Trends in the Accuracy of Older Person Trauma Triage from 2004 to 2008

Linda J. Scheetz, EdD, RN

Abstract

Background. Older injured persons are frequently undertriaged, increasing the risk for preventable mortality and morbidity in an already-vulnerable population. Changes made in 2006 to the American College of Surgeons Committee on Trauma (ACS-COT) Field Triage Decision Scheme might improve triage accuracy for this population. **Objective**. This study examined triage accuracy before and after the 2006 revisions. **Methods**. This secondary analysis of 2004, 2007, and 2008 data from the National Automotive Sampling System Crashworthiness Data System included persons aged 55 years and older who were transported to a hospital and had a maximum injury severity of uninjured or an Abbreviated Injury Scale score of 1 to 5. Trauma center and non–trauma center admission was a proxy for triage accuracy. Frequencies, means, standard deviations, sensitivities, specificities, positive predictive values (PPVs), and negative predictive values (NPVs) were calculated. **Results**. Although triage accuracy has improved from 2004 to 2008, the undertriage rate still remains higher than the ACS-COT target of 5–10%. Overtriage rates have remained slightly above or within an acceptable range, suggesting that gains in triage accuracy have not unduly overburdened trauma centers. Both PPV and NPV have improved since 2004. **Conclusions**. There is a positive trend in triage accuracy for older injured persons since 2004. Ongoing funding, continued trauma system development with more training emphasis on scene evaluation of older adults, and the use of the ACS-COT triage decision scheme are essential for further improvement of triage accuracy. More research is needed to identify and validate additional triage criteria that are sensitive to severe injuries in older persons. **Key words**: wounds and injuries; triage; emergency medical services; elderly; aged

PREHOSPITAL EMERGENCY CARE 2011;15:83–87

Received January 7, 2010, from the Department of Nursing, State University of New York, New Paltz, New Paltz, NY 12561. Revision received April 16, 2010; accepted for publication April 19, 2010.

There are no financial or personal relationships with other people or organizations that could inappropriately influence (bias) this work.

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Address correspondence and reprint requests to: Linda J. Scheetz, EdD, State University of New York, New Paltz, Nursing, van den Berg Hall, 1 Hawk Drive, New Paltz, NY 12561. e-mail: linda.scheetz@gmail.com

doi: 10.3109/10903127.2010.514088

Introduction

Older injured persons are frequently undertriaged, increasing the risk for preventable mortality and morbidity in an already-vulnerable population. Geriatric prehospital triage accuracy of injured patients was recognized as problematic in the mid-1990s.[1,2] Since then, additional evidence[3,4] suggests that the problem continued even after the 1999 recommendation by the American College of Surgeons Committee on Trauma (ACS-COT) that age 55 years and older be considered as an independent criterion for injury scene transport to a trauma center.[5] More recently, the Centers for Disease Control and Prevention (CDC) convened a panel of injury experts to revise the 1999 ACS-COT Field Triage Decision Scheme, which serves as the prototype for prehospital trauma triage in emergency medical services (EMS) throughout the United States. The CDC panel revised the 1999 triage decision scheme; the revised decision scheme was published in the 2006 ACS-COT manual, *Resources for Optimal Care of the Injured Patient*,[6] and was later released to the public on the CDC Website and published in the *Morbidity and Mortality Weekly Report* (*MMWR*).[7] The most recent changes are notable because of their potential to improve geriatric triage accuracy by reducing the unacceptably high rates of undertriage,[6] which have persisted despite the 1999 triage decision scheme changes.

