS trauma criteria irrespective of their priority status.

The overall undertriage rates in patients aged 65 years or older was 49.9% compared with 17.8% in patients younger than 65 years ($P < .001$). **Table 1** presents the undertriage rates in different subpopulations. In every calendar year, the undertriage rates were consistently higher in patients aged 65 years or older; in patients who expressed a preference for treatment center; and in patients who were transported to a specific hospital because it was the closest. Rates did not differ by sex; by physiology, injury, or mechanism criteria; or by whether paramedics or nonparamedic emergency medical technicians transported the patient. Additional analysis revealed the same finding in all jurisdictions across the state (data not shown).

On multivariate analysis, controlling for year, sex, physiology, injury, or mechanism criteria, transport reasons, EMS provider training level, presence or absence of 18 specific injuries, and jurisdictional region, age 65 years or older was associated with a 52% reduction in likelihood of TC transport (odds ratio [OR], 0.48; 95% confidence interval [CI], 0.30-0.76) (**Table 2**). Similar results were found in a subset analysis focusing on Baltimore (OR, 0.39; 95% CI, 0.28-0.54) (**Table 3**).

The **Figure** further illustrates the age relationship in trauma triage by presenting the ORs of TC transports in different 5-year age groups relative to patients younger than 30 years. All patients aged 50 years or older had significantly lower likelihoods of TC transport. Within this group, 3 broader age groups could be created: younger than 50 years (ORs not significantly different from 1.0 for any age groups in this interval), 50 to 69 years (OR, 0.59-0.71 for the 4 age groups in this interval), and 70 years or older (ORs < 0.53 for all age groups therein). When the multivariate regression analysis was repeated with these 3 broader age groups, with age younger than 50 years as the reference group, the OR for ages 50 to 69 years was 0.67 (95% CI, 0.57-0.77), and the OR for ages 70 years or older was 0.45 (95% CI, 0.39-0.53).

A total of 166 providers responded to the follow-up surveys, including 127 EMS providers and 32 medical providers (7 respondents refused to identify their training background). There were 89 women in this group (53.9%). Mean age was 41.0 years (median, 43 years). Among the EMS providers, the mean number of years of service was 12.0 years (median, 10 years), and most were level B emergency medical technicians or lower (74.8%). For the medical providers in this group, there were 14 attending physicians (43.8%), 4 residents (12.5%), 6 medical students (18.8%), and 8 nurses (25.0%). The factor for causing trauma patients to be transported to a non-TC that was weighed the most heavily was inadequate training for managing elderly trauma patients (mean weight, 25.3%; median, 20%). The second and third highest ranked factors were unfamiliarity with protocol (mean weight, 12.0%; median, 10%) and the transport not being worth it because of age (mean weight, 13.4%; median, 5%). The fourth and fifth highest factors were not being welcomed at the receiving TC (mean weight, 9.5%; median, 2%) and the transport not being

Table 1. Undertriage Rates in Patients Aged 65 Years or Older vs Patients Aged Younger Than 65 Years in the Maryland Ambulance Information System Database

