

# A FRAGILE BODY AND AN INJURED BRAIN: THE EFFECT OF FRAILTY ON OUTCOMES IN OLDER ADULTS WITH TRAUMATIC BRAIN INJURY

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**Introduction:** The aim of this study is to assess the effect of frailty on admission and 3-month post-discharge outcomes in older adults (OAs) with isolated traumatic brain injury (TBI).

**Methods:** This is a secondary analysis of the prospective observational AAST frailty multi-institutional trial conducted across 17 trauma centers (2019-2022). OAs (> 65 years) with isolated TBI (head AIS<sup>3</sup>2 and other-body region AIS ≤2) were included. Frailty was measured using the TSFI. Outcomes included in-hospital mortality and major complications, unfavorable discharge disposition (hospice/SNF), and 3-month post-discharge readmissions. Multivariable regression analyses were performed to identify the independent effect of frailty on outcomes.

**Results:** Of the 249 patients identified, 132 (53%) were non-frail and 117 (47%) were frail. Mean age was 78±9, 56% were male, 69% presented after a fall, median head AIS was 3 [2-3], and 66% presented with a mild (GCS≥13) TBI. Frail patients experienced an increased in-hospital mortality (OR 2.8, p=0.04) and major complications (OR 3.4, p<0.001), unfavorable discharge disposition (OR 2.1, p=0.02), readmission (OR 2.3, p=0.047) and post readmission major complications (OR 9.8 p=0.004). Similar trends were seen on subgroup analysis stratified by TBI severity. (**Table**)

**Conclusion:** Frailty in OAs with TBI significantly impacts outcomes, emphasizing the need for early screening of OAs with TBI to facilitate goals of care discussions and treatment plans in this vulnerable population.

Table - Independent Effect of Frailty on the Outcomes Stratified By Head Injury Severity (n=249)

Outcome Measures	Mild TBI			Moderate TBI			Severe TBI		
	aOR	95% CI	p-value	aOR	95% CI	P-value	aOR	95% CI	P-value
<b>Index Admission</b>									
Mortality	4.84	1.47-15.94	<b>0.010</b>	1.42	0.53-3.30	0.409	1.65	0.12-3.45	0.619
Major Complications	4.03	1.62-10.01	<b>0.003</b>	8.00	1.93-18.62	<b>0.048</b>	1.69	0.15-3.13	0.635
Discharge to Home	0.44	0.22-0.88	<b>0.021</b>	0.74	0.18-0.83	<b>0.016</b>	0.27	0.03-0.96	<b>0.042</b>
Unfavorable Disch. Disp.	2.72	1.09-6.82	<b>0.032</b>	1.87	1.35-4.05	<b>0.037</b>	2.80	1.71-11.09	<b>0.033</b>
<b>3-months Post-discharge</b>									
Readmissions	2.64	1.50-4.56	<b>0.046</b>	.*	-	-	-	-	-
Major Complications	5.42	2.75-17.13	<b>0.027</b>	2.01	1.03-3.45	<b>0.011</b>	-	-	-

aOR=adjusted odds ratio; CI=confidence interval; Unfavorable Disch. Disp.=discharge disposition to skilled nurse facility or Rehabilitation center or hospice  
 \* Multivariable regression analysis was not performed due to the small number of cases in these outcomes.

**AGE MATTERS: ADMISSION ENDOTHELIAL DIFFERENCES ARE ASSOCIATED WITH WORSE OUTCOMES IN OLDER ADULT PATIENTS AN ANALYSIS OF THE TXA IN TBI PREHOSPITAL CLINICAL TRIAL**

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**Introduction:** Injured older adults represent 25% of trauma admissions, with increased morbidity and mortality compared to younger adults. Factors contributing to their poor outcomes are not fully characterized. Endothelial dysfunction has been associated with poor outcomes in trauma patients. We aimed to characterize post-traumatic endothelial changes in older versus younger adult trauma patients and compare outcomes.

