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Triage Patterns for Medicare Patients Presenting to Nontrauma Hospitals With Moderate or Severe Injuries

Deepika Mohan, MD, MPH^{*,†}, Amber E. Barnato, MD, MPH, MS[‡], Matthew R. Rosengart, MD, MPH^{*,†}, Derek C. Angus, MD, MPH, FRCP^{*}, David J. Wallace, MD, MPH^{*,§}, and Jeremy M. Kahn, MD, MS^{*}

^{*}The CRISMA (Clinical Research, Investigation, and Systems Modeling of Acute Illness) Center, Department of Critical Care Medicine, University of Pittsburgh School of Medicine, Pittsburgh, PA

[†]Department of Surgery, University of Pittsburgh School of Medicine, Pittsburgh, PA

[‡]Department of Medicine, University of Pittsburgh School of Medicine, Pittsburgh, PA

[§]Department of Emergency Medicine, University of Pittsburgh School of Medicine, Pittsburgh, PA

Abstract

Objective—To understand hospital-level variation in triage practices for patients with moderate-to-severe injuries presenting initially to nontrauma centers.

Background—Many patients with moderate-to-severe traumatic injuries receive care at nontrauma hospitals, despite evidence of a survival benefit from treatment at trauma centers.

Methods—We used claims from the Centers for Medicare and Medicaid Services to identify patients with moderate-to-severe injuries who presented initially to nontrauma centers. We determined whether or not they were transferred to a level I or II trauma center within 24 hours of presentation, and used multivariate regression to assess the influence of hospital-level factors on triage practices, after adjusting for differences in case mix.

Results—Transfer of patients with moderate-to-severe injuries to trauma centers occurred infrequently, with significant variation among hospitals (median 2%; interquartile range 1%–6%). Greater resource availability at nontrauma centers was associated with lower rates of successful triage, including the presence of neurosurgeons (relative reduction in transfer rate: 76%, $P < 0.01$), more than 20 intensive care unit beds (relative reduction 30%, $P < 0.01$) and a high resident-to-bed ratio (relative reduction 23%, $P < 0.01$). However, patients were more likely to survive if they presented to hospitals with higher triage rates (odds of death for patients cared for at hospitals with the highest tercile of triage rates, compared with lowest tercile: 0.92; 95% confidence interval: 0.85–0.99, $P = 0.02$).

Conclusions—Injured Medicare beneficiaries presenting to nontrauma centers experience high rates of undertriage, determined in part by increasing availability of resources. Care at hospitals with low rates of successful triage is associated with worse outcomes.

Keywords

clinical practice guidelines; triage; trauma; variation

Treatment at designated trauma centers improves outcomes for patients with moderate-to-severe injuries.^{1–3} Accordingly, clinical practice guidelines endorse the systematic triage and transfer of these patients to trauma centers either directly from the field or after evaluation at a nontrauma center.⁴ Yet, between 30% to 40% of patients with moderate-to-severe injuries still receive definitive treatment at nontrauma centers, so-called “undertriage.”^{5,6} Much of undertriage occurs at hospitals rather than in the field, with 70% of patients initially presenting to a nontrauma center failing to reach a trauma center in a timely fashion.^{7,8}

To address undertriage, governmental agencies and professional organizations have focused on establishing accreditation standards for referral centers and disseminating clinical practice guidelines to individual providers.^{9,10} In contrast, institutional characteristics that might influence triage practices have received little attention and represent a major opportunity to improve the quality of trauma care.

The objective of this study was to understand hospital-level variation in triage practices for patients with moderate-to-severe injuries presenting initially to nontrauma centers. Specifically, we sought to quantify variation in triage rates across nontrauma centers, to identify the hospital-level factors associated with failure to successfully triage patients, and to examine the relationship between successful triage and patient outcomes. We performed this analysis using Medicare claims records, both because the elderly experience high rates of undertriage and because Medicare data offer the ability to follow trauma patients across their entire episode of care, enabling a comprehensive examination of triage patterns in the United States.

