ODPS Final Report

Title: Evaluation of Ohio's Geriatric-specific Trauma Triage Criteria: Assessing Accuracy and Improvement in Outcomes for Ohio's Elders

A. PROJECT RATIONALE

On December 29, 2008, Ohio became the first state to establish specific Geriatric Trauma Triage Criteria for its emergency medical services (EMS) providers. Several years of data are now available in the Ohio Acute Care Trauma Registry to study the effects of this change. This study evaluated the effect these Criteria have had on 1) rates of over- and under-triage, and 2) decreasing mortality for injured older adults in Ohio. Proving the success of these criteria will allow Ohio's criteria to serve as a model for development of similar criteria nationwide.

B. SIGNIFICANCE

When compared to younger adults (16-69 years old), the geriatric population (≥70 years old) presents not only a unique pattern of injuries and associated physiological responses, but also a significantly higher morbidity and mortality from injuries of similar severity.[2] Ohio's emergency medical services' (EMS) trauma triage criteria have long accounted for differences between pediatric and adult trauma patients. Yet, until December of 2008 there were no differences between younger and older adults in the Ohio criteria. As a result, until that time triage was identical for adults of all ages.

Ensuring appropriate EMS triage is a significant first step in improving outcomes for trauma patients.[3-7] EMS providers use such criteria to make a determination about the need for direct transfer of injured patients to a trauma center.[8,9] Analyses of the Ohio Acute Care Trauma Registry have confirmed that many characteristics associated with triage criteria manifest differently in older adults.[11] Overall mortality in trauma patients begins to increase at age 70 years.[12] Differences exist in both the physiologic (Glasgow Coma Scale [GCS], systolic blood pressure, etc.) and anatomic/mechanistic (involvement of multiple body systems, falls, etc.) domains. In our previous work, we found that older adults with a GCS ≤14 had similar mortality rates to younger adults at the currently accepted cutoff of ≤13.[13] We therefore proposed a modification of the GCS criterion to a GCS score ≤14 for EMS triage of injured elders.

Recognition of these differences in older adults led the Ohio Department of Public Safety's Trauma Committee to adopt the nation's first specific statewide Geriatric Trauma Triage Criteria for implementation on December 29, 2008.[10] The specific criteria were developed through a statewide panel of experts utilizing data from the Ohio Acute Care Trauma Registry.[2] Alterations to the prior Adult Criteria found in the new Geriatric Criteria include: a) Glasgow Coma Scale (GCS) score ≤14 in the presence of known or suspected traumatic brain injury; b) Systolic Blood Pressure (SBP) <100 mm Hg; c) fall from any height with evidence of traumatic brain injury; d) multiple body-system injuries; e) pedestrian struck by a moving vehicle; and f) the presence of any proximal long bone fracture following motor vehicle trauma. The criteria also suggested that geriatric patients with specific co-morbidities be considered for evaluation in a trauma center.

The effects of these criteria on EMS practice and geriatric patient outcomes in Ohio have not been systematically evaluated since their December 2008 implementation. This study conducted an in-depth analysis of data obtained from the Ohio Trauma Registry, with an **overall goal to evaluate the accuracy and effect on outcomes of Ohio's Geriatric-Specific Trauma Triage criteria.** Our **first objective** was to examine improvements in over- and under-triage of geriatric trauma patients after adoption of the Geriatric Criteria. Our **second objective** was to determine the effect of the Geriatric Criteria on mortality in Ohio's older adults.

C. SPECIFIC AIMS AND HYPOTHESES

***Specific aim 1*: To examine improvements in over- and under-triage of geriatric trauma patients after implementation of the Ohio Geriatric Trauma Triage Criteria.**

Hypothesis 1a: The Geriatric Criteria are more accurate in identifying need for trauma center care in older adults than the previous Adult Criteria.

Hypothesis 1b: Implementation of the Geriatric Criteria increased the proportion of older adults requiring trauma center care who were initially transported to a trauma center (i.e., decreased undertriage).