Of the two types of triage errors, undertriage is the more serious problem because it can result in adverse patient outcomes, ultimately leading to preventable deaths or disability. Nonetheless, overtriage is also a concern because valuable trauma center resources are used unnecessarily, diluting the availability of these resources for those who do need them and exacerbating staffing shortages, overcrowding, and financial burdens of trauma centers. Achieving acceptable under- and overtriage rates is a delicate dance—as undertriage rates are reduced, overtriage rates increase as more patients are transported to trauma centers to avoid missing life-threatening injuries. Given the 2006 revisions to the ACS-COT Field Triage Decision Scheme, the burgeoning population of mobile, older adults, concerns about health care access, issues related to adequate staffing, and the financial concerns of hospitals, it is imperative to reexamine triage accuracy for this population. To date, no published studies were found describing geriatric trauma triage accuracy since the 2006 implementation of the revised Field Triage Decision Scheme. Therefore, the specific aim of this study was to examine trends in under- and overtriage rates for injured older adults before and after the 2006 ACS-COT revisions.

METHODS

This study was a secondary analysis of 2004, 2007, and 2008 data from the National Automotive Sampling System Crashworthiness Data System (NASS CDS) database maintained by the National Highway Traffic Safety Administration's National Center for Statistics and Analysis.[8] The university institutional review board granted an exemption from full board review and waived the requirement for informed consent because all data were de-identified.

Population and Setting

The NASS CDS database is a representative, random sample of all police-reported motor vehicle collisions in the United States involving cars, sport utility vehicles (SUVs), vans, and light trucks in which at least one vehicle was towed from the scene and either personal injury and/or property damage occurred.[9] Highly trained NASS CDS field research team investigators collect data through crash scene reconstruction, review of police and medical records, and personal interviews. The NASS CDS database defines *fatality* as any death occurring within the first 30 days following injury. *Trauma center* is defined as a facility that meets the ACS-COT criteria for level I and II trauma centers. Inclusion criteria for this study were as follows: age 55 years or older; involved in a motor vehicle collision in 2004, 2007, or 2008; transported alive from the crash scene to a hospital; and maximum injury severity ranging from uninjured to an Abbreviated Injury Scale (AIS) score equal to 1 (minor), 2 (moderate), 3 (serious), 4 (severe), or 5 (critical). Occupants whose maximum AIS score was 6 were excluded from the study because this level of injury is so severe (maximal injury to the organ) that the probability of survival is miniscule, regardless of the triage disposition.[10] The level of care to which patients were transported from the injury scene (trauma center versus non–trauma center) was used as a proxy for triage accuracy. *Undertriage* was defined as transport of patients with maximum AIS 3, 4, or 5 injuries to non–trauma center hospitals. *Overtriage* was defined as transport of uninjured patients and those with maximum AIS scores of 1 or 2 to trauma centers regardless of whether the trauma team was activated.

Data Analysis

Data were analyzed using PASW Statistics, version 18 (SPSS, Inc., Chicago, IL). All analyses were weighted by an NASS CDS–derived factor to maintain the same representativeness as the original NASS CDS data. Frequencies, means, standard deviations, sensitivities, specificities, positive predictive values (PPVs), and negative predictive values (NPVs) were calculated. The level of significance was set at 0.05. One-way analysis of variance (ANOVA) with Bonferroni post-hoc analysis was performed to compare differences in mean age and Injury Severity Scores (ISSs) among the cohorts. Pearson chi-square analyses were performed to determine differences between gender, fatalities, and triage disposition (trauma center vs. non–trauma center) between the cohorts.

RESULTS

In 2004, the number of persons aged 55 years and older who met the inclusion criteria was 174,083, compared with the 2007 cohort of 223,739 and the 2008 cohort of 159,076, yielding a total sample of 556,898 patients. The mean age, ISS, gender distribution, number of fatalities, and triage disposition for each cohort are described in Table 1. Among all patients with maximum AIS 3, 4, or 5 injuries, those in the 2007 cohort were most severely injured and had the highest 30-day mortality rate (1.6%) versus 1.2% and 1.4% in the 2004 and 2008 cohorts. Thirty-day mortality of undertriaged patients also was highest in the 2007 cohort ($n = 535$, 5.9%), compared with 197 (4.2%) in the 2008 cohort and 272 (3.1%) in the 2004 cohort.

Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value

In 2004, there were 146,231 (87.7%) patients who were uninjured or sustained maximum AIS 1 or 2 injuries and 20,454 (12.3%) patients with maximum AIS 3, 4, or 5 injuries. The 2007 cohort included 191,591 (88.3%) patients who were uninjured or sustained maximum AIS 1 or 2 injuries and 25,441 (11.7%) patients who sustained maximum AIS 3, 4, or 5 injuries. In 2008, 132,797 (85.9%) patients were uninjured or had maximum AIS 1 or 2 injuries and 21,811 (14.1%) patients sustained maximum AIS 3, 4, or 5 injuries. Overall, the proportion of patients with maximum AIS 3, 4, or 5 injuries was greater in the 2008 cohort compared with the 2004 and 2007 cohorts (14.1% versus 12.3% and 11.7%, $p = 0.000$). Triage disposition of all patients to trauma centers and non–trauma center hospitals is detailed in Table 2. The sensitivities were 0.58 in 2004, 0.65 in 2007, and 0.78 in 2008 and reflect undertriage rates of 42%, 35%, and 22%, respectively. The specificities were 0.46 in 2004, 0.44 in 2007, and 0.52 in 2008, reflecting overtriage rates of 54%, 56%, and 48%, respectively. The PPVs were 0.13 in 2004 and 2007 and 0.21 in 2008. The NPVs were 0.89 in 2004, 0.90 in 2007, and 0.94 in 2008 (Table 3).

TABLE 1. Comparison of Demographic and Clinical Characteristics of Patients in the 2004, 2007, and 2008 Cohorts

	2004 *Mean (±SD)*	2007 *Mean (±SD)*	2008 *Mean (±SD)*	p-Value
Age				
All patients	65.2 (± 9.2)	68.1 (± 9.9)	66.0 (± 9.1)	0.000*
Uninjured, MAIS 1, 2 patients	64.9 (± 9.3)	67.9 (± 9.8)	66.4 (± 9.2)	0.000*
MAIS 3, 4, 5 patients	67.6 (± 8.7)	69.9 (± 10.4)	68.1 (± 9.2)	0.000*
ISS				
All patients	3.8 (± 6.2)	4.0 (± 7.3)	4.2 (± 6.9)	0.000*
MAIS 1, 2 patients	2.0 (± 1.7)	1.9 (± 1.8)	2.0 (± 1.9)	0.000*
MAIS 3, 4, 5 patients	17.2 (± 9.1)	19.8 (± 9.8)	18.2 (± 9.1)	0.000*
	Number (%)	*Number (%)*	*Number (%)*	
Gender				0.000†
Male	92, 110 (53.1%)	103, 237 (46.1%)	71, 900 (45.2%)	
Female	81, 421 (46.9%)	120, 502 (53.9%)	87, 176 (54.8%)	
Fatalities	2, 174 (1.2%)	3, 473 (1.6%)	2, 245 (1.4%)	0.000†
Triage disposition				0.000†
TC	90, 352 (54.2%)	122, 840 (56.6%)	81, 135 (52.5%)	
NTC	76, 333 (45.8%)	94, 192 (43.4%)	73, 473 (47.5%)	

*One-way analysis of variance (ANOVA) with Bonferroni post-hoc analysis.
†Pearson chi-square analysis.
ISS = Injury Severity Score; MAIS = maximum Abbreviated Injury Scale score; NTC = non–trauma center; SD = standard deviation; TC = trauma center.
All fatalities are 30-day mortality. Also, fatalities refer to patients with MAIS 3, 4, 5 injuries.

DISCUSSION

The vulnerability of injured older persons to higher rates of mortality, postinjury complications, and longer hospital stays has been acknowledged since Champion and colleagues' landmark study more than 20 years ago.[11] Subsequent studies suggested that poor outcomes were related to the presence of certain preexisting diseases, including cardiac disease, obstructive pulmonary disease, diabetes mellitus, coagulopathies, cirrhosis, and renal disease.[12–16] To further complicate triage, potentially life-threatening injuries in older patients may go undetected at the scene because of an altered hemodynamic response attributed to beta-blocker and angiotensin-converting enzyme (ACE) inhibitor therapy,[15] cardiac conduction defects, and diminished sensitivity to intrinsic catecholamines.[17] Coupled with a diminished physiologic reserve, older persons may decompensate easily and often suddenly,[15] resulting in death or subsequent organ failure. Considering these physiologic factors, accurate prehospital triage of older injured patients takes on even greater significance.