**Methods:** We performed a secondary analysis of the “Prehospital Tranexamic Acid (TXA) for TBI” trial. We studied patients with admission endothelial biomarkers: ICAM1, angiotensin-1, thrombomodulin, VCAM1, angiotensin-2, syndecan-1, thrombospondin. To avoid using an arbitrary age cut off, we divided patients into age quartiles and defined the upper quartile as the oldest age quartile (OA) and compared it to the three youngest quartiles (YA). In-hospital, discharge, and mortality outcomes were compared. Significance was set at  $p < 0.05$ .

**Results:** 436 patients met our criteria. Mean OA age was 66 years (54-88 years,  $n=327$ ), similar to the ACS older patient guidelines of  $>55$  years. YA mean age was 30 years (15-54 years,  $n=107$ ). No difference was observed between the OA and YA in rates of penetrating trauma (3.4% vs 1.8%,  $p=0.626$ ), head AIS score (mean 3 vs 3,  $p=0.582$ ), or ISS (mean 19 vs 21,  $p=0.265$ ). TXA dosing was not different between cohorts ( $p=0.571$ ). OA was associated with higher thrombomodulin (median 693.3 vs 593.4 pg/mL,  $p<0.001$ ), VCAM1 (median 71035.6 vs 59708.3 pg/mL,  $p<0.001$ ) and angiotensin-2 (164.9 vs 134.7 pg/mL,  $p=0.007$ ). No differences in Syndecan-1 was observed (median 291.1 vs 247.7 pg/mL,  $p=0.267$ ). OA patients had fewer hospital free days (median 8 vs 18,  $p<0.0001$ ), ICU free days (median 20 vs 24,  $p=0.002$ ), and ventilator free days (median 24 vs 26,  $p=0.005$ ), lower Glasgow Outcome Scale Extended scores at discharge (mean 3.5 vs 4.2,  $p<0.001$ ), lower Glasgow Outcome Scale Extended scores at discharge (mean 3.5 vs 4.2,  $p<0.001$ ), and higher 28-day mortality (20.5% vs 9.8%,  $p=0.011$ ).

**Conclusion:** Despite similar injury patterns, OA patients presented with higher admission endothelial plasma biomarkers and had worse outcomes. This warrants further investigation into the association between endothelial dysfunction post-traumatic outcomes.

## FALL-RELATED REINJURY: IDENTIFYING INJURY PATTERNS ASSOCIATED WITH GERIATRIC FALL RECIDIVISM

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**Introduction:** Falls represent a major source of morbidity and mortality for geriatric patients. This is especially true for patients who suffer repeated falls, as they often experience more severe injuries and greater disability. This study sought to identify injury patterns most associated with repeat fall admission using a nationally representative database.

**Methods:** Using the 2019 National Readmissions Database, patients  $\geq 65$  years admitted with fall-related injuries were identified. Patients that died during the index fall admission, out-of-state residents, and those with less than 90 days of follow-up were excluded. Patients were classified by their injury pattern into the following mutually exclusive cohorts: traumatic brain injury, spine fracture, thoracic fracture, pelvic fracture, upper extremity fracture, lower extremity fracture, femoral neck fracture, superficial injuries, or multi-region injuries. Mortality risk for the index admission was assessed using the Trauma Mortality Prediction Model for ICD-10. Using survey-weighted estimates, descriptive statistics and logistic regression were used to compare outcomes by injury type, with a primary outcome of repeat fall-related admission within 90 days.

**Results:** A total of 236,903 patients met criteria, correlating to a survey-weighted population of 410,107 individuals. The most common injury patterns were femoral neck fractures (38%), multi-region injuries (15%), and traumatic brain injury (12%). Overall, 3% of patients were readmitted within 90 days for repeat fall-related injuries. In addition, 19% were readmitted within 90 days for any non-elective cause, and 2% died within 90 days of discharge. After adjusting for patient age, gender, number of comorbidities, mortality risk, non-home discharge after fall, and occurrence of a major operative procedure, traumatic brain injury was significantly associated with greater risk of repeat fall-related readmission than all other patient injury cohorts, including 72% greater odds than patients with femoral neck fractures (OR 1.72, 95% CI 1.54-1.92,  $p < 0.001$ ).