***Specific aim 2*: To determine the effect of the Ohio Geriatric Trauma Triage Criteria on morbidity and mortality in Ohio's older adults**

Hypothesis 2a: The adjusted mortality rate is significantly lower for geriatric trauma patients after adoption of the Geriatric Criteria.

D. APPROACH: METHODOLOGY AND DATA ANALYSIS

Study Design and Setting

We conducted a retrospective, quasi-experimental study of patients in the Ohio Acute Care Trauma Registry (OTR) from 2006 through 2011. A quasi-experimental study is a non-randomized intervention study which measures outcomes both before and after a discrete intervention, in this case implementation of the Geriatric Criteria on 12/31/2008.[16] [17] We stratified data by date of injury with particular focus on the three years before adoption of the Geriatric Criteria (2006-2008) as compared to the three years after adoption (2009-2011). Hospital institutional review board approval was obtained. For reporting, we adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.

Selection of Participants

The Ohio Trauma Registry is a statewide database maintained by the Ohio Department of Public Safety (ODPS). Because participation is required by law, approximately 87% of Ohio hospitals, including trauma and nontrauma centers, submit patient data to the registry. Registry patients must have had an *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) code for injury (ranging from 800.0 to 995.5) and at least 1 of the following criteria: a first or initial admission of greater than or equal to 48 hours, transfer into or out of a hospital or emergency department (ED) setting regardless of length of stay, dead on arrival, or death after receipt of any evaluation or treatment. Patients coded only for isolated hip fractures, late effects of injury, superficial abrasions, or foreign bodies are excluded from the registry. Registry policies, procedures, data elements, and codebook are available online.

Inclusion criteria for our study included all patients aged 16 years or older and initially transported from the scene by EMS personnel from January 1, 2006, through December 31, 2011.

Methods of Measurement

ODPS provided a matched data set to study investigators. Specific traumatic events may appear in the registry more than once because of transfer between institutions (eg, a patient transferred from a nontrauma center to a trauma center would have registry entries from both institutions). To account for these patients, probabilistic linkage was performed by ODPS

personnel to match and create a single entry for each traumatic event, using LinkPlus (version 8.2; Centers for Disease Control and Prevention, Atlanta, GA). Such linkage has previously been used for EMS data. Registry entries were matched according to sex, age, hospital identifier codes, arrival date and transfer date (tolerance ± 2 days), injury date (tolerance ± 4 days), and external cause of injury code (E-code). Weighted probabilities were initially used for each field. Subjects were blocked on sex. After obtaining linkage scores, we retained those with greater than 90% probability of being an accurate match. To ensure accuracy, we manually inspected both matching and nonmatching records. We found that a proportion of records below our cutoff threshold had equal values for sex, age, hospital codes (sending and receiving), and dates (within tolerances), with only E-code nonmatching. We believed that such patients did actually represent true matches and therefore included them in the study data set. If a match could not be found for a record, it was excluded from the study.

The dataset included patient demographics, mechanism of injury, EMS run sheet data, ED data, and inpatient hospital data. Entries with linked data were analyzed as a single entry. EMS data fields included adult field triage criteria met and individual GCS measures and procedures at the scene, including intubation, cardiopulmonary resuscitation (CPR), thoracostomy, or spinal immobilization. Relevant ED data fields included arrival source, initial blood pressure and respiratory rate, ED GCS components, ED disposition, and ED procedures. Inpatient data fields included hospital type (Level I or II trauma center versus nontrauma center), Abbreviated Injury Scale score and description code(s), Injury Severity Score, comorbidities, ICU days, operating room visit, *ICD-9-CM* codes, external cause of injury codes (E-codes), and discharge status.

We used trauma registry information to determine whether each patient met both the Ohio adult triage criteria and the geriatric triage criteria. In some cases, EMS providers document one or more reasons for transfer to a trauma center (Field 17—EMS Documented Adult Field Triage Criteria). However, this field is specific only to the adult criteria and was not reliably completed. Therefore, we used several additional methods to identify patients meeting trauma triage criteria. We determined whether each triage criteria element was present by constructing lists of relevant *ICD-9-CM* diagnosis codes, E-codes, and both EMS and ED procedures, GCS variables, and vital signs. We then determined whether a patient met either the

Ohio adult or geriatric triage criteria. Patients were divided into younger adults aged 16 to 69 years and older adults aged 70 years or older.

