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THE AGE OF UNDERTRIAGE: CURRENT TRAUMA TRIAGE CRITERIA UNDERESTIMATE THE ROLE OF AGE AND COMORBIDITIES IN EARLY MORTALITY

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☐ **Abstract—Background: National guidelines recommend that prehospital and emergency department (ED) criteria identify patients who might benefit from trauma center triage and highest-level trauma team activation. However, some patients who are seemingly "stable" in the field and do not meet the standard criteria for trauma activation still die. Objectives: The purpose of this study was to identify these at-risk patients to potentially improve triage algorithms. Methods: Patients enrolled in the National Trauma Data Bank (2007–2012) were included. All adult blunt trauma patients that were stable in the field and upon arrival to the ED (defined as a Glasgow Coma Scale score of 13–15, a heart rate ≤120 beats/min, systolic blood pressure ≥90 mm Hg, and diastolic blood pressure ≤200 mm Hg) and did not meet the standard criteria for the highest-level trauma team activation as defined by the American College of Surgeons were included. Demographic, clinical, and injury data including comorbidities, ED vitals, and outcome were collected. Regression models were used to identify independent risk factors for mortality. Results: A total of 1,003,350 patients were stable in both the field and ED. Of these 11,010 (1.1%) died, including 1785 (0.2%) who died within 24 hours of hospital admission. The mortality in patients ≥60 years of age was 2.6%, and in patients ≥60 years of age with either a cerebrovascular accident (CVA) or congestive heart failure (CHF) was 5.4%. Age ≥60 years was a significant independent predictor of early mortality (odds ratio [OR] 4.53, $p < 0.001$). CHF (OR 1.88, $p < 0.001$) and a history of stroke (OR 1.52, $p < 0.001$) were also significant independent predictors of mortality. Conclusions: Despite apparent evidence of both prehospital stability and stability upon arrival to the ED, patients ≥60 years of age and with a history of CHF or CVA have a significantly increased risk of early mortality after blunt trauma. These patients are at risk for subsequent clinical deterioration and should be considered for early transfer to a trauma center with highest-level activation.** © **2018 Elsevier Inc. All rights reserved.**

☐ **Keywords—age; comorbidities; trauma; undertriage**

INTRODUCTION

The recent growth of the annual mortality rate from trauma has outpaced the rate of growth of the population. From 2000 to 2010, trauma deaths increased by 22.8% while the population increased by 9.7% (1). During this time, the median age in the United States by census data increased from 35.3 to 37.2 years old with a 15.1% increase in persons >65 years of age (https://www.census.gov/prod/cen2010/briefs/c2010br-03.pdf). Although immediate on-scene mortality may be ameliorated with preventative measures, improving in-hospital

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mortality requires an evaluation of both the care delivered and the resources available at a given institution. Level I trauma centers are designed to centralize resources in high-volume centers and deliver timely care to the most critical trauma patients (2). Trauma triage criteria have been recommended to rapidly identify critical patients in the prehospital setting who might benefit from early utilization of the highest level of trauma resources. These criteria are designed to avoid preventable deaths in underresourced institutions by facilitating transfer to designated trauma centers. In doing so, however, it is important to avoid excessive overtriage that can overwhelm the system by using excess resources unnecessarily (3,4).

The Committee on Trauma of the American College of Surgeons has published specific criteria based on patient physiology and anatomy and mechanism of injury that mandate activation of the highest-level trauma team response (3). These guidelines include 1) confirmed blood pressure <90 mm Hg at any time in adults or age-specific hypotension in children; 2) gunshot wounds to the neck, chest, or abdomen or extremities proximal to the elbow/knee; 3) Glasgow Coma Scale score <9 with mechanism attributed to trauma; 4) transfer of patients from other hospitals receiving blood to maintain vital signs; 5) intubated patients transferred from the scene or patients who have respiratory compromise or are in need of an emergent airway; and 6) emergency physician's discretion. In addition to these guidelines, individual centers continue to modify and augment these criteria in an effort to optimize over- and undertriage, with special emphasis on high-risk patients who are not captured by the existing national guidelines (5–8).

Despite these national guidelines, there still exists a subset of patients that are seemingly "stable" in the field or in the emergency department (ED) and who have not been identified as "high risk" yet progress to early mortality after trauma. The present study aims to analyze characteristics of these potentially undertriaged patients to facilitate earlier identification of the "at risk" populations to improve triage and patient safety.

MATERIALS AND METHODS

After institutional review board approval, all blunt trauma patients were extracted from the National Trauma Data Bank (2007–2012). All patients that were considered stable in the field (defined as a Glasgow Coma Scale score 13–15, a systolic blood pressure ≥90 mm Hg, and a heart rate ≤120 beats/min) were collected. Patients <16 years of age, interfacility transfers, and patients with missing Injury Severity Score (ISS) data were excluded.

Demographic data, pretrauma comorbidities, ED data, ISS, body Abbreviated Injury Scale, injury-specific data, procedures performed, and in-hospital complications were recorded. The primary outcome was in-hospital mortality with an emphasis on early mortality within the first 24 hours of admission.

Statistical Analysis

Continuous variables were dichotomized using clinically relevant cutpoints. Age was divided into 5 groups (16–45, 46–60, 61–75, 75–90, and >90 years of age). Values were reported as percentage for categorical variables and median with interquartile range for continuous variables. Univariate analysis was performed to identify differences in the baseline characteristics between the groups. Pearson chi-square or Fisher exact tests were used to compare proportions for categorical variables and the Mann–Whitney *U* test was used to compare medians for continuous nonparametric variables.

Independent risk factors and adjusted difference in outcome were then identified using stepwise forward logistic regression. Potential risk factors with p values <0.2 were included into multivariate analysis. A multicollinearity test was performed to identify any correlation between variables. Variables with p values <0.05 were considered statistically significant. The C-statistic denoting the area under the receiver operating characteristic curve with its 95% confidence interval (CI) was calculated for each model. Predicted probabilities of early in-hospital mortality were calculated from a multivariate regression model using individual data elements that represented each age subgroup and each of the patient's comorbidities. Statistical analysis was performed using SPSS 20.0 for Windows (SPSS Inc., Chicago, IL).

RESULTS

Overall, 1,128,130 patients were identified as stable in the field by the criteria stated in the methods section and were included in the study (Figure 1). A total of 124,780 patients were identified to have early decline during transport, manifest as either signs of hemodynamic instability or decline in the Glasgow Coma Scale score. Exclusion of these patients resulted in a study population of 1,003,350 patients that were stable in both the field and ED (Table 1). The population was predominately young (16–45 years of age, 44.2%), white (75.8%), and male (58.8%). The median ISS was low (9, interquartile range 4–10), with the greatest proportion of severe injury (Abbreviated Injury Scale ≥3) to the head (n = 130,330, 13%), chest (n = 137,415, 13.7%), and lower extremity (n = 216,373, 21.6%). Few patients underwent craniotomy or laparotomy (n = 3304, 0.3% and n = 2868, 0.3%, respectively). The most common comorbidities were hypertension (n = 255,608, 25.5%) and diabetes (n = 99,846, 10.0%).