METHODS

Study Design and Data

We performed a retrospective cohort study of hospital-level triage rates for patients with moderate-to-severe traumatic injuries using 2008 inpatient and outpatient data from the Centers for Medicare and Medicaid Services (CMS). We studied Medicare beneficiaries in 14 states, thought to be representative of the US population: California, Delaware, Florida, Georgia, Iowa, Massachusetts, Missouri, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Texas, and Washington. These states contain both rural and urban populations, include a representative mix of trauma injury severity and mechanism, and implement formal regionalization of trauma care through inclusive trauma systems (which specify practice standards for all acute care hospitals) and exclusive systems (which specify standards for accredited trauma hospitals).¹¹ Collectively, they include 51% of all Medicare beneficiaries.

We obtained hospital-level data from the 2008 CMS Healthcare Cost Report Information System (HCRIS). HCRIS contains facility-level characteristics of all nonfederal hospitals,

including bed counts, ownership, and teaching status. Because HCRIS does not contain data on the trauma status of hospitals, we linked HCRIS to the Trauma Information Exchange Program to identify the trauma center designation for each hospital in 2008.¹² We obtained patient-level data from the 2008 CMS Medicare Beneficiary Summary File, Medicare Provider Analysis and Review (MedPAR), Outpatient, and Carrier files. These files contain the clinical and demographic characteristics of all fee-for-service Medicare beneficiaries.

Constructing Episodes of Care for Trauma Patients

We obtained the claims of all patients over the age of 65 admitted to an acute care hospital in 2008 for a primary diagnosis of trauma using International Classification of Diseases, version 9, Clinical Modification (*ICD-9-CM*) codes. We classified patients as having experienced a trauma if they had an *ICD-9-CM* code between 800 and 959, excluding those seen for late effects of injuries (*ICD-9-CM* codes 905–909), foreign bodies (*ICD-9-CM* codes 930–940), burns (*ICD-9-CM* codes 940–950), or minor injuries, including isolated strains/sprains (*ICD-9-CM* codes 840–849), superficial injuries (*ICD-9-CM* codes 910–919), and contusions (*ICD-9-CM* 920–924).¹³ We did not obtain records for patients who were not admitted, a group that would have included both those with minor injuries and those with severe injuries who died in the emergency department (ED). We wanted to understand determinants of transfer practices for severely injured patients, and believed that transfer would not have been possible for these patients.

We identified admissions in MedPAR, which contains final action claim records for inpatient hospitalizations. We found ED visits that occurred within 1 day of each hospitalization by linking admissions by beneficiary and date to the Outpatient and Carrier files, using validated place of service, revenue center, and procedure codes.¹⁴ We identified the location of each visit in the MedPAR and Outpatient files by linking the hospital identifier to HCRIS. For the Carrier file, which does not include institutional information, we mapped physician billing zip codes to the closest hospital, ranked by trauma volume, using linear arc distances. We then constructed episodes of care for each patient, which began at the initial ED evaluation and ended when the patient spent at least 1 day in an acute care hospital. We excluded patients whose initial hospital presentation was at a high-level trauma center (Trauma Information Exchange Program I–II) and patients initially evaluated at hospitals that could not be linked to HCRIS.

Variables

We abstracted patient demographics [age, sex, and race (white, black, Hispanic, and other)] and vital status 90-days after admission from the Medicare Beneficiary Summary file. We abstracted comorbid conditions using the Elixhauser methodology and injury characteristics using *ICD-9-CM* diagnosis codes from the claims.¹⁵ We used *ICD-9-CM* codes to identify life-threatening/critical injuries, on the basis of the American College of Surgeons Committee on Trauma interfacility transfer guidelines (see Appendix), and used a validated algorithm to translate *ICD-9-CM* diagnostic codes into abbreviated injury scores.^{4,13,16}

We used HCRIS and MedPAR to define hospital characteristics that might influence trauma triage practices. From HCRIS, we identified each hospital's teaching status (defined using

the resident-to-bed ratio), ownership (nonprofit, for profit, and government run), number of intensive care unit (ICU) beds, rural and urban status (defined using the size of the hospital's metropolitan statistical area), the number of trauma centers in the hospital's Dartmouth Atlas Hospital Referral Region (HRR), and the linear arc distance from the hospital to the nearest level I/II trauma center.