Characteristic			No. of Patients Wrongly Transported to Non-TC/Total No. of Patients (%)		*P* Value
			Patient Age, ≥65 y	Patient Age, <65 y	
Year					
1995			292/565 (51.7)	634/3478 (18.2)	<.001
1996			180/424 (42.5)	460/3145 (14.6)	<.001
1997			128/284 (45.1)	364/1997 (18.2)	<.001
1998			132/263 (50.2)	344/1628 (21.1)	<.001
1999			178/358 (49.7)	439/2448 (17.9)	<.001
2000			147/333 (44.1)	372/2452 (15.2)	<.001
2001			158/306 (51.6)	369/2013 (18.3)	<.001
2002			187/341 (54.8)	375/1891 (19.8)	<.001
2003			215/378 (56.9)	418/2160 (19.4)	<.001
2004			173/338 (51.2)	318/1763 (18.0)	<.001
Sex					
F			826/1636 (50.5)	1331/5847 (22.8)	<.001
M			908/1842 (49.3)	2594/16 246 (16.0)	<.001
Physiology criteria met			1687/2836 (59.5)	3420/13 296 (25.7)	<.001
Systolic blood pressure < 90 mm Hg			678/1011 (67.1)	1416/4760 (29.8)	<.001
Respiratory rate < 10 or > 29/min			828/1227 (67.5)	1842/5532 (33.3)	<.001
Glasgow Coma Scale score < 14			1227/2122 (57.8)	2691/10 057 (26.8)	<.001
Revised trauma score < 11			832/1374 (60.6)	1747/6281 (27.8)	<.001
Injury criteria met			184/1006 (18.3)	1143/12 470 (9.2)	<.001
Patient in shock			46/157 (29.3)	277/1889 (14.7)	<.001
Multisystem trauma			96/500 (19.2)	592/5319 (11.1)	<.001
Severe single-system trauma			45/237 (19.0)	273/2332 (11.7)	.001
Penetrating wound			10/71 (14.1)	245/3931 (6.2)	.007
CNS injury			38/278 (13.7)	234/2745 (8.5)	.004
Mechanism criterion met			177/868 (20.4)	1153/9914 (11.6)	<.001
Vehicle deformity			90/465 (19.4)	531/4660 (11.4)	<.001
Ejection			12/49 (24.5)	203/1550 (13.1)	.02
Entrapment			43/220 (19.6)	310/2521 (12.3)	.002
Fall > 3 × height			32/147 (21.8)	78/1089 (7.2)	<.001
Speed of vehicle			57/306 (18.6)	590/4786 (12.3)	.001
ACS triage category					
Physiology	Injury	Mechanism			
–	–	+	56/275 (20.4)	358/3429 (10.4)	<.001
–	+	–	35/251 (13.9)	194/3840 (5.1)	<.001
+	–	–	1508/2184 (69.1)	2377/5773 (41.2)	<.001
+	+	–	70/287 (24.4)	369/3448 (10.7)	<.001
+	–	+	42/125 (33.6)	215/1303 (16.5)	<.001
–	+	+	12/228 (5.3)	121/2410 (5.0)	NS
+	+	+	67/240 (27.9)	459/2772 (16.6)	<.001
Reason for transport to non-TC					
Patient preference			51/72 (70.8)	51/172 (29.7)	<.001
Closest hospital			1637/2404 (68.1)	3728/10 140 (36.8)	<.001
EMT level					
Paramedic			1111/2404 (46.2)	2321/15 125 (15.4)	<.001
Nonparamedic			679/1186 (57.6)	1772/7850 (22.6)	<.001
Total			**1790/3590 (49.9)**	**4093/22 975 (17.8)**	<.001

Abbreviations: ACS, American College of Surgeons; CNS, central nervous system; EMT, emergency medical technician; NS, nonsignificant; TC, trauma center; –, did not meet criteria; +, met criteria.

worth it because of poor prognosis (mean weight, 5.4%; median, 2%) (**Table 4**).

COMMENT

With the aging of the baby boomer generation, it is estimated that 39% of all trauma patients will be aged 65 years or older by the year 2050.[12] Trauma will no longer be a disease of the young.

This study identifies a significant undertriage problem in elderly trauma patients. Among patients whose injuries were both recognized (in the recording of objective measures that met ACS criteria) and acknowledged by the EMS providers (in their declaration of priority I status), elderly trauma patients are half as likely as younger patients with similar conditions to be transported to a designated TC. While overall compliance with trauma triage protocol is a recognized problem,[13] this study goes a step further and

Table 2. Multiple Logistic Regression of Factors Associated With Transport to a Designated Trauma Center in Priority I Patients Meeting ACS Criteria[a]

