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Age and preexisting conditions as risk factors for severe adverse events and failure to rescue after injury

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ABSTRACT

Background: Failure to rescue (FTR: the conditional probability of death after complication) has been studied in trauma cohorts, but the impact of age and preexisting conditions (PECs) on risk of FTR is not well known. We assessed the relationship between age and PECs on the risk of experiencing serious adverse events (SAEs) subsequent FTR in trauma patients with the hypothesis that increased comorbidity burden and age would be associated with increased FTR.

Materials and methods: We performed a retrospective cohort analysis at an urban level 1 trauma center in Pennsylvania. All patients aged ≥16 y with minimum Abbreviated Injury Scale score ≥2 from 2009 to 2013 were included. Univariate logistic regression models for SAE and FTR were developed using age, PECs, demographics, and injury physiology. Variables found to be associated with the end point of interest ($P \leq 0.2$) in univariate analysis were included in separate multivariable logistic regression models for each outcome.

Results: SAE occurred in 1136 of 7533 (15.1 %) patients meeting inclusion criteria (median age 42 [interquartile range 26-59], 53% African-American, 72% male, 79% blunt, median ISS 10 [interquartile range 5-17]). Of those who experienced an SAE, 129 of 1136 patients subsequently died (FTR = 11.4%). Development of SAE and FTR was associated with age ≥ 70 y (odds ratio 1.58-1.78, 95% confidence interval 1.13-2.82). Renal disease was the only preexisting condition associated with both SAE and FTR.

Conclusions: Trauma patients with renal disease are mostly at increased risk for both SAE and FTR, but other PECs associated with SAE are not necessarily those associated with FTR. Future interventions designed to reduce FTR events should target this high-risk cohort.

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Introduction

Although mortality and complication rates have been used as proxies of quality of care after injury for decades, the failure to rescue (FTR) rate has only relatively recently been examined as an outcome metric in trauma cohorts.[1,2] Developed by Silber *et al.* in 1992,[3] FTR is defined as death after a major complication (hereafter referred to as a serious adverse events [SAEs]) and speaks to how well centers recognize SAE. The FTR rate has several potential advantages over more convention outcome metrics. Although it has been repeatedly shown that center-level SAE rates correlate poorly with center-level mortality rates,[4,5] center-level FTR rates are strongly associated with center-level mortality across a wide variety of elective surgical populations.[6–8] Moreover, relative to risk of SAE, risk of FTR is more strongly associated with potentially modifiable center-level factors such as staffing patterns and infrastructure.[9] As these structural variables are potentially subject to modification, focusing on FTR represents an opportunity to reduce mortality, whereas focusing on SAE alone may not.

Although a promising avenue of inquiry to reduce mortality rates, much of what has been published regarding FTR in the trauma population has either focused on demonstrating that the relationships between center-level SAE, FTR, and mortality rates are similar to what have been demonstrated in elective surgical cohorts[1,2] or on identifying center-level variables (e.g., volume,[10] proportion of minority patients[11]) that are associated with differential rates of FTR. Translating observational knowledge of FTR into improvements in center-level FTR rates is contingent on developing hypotheses surrounding specific interventions and then testing them in a trauma population at high risk for FTR. The literature regarding the characteristics of this at-risk population after injury is currently sparse, but PECs and age are known to be important drivers in other populations.[12,13] Unfortunately, the largest study to date examining the association between PECs and FTR in a trauma population is limited in that in includes patients aged only up to 65 y.[14] One of the main proposed drivers of increased rates of SAE and mortality in the United States is the increased rate of preexisting conditions (PECs) in the elderly.[15] Up to 86% of older Americans are thought to have at least one PEC,[16] and both age[17,18] and PECs[18–21] contribute to risk of major SAE after injury. Older trauma patients have increased rates of SAE and mortality rates as compared with their younger counterparts,[22–25] and by 2020, over one-fifth of the US population will be aged older than 65 y.[26] Given the increased risk of SAE in the elderly population and the increased proportion of injured patients, they will come to represent as the population ages, understanding risk factors for FTR in this population represents a critical gap in our current knowledge.

To that end, the purpose of this study was to identify specific PECs as risk factors for: (1) SAE and (2) death after SAE (also known as FTR) in a large cohort of trauma patients. We hypothesized that the same PECs that conferred risk of SAE would also independently contribute to risk of FTR after these complications. Because PECs are often known at admission, the ultimate goal of this work is to help identify a high-risk subset of trauma patients who might benefit from targeted interventions to reduce death, or FTR, after experiencing SAE.

Materials and methods

Patients

We performed a retrospective cohort study at a single urban level 1 trauma center in Pennsylvania. Patients eligible for inclusion ($n = 7533$) had the following characteristics: seen at the trauma center between January 1, 2009 and December 31, 2013, $\geq$16 y old, and an Abbreviated Injury Scale (AIS) ≥ 2 for at least one body region. We excluded patients with a primary diagnosis of burn (Fig. 1).

Data

The data for this study were obtained from our institutional registry, which is part of the Pennsylvania Trauma Outcomes Study (PTOS), a large trauma registry in the state of Pennsylvania. This database is maintained by the Pennsylvania Trauma Systems Foundation (PTSF), which is responsible for accreditation and quality of trauma centers in Pennsylvania. A total of ~40,000 unique records are submitted to PTOS annually from trauma centers in the state, which are subject to mandatory reporting of data on trauma patients. To ensure the quality of data collection at the center level, specially trained registrars at each trauma center prospectively abstracts detailed data from the medical chart of each patient meeting inclusion criteria into the PTOS registry. These data are collected according to standardized definitions put forth by the PTSF, and a subset of charts is rereviewed to ensure inter-rater reliability by registrars. Centrally, the PTSF assures the quality of the data by submitting it to range, logic, and missingness checks. In addition, subsets of submitted data are reabstracted by the PTSF during site accreditation visits to verify accuracy. As data quality is linked to accreditation, centers are strongly incentivized to accurately report data, and rates of missing data are low (<5% of variables based on previous work[27]).

Variables

Exposures of interest included gender, age, race, Injury Severity Score (ISS), maximum abbreviated injury score (max AIS), Glasgow Coma Score (GCS), admission vital signs, and 26 PECs. We defined PECs according to PTOS definitions (Appendix 12: Pre-existing Conditions, available online at http://www.ptsf.org/upload/2015_PTOS_Manual_FINAL_Updated_4-3-2015.doc).[28] To be included as a PEC in the PTOS, conditions must be present before patient arrival at the emergency department/hospital, and ascertainment is based on documentation in the medical record. Data at our center are abstracted prospectively by trained registrars according to standardized definitions for submission to the PTOS, and questions arising as to the presence or nature of PECs are resolved through queries to clinical providers. To avoid