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Injuries and outcomes associated with traumatic falls in the elderly population on oral anticoagulant therapy

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ABSTRACT

Introduction: Fall risk for older adults is a multi-factorial public health problem as 90% of geriatric injuries are caused by traumatic falls. The CDC estimated 33% of adults >65 years incurred a fall in 2011, with 30% resulting in moderate injury. While much has been written about overall risk to trauma patients on oral anticoagulant (OAC) therapy, less has been reported on outcomes in the elderly trauma population. We used data from the National Trauma Data Bank (NTDB) to identify the types of injury and complications incurred, length of stay, and mortality associated with OACs in elderly patients sustaining a fall.

Methods: Using standard NTDB practices, data were collected on elderly patients (≥65 years) on OACs with diagnosis of fall as the primary mechanism of injury from 2007 to 2010. Univariate analysis was used to determine patient variables influencing risk of fall on OACs. Odds ratios were calculated for types of injury sustained and post-trauma complications. Logistic regression was used to determine mortality associated with type of injury incurred.

Results: Of 118,467 elderly patients sampled, OAC use was observed in 444. Predisposing risk factors for fall on OACs were >1 comorbidity ($p < 0.0001$). Patients on OACs were 188% and 370% more likely to develop 2 and >3 complications ($p < 0.0001$); the most significant being ARDS and ARF ($p < 0.0001$). The mortality rate on OACs was 16%. Injuries to the GI tract, liver, spleen, and kidney ($p < 0.0002$) were more likely to occur. However, if patients suffered a mortality, the most significant injuries were skull fractures and intracranial haemorrhage ($p < 0.0001$).

Conclusions: Risks of anticoagulation in elderly trauma patients are complex. While OAC use is a predictor of 30-day mortality after fall, the injuries sustained are markedly different between the elderly who die and those who do not. As a result there is a greater need for healthcare providers to identify preventable and non-preventable risks factors indicative of falls in the anti-coagulated elderly patient.

Introduction

Falls are a major cause of morbidity and mortality in elderly trauma patients in the U.S. The Centers for Disease Control and Prevention estimate one in three adults ≥65 years experienced a fall in 2011, and 20% to 30% of those who fell sustained a moderate to severe injury. Ninety percent of all geriatric injuries are caused by traumatic falls, making this an important public health problem [1]. Additionally, there is a 50% mortality for those hospitalised due to severe injuries resulting from their fall that are greater than 65 years of age. Major sources of morbidity and mortality include intracranial haemorrhage (ICH), skeletal fractures, and thoracic or intra-abdominal visceral injury. Increased mortality after ICH has previously been shown in elderly patients on oral anticoagulation [1].

ICH, especially in elderly patients on oral anticoagulant (OAC) therapy, has been identified as an independent predictor of 30-day mortality after fall [1]. In one prospective cohort of patients sustaining an ICH while receiving warfarin, mortality was 52%, compared to 25.8% in those not taking warfarin [2]. In a review of elderly trauma patients with CT-documented ICH, those on OACs had a lower GCS on presentation and a higher 30-day mortality, which increased in a linear fashion as INR increased [3–5]. Elderly patients on antiplatelet agents, including aspirin or clopidogrel, have also been shown to have an increase in all-cause mortality [6,7].

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While much as been written about the overall mortality of elderly trauma patients on OACs, less has been reported on injuries and outcomes in the elderly trauma population. The objective of this study was to use data from the National Trauma Data Bank (NTDB) to identify the relative risks for types of injuries sustained and post-trauma complications incurred, length of stay (LOS), and mortality associated with OAC use in elderly patients with fall as their primary mechanism of injury.

Methods

Data

Data for this study were from the NTDB. The NTDB was created in 1989 by a collaborative group from the American College of Surgeons (ACS) Committee on Trauma, and related medical and governmental organisations to provide a better understanding of trauma care systems in the United States. As the largest aggregation of trauma registry data, the NTDB contains greater than 2.5 million records from more than 900 trauma centres in the U.S. and Puerto Rico. To collect and maintain trauma injury data, the NTDB recognises all ACS-verified trauma centres and accepts data from each participating hospital [8]. In 2008, NTDB adopted the National Trauma Data Standard (NTDS) as the basis for data collection. NTDS is a standardised definition of trauma injury information submitted to NTDB by participating hospitals [9].

Our analysis was limited to elderly trauma patients $\geq$65 years with a diagnosis of fall as the primary mechanism of injury between 2007 and 2010. Data from the NTDB registry included demographics (age, sex, race/ethnicity, co-morbidities), injury severity scores, abbreviated injury scores, hospital characteristics (profit/teaching status) and trauma level, types of injuries, complications, LOS, and mortality. The initial data set included 2431,286 trauma patients between 2007 and 2010. Patients with age <65 years, including those patients with an unknown age were excluded. This yielded 469,507 patients age $\geq$65 years with an inpatient admission greater than 24 h. Patients with a primary mechanism of injury other than fall were dropped from the analysis as well as 1095 patients whose sex was not identified. This yielded a final data set of 118,467 patients.