Characteristic	Odds Ratio (95% Confidence Interval)	*P* Value
Age ≥ 65 y	0.48 (0.30-0.76)	.002
Year		
1995	1 [Reference]	
1996	1.22 (0.99-1.51)	NS
1997	1.34 (1.06-1.69)	.01
1998	1.23 (0.98-1.54)	NS
1999	1.45 (1.18-1.78)	<.001
2000	1.53 (1.23-1.91)	<.001
2001	1.54 (1.23-1.92)	<.001
2002	1.59 (1.26-1.99)	<.001
2003	1.47 (1.19-1.82)	<.001
2004	1.36 (1.06-1.74)	.02
Male sex	1.09 (0.97-1.21)	NS
ACS physiology criteria	0.35 (0.30-0.41)	<.001
ACS injury criteria	1.74 (1.52-1.99)	<.001
ACS mechanism criteria	1.48 (1.26-1.74)	<.001
Age ≥ 65 y × physiology interaction	1.00 (0.63-1.57)	NS
Age ≥ 65 y × injury interaction	1.55 (1.10-2.17)	.01
Age ≥ 65 y × mechanism interaction	1.09 (0.73-1.61)	NS
Transport reason was to closest hospital	0.03 (0.03-0.04)	<.001
Patient expressed a preference	0.08 (0.05-0.12)	<.001
Transported by EMT-paramedic	1.18 (1.05-1.32)	.004

Abbreviations: ACS, American College of Surgeons; EMT, emergency medical technician; NS, nonsignificant.

[a]Other variables included in the analysis were presence of 18 specific causes of injuries and jurisdictional regions.

Table 3. Multiple Logistic Regression of Factors Associated With Transport to a Designated Trauma Center in Priority I Patients Meeting ACS Criteria in Baltimore[a]

Characteristic	Odds Ratio (95% Confidence Interval)	*P* Value
Age ≥ 65 y	0.39 (0.28-0.54)	<.001
Year		
1995	1 [Reference]	
1996	1.43 (0.89-2.31)	NS
1997	1.66 (0.79-3.52)	NS
1998	2.22 (1.07-4.62)	.03
1999	1.49 (0.98-2.27)	NS
2000	1.86 (1.19-2.91)	.007
2001	1.22 (0.73-2.06)	NS
2002	1.53 (0.90-2.60)	NS
2003	1.29 (0.84-1.98)	NS
2004	0.53 (0.12-2.37)	NS
Male sex	1.36 (1.03-1.79)	.03
ACS physiology criteria	0.40 (0.25-0.64)	<.001
ACS injury criteria	1.59 (1.09-2.32)	.02
ACS mechanism criteria	3.07 (1.86-5.05)	<.001
Transport reason was to closest hospital	0.09 (0.06-0.14)	<.001
Patient expressed a preference	0.07 (0.01-0.40)	.002
Transported by EMT-paramedic	0.96 (0.74-1.24)	NS

Abbreviations: ACS, American College of Surgeons; EMT, emergency medical technician; NS, nonsignificant.

[a]To reduce the effect of distance as a potential reason for the different in transport rates. Other variables included in the analysis were presence of 18 specific causes of injuries. Interaction terms were examined but were not significant and were removed in the final analysis.

identifies the pattern of this compliance relative to patients' ages. Many possible explanations for this finding can be ruled out by the current study.

First, while the quality of EMS data is often problematic, this is unlikely to have created the undertriage phenomenon as currently observed. These data errors are most likely randomly distributed across the data set, and there is no reason to suspect that the errors would occur more or less frequently among elderly or younger patients. Therefore, these errors would unlikely sway the finding one way or another.

Second, as with any large data set analysis, there is always the possibility that the findings are spurious and statistical. However, the consistency of the finding in all subgroup analyses suggests that this is not random. Moreover, this observation is consistent with the previous report based on Maryland's 1995 data.[2]

Third, it is true that trauma in elderly individuals is often underrecognized, which can lead to those patients being sent to non-TCs.[14] However, the focus of this current analysis was on patients who not only met the objective criteria for trauma but whose injuries were also acknowledged by the EMS providers. These are not patients whose injuries were not being recognized. In fact, the true magnitude of the problem may be even larger if one considers that there may be many other elderly trauma patients whose injuries were not recognized at all and were thus not even considered for TC transport.

