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Morbidity or mortality? Variations in trauma centres in the rescue of older injured patients

Syed Nabeel Zafar [a], Adil A. Shah [b,c], Cheryl K. Zogg [b], Zain G. Hashmi [d], Wendy R. Greene [a], Elliott R. Haut [e], Edward E. Cornwell III [a], Adil H. Haider [b,*]

[a] Department of Surgery, Howard University Hospital, Washington, DC, USA
[b] Center for Surgery and Public Health, Harvard Medical School and Harvard T.H. Chan School of Public Health, Department of Surgery, Brigham & Women's Hospital, Boston, MA, USA
[c] Division of General Surgery, Mayo Clinic, Scottsdale, AZ, USA
[d] Department of Surgery, Sinai Hospital, Baltimore, MD, USA
[e] Department of Surgery, Johns Hopkins University School of Medicine, Baltimore, MD, USA

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ABSTRACT

Introduction: Prior analysis demonstrates improved survival for older trauma patients (age > 64 years) treated at trauma centres that manage a higher proportion of geriatric patients. We hypothesised that 'failure to rescue' (death after a complication during an in-hospital stay) may be responsible for part of this variation. The objective of the study was to determine if trauma centre failure to rescue rates are associated with the proportion of older trauma seen.

Methods: We analysed data from high volume level 1 and 2 trauma centres participating in the National Trauma Data Bank, years 2007–2011. Centres were categorised by the proportion of older trauma patients seen. Logistic regression analyses were used to provide risk-adjusted rates for major complications (MC) and, separately, for mortality following a MC. Models were adjusted for patient demographics, comorbid conditions, mechanism and type of injury, presenting vital signs, injury severity, and multiple facility-level covariates. Risk-adjusted rates were plotted against the proportion of older trauma seen and trends determined.

Results: Of the 396,449 older patients at 293 trauma centres that met inclusion criteria, 30,761 (8%) suffered a MC. No difference was found in the risk-adjusted incidence of MC by proportion of older trauma seen. A MC was associated with 34% of all deaths. Of those that suffered a MC, 7413 (24%) died and 76% were successfully rescued. Centres treating higher proportions of older trauma were more successful at rescuing patients after a MC occurred. Patients seen at centres that treat >50% older trauma were 33% (OR = 0.67, 95% CI 0.47–0.96) less likely to die following a MC than in centres treating a low proportion (10%) of older trauma.

Conclusions: Centres more experienced at managing geriatric trauma are more successful at rescuing older patients with serious complications. Processes of care at these centres need to be further examined and used to inform appropriate interventions.

Introduction

Individuals aged 65 years and older represent the fastest growing demographic in the United States, comprising an estimated 14.1% of the national population (44.6 million people) [1]. Within this population, traumatic injuries are a source of considerable concern. The Centers for Disease Control and Prevention (CDC) estimate that in 2012, more than 52,000 older adults (aged ≥ 65 years) died due to traumatic injury-related wounds [2]. An additional 3.99 million (95% CI: 3.41–4.57 million) were treated for non-fatal injuries in the emergency department (ED), of whom more than 865,000 (95% CI: 683,000–1,048,000) were hospitalised [2]. Compared to their younger counterparts, trauma among older patients tends to be particularly devastating.

* Corresponding author at: Brigham & Women's Hospital, 1620 Tremont Street, One Brigham Circle, Suite 4-020, Boston, MA 02120, USA. Tel.: +1 617 525 9280; fax: +1 617 525 7723.
E-mail address: ahhaider@partners.org (A.H. Haider).

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Older patients have longer hospital stays, greater medical expenses, and higher mortality rates [3–5]. For this reason, improving outcomes associated with older trauma is a priority.

A recent study using data from the National Trauma Data Bank (NTDB) reported that older trauma patients matched to patients $<$65 years of age experienced a 4.20 (95% CI: 3.99–4.50) times greater risk-adjusted odds of mortality [6]. The study also found an association between in hospital mortality and the proportion of older trauma seen at trauma centres. Older patients treated at centres that managed a high proportion of older trauma were 34% less likely to die (OR: 0.66, 95% CI: 0.54–0.97) relative to patients presenting at low proportion centres. We hypothesised that this survival benefit may, in part, be due to variations in the incidence of major complications (MCs) and better 'rescue' of patients suffering a MC.

'Failure to rescue' (FTR), defined as death resulting from post-operative complication(s), is a commonly used hospital quality indicator supported by the Agency of Healthcare Research and Quality [7,8]. Prior research comparing hospital performance among patients undergoing complex, high-risk surgical procedures found a strong association between FTR rates and mortality differences [9]. Similarly, for trauma patients, centres with a lower overall mortality were more successful at rescuing patients who suffered a major complication [10]. In Pennsylvania, older patients treated at level 1 or 2 trauma centres were found to experience higher rates of in-hospital mortality, major complications, and FTR if the centre provided an overall lower volume of geriatric trauma care [11].