Definitions

Primary mechanism of injury of fall was identified using International Classification of Diseases 9th Version (ICD9), External Cause of Injury Codes for unintentional falls or falls from standing height (880.0, 880.1, 880.9, 987, 987.0, 987.1, 987.2, 987.9) and for falls of undetermined cause (886.9, 888.0, 888.1, 888.8, 888.9).

OAC use was identified using ICD9 Clinical Modification (ICD9-CM) codes for warfarin (858.2, 863.7, 934.2, 950.4, 950.6, 962.0, 962.1, 980.4, 980.7), aspirin (58.61, 58.66), long-term use of antiplatelets and antithrombotics (58.62, 58.69), and encounter for therapeutic anticoagulant drug monitoring (58.63).

Traumatic injuries were defined using ICD9-CM codes for skull fractures (800, 801, 803), vertebral column fractures (805, 806), rib fractures (807), pelvic fractures (808), upper extremity fractures (810–813), lower extremity fractures (820–823), ICH (852–854), cardiac/pulmonary injuries (860, 861), gastrointestinal injury (stomach, duodenum, small intestine, large intestine and pancreas; 863), liver injury (864), splenic injury (865), and renal injury (866).

Statistical analysis

The statistical analysis was designed to identify patient characteristics for fall in the elderly trauma population on OACs, the likelihood of traumatic injuries sustained and post–trauma complications incurred, identify LOS, and mortality associated with fall after controlling for other potentially confounding variables (OAC use and injuries). Patient characteristics were compared between those receiving and not receiving OACs using Student's *t*-test for continuous variables, and chi-square test for binary and categorical variables. In cases where categorical variables contained fewer than ten observations a two-tailed Fisher's exact test was used instead of chi-square analysis. Odds ratios were calculated to identify types of injury sustained and complication incurred in those taking OACs compared to patients not taking OACs. Logistic regression was used to predict mortality for all patients with primary mechanism of injury as fall while controlling for potentially confounding variables. The dependent or explanatory variable in the model was mortality and the independent or predictor variables were OAC use and injuries incurred. Descriptive statistics were used to calculate total LOS, ICU LOS, and number of ventilator days for patients taking OACs. Additionally a subgroup analysis was performed on the OAC group to identify the odds ratios for types of injury sustained stratified by the addition of aspirin or antiplatelet agents to warfarin, or warfarin use only. Statistical significance among anticoagulation groups for each injury was determined by chi-square analysis. The Hosmer–Lemeshow goodness of fit statistic and the area under the receiver operator curve were calculated as measures of calibration and discrimination for the models where appropriate.

In logistic regression models, if the sample size is small or if a predictor is strongly associated with one of the possible outcomes, the estimated coefficients may be biased. A similar problem occurs in contingency tables when the sample size is small or when too many cells in the table have low counts. This concept is known as separation. To address the separation problem "exact tests" can be used; however, in logistic regression exact methods are only practical in simple cases with just one predictor. An alternative approach is to use Firth's bias-adjusted estimate. Firth's method is computationally efficient and maximises a penalised likelihood function, as well as guarantees that the parameter estimates will be finite [10]. Given that the OAC group had several outcomes with few observations and complete separation of data (outcomes with zero observations) the above method of penalised-likelihood logistic regression was used to calculate the odds ratios and confidence intervals. It is important to note that with penalised regression, estimates are weighted towards the large sample size in the no OAC group. However, this feature allows for the calculation of odds ratio estimates with a count of zero. All statistical analyses were performed using STATA software (version 11, StataCorp, College Station, TX). Statistical significance was defined as p value <0.05.

Results

Demographics and hospital characteristics

Patient characteristics stratified by OAC use (Table 1) show these groups were similar in demographic characteristics such as age ($p = 0.05$), and sex ($p = 0.22$). There were, however, some significant differences between the groups, suggesting risk factors for the need for OAC use. Seven percent of the OAC group were black vs 4.7% of the control group. Several co-morbidity variables such as congestive heart failure ($p < 0.0001$), current smoker ($p < 0.0001$). History of cerebrovascular accident ($p < 0.0001$), angina ($p = 0.04$), MI ($p < 0.0001$), and hypertension ($p < 0.0001$) were also significant between the groups. Interestingly, patients not on OACs had a higher injury severity score (>16) and a lower Glasgow coma score ($\leq$7) at presentation. Patients taking OACs reported to Level 1, university hospitals ($p < 0.0001$). Patients not