From MedPAR, we identified 9 radiological and subspecialty surgical services that might influence the triage of trauma patients, including computed tomographic (CT) scans, magnetic resonance imaging, neurosurgery, spine surgery, orthopedic surgery, cardiothoracic surgery, vascular surgery, urologic surgery, and maxillofacial surgery. We considered hospitals to have the resource if they issued 10 or more claims in 2008.

Analysis

We classified patients as having moderate-to-severe injuries as specified by the American College of Surgeons Committee on Trauma definition, which includes those with either a life-threatening/critical injury or an injury severity score (ISS) greater than 15.⁴ On the basis of the episodes of trauma care we had constructed, we defined *successful triage* as the transfer of a patient with moderate-to-severe injuries to a level I or II trauma center either directly from the ED or within 1 day of admission. We defined *unsuccessful triage* as admission to a nontrauma center or a level III/IV center for more than 1 day, or transfer to a non-level I or non-level II trauma center. We compared the characteristics of successfully and unsuccessfully triaged patients using the Student *t* test and χ^2 test.

Hospital-Level Variation in Successful Triage Rates

Recognizing that triage rates would reflect differences in case mix and volume at hospitals, we used adjusted triage rates to study variation. For each nontrauma center, we calculated hospital-specific triage rates, defined as the proportion of evaluated patients who were triaged successfully. We then used a patient-level multivariable hierarchical logistic regression model to create hospital-specific adjusted triage rates that accounted for differences in case-mix and low reliability at small volume hospitals.¹⁷ Variables in this model included age, sex, selected comorbidities known to influence mortality, and the maximum abbreviated injury scores by body region.¹⁸ After calculating the adjusted rates, we quantified variation using standard summary statistics. We graphically examined variation by plotting observed-to-expected rates of transfer against hospital volume.

Hospital Factors Associated With Successful Triage Rates

To determine the relationship between hospital characteristics and triage rates, we categorized hospitals as having a low (<1%), moderate (1%–4%), or high (>4%) adjusted successful triage rate based on terciles of patients. We performed bivariate analyses using χ^2 or analysis of variance tests. We also performed a hospital-level multivariate analysis using random-effects negative binomial regression, in which the dependent variable was a count of each hospital's successfully triaged patients, accounting for the total number of patients with moderate-to-severe injuries. We included all hospital and region-level factors as fixed effects and specified an HRR-level random effect. The exponentiated coefficients in this

model were interpreted as hospital-specific incidence rate ratios, controlling for the other covariates in the model.

Association Between Successful Triage Rates and Patient Outcomes

Finally, we examined the relationship between hospital-level triage rates and patient outcomes. We hypothesized that patients with moderate-to-severe injuries presenting to hospitals with higher successful triage rates would experience lower mortality, because they would ultimately be more likely to receive care at high-level trauma centers.¹ To test this hypothesis, we fit patient-level logistic regression models in which the dependent variables were 30-day, 90-day, and 365-day mortality from admission and the independent variables were the adjusted successful triage rate of the presenting hospital, the size of the hospital's metropolitan statistical area, distance to the nearest trauma center, and the number of trauma centers in the hospital's HRR. We used generalized estimating equations with robust variance estimators to account for clustering by hospital.

Data management and statistical analyses were performed using STATA 12.0 (College Station, TX), with statistical significance set at $P < 0.05$. The University of Pittsburgh institutional review board approved this project.

RESULTS

In the 14-state sample, 1757 level III, level IV, or nondesignated trauma centers evaluated at least 1 trauma patient with moderate-to-severe injuries. We could not match 52 (3%) hospitals in HCRIS, leaving 1705 hospitals in the final analysis. A total of 35,621 trauma patients with moderate-to-severe injuries presented initially to these 1705 hospitals. Of these, 4123 (12%) were transferred to a level I or II trauma center ("successful triage"). A total of 28,828 (92%) were admitted to the initial hospital for more than 1 day, and 2670 (8%) were transferred to another nontrauma center, a level III or a level IV trauma center ("unsuccessful triage") (Fig. 1). Among the 28,828 patients admitted to the initial hospital, 104 (0.4%) were transferred after 24 hours: 47 (45%) to a level I/II trauma center, and 57 (55%) to a non-level I/II trauma center. Patients triaged successfully were older, less likely to have comorbidities, and more likely to have higher ISSs (Table 1).