Fourth, some have suggested that elderly patients may prefer non-TC hospitals, given their relationships with local physicians owing to longer medical histories. While patient preference may indeed bring patients to non-TC hospitals, it would still not have produced the observation of undertriage in the data. Very few patients included in this analysis expressed a preference of hospital (n=244), which is not surprising since the patients who were included by the design of the current analysis were major trauma patients and probably would not have time to discuss preferences. Even after controlling for patient preference in multivariate analysis, the observation of undertriage still holds.

Fifth, some may argue that, because of concerns about elderly patients, EMS providers may simply be transporting their elderly patients to the closest hospitals instead of to a TC that may be farther away. However, this may not be the cause of the undertriage. First, among patients who were transported to the closest hospital, there was still a lower rate of transport to TCs among elderly patients than among younger patients. Second, the observation of undertriage still holds after controlling for transport to closest hospitals in multivariate analysis. Third, in the subset analysis focusing on Baltimore, a small area with 4 TCs, the observation of elderly undertriage still persists, and in a small urban area it is unlikely that any hospital is substantially closer than any other. So, distance to a hospital is probably not the reason why elderly patients were less likely to be transported to a TC.

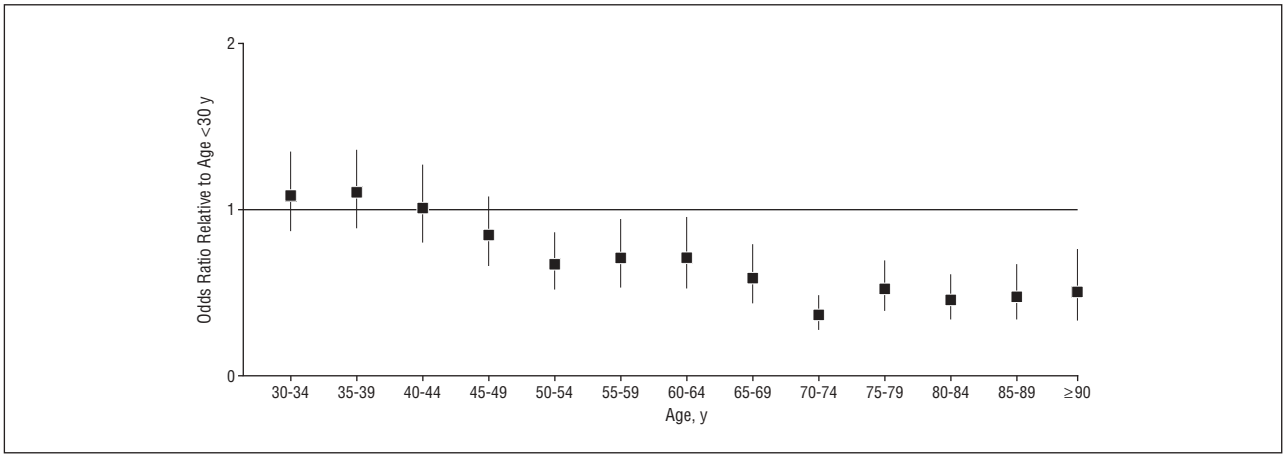

Figure. Multiple logistic regression analysis to examine the trends in emergency medical services transport of trauma patients to designated trauma centers by age. This is the same multiple logistic regression analysis as in Table 2, except the interaction variables with age were removed because of the total number of age categories in this analysis.

Table 4. Summary of Survey Findings of Prehospital Providers

Undertriage Factor	Mean (Median) Weights Ascribed to Each Factor as Contributing to the Elderly Undertriage Problem, %
Inadequate training in managing injured elderly patients	25.3 (20)
Not worth it to spend expensive trauma center resources on elderly patients because they are old	13.4 (5)
Unfamiliarity with triage protocol or have erroneous impressions about the protocol	12.0 (10)
Prehospital providers not welcomed when bringing an elderly trauma patient to a trauma center	9.5 (2)
Not worth it to send elderly patients to trauma centers because they have poorer prognoses	5.4 (2)
Believed elderly patients would do worse at larger hospitals, such as a trauma center	1.6 (0)
Encouraged by community hospitals to bring elderly patients there	1.3 (0)
Instructed by the elderly patients to bring them to the hospitals they frequent	5.9 (0)

