Predicting In-Hospital and 1-Year Mortality in Geriatric Trauma Patients Using Geriatric Trauma Outcome Score

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BACKGROUND: The Geriatric Trauma Outcome Score (GTOS; [age] + [2.5 × Injury Severity Score] + 22 [if packed RBC transfused within ≤24 hours of admission]), was developed and validated as a prognostic indicator for in-hospital mortality in elderly trauma patients. However, GTOS neither provides information about post-discharge outcomes nor discriminates between patients dying with and without care restrictions. Isolating the latter, GTOS prediction performance was examined during admission and 1-year post discharge in a mature European trauma registry.

STUDY DESIGN: All trauma admissions 65 years of age and older in a university hospital during 2007 to 2011 were considered. Data on age, Injury Severity Score, packed RBC transfusion within ≤24 hours, therapy restrictions, discharge disposition, and mortality were collected. In-hospital deaths with therapy restrictions and patients discharged to hospice were excluded. The GTOS was the sole predictor in a logistic regression model estimating mortality probabilities. Performance of the model was assessed by misclassification rate, Brier score, Tjur R^2, and area under the curve.

RESULTS: The study population was 1,080 patients with a median age of 75 years, mean Injury Severity Score of 10, and packed RBCs transfused in 8.2%. In-hospital mortality was 14.9% and 7.7% after exclusions. Misclassification rate fell from 14% to 6.5% and Brier score from 0.09 to 0.05, and area under the curve increased from 0.87 to 0.88. Equivalent values for the original GTOS sample were 9.8%, 0.07, and 0.82, respectively. One-year mortality follow-up showed a misclassification rate of 17.6% and Brier score of 0.13.

CONCLUSIONS: Excluding patients with care restrictions and discharged to hospice improved GTOS performance for in-hospital mortality prediction. The GTOS is not adept at predicting 1-year mortality. (J Am Coll Surg 2017;224:264−269. © 2016 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

During the last few decades, life expectancy in developed countries has increased considerably, and trauma has risen in the list of leading causes of death in the elderly population.[1] Old age is considered to be one of the most important factors in predicting the risk of fatal outcomes after traumatic injuries.[2] It has also been demonstrated that the risk of death increases at the age of 56 years and does so independently from the Injury Severity Score (ISS). Geriatric patients have a higher risk of mortality for a longer period of time after a traumatic event in comparison with younger patients with an equivalent injury burden.[3,4] This phenomenon is, to a large extent, explained by pre-existing comorbidities, degeneration of physiologic reserves, and an increased state of general frailty.[5-7]

Advances in prehospital care and trauma services have led to re-evaluation of the historic golden hour and the trimodal distribution of trauma deaths. The traditional late peak in in-hospital deaths is reducing across all age groups.[8-10] The severely injured geriatric trauma patient generally requires intensive investigations, monitoring, and treatment to optimize overall outcomes and

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Abbreviations and Acronyms

GTOS = Geriatric Trauma Outcome Score
ISS = Injury Severity Score
AUC = area under curve

subsequent functional recovery. Additionally, this care must be provided in the context of care systems that possess limited resources. With these factors in mind, it is the responsibility of the physician to make decisions about care provision as well as whether it is appropriate to discuss with the patient or their surrogates possible consideration of placing any limitations on the aggressiveness of the treatment plan. Due to the inevitable subjectivity and value judgments that enter into the process of making such decisions with patients or their surrogates, this process can be a dilemma for all of the stakeholders. Although these decisions are complex and multifactorial, they tend to be rooted in the projected prognosis of the patient.

Historically, the process of goal setting and potentially transitioning to comfort care in the geriatric trauma population has been based on the individual experience of the treating physician. Recently, investigations have been undertaken to better predict mortality in the geriatric trauma population to provide clinicians with an evidence-based tool to accurately assess prognosis.[11] With the purpose of predicting in-hospital mortality in patients older than 65 years, Zhao and colleagues[12] at Parkland Memorial Hospital developed an objective tool based on the covariates of age, ISS, and transfusion requirements during the first 24 hours of care. The formula, named The Geriatric Trauma Outcome Score (GTOS), is [age] + [2.5 × ISS] + 22 [if packed RBCs transfused within ≤24 hours of admission] and it has recently been validated by the PALLIATE (Prognostic Assessment of Life and Limitations After Trauma in the Elderly) consortium.[13] The GTOS has been shown to accurately predict in-hospital mortality for trauma admissions aged 65 years or older, and is calculable at 24 hours after injury to assist with early goal-setting conversations after injury in the elderly.

It bears mentioning that the analyses creating and validating GTOS considered all-cause mortality, and made no consideration as to whether care was withdrawn in potentially salvageable cases. Limitations included restricting its outcomes to in-hospital mortality only with no provision made for post-discharge outcomes or destinations. These confounding factors are of great importance and might impact the performance of the GTOS model. This study sought to assess the performance of the GTOS formula after accounting for these confounders using the registry of a mature European trauma system.

METHODS

Patient data

Ethical approval was obtained from the Regional Review Board (Uppsala County) and the IRB at Karolinska University Hospital in Stockholm in Sweden. Patients aged 65 years or older were recruited from the trauma registry at Karolinska University Hospital between January 1, 2007 and December 31, 2011. Patient demographics and outcomes, including age, sex, mechanism of trauma, number of ICU days, total length of hospital stay, ISS, blood transfusion requirements during the first 24 hours, and mortality both in-hospital and at 1-year post discharge were obtained from the trauma registry. Patient electronic medical records were then reviewed retrospectively to obtain information about withdrawal of care and discharge disposition. A withdrawal of care decision or restrictions in care are documented in a computerized spreadsheet and is readily accessible for every patient. The decision is routinely made in a multidisciplinary group in discussion with the patient and/or their proxy.

Statistical analysis

The original GTOS formula (GTOS = age + [2.5 × ISS] + 22 [if packed RBC transfused]) was used as the predictor model of mortality.[12] The GTOS was the sole predictor in a logistic mixed regression model to estimate mortality probabilities in the studied geriatric patient sample. Performance of the model was assessed using the misclassification (error) rate, Brier score, Tjur R^2 and area under the curve (AUC).[14-16] The misclassification rate is the fraction of observations where the predicted mortality and true mortality differ. The Brier score and Tjur R^2 measure the accuracy of probabilistic predictions and stretch between 0 and 1 (for Brier score 0 = total agreement and 1 = total disagreement and for Tjur R^2 the opposite apply). The AUC is used to test the discriminatory ability for mortality status. The total cohort was analyzed for predicting in-hospital deaths before the exclusion of patients where care was withdrawn or where limitations of care were instated (eg no intensive care) and if discharged from hospital to hospice. After exclusions of patients as described, the cohort was analyzed for predicting both in-hospital and 1-year mortality. The 3 separate analyses were then compared to establish the best goodness of fit to GTOS. Statistical Package for Social Science, version 21 (IBM Corp) was used for analysis. A 2-tailed p value <0.05 was considered statistically significant for all analyses.