Among the 1705 nontrauma centers, we found variation in successful triage rates among hospitals (Fig. 2). The median adjusted triage rate was 2%, with an interquartile range of 1% to 6% and a total range of 0% to 82%.

After categorizing hospitals into terciles, we found that greater resources available at the nontrauma centers, including more ICU beds, a higher resident-to-bed ratio, and the presence of specialty surgical services, were associated with lower rates of successful triage in bivariable analyses (Table 2). Location in the northeast region of the country, in a larger metropolitan statistical area, and proximity to a level I/II trauma center were also associated with lower rates of successful triage. In the multivariable model, the presence of trauma-related resources at the nontrauma center, ownership of the hospital, and size of the metropolitan statistical area remained associated with lower successful triage rates (Table 3).

After adjustment for hospital and regional characteristics, the odds of death at 30 and 90 days after a moderate-to-severe injury were not associated with rates of successful triage. However, the odds of death at 365 days was inversely associated with rates of successful triage (odds ratio = 0.97, confidence interval: 0.91–1.04, $P = 0.43$ if moderate success compared with low; odds ratio = 0.92, confidence interval: 0.85–0.99, $P = 0.02$ if high success compared with low) (Fig. 3).

DISCUSSION

In a retrospective analysis of triage patterns at nontrauma centers, we found that Medicare beneficiaries with moderate or severe trauma were typically not sent to trauma centers, despite long-standing quality improvement efforts by stakeholders. Even after adjusting for differences in patient characteristics, we found wide variation in how successfully these hospitals triaged patients. Nontrauma hospitals most likely to keep trauma patients tended to be better resourced, with many of the features of trauma centers, including more ICU beds and the presence of surgical subspecialties, but without the trauma center designation. Nonetheless, patients admitted to these hospitals experienced higher mortality than patients taken to worse resourced hospitals with greater success at triage.

There are several potential explanations for the association between hospital resources and triage success. First, the presence of resources for acute care may influence physician decision making. Physicians may substitute the question of whether their hospital has the resources necessary to manage the patient's case for the more complex one of whether the patient meets the criteria of the American College of Surgery for transfer. Robust evidence indicates that people faced with complex tasks routinely overestimate their abilities, resulting in predictable errors (biases).²⁰

A second possibility is that nonclinical factors may factor into the transfer decisions, such as the social networks of physicians or institutional norms. As in other contexts, physicians may prefer to make referrals to local colleagues with whom they have a relationship, instead of sending patients to an anonymous trauma surgeon at a tertiary care center.²¹ Institutional norms could influence the treatment of trauma patients if hospitals belong to health systems that influence transfer rates independent of guidelines, or if hospitals exert implicit or explicit pressure on emergency physicians to retain patients in-house. Finally, patient preferences may also exert an influence on transfer rates. In other clinical contexts, patients describe a willingness to trade the convenience of receiving care close to home for the increased risk of worsened morbidity (the so-called distance-quality tradeoff).^{22,23}

Our study corroborates and extends prior work demonstrating the importance of institutional characteristics on trauma triage practices.⁸ Gomez et al examined the influence of 5 physical and human resources on transfer practices in Ontario, Canada, and concluded that the presence of a CT scanner and a general surgeon reduced the likelihood of transfer to a trauma center. In contrast to their study, we found that the availability of other subspecialists also played an important role in triage practices. This observation may reflect the differences between Canadian and American hospitals; for example, only 21% of Canadian hospitals

had both a CT scanner and orthopedic surgeon, whereas 96% of hospitals in the United States had both of these resources.

Together, these findings have important implications for improving regionalization in trauma. Existing quality improvement efforts have focused on establishing accreditation standards for referral centers and disseminating clinical practice guidelines to individual providers.^{9,10} This study confirms that these efforts have had only modest success. A possible solution might involve creating financial incentives for transfer through pay-for-performance, rewarding hospitals with high successful triage rates. At the same time, hospitals that excel at triaging trauma patients have the potential to provide insights to institutions that wish to improve their performance—structural factors at these hospitals, such as decision support tools, might be exported, potentially improving transfer rates.²⁴ Other possibilities include greater effort at regionalizing the resources most likely to influence triage patterns, such as the availability of neurosurgery, as have Veteran Affairs hospitals.²³ Finally, use of basic behavioral science methods to analyze variability might result in novel approaches to quality improvement. Groups like the Transportation Security Administration have effectively used strategies like recalibrating the heuristics of baggage screeners to improve threat detection.²⁵