Definition of study variables

Definition - Meeting Geriatric Trauma Triage Criteria: Presence of ≥1 of the characteristics requiring transport to a trauma center as defined in the Ohio Geriatric Trauma Criteria.[2]

Definition – Meeting Adult Trauma Triage Criteria: Presence of ≥1 of the characteristics requiring transport to a trauma center as noted in the Ohio Adult Trauma Criteria. These criteria applied to the entire adult population prior to 12/29/2008 and only to the 16-69 year old population after that date.

Outcome - Hypotheses 1a, 1b – Need for trauma center care: Patients were determined to need trauma center care if their Injury Severity Score (ISS) is >15. This is a commonly used definition in the literature. We also explored secondary measures of need for trauma center care such as surgery within 48 hours of arrival, in-hospital mortality, and ICU care.

Outcome - Hypothesis 2a – In-hospital mortality rate: the proportion of patients who died prior to hospital discharge.

Primary Data Analysis

All analyses were conducted with Stata (version 12; StataCorp, College Station, TX). Multiple imputation was used to handle missing data for GCS score components, systolic blood pressure, respiratory rate, EMS intubation, and EMS CPR.. Multiple imputation was performed iteratively by using chained equations to generate 5 imputed data sets. We used ordered logit regression for eye, verbal, and motor GCS scores; logit regression for intubation and CPR; and truncated regression for respiratory rate and systolic blood pressure. For all imputations, age, sex, race, injury type, logarithm of Injury Severity Score, and ICU discharge status were used as independent variables. Convergence of chained equations was examined visually by generating trace plot summaries of the distribution. The 5 data sets were combined with Rubin's rules.

Specific data analysis for Hypothesis 1a

For Aim I, Hypothesis 1a, we excluded patients who had absent data to measure the primary outcome, Injury Severity Score. We calculated descriptive statistics for study variables,

including means, medians, and proportions as appropriate for the entire population and stratified by aged 70 years or older. We then calculated sensitivity specificity and area under the curve with 95% confidence intervals (CIs) for both geriatric and adult triage criteria in predicting each of the study outcomes. This analysis was performed in both the younger adult and older adult age groups. We also conducted several sensitivity analyses which are described in the published manuscript.

Specific data analysis for Hypotheses 1b and 2a:

In our analysis for Hypothesis 1a using this dataset to identify the accuracy of the geriatric criteria, patients with missing injury severity score (ISS) were excluded as ISS was the primary outcome of interest. However, patients with missing ISS were retained for data analysis in these portions of the project. Data analyses for these Hypotheses included only patients aged 70 and over. Multiple imputation was performed as described above with the addition of ISS as an imputed variable.

We calculated descriptive statistics for this cohort over aged 70 which were stratified overall and pre- and post-geriatric triage implementation. We identified proportion of patients meeting triage criteria who were transferred to trauma centers before and after implementation (with 95% confidence intervals).

For Hypothesis 2a, we calculated mortality rates overall, before and after criteria implementation. We created multivariable logistic regression model to identify if mortality rates were affected by triage criteria implementation. The primary outcome of interest was inpatient mortality, defined as death occurring in the ED or during the inpatient hospitalization. This was defined as a value of 1 or 2 in field 28 of the Registry. We also constructed an interrupted time series plot to identify changes in outcome over time.

E. RESULTS

Results for Hypothesis 1a: (See Ann Emerg Med, 2015, 65(1): 92-100 for complete results).

Initial review for Hypothesis 1a revealed 20,887 records indicating a transfer from an initial ED to another receiving ED and 20,854 receiving ED records indicating arrival from an initial ED. Of these, 15,195 (73%) could be linked by Ohio Department of Public Safety. After addition of records with only 1 site of care and applying study exclusion criteria (not transported

by EMS, absent ISS), there were 101,577 patients eligible for study inclusion, 33,379 of whom were 70 years or older.