In the 2006 ACS-COT revisions to the Field Triage Decision Scheme,[6] age 55 years and older was retained as a criterion to be considered during the last step of triage evaluation. Additional changes to the 2006 decision scheme that might affect the triage of older patients included the deletion of preexisting diseases in the Step 4 "consideration" category, including cardiac and respiratory disease, insulin-dependent diabetes mellitus, cirrhosis, and immunosuppression. However, anticoagulation was added as a criterion for consideration for trauma center transport. Deletion of cardiac disease, respiratory disease, and insulin-dependent diabetes mellitus was justified on the basis that these conditions do not increase injury severity per se, nor are they effective in identifying injuries.[7] The CDC panel's rationale for deleting insulin-dependent diabetes mellitus and cirrhosis as "consideration" criteria was the lack of scientific evidence supporting their inclusion in the absence of physiologic, anatomic, or mechanistic triage criteria. Furthermore, the panel noted that not all cirrhotic patients have coagulopathies, and those who do should be considered for trauma center transport in light of the coagulopathy rather than the cirrhosis per se. Immunosupression was deleted as a criterion because the panel concluded that immunosuppression alone does not increase the risk of severe injury.[7] Extrication time greater than 20 minutes and vehicular rollover were deleted from the mechanistic criteria with the 2006

TABLE 2. Triage Disposition of Patients Admitted to Trauma Centers and Non–Trauma Center Hospitals in 2004, 2007, and 2008

	2004		2007		2008	
	TC *n* (%)	NTC *n* (%)	TC *n* (%)	NTC *n* (%)	TC *n* (%)	NTC *n* (%)
Uninjured patients	3, 732 (4.1%)	4, 274 (5.6%)	5, 090 (4.1%)	9, 436 (10.0%)	2, 495 (3.1%)	5, 764 (7.8%)
MAIS 1, 2 patients	74, 817 (82.8%)	63, 408 (83.1%)	101, 352 (82.5%)	75, 713 (80.4%)	61, 567 (75.9%)	62, 971 (85.7%)
MAIS 3, 4, 5 patients	11, 803 (13.1%)	8, 651 (11.3%)	16, 398 (13.4%)	9, 043 (9.6%)	17, 073 (21.0%)	4, 738 (6.5%)
TOTAL	90, 352	76, 333	122, 840	94, 192	81, 135	73, 473

MAIS = maximum Abbreviated Injury Scale score; NTC = non–trauma center; TC = trauma center.

TABLE 3. Comparison of 2004, 2007, and 2008 Cohort Sensitivities, Specificities, Positive Predictive Values, and Negative Predictive Values

	2004	2007	2008
Sensitivity	0.58	0.65	0.78
Specificity	0.46	0.44	0.52
Positive predictive value	0.13	0.13	0.21
Negative predictive value	0.89	0.90	0.94

revision, whereas less stringent vehicular intrusion parameters were added.

The sensitivities and specificities in 2004, 2007, and 2008 reflect an overall reduction of both undertriage and overtriage rates. The PPVs improved over time as well, suggesting an improvement in the predictive validity for life-threatening injuries. The NPVs were strong in all three cohorts, suggesting the robustness of the triage process for predicting the absence of life-threatening injuries.

The upward trend in triage accuracy in 2007 and 2008 following implementation of the revised Field Triage Decision Scheme is encouraging and should be monitored. Nonetheless, the triage accuracy for patients with AIS 3, 4, and 5 injuries is lower than the 5–10% deemed acceptable by the ACS-COT.[6] However, when compared with those of earlier studies, the undertriage rates found in this study suggest some improvement. Previous estimates of geriatric undertriage rates were reported to be 49.9% in Maryland,[3] 63.4% in Pennsylvania,[18] 42% in Washington state,[4] approximately 40% in Florida,[19] 39.6% in New Jersey,[20] and 60% in California.[21] Overtriage rates were slightly higher than those suggested as acceptable[6] in 2004 and 2007, but within an acceptable range in 2008,[6] suggesting that gains in triage accuracy have not unduly overburdened trauma centers.