We also confirmed an association between triage quality and patient outcomes. Although our primary goal was to examine variation in transfer guideline adherence, many experts question the validity of the triage guidelines in elderly patients.²⁶ Our results support the notion that improved guideline adherence may be associated with lower mortality, at least at the hospital level. We avoided a patient-level analysis because of concerns that we could not adequately adjust for indication biases inherent in patient-level triage decisions. We acknowledge that hospital triage rates might serve as a proxy for other performance metrics, such as overall quality of care.

Our study has several limitations. First, we restricted our sample to Medicare beneficiaries, which may prevent generalizability of our findings to other trauma patients. Elderly patients are a unique population with specific needs, and they may have had prior interactions with local hospitals, making triage patterns less representative of the general population. Nonetheless, Medicare patients account for more than 25% of all deaths from injury and experience high rates of undertriage.^{27,28} Moreover, by concentrating on this population, we could reduce the effect of 2 patient-level characteristics known to influence triage patterns: age and insurance status.^{29,30} Second, we sampled only patients with moderate-to-severe injuries, which might also limit generalizability. However, we hypothesized that factors associated with undertriage would differ from those associated with overtriage (the inappropriate transfer of patients with minor injuries to trauma centers) and would bias our results if we conflated the groups. Third, we used HRRs as a surrogate for trauma referral regions. HRRs were developed to describe referral patterns for cardiothoracic surgery and neurosurgery, and little is known about the validity of these regions in trauma. If HRRs do not accurately describe trauma referral patterns, then we may have underestimated the influence of the region on hospital performance. Fourth, we limited our analysis to hospital-level variables, not including other potentially important determinants of variation, such as patient preferences and the practice style of individual physicians.

CONCLUSIONS

Improving the quality of trauma regionalization is a high priority for multiple health care stakeholders.²⁴ Using Medicare claims, we found substantial room for improvement, with wide variation in hospital rates of triage, even after adjusting for differences in case mix. Several hospital-level factors served to explain this variation, suggesting that current clinical decision making is driven by heuristics surrounding resource availability rather than the existing guidelines. Given the association between variation and outcome, this study indicates the need for greater implementation efforts designed to improve triage quality, as well as, the need for research aimed at understanding of how resource availability influences triage decision making.

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Appendix

APPENDIX

Algorithm Used to Select Injuries Described by the ACS-COT as Indicating the Need for Transfer

Injuries the ACS-COT Considers Life-Threatening or Critical	ICD-9-CM Codes	Assumptions/Notes
Carotid or vertebral injuries	900	
Aorta or great vessel injuries	901	
Cardiac rupture	861.0 and 861.1	1. Unable to identify cardiac rupture from diagnosis codes so included all cardiac injuries.
Bilateral pulmonary contusions with PaO ₂ /FiO ₂ ratio < 200	—	1. Unable to identify based on discharge codes
Major abdominal vascular injury	902	
Grade IV or V liver injury with >6 units pRBC	864.04 or 864.14	1. Unable to identify RBC transfusion so included all Grade IV liver lacerations
Unstable pelvic fracture with >6 units pRBC	808.43 or 808.53	1. Unable to identify unstable fractures so used the surrogate of the disrupted pelvic circle.
Fracture or dislocation with loss of distal pulses	903.1–903.3 in conjunction with 812, 813, and 818	1. Unable to identify fractures with loss of pulses so used the surrogate of fracture with vascular injury.
	904.1–904.5 in conjunction with 821, 822, 823, 824, and 827	2. Excluded patients with amputations, which would technically fit into this category, because of the problem of misclassification. ¹³