Comparing younger with older patients, older adults were less severely injured, with lower Injury Severity Score scores and with only 13% having an Injury Severity Score greater than 15, indicating moderate to severe injury, compared with 29% of younger adults. They were also less likely to have an ICU stay (17% versus 28%) and an operating room procedure within 48 hours (13% versus 29%). Despite the lower Injury Severity Score, mortality between the 2 groups was similar: 6.8% of older adults and 9.3% of younger adults died in the ED or hospital. Overall, 57% of patients met the adult criteria and 68% met the geriatric criteria for transfer to a trauma center. In the younger adult population, 64% met adult criteria and 73% met geriatric criteria. In older adults, 42% met the adult criteria and 57% met the geriatric criteria.

Test characteristics for each of the triage criteria stratified by age are shown in the **Table**. For all outcomes, the sensitivity of the adult triage criteria when applied in older adults was less than in younger adults. Application of the geriatric criteria resulted in increased sensitivity among older adults, reaching values of sensitivity near those observed for younger adults with the adult criteria. The levels obtained for specificity in older adults with the geriatric triage criteria were similar to the specificity identified for younger adults with the adult triage criteria.

Table: Test characteristics of geriatric and adult trauma triage criteria for predicting need for trauma center care, stratified by age. (adopted from Ann Emerg Med, 2015, 65(1): 92-100).

Outcome Measure	Geriatric Triage Criteria			Adult Triage Criteria		
	Sensitivity (95% CI)	Specificity (95% CI)	AUC	Sensitivity (95% CI)	Specificity (95% CI)	AUC
ISS score >15						
Age ≥70 y	93 (92 to 93)	49 (48 to 49)	0.71	61 (60 to 62)	61 (61 to 62)	0.61
Age ≤70 y	94 (94 to 95)	35 (35 to 35)	0.65	87 (86 to 87)	44 (44 to 45)	0.65
OR visit <48 h						
Age ≥70 y	47 (46 to 49)	42 (41 to 42)	0.44	35 (34 to 37)	57 (56 to 58)	0.46
Age ≤70 y	73 (72 to 73)	27 (26 to 27)	0.5	65 (64 to 65)	36 (35 to 36)	0.5
ICU stay						
Age ≥70 y	81 (80 to 82)	48 (47 to 48)	0.64	56 (55 to 57)	61 (60 to 62)	0.58
Age ≤70 y	91 (90 to 91)	34 (33 to 34)	0.62	82 (82–83)	42 (42 to 43)	0.62
Mortality						
Age ≥70 y	90 (89 to 91)	45 (45 to 46)	0.68	74 (72 to 76)	60 (60 to 61)	0.67
Age ≤70 y	99 (99 to 100)	30 (29 to 30)	0.64	98 (97 to 98)	39 (39 to 39)	0.68

AUC, Area under the curve.

For the outcome defining need for trauma center care as Injury Severity Score greater than 15, the adult triage criteria displayed good sensitivity for younger adults (87%; 95% CI 86% to 87%) but significantly worse sensitivity for older adults (61%; 95% CI 60% to 62%). When the geriatric triage criteria were applied, sensitivity for older adults significantly increased, to 93% (95% CI 92% to 93%), a difference of 32% (95% CI 30% to 33%). For these older adults, specificity decreased from 61% with the adult triage criteria to 49% with the geriatric triage criteria. However, this specificity of 49% was similar to that for younger adults with the adult triage criteria (44%). Accuracy, as measured by area under the curve, improved for older adults with the Injury Severity Score and ICU stay outcomes, but not for the other outcomes. No improvements were found in area under the curve for younger adults with any outcome if the geriatric criteria were applied to them.

For the operating room visit in less than 48 hours, the geriatric criteria showed improvement (increased sensitivity by 12%; 95% CI 11% to 13%) but remained insensitive (47%; 95% CI 46% to 49%). For both ICU stay and mortality, sensitivity increased to more than 80% in older adults with the geriatric criteria.

