

**ANTIPLATELET MEDICATIONS: MAYBE NO BIG DEAL?**

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**Introduction:** Brain Injury Guidelines (BIG), using clinical presentation, computed tomographic imaging of the brain (CT), and preinjury medications, are meant to assist in the management of traumatic brain injury (TBI) patients with a goal of determining who would benefit from repeat CT (RCT), admission, and neurosurgery involvement (NSi). The use of antiplatelet medication (AP) or anticoagulants (AC) was classified as BIG3 regardless of CT findings. The goal of this study was to determine the natural progression of lesions that would have been classified as BIG1 based upon imaging but were upgraded to BIG3 based solely on AP +/- AC usage.

**Methods:** This is an IRB exempt, retrospective study of all blunt TBI patients presenting from 1/2020-12/2021 to a Level II Trauma Center. All patients had a normal neurological exam, lacked intoxication, and had a positive initial CT consistent with BIG1 criteria. Patients were then stratified based upon usage of AP, AC, or BOTH medications. Primary outcome was need for NSi. Secondary outcome was injury progression on RCT. Independent t-tests were performed with statistical significance defined as  $p < 0.05$ .

**Results:** 223 patients met inclusion criteria. Mechanism of injury was most commonly fall in all groups. RCT was obtained in 206 patients (92%). Platelet function screens (PFS) were performed on 49 of the BIG1+AP patients (77%). Of those screened, 27 patients (55%) had an abnormal PFS of which 70% were treated with DDAVP +/- platelets. Within the BIG1+AC group, warfarin (n=11) was utilized with an average INR 2.4 (1.8-3.3). Warfarin reversal (PCC +/- Vitamin K) was performed in 82% (n=9). Novel oral ACs comprised the remainder of BIG1+AC patients (n=16) which were treated with PCC in 56% (n=9). No patient in the BIG1+BOTH received any reversal agents. No BIG1, BIG1+AP, or BIG1+BOTH patient required NSi but RCT did reveal clinically insignificant injury progression in 5%, 3% and 0%, respectively. However, 4 patients (15%) in the BIG1+AC group worsened radiographically and 2 (7%) required surgery for evacuation of increasing intracranial hemorrhage (ICH). All BIG1+AC patients with worsening RCT had received reversal agents. (PCC 4/4; Vit K 1/4).

**Conclusions:** While the use of AC emerged as a statistically significant risk factor for ICH progression when compared to BIG1 alone and resulted in the need for NSi in 7% of patients, AP usage did not appear to confer the same risk. We believe the need for reflex admission and NSi in BIG 1+AP patients would benefit from future multicenter study.

SDH (subdural hematoma); SAH (subarachnoid hemorrhage); IPC (intraparenchymal contusion) \*statistically significant difference compared to BIG1

	<b>BIG1</b>	<b>BIG1+ AP</b>	<b>BIG1+AC</b>	<b>BIG1+BOTH</b>
Total Patients	128	64	27	4
Initial CT findings (%)	SDH(58); SAH(51); IPC(5); >1(14)	SDH(55); SAH(52); IPC(6); >1(14)	SDH(58); SAH(53); IPC(5); >1(16)	SAH(100)
Reimaged	115 (89.8%)	60 (93.8%)	27 (100%)	4 (100%)
Stable	82 (71.3%)	41 (68.3%)	20 (74.1%)	2 (50%)
Improved	27 (23.5%)	17 (28.3%)	3 (11.1%)	2 (50%)
Worsened	6 (5.2%)	2 (3.3%)	4 (14.8%) *	0 (0%)
Intervention	0 (0%)	0 (0%)	2 (7.4%)	0 (0%)

## APPLICATION OF THE MODIFIED BRAIN INJURY GUIDELINES MAY REDUCE LOW VALUE TRAUMA TRANSFERS

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**Introduction:** Traditional management of traumatic brain injury (TBI) has required substantial resource utilization including ICU admission, repeat CT imaging, and neurosurgical consultation. The modified Brain Injury Guidelines (mBIG) can be used to risk stratify patients with mild TBIs. These guidelines have the potential to reduce low value transfers in patients who would otherwise not require a higher level of care. This study is unique from prior validation studies in examining transferred patients as a pre-specified subgroup.

**Methods:** The primary objective was to retrospectively validate the mBIG and secondarily examine the safety of mBIG 1 for transfer patients. A 1-year retrospective analysis of adult trauma patients with a diagnosis of mild TBI evaluated at an urban level 1 trauma center with a large rural catchment area was performed. Primary outcome measures were rates of neurosurgical intervention, unplanned ICU admission, and in-hospital mortality. A subgroup analysis of mBIG 1 patients was performed based on transfer status.

**Results:** Among 230 patients identified, 37, 51, and 142 were classified into the mBIG 1, 2, and 3 categories respectively. Neurosurgical intervention was performed in 8.45% of mBIG 3 patients and no mBIG 1 or 2 patients. There was 1 unplanned ICU admission in the mBIG 2 and 3 groups. There were no neurosurgical interventions, unplanned ICU admissions, or in-hospital mortality in the mBIG 1 group regardless of transfer status. 92% of mBIG 1 patients transferred from other facilities were discharged home.