Injuries the ACS-COT Considers Life-Threatening or Critical	ICD-9-CM Codes	Assumptions/Notes
Open skull fracture or penetrating injury	800.5–800.9	1. Unable to identify penetrating injury so captured only the open skull fractures.
	801.5–801.9	
	803.5–803.9	
	804.5–804.9	
GCS < 14 or lateralizing neurologic injury	800–804	1. Unable to calculate GCS from discharge diagnosis codes so used the fifth digit subclassification to identify patients who had either a moderate (1–24 h) or prolonged (>24 h) loss of consciousness (eg, 852.03). We assumed these patients would appear clinically to have a GCS < 14.
	850.2–850.5	
	851–854	
Spinal cord deficit or lateralizing neurologic sign	806	
	952–955.2	
	956–956.2	
Spinal column fractures	—	1. Excluded because of the problem of misclassification. ¹³
>2 unilateral rib fractures or bilateral rib fractures	807.03–807.1	1. Unable to identify patients with bilateral rib fractures so included only patients with >2 rib fractures.
	807.4–807.6	
Open long bone fracture	812.1, 812.3, 812.5	
	813.1, 813.3, 813.5	
	820.1, 820.3, 820.5	
	821.1, 821.3, 821.5	
	823.1, 823.3, 823.5	
	824.1, 824.3, 824.5	
Significant torso injury with advanced comorbid disease	860.1, 860.3, 860.5	1. ICD-9-CM codes indicated significant torso injury. We included patients who had these ICD-9 codes as well as an Elixhauser comorbidity code.
	861.2–861.9	
	862–870	

ACS-COT = American College of Surgeons - Committee on Trauma; MSA = metropolitan statistical area; TC = trauma center. ACS-COT indicates American College of Surgeons - Committee on Trauma.

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FIGURE 1.
Flowchart of patients and episodes of care in the study.

FIGURE 2.

Funnel plot of adjusted triage rates for patients with moderate to severe injuries in 1705 nontrauma centers. The mean triage rate was 4%, with 151 hospitals performing more than 2 standard deviations less than the mean rate and 281 hospitals performing more than 2 standard deviations more than that (shown in gray).

FIGURE 3.

Relationship between rates of successful triage and 365-day mortality. The adjusted odds of death are presented relative to patients treated at hospitals with the lowest tercile of successful triage rates.

TABLE 1

Characteristics of Patients by Triage Status*

Variable	Successfully Triage (n = 4123)	Unsuccessfully Triage (n = 31,498)	P
Age, mean (SD), yr	80 (8.4)	78(11.6)	<0.01
Female, n (%)	2173 (53)	17,572 (56)	<0.01
Race, n (%)			<0.01
White	3791 (92)	27,680 (88)	
Black	155 (4)	1538 (5)	
Hispanic	55 (1)	980 (3)	
Other	122 (3)	1300 (4)	
Select comorbidities, n (%)			<0.01
Cirrhosis	18 (0.4)	360 (1)	
Congenital coagulopathy	165 (4)	997 (3)	
Congestive heart failure	346 (8)	3497 (11)	
Chronic obstructive pulmonary disease	337 (8)	4442 (14)	
Diabetes	675 (16)	6316 (20)	
30-d mortality	616 (15)	3738 (12)	<0.01
90-d mortality	843 (20)	5492 (17)	<0.01
365-d mortality	1134 (28)	8291 (26)	0.1
Types of life-threatening injuries, n (%)			<0.01
Traumatic brain injury	826 (20)	2546 (8)	
Multiple rib fractures	584 (14)	6094 (19)	
Cardiac injury	210 (5)	1179 (4)	
Open long bone fracture	180 (4)	3869 (12)	
Severe torso injury with comorbidity	262 (6)	2883 (9)	
ISS, mean (SD)	18.0 (5.9)	14.6 (6.0)	

* Patients who presented to acute care nontrauma centers in California, Delaware, Florida, Georgia, Iowa, Massachusetts, Missouri, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Texas, and Washington in 2008 after a traumatic injury.

TABLE 2

Hospital Characteristics by Terciles of Adjusted Successful Triage Rates at Nontrauma Centers *