**Conclusions:** Geriatric patients with traumatic brain injury after fall are at increased risk of readmission for fall-related injuries within 90 days. Increased screening and preventative interventions within this population are warranted to target patients at greatest risk and reduce rates of potentially preventable reinjury.

## FRATILITY ASSESSMENT FOR PREDICTING ADVERSE OUTCOMES IN HIP FRACTURE PATIENTS: A COMPARATIVE ANALYSIS USING THE UNITED STATES NATIONAL INPATIENT SAMPLE

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**Introduction:** With the annual number of hip fractures increasing globally, it is important to be able to determine which patients suffer from a disproportionate risk of further deterioration. The aim of the current investigation was to compare the ability of several frailty scores to predict morbidity and mortality in hip fracture patients.

**Methods:** All adult patients (18 years or older) who suffered a hip fracture due to a fall and underwent surgical fixation were extracted from the 2019 National Inpatient Sample (NIS) Database. A combination of logistic regression and bootstrapping was used to compare the predictive ability of several frailty scores for adverse outcomes. These scores included the Orthopedic Frailty Score (OFS), the Nottingham Hip Fracture Score (NHFS), the 11-factor (11-mFI) and 5-factor (5-mFI) modified frailty index, as well as the Johns Hopkins Frailty Indicator.

**Results:** 227,850 patients were extracted from the NIS. In the prediction of both in-hospital mortality and FTR, the OFS surpassed all other frailty measures, approaching an acceptable predictive ability for mortality [AUC (95% CI): 0.69 (0.67-0.72)] and achieving an acceptable predictive ability for FTR [AUC (95% CI): 0.70 (0.67-0.72)]. All scores struggled to predict complications; however, the NHFS demonstrated the highest predictive ability [AUC (95% CI): 0.62 (0.62-0.63)]. On the other hand, the 11-mFI demonstrated the highest predictive ability for cardiovascular complications [AUC (95% CI): 0.66 (0.64-0.67)] and the NHFS achieved the highest predictive ability for delirium [AUC (95% CI): 0.69 (0.68-0.70)]. No score succeeded in effectively predicting venous thromboembolism or infections.

**Conclusion:** The OFS surpassed all other frailty scores when predicting mortality and failure-to-rescue, while the NHFS and 11-mFI demonstrated the best ability to predict delirium and cardiovascular complications, respectively.

## GETTING WITH THE GUIDELINES: GERIATRIC TRAUMA ACTIVATION

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**Introduction:** The ACS Committee on Trauma recently revised geriatric trauma activation criteria. Accordingly at our facility, the partial or full trauma team is activated for geriatric patients with SBP <110, HR>120, fall on anticoagulant/antiplatelets, any long bone fracture, or GCS<13. We evaluated the effects of the revised criteria.

**Methods:** A retrospective review of the trauma registry at a level 1 trauma center for all patients age >65 years presenting to the ED who were hospitalized with blunt traumatic injury during the 11 months before (2022) and after (2023) institution of the revised trauma team activation criteria.