In younger adults, applying the geriatric criteria resulted in minimal increases in sensitivity, with greater decreases in specificity. For the Injury Severity Score outcome, sensitivity increased from 87% to 94% but specificity decreased from 44% to 35%. Similar patterns were observed for the other secondary outcome measures.

Results: Hypotheses 1b, 2a:

Number included in this study differ slightly from those discussed above for Hypothesis 1a because those with missing ISS were retained for these Hypotheses and the missing ISS score was imputed. There were 103,570 eligible patients in the study, with 34,499 age $\geq$70 years included in the analysis.

Examination of clinical characteristics of the older study population before and after implementation of geriatric triage criteria reveals that demographic data, mechanism of injury, and ISS distribution were similar for both time periods. In the pre-implementation phase, 44% of older adults met the adult triage criteria, indicating need for trauma center transfer. After implementation of the geriatric criteria, 58% met the new criteria and were appropriate for transfer to a trauma center.

Hypothesis 1b: There were only minimal increases in transfer of older adults to trauma centers (52% [95% CI, 51-53%] to 54% [95% CI, 54-55%]) after criteria implementation. This finding was statistically significant ($p<0.05$) but of questionable clinical significance. Among older adults with an ISS >15, initial transfers to trauma centers increased only from 62% before the guideline change to 65% after the change. Of patients with an ISS <=10, initial transfer rates to trauma centers increased from 44% before the guideline change to 46% after the change. Similar small changes were seen if Level III trauma centers were also included in the totals.

Hypothesis 2a: Among older adults, there was an unadjusted decrease in mortality from 7.1% (95% CI, 6.6%-7.4%) to 6.6% (95% CI, 5.9%-6.6%) after implementation of the criteria which was not statistically significant ($p=0.098$). When evaluating moderately (ISS 10-15) and severely (ISS >15) injured geriatric patients, mortality was not significantly different after the criteria change. However, in patients with ISS <10, mortality decreased from 2.9% (95% CI 2.6-3.2%) before the criteria changed to 2.4% (95% CI 2.1-2.6%) afterwards ($p<0.05$).

Results of the multivariable logistic regression analysis are shown in the **Table**. ISS was not linear in the logit and was initially included in the model using the square root of ISS. However, an interaction existed between the square root of ISS and geriatric criteria implementation. This substantially complicated the interpretation of the effect of the geriatric criteria. For clarity, we converted ISS to a 3-level variable. An interaction continued to exist between geriatric criteria implementation and ISS group. **When accounting for this interaction term, implementation of the geriatric criteria was associated with a significant decrease in mortality among older adults with ISS<10 (OR 0.81, 95% CI 0.70-0.95).** There were no significant changes in mortality among those with ISS 10-15 or >15. These results were supported in a sensitivity analysis in which we retained the square root of ISS in the model.

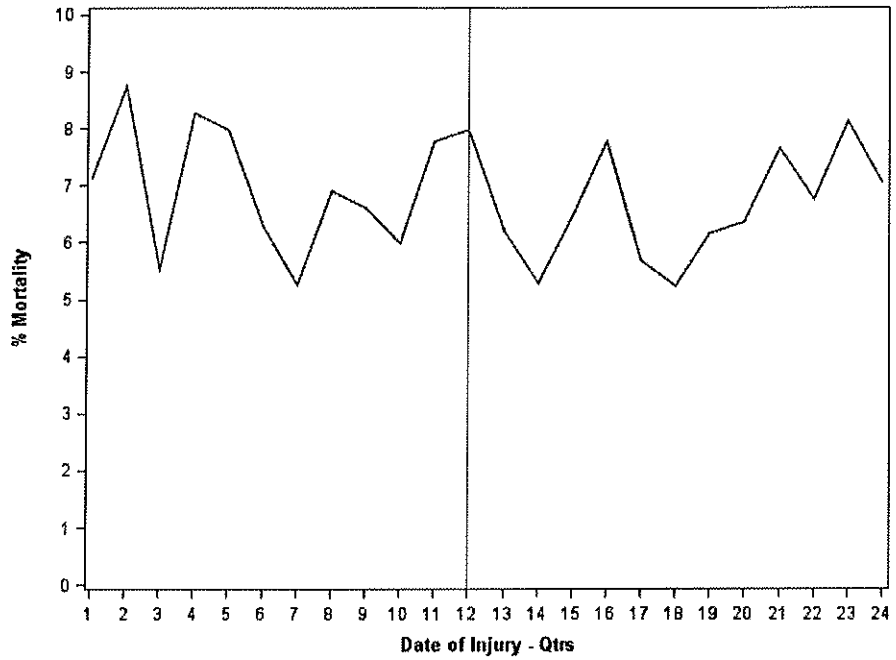
Table: Multivariable logistic regression to identify predictors of mortality in geriatric trauma patients in the 2006-2011 Ohio Trauma Registry demonstrating the presence of interaction between Geriatric Triage Implemented and ISS variables