In summary, we find no logical explanation for the undertriage of older trauma patients to designated TCs based on the registry data analysis. We thus approached EMS providers to present these data and seek their reaction and input, which led to several interesting observations. The providers believed that lack of training about elderly trauma patients was the most significant issue contributing to elderly undertriage. Unfamiliarity with protocol and a feeling that transportation to a TC was not worth it were the second or third most significant issues (depending on whether mean or median weights were used in the summary analysis). More interesting is the observation that the EMS providers actually ranked the age bias statement as the second or third highest problem (again, depending on whether mean or median weights were used in the summary analysis). Additionally, they also reported that they were often not welcomed at the receiving TC when transporting an elderly trauma patient.

We believe that the surveys, combined with the circumstantial case built earlier from the registry analysis, suggest that undertriage of the elderly may be a multifactorial problem. A lack of training related to elderly trauma patients and unfamiliarity with protocol may be allowing unconscious bias to affect the triage decisions and that this problem occurs among both EMS providers and medical providers at the receiving TC.

It was surprising to find that part of the problem may involve personnel in the receiving TC. There were 2 major categories of concern raised by the EMS providers. The first is that most residents (and even some attending physicians) are not aware of trauma triage protocols, and so any age bias among medical providers may compound the problem. This may especially be a problem among young physicians in training, as being younger has been documented to be associated with having more negative attitudes toward elderly patients.[15] Often, residents who are rotating through a trauma service want to have experiences in treating major trauma, such as motor vehicle crash injuries or gunshot wounds. An older patient who fell down a flight of stairs may not be as "exciting," though the literature suggests that these patients have a high likelihood of severe injuries.[16,17] The second concern is that if we were to correct the problem of undertriage, we would be transporting more patients to TCs and overwhelm their capacity. However, the statuses of patients who do not have major trauma can easily be downgraded in a TC, even in the emergency department before being seen by the trauma team. Furthermore, from a systems perspective, the time required to correct the cases that should have gone to a TC will be much greater than the time required to downgrade the patients who were sent to a TC but had only minor injuries.

The problem of age bias raised in this study may negate efforts to improve clinical care for elderly trauma patients within TCs if the system as a whole does not func-

tion properly and deliver patients appropriately to needed resources. However, it may be difficult to change attitudes of age bias and may require a broad societal campaign. Nevertheless, it may be possible to address this problem without directly addressing age bias. A focus on retraining the providers about triage protocols may be sufficient. Additionally, it may be helpful to highlight the literature that now suggests that elderly trauma patients do, in fact, return to productive lives after their injury,[18,19] which can eliminate the perception of futility of care that may be used consciously or subconsciously to justify age bias. This is what we are attempting to do in our series of presentations to EMS providers and groups of trauma physicians and administrators in the state.

An interesting observation can be made by examining the age trend in TC transports in the Figure. Since these transport decisions are made in the field without objective diagnostic equipment, the trends probably reflect the providers' subjective perception of what *old* means. It is interesting to note that the differences in triage occurred as early as age 50 years, with another drop at age 70 years. These observations suggest that currently *young* may be defined socially as those younger than 50 years, while old may be defined as age 70 years or older.

We acknowledge that the actual effect of this undertriage on patient outcomes is unknown. We attempted to link the EMS data to Maryland hospital discharge data to examine the outcomes of patients incorrectly triaged to non-TC hospitals. However, the success rate of our linkage was very low, leaving us with an insufficient sample to analyze patient outcomes. Additional studies are needed to examine the outcomes of elderly patients at TCs and non-TC hospitals.

In conclusion, the undertriage of elderly trauma patients cannot be explained by EMS registry data. Even when trauma is recognized and acknowledged by paramedics, providers are still less likely to consider TCs for elderly trauma patients. Survey results suggest that lack of training related to elderly trauma patients and unfamiliarity with protocol may be allowing unconscious bias to affect triage decisions and that this problem occurs among both EMS providers and medical personnel at receiving TCs.

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