**Results:** Geriatric Trauma Team Activations

	2022	2023	P value
Partial & Full activations (n)	190	532	<0.001
Mechanism of Injury: Fall	71.6%	85.2%	0.01
Anticoagulant/antiplatelets (%)	41.1%	68.1%	<0.001
Injury Severity Score	10 (5, 17.7)	9 (4,10)	<0.001
Head/neck AIS>3 (%)	30%	22%	<0.001
Hospital LOS (days)	8 (3.2, 13.7)	5 (2,9)	<0.01
ICU admission (%)	56%	37%	<0.001
Complications (%)	21%	32%	0.003
In-hospital mortality (%)	12%	5.6%	0.003

**Conclusions:** Trauma team activation reduced ( $p<0.001$ ) the time to CT vs non-activations (2022: 48 (41,61) vs 217 (145, 303) min,  $p<0.001$  and 2023: 46 (38,55) vs 186 (130, 251) min,  $p<0.001$ ). The volume of trauma activations increased by 2.5-fold (190/1136 vs 532/1286 geriatric admissions) following the revised guidelines. Post guideline implementation patients were more often on anticoagulants/antiplatelets but were less severely injured including less often severe head injury. They had less ICU admissions, shorter hospital length of stay, and lower mortality. Given the intensive resources required for trauma activation in less severely injured patients, further study is indicated for optimal activation criteria.

## IDENTIFYING OLDER ADULTS AT RISK FOR FUTURE FALLS VIA PHYSICAL & OCCUPATIONAL THERAPY ASSESSMENTS

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**Introduction:** Unintentional falls are the leading cause of non-fatal injuries for admitted adults  $\geq 65$  years, and many of these encounters are for recurrent events. This project examined predictors of subsequent fall admissions based on physical and occupational therapy assessments, treatments, and recommendations during an index admission.

**Methods:** This retrospective matched case-control study examined patients  $\geq 65$  years admitted to our trauma center for a fall in 2015-2019. Cases were those with a second fall admission within one year of discharge. Controls did not admit for a second fall within one year. Patients were identified via the trauma registry and matched 1:1 on age, sex, race, ethnicity, fall height, initial Glasgow Coma Scale - motor, anatomic injury grade in each body region, insurance type, and admission year. Predictors of subsequent admissions were screened with cross-validated LASSO regression and tested in a paired Cox hazards model. Alpha was set at 0.05.

**Results:** 208 total patients were included. Median [Q1, Q3] age at index was 84 [77, 88] years, 69% were female. Injury Severity Scores were 9 [5, 10] at index and second admission. The model revealed increased fall hazard from requiring minimal or moderate assistance with bathing at discharge (HR = 2.27, 95% CI = 1.11 - 4.64), requiring minimal assistance walking at discharge (HR = 4.97, 95% CI = 1.05 - 23.56), using a rolling walker prior to index injury (HR = 1.70, 95% CI = 1.05 - 2.75), and physical therapy recommending discharge to a skilled nursing facility (HR = 1.92, 95% CI = 1.32 - 2.81). In contrast, there was reduced fall hazard from being referred to outpatient occupational therapy (HR = 0.42, 95% CI = 0.24 - 0.76) and having no deficit in toileting-related activities of daily living at discharge (HR = 0.60, 95% CI = 0.38 - 0.93).

**Conclusion:** This study of older adults suggests using a rolling walker prior to injury or needing even minimal assistance with walking, bathing, or toileting at discharge may increase the risk of serious falls within one year. Further work is needed to clarify which additional referrals or services would help mitigate the risk of future falls in this population.

## **RIB FRACTURE INJURY GUIDELINES FOR PATIENTS OVER AGE 65: SHOULD THESE PATIENTS ROUTINELY BE ADMITTED TO THE ICU?**

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**Introduction:** Elderly patients with rib fractures have a high incidence of complications including pneumonia, extended intensive care unit (ICU) stay, and mortality. To date, there are small studies assessing proper admission triage of elderly patients with rib fractures. 2022 EAST guidelines state there is insufficient data to recommend ICU versus non-ICU admission for patients over age 65 with greater than three rib fractures and 2016 WEST guidelines recommend ICU admission for patients over age 65 with two rib fractures. At our institution, we routinely admit patients over age 65 with three or more rib fractures to the ICU for at least 24 hours to achieve adequate pain control and maximize pulmonary hygiene; however, this may lead to an overutilization of scarce resources. The goal of this study is to determine which factors are associated with worse outcomes to create a new admission triage algorithm for elderly patients with rib fractures.