Variable	*Level*	*Odds Ratio*	*OR 95% CI (+/-)*	*p-value*
Geriatric Triage Implemented	No (pre-2009)	Ref*		
	Yes	0.81*	0.695	0.011
Gender	Female	Ref		
	Male	1.80	1.64	<.0001
Age	(years)	1.02	1.013	<.0001
Race	Black	1.00	0.754	0.993
	Hispanic	0.87	0.356	0.754
	White	0.98	0.804	0.826
Injury type	Blunt	Ref		
	Burns/ Asphyxia	7.80	5.41	<.0001
	Penetrating	7.12	5.255	<.0001
Injury severity score group	<10	Ref*		
	10-15	1.79*	1.421	<.0001
	>15	11.89*	10.279	<.0001
Interaction term for Geriatric Triage Implemented and ISS group	Triage Implemented =Yes and ISS score 10-15	1.36*	1.003	0.048
	Triage Implemented =Yes and ISS score >15	1.34*	1.094	0.005

*Interpretation of odds ratios for Geriatric criteria implementation and ISS group require appropriate consideration of the interaction term.

The **Figure** demonstrates an interrupted time series of mortality over time before and after the geriatric criteria were implemented (reference line at quarter 12 representing the date of guideline changes). There was no pattern of change for mortality over time either before or after the change.

Figure: Mortality over time among older adults in the Ohio Trauma Registry



Quarter 1=1st quarter of 2006
Quarter 24=4th quarter of 2011
Quarter 12 reference line=time up until December 29, 2008 initiation of Geriatric Criteria

F. DISCUSSION

Hypothesis 1a: Using a statewide trauma registry, we demonstrated that application of Ohio's geriatric trauma triage guidelines to the older adult population would result in improved sensitivity, with acceptable decreases in specificity for older adults. We showed that current standard adult triage guidelines provide poor sensitivity in identifying older adults with moderate to severe injury who need trauma center care. In addition, we found that using the geriatric trauma triage guidelines in younger adults provides minimal appreciable increase in sensitivity, but substantial decreases in specificity.

We found that, under the standard adult triage criteria, the sensitivity for predicting need for trauma center care was significantly worse for older adults than for younger adults regardless of the definition of need for trauma center care examined. In older adults these adult triage criteria were more specific than in younger adults. It is likely that for older adults, the standard adult triage criteria are too restrictive in identifying need for transfer to a trauma center.

Application of the new geriatric triage criteria to older adults corrected these deficiencies. For all outcome measures, sensitivity improved substantially and became similar to the

sensitivity found for younger adults with the standard adult triage criteria, with the exception of operating room visit in fewer than 48 hours. As would be expected, specificity did decrease, but the levels of specificity in older adults were similar to those of younger adults under the standard adult triage criteria. As a result, we consider this an acceptable decrease in specificity to improve the sensitivity of the criteria.

Hypothesis 1b: We found that transfer of geriatric patients to trauma centers increased only slightly in Ohio following introduction of the geriatric trauma triage criteria. In all subgroups, the increase in proportion transferred was about 2%. This number is below the increase in geriatric patients meeting triage criteria for trauma center transport. The proportion of geriatric patient meeting criteria for trauma center transport increased from 44% to 58% but there was not a corresponding increase in trauma center transport. There are multiple possible reasons for this including provider choice, patient choice, geographic availability of trauma centers and other. More in depth understanding of the reasons behind this failure to see a change will require work extending beyond that of the trauma registry.

