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Post-trauma mortality increase at age 60: a cutoff for defining elderly?

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Elderly trauma;
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Age cutoff

Abstract

BACKGROUND: There has been an increasing emphasis on identifying elderly trauma patients. However, definitions based solely on age vary widely, ranging from age 55 to 80 years, hampering optimal trauma management for older patients. The goal of this study was to develop an objective, data-driven definition for "elderly" in trauma care by evaluating mortality risk as a function of age.

METHODS: We conducted a retrospective analysis of 872,861 adult ($\geq$18 years) patients from the National Trauma Data Bank's National Sample Program from 2003 to 2010. The primary outcome was risk-adjusted in-hospital mortality determined using multivariate logistic regression. Contribution of age to mortality was investigated through step-wise regression and percent of R^2 attributable to age. We searched for straight-line trends in mortality rate at each age using the spline function of Statistical Analysis Software.

RESULTS: Statistically significant increases in mortality rate were noted at ages 37, 60, and 78. Age was found to contribute 10% to mortality compared with greater than 80% for Glasgow coma scale and injury severity score combined.

CONCLUSIONS: Our findings suggest using age 60 years as a data-driven definition of "elderly" in trauma.

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Trauma centers across the United States are treating a growing number of older patients.[1,2] This trend is likely related to increasing life expectancy and more active and independent lifestyles in older populations.[3] Studies suggest patients older than 65 years make up the fastest growing segment of patients admitted to trauma centers, currently accounting for 23% of all trauma admissions, although representing slightly less than 14% of the population.[1,4,5] In fact, trauma remains a leading cause of morbidity and ranks seventh in cause of death among patients older than 65 years.[6] Management of older trauma patients presents unique challenges such as decreased physiological reserve, underestimated injury severity, and documented comorbidities.[7–15] Medical care providers and researchers have made efforts to address these differences by evaluating the effects of frailty, comorbidities, and advanced age on postinjury outcomes.[16–18] Additionally, several trauma centers have

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established "geriatric" trauma units enacting protocols developed for optimal treatment of older trauma patients.[19] However, efforts to evaluate postinjury mortality and develop protocols derived from recent publications are hampered by lack of a consistent definition of the "elderly" age.

Elderly in trauma is most frequently defined as those aged 65 and older.[5,20–22] The Eastern Association for the Surgery of Trauma's (EAST) practice management guideline for geriatric trauma states "the threshold is consonant with what seems to be the most common assumptions and designations…regarding advanced age."[23] Both the American College of Surgeons (ACS) Committee on Trauma's Trauma Quality Improvement Program (TQIP) and Advanced Trauma Life Support use age 65 years to classify patients as elderly in their trauma management guidelines.[6,24] However, the ACS also suggests age 55 years as a "special consideration" for triage, and EAST acknowledges that independent risk of post-trauma mortality may begin at a much younger age than 65.[12,23] One study determined mortality from moderate-to-severe trauma increased as early as age 40.[25] Another study found age older than 60 years to be a significant risk factor for death.[26] Other definitions range from as low as 55 years[27,28] to 80 years.[29,30]

There are two important limitations of current definitions of elderly or geriatric trauma patients. First, prior studies used arbitrary cutoff points to dichotomize or categorize age groups. In these studies, the older groups have higher mortality risk and worse outcomes, whether researchers used age 40, 55, 60, 70, or other as a cutoff. These studies assume adverse outcomes increase in a stepwise leap at a given age (or ages) or that the relationship between age and mortality is linear, neither of which may be true.[7,14] Second, several studies did not take into account differences in injury severity between age groups and attributed the entire increase in mortality in the older age group to aging.[31]

We view elderly here as a stratum of chronological age that serves as a proxy to a person's increased vulnerability to in-hospital death after trauma. We focus on mortality outcome because of its considerable attention in prior research with aging and its importance as a benchmark in assessing trauma center standards of care.[32,33] Although recent research suggests a frailty index may be a better tool than age alone for risk stratification among a geriatric population, we seek a less complex tool for the trauma environment that may be used either alone or in support of other measures.[34] The purpose of our study was to develop an objective, data-driven definition for elderly trauma patients that is based on changes in risk-adjusted mortality rates at different ages without using any arbitrary or subjective cutoffs. We also sought to estimate the increase in risk of death that can be attributed to age alone and not injury severity.

Methods

We performed an 8-year retrospective analysis of 930,907 patients from the National Trauma Data Bank's National Sample Program (NTDB NSP) treated at 100 level I and II trauma centers from 2003 to 2010. The NSP is a statistically representative sample of trauma patients.[35] All adult patients aged 18 to 89 years were included, whereas patients older than 89 years were excluded because the NSP combines these patients into one age category, eliminating specific age values beyond 89 years. Our primary outcome of interest was in-hospital mortality, including death in the emergency department. Therefore, patients with missing discharge disposition (including mortality) and those designated as "dead on arrival" were excluded. These criteria identified 872,861 adult trauma patients.

Multivariate logistic regression analysis was performed to determine mortality rates, after adjusting for well-known predictors of mortality similar to those used by the ACS TQIP and Haider et al.[36,37] These included age, race/ethnicity, sex, insurance, systolic blood pressure and Glasgow coma scale (GCS) score on presentation, injury severity score (ISS), ventilator use, and mechanism of injury (blunt vs penetrating). Pulse rate and comorbidities were considered but not included in the final model due to the large numbers of missing values. Specifically, pulse rate was not collected before 2007, and comorbidity data were missing for more than 50% of the study patients. Subsequent exploratory analysis found that our prediction model and resulting outcomes showed no change with the inclusion of comorbidity as a covariate, but nearly halved the sample population size. The final model yielded an area under the receiver operating characteristic curve of C = .95, indicating it was a strong predictor of mortality.

To measure the trend relationship between age and mortality, we calculated a smoothed adjusted mortality rate for each age (in years) by using the binning procedure described by Bruns.[38] In this process, patients are grouped into age bins containing overlapping ranges of 5 years relabeled at the midpoint. For example, the bin labeled age 60 contains patients aged 58 through 62 and age bin 61 contains those aged 59 through 63. The mortality rate was calculated for all patients in an age bin and plotted at each midpoint value of the bin. We then searched for straight-line trends in mortality rate by using the Statistical Analysis Software spline option. A spline is a piecewise function that approximates mortality rate trends as a function of age, where the pieces are straight lines joined at age locations. Our analysis determined an excellent fit of adjusted mortality rates with 4 trend lines joined at 3 locations identified by the software ($R^2 = .99$). The 3 age locations identified ages at which risk-adjusted mortality started to increase at a significantly higher rate than the previous age.

To measure the relative importance of age in explaining mortality rate, we conducted stepwise regression analysis of the R^2 statistic, a measure of the overall predictive strength of a model. We measured change in R^2 with and without age in the full regression model and then calculated percent change that could be attributed to age alone.

Results are presented as means ± standard deviations, medians and interquartile ranges, proportions, and odds ratios