Variable	Low Success Rates; <1% (n = 276)	Moderate Success Rates; 1–4% (n = 605)	High Success Rates; >4% (n = 824)	P
No. moderate-to-severe trauma admissions	33 (13–59)	11 (3–26)	9 (4–19)	<0.01
ICU bed number	22 (12–38)	10 (0–21)	7 (0–12)	<0.01
Ownership				<0.01
Government	34 (11)	135 (22)	205 (27)	
Nonprofit	172 (55)	303 (49)	445 (58)	
For profit	105 (34)	186 (30)	120 (16)	
Teaching status [†]				<0.01
Nonteaching	197 (63)	519 (83)	654 (85)	
Small teaching	87 (28)	68 (11)	85 (11)	
Large teaching	27 (9)	37 (6)	31 (4)	
Resources available				<0.01
Neurosurgery	191 (61)	160 (26)	48 (6)	
Orthopedic surgery	293 (94)	473 (76)	535 (69)	
Spine surgery	266 (86)	358 (57)	347 (45)	
Cardiothoracic surgery	273 (88)	382 (61)	391 (51)	
Facial surgery	25 (8)	32 (5)	20 (3)	
Vascular surgery	258 (83)	341 (55)	302 (39)	
Urology	285 (92)	433 (69)	467 (61)	
CT	300 (96)	582 (93)	753 (98)	
Magnetic resonance imaging	85 (27)	110 (18)	74 (10)	
MSA size				<0.01
<100,000	31 (10)	162 (26)	331 (43)	
100,000 to 1 million	110 (35)	147 (24)	192 (25)	
>1 million	170 (55)	315 (50)	247 (32)	
Distance to nearest level I/II trauma center, miles				<0.01
<2	32 (10)	59 (9)	48 (6)	
2–7	99 (32)	123 (20)	99 (13)	
8–20	58 (19)	127 (20)	129 (17)	
21–49	58 (19)	144 (23)	321 (42)	
50	64 (21)	171 (27)	173 (23)	
No. level I/II trauma centers in region	1 (1–3)	2 (1–4)	2 (1–3)	0.02
Region				<0.01
Northeast	55 (18)	150 (24)	232 (30)	
South	161 (52)	296 (47)	267 (35)	
Midwest	12 (4)	36 (6)	146 (19)	
West	83 (27)	142 (23)	125 (16)	

MSA indicates metropolitan statistical area.

* Successful adjusted triage rates for patients presenting to nontrauma centers with moderate-to-severe injuries.

[†]Teaching status categorized by resident-to-bed ratio (nonteaching = 0, small teaching = >0 and <0.25 , large teaching = >0.25).

TABLE 3Association Between Hospital and Regional Characteristics and Successful Adjusted Triage Rates^{*}

Variable	Incident Rate Ratio	P
ICU bed number		
<10	Referent	
10–20	0.86 (0.76–0.99)	0.03
>20	0.70 (0.60–0.81)	<0.01
Ownership		
Government	Referent	
Nonprofit	0.88 (0.79–0.98)	0.02
For profit	0.77 (0.67–0.88)	<0.01
Teaching status		
Nonteaching	Referent	
Small teaching	0.86 (0.77–0.96)	<0.01
Large teaching	0.77 (0.63–0.93)	0.26
Resources		
Neurosurgery	0.34 (0.31–0.39)	<0.01
Spine surgery	0.84 (0.74–0.95)	<0.01
Orthopedic surgery	0.87 (0.75–1.01)	0.07
Cardiothoracic surgery	0.95 (0.81–1.10)	0.48
Vascular surgery	0.86 (0.75–0.99)	0.03
Urology	0.87 (0.75–1.00)	0.07
MSA		
<100,000	Referent	
100,000–1 million	0.87 (0.77–0.98)	0.02
>1 million	0.82 (0.71–0.95)	<0.01
Distance to nearest TC, miles		
<2	Referent	
2–7	0.93 (0.79–1.09)	0.36
8–20	0.87 (0.73–1.03)	0.10
21–49	0.89 (0.75–1.05)	0.17
50	0.67 (0.55–0.82)	<0.01
No. trauma centers in HRR		
0	Referent	
1–3	1.43 (1.16–1.75)	<0.01
4	1.27 (0.97–1.65)	0.08
Region		
Northeast	Referent	
South	1.00 (0.99–1.20)	0.93
Midwest	1.25 (0.72–1.57)	0.06
West	0.88 (0.72–1.06)	0.18

MSA indicates metropolitan statistical area; TC, trauma center.

* Estimates obtained from a negative binomial regression model. The incident rate ratio can be interpreted so that for a 1-unit change in the predictor variable, the rate ratio of successful triage is expected to change by the respective regression coefficient, presented in exponentiated form.