Hypothesis 2a: We also demonstrated that implementing statewide geriatric triage guidelines for EMS providers did not improve mortality in moderately to severely injured (ISS >10) geriatric patients, but did decrease mortality rates in those with mild injuries (ISS <10). Mortality did not demonstrate a pattern of change over time following the guideline change, indicating that under-triage or lack of compliance with the new triage guidelines could have remained a consistent problem following implementation. The decrease in mortality that we noted could be a sign of slight improvement in appropriate triage of older adults. It is possible that more of these mildly injured patients, who would have been missed by standard adult triage guidelines, were identified using geriatric criteria and successfully transferred to trauma centers where they experienced improved care. As noted for Hypothesis 1b, a more in-depth understanding of transport decisions for geriatric patients could better clarify this reduction in mortality.

Mortality in the ISS >15 group did not improve following implementation. Although transfer rates to trauma centers improved slightly for severely injured geriatric patients, they remained markedly lower than those of similarly injured younger adults. When examining patients who actually met criteria for trauma care, close to 40% of geriatric patients were still not transferred despite meeting the new guidelines, compared to only 12% of younger adults meeting

standard adult criteria. This is indicative of an ongoing propensity toward under-triage, which is associated with increased mortality in older patients with severe injuries. It is likely that the guidelines did not substantially reduce rates of under-triage of those with ISS >15 and were thereby unsuccessful at reducing mortality.

G. CONCLUSION

In conclusion, application of Ohio's EMS geriatric trauma triage guidelines to the older adult population results in improved sensitivity in identifying need for trauma center care in older adults. Standard adult triage guidelines provide poor sensitivity in older adults. In addition, application of the criteria to younger adults provides minimal increases in sensitivity but substantial decreases in specificity.

However, increases in eligibility for trauma center care did not translate into corresponding increases in transport to a trauma center for older adults. Older adults meeting transport criteria are still taken to a trauma center at lower rates than younger adults, including in the subgroups with severe injury (ISS >15). Despite the small effect on transfer rates, there was a significant decrease in mortality after triage criteria implementation among older adults with less severe injuries (ISS<10).

H. PLAN FOR DISSEMINATION

1. The findings for Hypothesis 1a have been published in **Annals of Emergency Medicine** as "Geriatric-Specific Triage Criteria Are More Sensitive Than Standard Adult Criteria in Identifying Need for Trauma Center Care in Injured Older Adults" Brian Ichwan BS, Subrahmanyam Darbha MS, Manish N. Shah MD, MPH, Laura Thompson MD, MPH, David C. Evans MD, Creagh T. Boulger MD, and Jeffrey M. Caterino MD, MPH. 2015, 65(1): 92-100.

2. The findings surrounding outcomes (Hypothesis 2a) will be submitted as an abstract to the national meeting of the American College of Emergency Physicians (submission April 2015) with plans for submission of a peer-reviewed manuscript by end of April 2015 to either Annals of Emergency Medicine, Journal of Trauma, or Journal of the American Geriatrics Society..

3. The findings surrounding transport to a trauma center and further analysis of the factors associated with this transport (Hypothesis 1b) are currently undergoing further in-depth analysis. They will be submitted a manuscript to a peer-reviewed publication by August 2015.

4. Authors are available at ODPS convenience to present to the Trauma Board.

I. FUTURE DIRECTIONS AND RECOMMENDATIONS

Future direction could include disseminating and repeating this work beyond Ohio. Additionally, cost analysis could be used to determine the criteria's effects on health care costs. Finally, the techniques used (especially interrupted time series analysis) can be used for future studies in a large number of topics using the Ohio Trauma Registry. Specific recommendations from our findings for future directions include:

The study raises concerns over actual adoption and implementation of the criteria. There are multiple possible reasons for not transporting someone to a trauma center (e.g. rural areas, patient preference). However, given the evidence that the new geriatric criteria are accurate for older adults, further analysis, education, and training maybe required to ensure that Ohio's injured elders get optimum benefit from these criteria.