To build on previous national findings that older patients are less likely to die if they are treated at centres managing a high versus low proportion of older trauma patients [12], the present study sought to determine if this difference can be explained by variations in FTR and/or lower complication rates. Specifically, we aimed to define the variation in the incidence of major complications among older trauma patients treated at level 1 or 2 trauma centres and to determine if centres that treat a higher proportion of older trauma have more success at rescuing older patients relative to centres that treat lower proportions of similarly-aged patients.

Methods

Patient population

Data from the 2007–2011 National Trauma Data Bank (NTDB) were analysed. The NTDB is maintained by the American College of Surgeons Committee on Trauma and is the largest trauma database available in the United States [13]. It contains clinical, injury-related, and outcome information from over 5 million patients. Information is contributed voluntarily from more than 900 trauma centres across the United States. Patients included in the NTDB include all patients admitted to a participating hospital with an International Classification of Disease, 9th edition, Clinical Modification (ICD-9-CM) discharge diagnosis code of 800.00–959.9 excluding, 905–909 (late effects of injury), 910–924 (blisters, contusions, abrasions, insect bites), and 930–939 (foreign bodies). Patients who die in the ED or are declared 'dead on arrival' (DOA) are also included.

For the purposes of this study, information was selected from all level 1 and level 2 trauma centres with an annual volume of at least 500 admissions per year. Differences in trauma outcomes among geriatric patients have been shown to be affected by volume [11]. By choosing a cutoff of 500 trauma admissions per year, the study limited biases introduced by trauma centre performance alone. Data from centres that did not report comorbid conditions or complications and those that excluded patients based on isolated hip injuries in their registry were also excluded. From remaining trauma centres, the study selected patients aged $\geq$65 years with a length of hospital stay $>$1 day. Patients who were DOA, who were transferred out to another acute care facility, or who had missing outcome information were excluded.

Outcome information

The study considered two primary outcome measures: occurrence of MC and FTR. MCs included: systemic sepsis, pneumonia, pulmonary embolism (PE), acute respiratory distress syndrome (ARDS), acute renal failure (ARF), cerebrovascular accident (CVA), cardiac arrest, and/or myocardial infarction. This list of complications has previously been shown to have the highest attributable mortality among trauma patients [14] and has previously been used to study FTR in trauma patients [10]. FTR was defined as in-hospital mortality after suffering at least one MC. Many included trauma patients did not undergo operative intervention. Outcomes of MC and FTR were considered in this study, regardless of operative receipt.

Statistical methods

Level 1 and 2 trauma centres were categorised by the proportion of older trauma patients seen – calculated as the number of admissions for patients aged $\geq$65 years divided by the total number of trauma admissions at a given centre. Centres were categorised into 1 of 8 geriatric proportion categories: $<$10%, 10–20%, 20–25%, 25–30%, 30–35%, 35–40%, 40–50%, and $>$50% older patients. For each category, mean risk-adjusted rates of MC and FTR were calculated. Mean rates of MC were calculated by dividing the observed incidence of MC in each category by the 'expected rate' of MC and then multiplying this ratio by the overall incidence of MC. Similarly, for risk-adjusted FTR rates, the observed mortality among patients suffering a MC in each category was divided by the expected mortality for that category and multiplied by the mean mortality proportion among all patients suffering a MC.

Expected estimates of MC and mortality after suffering a MC were computed based on two separate multivariable logistic regression analyses. The first included a binary outcome variable for the occurrence of a MC (yes/no), indicating the presence of at least one of the above mentioned MCs. The second, for FTR, was a subset restricted to only consider patients who had suffered at least one MC. It also included a binary outcome variable indicating mortality (yes/no) (mortality after suffering at least one MC). Models were adjusted for potential confounding from patient demographic information (age, sex, race, insurance status, year of admission, and number of comorbid conditions); injury-related information (mechanism of injury, injury severity score (ISS), presenting systolic blood pressure (SBP), presenting heart rate (pulse), presenting Glasgow comma scale (GCS), and need for ventilator support); and facility-level information (trauma centre level designation, hospital type, teaching status, bed size, region, and number of trauma surgeons). Each variable was included as a categorical variable. The models included variables previously shown to demonstrate the best risk adjustment when estimating mortality outcomes from the NTDB [15] and accounted for clustering within facilities using robust (Huber–White) standard errors.

Multiple imputation techniques were used to address missing information within the study population [16–18]. The approach utilises regression modelling to fill in missing information based on information provided for other variables relative to similar patterns observed among non-missing information [16–18]. Prior to multiple imputation, variables missing $<$10% of information were tested for significant associations ($p < 0.10$) between missing values (based on generated indicator variables) and mortality using χ^2 tests in order to ascertain whether an assumption of missing at random (MAR) could be reasonably assumed. Visualisation of