LIMITATIONS AND FUTURE RESEARCH

Accurate triage is a complex process affected by numerous factors, including whether the crash occurred in an area covered by a regionalized system of trauma care, adaptation of the ACS-COT decision scheme to meet local needs, availability of EMS personnel and the appropriate transport vehicles, transport distance to the nearest trauma center or non–trauma center hospital, weather conditions affecting the decision to transport patients to a trauma center versus the nearest hospital, EMS provider training with regard to geriatric assessment, patient preferences, and perhaps even EMS provider bias toward elderly persons, as suggested by Chang and colleagues.[3] Any of these factors might influence the decision to transport a seriously injured person to a non–trauma center hospital, resulting in undertriage. No distinction between overtriage and correct triage was made when uninjured patients or those with AIS scores of 1 or 2 were transported to trauma centers and the trauma team was not activated, for example, in rural areas where a trauma center also was the nearest or only hospital. This may have resulted in an overestimation of overtriage rates.

Furthermore, this study did not evaluate interfacility transfers to a higher level of care that might have occurred later. Although the ACS-COT Field Triage Decision Scheme is the national prototype for EMS triage of injured persons, this study was not designed to evaluate how much of the triage variance was attributable to the influence of this decision scheme versus other factors.

As is true with any secondary analysis, this study is limited by the quality of the data, which potentially could introduce inaccuracy in the findings and conclusions. However, it is worth noting that NASS CDS field team investigators undergo rigorous training and data are subjected to quality checks in an effort to enhance data quality. One limitation of the NASS CDS database is the lack of data related to anticoagulation status. Hypercoagulation states have been associated with poor outcomes in patients with brain injuries[22,23] and anticoagulation status is one of the criteria for consideration in the ACS-COT Field Triage Decision Scheme.

Finally, this study was not designed to examine long-term mortality or morbidity, although these are legitimate concerns when evaluating triage outcomes. Criddle[24] reported an ongoing multiyear relationship between injury and shortened life span in geriatric trauma patients compared with an uninjured cohort that appeared to be influenced by host factors rather than injury factors. Nonetheless, the improved trend in triage accuracy is encouraging when comparing the 2007 and 2008 cohorts with the 2004 cohort, all of which might have been affected by the factors noted above.

Because factors other than field triage decision schemes influence triage accuracy, greater efforts are needed to improve funding and development of trauma systems, train EMS providers in the field assessment of injured older persons and use of the triage decision scheme, educate severely injured patients regarding the wisdom of transport to a trauma center rather than the closest non–trauma center hospital, and eliminate age bias. Continued monitoring of triage accuracy is also warranted. More research is needed to identify and validate additional triage criteria that are sensitive to severe injuries in older persons.

CONCLUSIONS

This study provided population-based evidence of an upward trend in geriatric trauma triage accuracy from 2004 to 2008. However, the concern remains that even the lowest undertriage rate was 22%, much higher than the 5–10% deemed acceptable by the American College of Surgeons.[6] Insofar as age older than 55 years is a consideration for transport to a trauma center, the decision regarding transport to a trauma center or a non–trauma center hospital is made by EMS personnel and medical control physicians based on numerous situational factors. Despite the improving trend in geriatric trauma triage accuracy, undertriage remains a persistent problem in this population.