Reference List

(1) _____ HIPAA Privacy Rule and Public Health. MMWR Supplements May 2, 2003/ 52(S-1); 1-12 (accessed Mar.16, 2012)

(2) Werman HA, Erskine T, Caterino J, Riebe JF, Valasek T; Members of the Trauma Committee of the State of Ohio EMS Board. Development of statewide geriatric patients trauma triage criteria. *Prehosp Disaster Med.* 2011 Jun;26(3):170-9. Review.

(3) Chiara O, Cimbanassi S. Organized trauma care: does volume matter and do trauma centers save lives? *Curr Opin Crit Care.* 2003; 9(6):510-514.

(4) Durham R, Pracht E, Orban B et al. Evaluation of a mature trauma system. *Ann Surg.* 2006;243(6):775-783.

(5) Smith JS, Jr., Martin LF, Young WW et al. Do trauma centers improve outcome over non-trauma centers: the evaluation of regional trauma care using discharge abstract data and patient management categories. *J Trauma.* 1990; 30(12):1533-1538.

(6) Hartl R, Gerber LM, Iacono L et al. Direct transport within an organized state trauma system reduces mortality in patients with severe traumatic brain injury. *J Trauma.* 2006; 60(6):1250-1256.

(7) Meldon SW, Reilly M, Drew BL et al. Trauma in the very elderly: a community-based study of outcomes at trauma and nontrauma centers. *J Trauma.* 2002; 52(1):79-84.

(8) Ma MH, MacKenzie EJ, Alcorta R et al. Compliance with prehospital triage protocols for major trauma patients. *J Trauma.* 1999; 46(1):168-175.

(9) Zimmer-Gembeck MJ, Southard PA, Hedges JR et al. Triage in an established trauma system. *J Trauma.* 1995; 39(5):922-928.

(10) _____ Notice of changes to trauma triage rules. http://www.publicsafety.ohio.gov/links/ems_oac4765_14_geriatric_triage_details09.pdf (accessed Mar.16, 2012)

(11) _____ Geriatric Trauma Triage Criteria: How and Why http://www.publicsafety.ohio.gov/links/ems_geriatric%20Triage09.ppt (accessed Mar.16, 2012)

(12) Caterino JM, Valasek T, Werman HA. Identification of an age cutoff for increased mortality in patients with elderly trauma. *Am J Emerg Med.* 2010 Feb; 28(2):151-8.

(13) Caterino JM, Raubenolt A, Cudnik MT. Modification of Glasgow Coma Scale criteria for injured elders. Acad Emerg Med. 2011 Oct;18(10):1014-21. doi: 10.1111/j.1553-2712.2011.01164.x. Epub 2011 Sep 26.

(14) Caterino JM, Valasek T, Werman HA. Identification of an age cutoff for increased mortality in patients with elderly trauma. *Am J Emerg Med.* 2010 Feb; 28(2):151-8.

(15) Caterino JM, Raubenolt A. The prehospital simplified motor score is as accurate as the prehospital Glasgow coma scale: analysis of a statewide trauma registry. *Emerg Med J.* 2011 July. [Epub ahead of print] PMID: 21795294

(16) Harris AD, Jessina MC, Eli PN, Jon FP, Jingkun Zhu, Dan PE, Joseph Finkelstein. The use and interpretation of Quasi-experimental studies in medical informatics. *J Am MEd Inform Assoc.* 2006; 13:16-23

(17) Wagner, AK, Soumerai, SB, Zhang, F, Ross-Degnan, D. Segmented regression analysis of interrupted time series studies in medication use research. *Journal of Clinical Pharmacy and Therapeutics.* 2002; 27, 299-309

(18) _____ Ohio Trauma Registry Data Dictionary 2004. http://www.publicsafety.ohio.gov/links/ems_otr_data_dictionary04.pdf (accessed Mar.16, 2012)

(19) Newgard CD, Haukoos JS. Advanced statistics: missing data in clinical research – part 2: multiple imputation. *Acad Emerg med.* 2007 Jul:14(7):669-78