**Methods:** Patients aged 65 or older with three or more rib fractures were identified between 2016 and 2023 using our institutional trauma database. Patient demographics, comorbidities, and injury characteristics were collected. The primary outcome was predictors of a composite negative outcome (mortality, pneumonia, and readmission to ICU).

**Results:** 495 patients were included in the analysis with 340 patients admitted to the ICU and 155 patients admitted to the floor. ICU patients were more likely to be older, frail, and have  $\geq 5$  rib fractures (all  $p < 0.05$ ). Less than 1% of patients initially admitted to the floor had an unplanned ICU admission and 25% of patients who ultimately died were readmitted to the ICU from the floor. Multivariable analysis demonstrated that frailty (OR:11.82,  $p < 0.001$ ),  $\geq 5$  rib fractures (OR:2.64,  $p = 0.04$ ), chest tube placement (OR:3.31,  $p = 0.04$ ), and regional nerve block (OR:4.66,  $p = 0.001$ ) were all associated with worse outcomes.

**Conclusions:** Patients with blunt thoracic trauma who are 65 or older, frail, and have  $\geq 5$  rib fractures may benefit from ICU admission. Future studies will assess the safety of this new proposed admission triage algorithm.

## TRAUMA ACTIVATION FOR GERIATRIC FALLS ON BLOOD THINNERS RESULTS IN OVER TRIAGE

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**Introduction:** Unintentional falls account for approximately 70% of all geriatric emergency department visits. Patients on blood thinners who suffer low level falls are at an increased risk for deterioration from intracranial hemorrhage (ICH). Early recognition of ICH is crucial for prevention of a life-threatening event. However, our previous assessment found that implementing a trauma triage criterion for any patient over the age of 65 who had a fall on a blood thinner resulted in significantly over-triage. Further analysis aims to show that the removal of this trauma activation criteria does not significantly impact the mortality of patients due to ICH.

**Methods:** A retrospective case-controlled study was conducted comparing patients over 65 on a blood thinner who fell and had an intracranial hemorrhage with a partial trauma activation (initial criteria) and without an activation (modified criteria). Patients meeting only this criterion were accrued for a period of 6 months prior to the modification (n=20), then for a full year following (n=33). Primary outcome measure was all cause in hospital mortality. Secondary outcomes included the time from initial presentation in the emergency department to receiving a head CT.

**Results:** There was no significant difference in mortality between the patients within the initial criteria (10% mortality) vs the modified criteria (15% mortality) (p=0.59). Time (min) from door to CT was significantly higher for the patients in the modified criteria (median 169 [6.00, 391]) vs the initial criteria (median 39.0 [21.0,88.0]) (p < 0.001).

**Conclusion:** Inclusion of a trauma activation criterion for patients over 65 on a blood thinner who fell results in over triage, and its removal does not increase the risk of mortality. For patients with an intracranial hemorrhage, time to receive a head CT was significantly increased with the removal of the low-level trauma team activation criteria. It is still important to implement systems in the emergency department that recognize patients at risk of mortality from ICH and ensure that they receive a CT scan promptly.



## TRAUMA IN CENTENARIAN: WHAT AFFECTS IN-HOSPITAL MORTALITY AND FUNCTIONAL OUTCOMES?

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**Introduction:** Advances in health care and the development of various technologies have improved disease-free longevity and healthy centenarians are gradually increasing. While independent living can help to maintain quality of life in centenarians, a risk of injury is also expanding due to sustained physical functions. As literature is sparse on post-injury functions in centenarians, we aimed to elucidate clinical predictors for mortality and unfavorable functions after injury among centenarians.