References

1. Phillips S, Rond PC 3rd, Kelly SM, Swartz PD. The failure of triage criteria to identify geriatric patients with trauma: results from the Florida Trauma Triage Study. J Trauma. 1996;40:278–83.
2. Zimmer-Gembeck MJ, Southard PA, Hedges JR, et al. Triage in an established trauma system. J Trauma. 1995;39:922–8.
3. Chang DC, Bass RR, Cornwell EE, Mackenzie EJ. Undertriage of elderly trauma patients to state-designated trauma centers. Arch Surg. 2008;143:776–81.
4. Lehmann RK, Beekley AC, Casey LE, Salim A, Martin MJ. The impact of advanced age on trauma triage decisions and outcomes: a statewide analysis. Am J Surg. 2009;197:571–5.
5. American College of Surgeons. Resources for Optimal Care of the Injured Patient: 1999. Chicago, IL: American College of Surgeons, 1999.
6. American College of Surgeons. Resources for Optimal Care of the Injured Patient: 2006. Chicago, IL: American College of Surgeons, 2006.
7. Centers for Disease Control and Prevention. Guidelines for field triage of injured patients: recommendations of the National Expert Panel on Field Triage. MMWR. 2009;58:1–35. Available at: http://www.cdc.gov/mmwr/PDF/rr/rr5801.pdf. Accessed January 23, 2009.
8. National Center for Statistics and Analysis. National Automotive Sampling Survey Crashworthiness Data System (NASS CDS). In: National Automotive Sampling Survey Crashworthiness Data System (NASS CDS). Washington, DC: National Highway Traffic Safety Administration, 2009.
9. National Center for Statistics and Analysis. National Automotive Sampling System Crashworthiness Data System Analytical User's Manual. Washington, DC: National Highway Traffic Safety Administration, 2007. Available at: http://www-nrd.nhtsa.dot.gov/Pubs/NASS07.PDF. Accessed October 16, 2009.
10. Gennarelli TA, Wodzin E. AIS 2005: a contemporary injury scale. Injury. 2006;37:1083–91.
11. Champion HR, Copes WS, Buyer D, Flanagan ME, Bain L, Sacco WJ. Major trauma in geriatric patients. Am J Public Health. 1989;79:1278–82.
12. Perdue PW, Watts DD, Kaufmann CR, Trask AL. Differences in mortality between elderly and younger adult trauma patients: geriatric status increases risk of delayed death. J Trauma. 1998;45:805–10.
13. Grossman MD, Miller D, Scaff DW, Arcona S. When is an elder old? Effect of preexisting conditions on mortality in geriatric trauma. J Trauma. 2002;52:242–6.
14. Morris JA Jr, Mackenzie EJ, Edelstein SL. The effect of preexisting conditions on mortality in trauma patients. JAMA. 1990;263:1942–7.
15. Demetriades D, Sava J, Alo K, et al. Old age as a criterion for trauma team activation. J Trauma. 2001;51:754–6.
16. Scheetz LJ. Relationship of age, injury severity, injury type, comorbid conditions, level of care, and survival among older motor vehicle trauma patients. Res Nurs Health. 2005;28:198–209.
17. Ferrera PC, Bartfield JM, D'Andrea CC. Outcomes of admitted geriatric trauma victims. Am J Emerg Med. 2000;18:575–80.
18. Lane P, Sorondo B, Kelly JJ. Geriatric trauma patients: are they receiving trauma center care? Acad Emerg Med. 2003;10:244–50.
19. Pracht EE, Langland-Orban B, Tepas JJI, Celso BG, Flint L. Analysis of trends in the Florida Trauma System (1991–2003): changes in mortality after establishment of new centers. Surgery. 2006;140:34–43.
20. Scheetz LJ. Trauma center versus non-trauma center admission in adult trauma victims by age and gender. Prehosp Emerg Care. 2004;8:268–72.
21. Vassar MJ, Holcroft JJ, Knudson MM, Kizer KW. Fractures in access to and assessment of trauma systems. J Am Coll Surg. 2003;197:717–25.
22. Wong DK, Lurie F, Wong LL. The effects of clopidogrel on elderly traumatic brain injured patients. J Trauma. 2008;65:1303–8.
23. Jones K, Sharp C, Mangram AJ, Dunn EL. The effects of preinjury clopidogrel use on older trauma patients with head injuries. Am J Surg. 2006;192:743–5
24. Criddle LM. 5-year survival of geriatric patients following trauma center discharge. Adv Emerg Nurs J. 2009;31:323–36.