**Methods:** A retrospective observational study was conducted using a nationwide trauma database, including patients aged  $\geq 100$  years who required admission due to injury at  $\geq 250$  institutions in 2019-2022. Patient demographics, comorbidities, mechanism and severity of injury, vital signs on hospital arrival, and pre- and in-hospital treatments were obtained and compared between survivors and non-survivors. Among survivors, patient, injury, and treatment characteristics were also compared between those with and without dependency in daily life at discharge, which was defined as Glasgow Outcome Scale  $\leq 3$  out of 1 to 5 scale. Independent predictors for in-hospital mortality and unfavorable function at discharge were examined using a generalizing estimating equation model to consider institutional and regional differences in management and characteristics of centenarians.

**Results:** Among 409 centenarians in this study, 384 (93.9%) survived to discharge. While 208 patients (50.9%) had lived independently before the injury, only 91 (22.2%) could live independently at discharge. All patients suffered from blunt injury and fall from standing was most frequent (86.6%). Injury Severity Score was  $10 \pm 5$  and surgeries/angiographies were performed in  $< 2\%$  of centenarians, except for fracture fixation in extremity/pelvis which was conducted in 225 patients (55.0%). The adjusted model revealed three independent predictors for in-hospital mortality; male sex, mechanism of injury other than fall from standing; and Glasgow Coma Scale (GCS) on arrival, whereas only injury severity in extremity/pelvis was the independent predictor for dependency in daily life after injury.

**Conclusion:** Male sex, non-fall-from-standing injury, and GCS on arrival were associated with in-hospital mortality. Severe injury in extremity/pelvis was related to dependent living after injury in centenarians.

## TRAUMA OUTCOMES IN PATIENTS WITH A HISTORY OF CEREBROVASCULAR ACCIDENT

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**Introduction:** Traumatic brain injury (TBI) and cerebral vascular accident (CVA); are both leading causes of mortality and morbidity, worldwide. Outcomes in patients who have suffered TBI have been studied extensively, however, outcomes in TBI patients who have a history of CVA (HxCVA) are not well defined. Here we aimed to seek the differences in outcomes between TBI patients with and without a history of CVA (HwoCVA).

**Methods:** Using the TQIP, adult patients (age $\geq$ 18) with isolated blunt TBI from 2017 to 2019 were selected. Transferred patients and those who were dead on arrival were excluded. Patients were then grouped based on CVA as a comorbidity. Morality, hospital disposition, hospital and ICU length of stay, were compared.

**Results:** 655,686 patients with isolated blunt TBI patients were identified. The HxCVA group (n = 23,482) were older (72.18 $\pm$ 12.1 years vs. 54.10 $\pm$ 21.28 years, p<0.001) and had a lower ISS (13.60 $\pm$ 8.4 vs. 14.33 $\pm$ 10.4, p<0.001), than HwoCVA. TGCS was higher in HxCVA patients (13.58 $\pm$ 3.9 vs. 12.99 $\pm$ 3.0, p< 0.001). Mortality rates were higher in HxCVA (8.39% vs 7.94%, p<0.001). Hospital disposition was also significantly different between groups (p<0.001) with HxCVA more likely to be discharged to a nursing facility (22.88% vs. 9.11%). The mean hospital length of stay was significantly higher in the HxCVA (7.10 $\pm$ 13.35 days vs. and 6.68 $\pm$ 10.30 days, p<0.001), in comparison to HwoCVA. However, ICU length of stay was significantly lower in HxCVA (4.46 $\pm$ 5.22 days vs. 5.44 $\pm$ 6.98 days, p<0.001). Having a history of CVA significantly increased odds of mortality (OR: 1.283, 95% CI: 1.208 – 1.363, p< 0.001).

**Conclusion:** TBI patients with a history of CVA were associated with significantly increased odds of mortality, spent more days in the hospital, and less days in the ICU in comparison to TBI patients without a history of CVA. These results suggest a significant relationship between CVA history and TBI outcomes, potentially due to increased comorbidity burden, autonomic/endocrine dysfunction, and chronic post stroke systemic inflammation.