**Conclusion:** Application of the mBIG may help safely avoid low value transfers. In our study, mBIG 1 transfer patients suffered no adverse outcomes related to their TBI and could have potentially avoided transfer. As the vast majority of mild TBI patients with low-risk features return home from the hospital, allowing patients to safely remain within their community for care may be beneficial from a patient and resource-utilization perspective.

## **GCC INTUBATION THRESHOLDS AND OUTCOMES OF PATIENTS WITH TRAUMATIC BRAIN INJURY: THE NEED FOR TAILORED PRACTICE MANAGEMENT GUIDELINES**

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**Introduction:** Intubation of patients with a Glasgow Coma Scale score (GCS) of 8 or below remains a standard practice across U.S. healthcare institutions. This study aims to re-evaluate the GCS threshold for intubation in patients presenting to the ED with a traumatic brain injury to optimize outcomes and provide evidence for future practice management guidelines.

**Methods:** We retrospectively reviewed the ACS-TQIP-Participant Use File (PUF) 2015-2019 for adult trauma patients 18 years and older who experienced blunt traumatic head injury and received computerized tomography. Multivariable regressions were performed to assess associations between outcomes and GCS intubation thresholds of 5, 8, and 10.

**Results:** In patients with a  $GCS \leq 5$ , there were no differences in mortality ( $GCS \leq 5$ : 26.3% vs  $GCS > 5$ : 28.3%, adjusted  $p=0.08$ ), complication rates ( $GCS \leq 5$ : 9.1% vs  $GCS > 5$ : 10.3%, adjusted  $p=0.91$ ), or ICU length of stay ( $GCS \leq 5$ : 5.4 vs  $GCS > 5$ : 4.7, adjusted  $p=0.36$ ) between intubated and non-intubated patients. Intubated patients at GCS thresholds  $\leq 8$  (26.2% vs. 19.1%, adjusted  $p<0.0001$ ) and  $\leq 10$  (25.6% vs. 15.8%, adjusted  $p<0.0001$ ) had significantly higher mortality rates than non-intubated patients. Intubation at all GCS thresholds  $> 5$  resulted in higher rates of complications, H-LOS, and ICU-LOS when compared to non-intubated patients with the same GCS score.

**Conclusion:** A  $GCS \leq 5$  was the threshold at which intubation in TBI patients conferred an additional benefit in disposition without worsened outcomes of mortality, H-LOS, or ICU-LOS. Trauma societies and hospital institutions should revisit existing guidelines & protocols concerning the GCS threshold as an indicator of when intubation is necessary and safe.

## IS MAGNETIC RESONANCE ANGIOGRAPHY (MRA) EQUIVALENT TO CT ANGIOGRAPHY (CTA) FOR DETECTING BLUNT CEREBROVASCULAR INJURY (BCVI)?

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**Introduction:** Magnetic resonance angiography (MRA) screening for blunt cerebrovascular injury (BCVI) is considered to have decreased accuracy compared to CT angiography (CTA). However, MRA may be a more convenient test if other magnetic resonance imaging (MRI) is also ordered. There have been few studies directly comparing MRA and CTA for the diagnosis of BCVI. We hypothesized that with modern high field MRA imaging CTA and MRA would be equivalent.

**Methods:** All trauma patients with blunt injury who underwent both CTA and MRA from 6/2013 through 6/2022 were identified using the trauma registry and medical record data. Imaging findings were reviewed, and grade of injury assigned if not graded on the initial imaging report. Additional data collected included time between studies, vessels injured and if a stroke referable to an injured vessel was present. Grade of injury was compared between the imaging modalities and interrater reliability between MRA and CTA was assessed with intraclass correlation coefficient.

**Results:** 127 patients underwent both CTA and MRA to screen for, confirm or follow up a BCVI. With respect to image grading the table demonstrates high grade correlation for BCVI between MRA and CTA (table, highlighted boxes). Median time between studies was 1 day IQR (1,2). There were seven injuries (6 grade I, 1 grade II) present on CTA not detected by MRA. There was one grade I injury by MRA not detected by CTA. The intraclass correlation coefficient across all grades demonstrated excellent agreement [0.981, 95% CI (0.973 – 0.987),  $p < 0.001$ ]. There were 22 strokes with 19 occurring in patients with BCVI of which 12 were potentially referable to the injured vessel. There were no strokes in the patients where CTA and MRA were discordant on the presence of an injury. The only stroke that occurred with discordant studies occurred where the MRA grade was II and the CTA grade was I.

**Conclusions:** Using modern MRA imaging there appears to be a high degree of agreement between MRA and CTA for BCVI. MRA could be considered an acceptable screening alternative to CTA when MRA is a more convenient imaging modality. Additional larger studies comparing high field strength MRA to CTA should be done to validate these findings.

## IT'S ALL IN YOUR HEAD: SAFETY OF WEIGHT-BASED, TARGETED ENOXAPARIN PROPHYLAXIS IN TBI PATIENTS

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**Introduction:** Standard enoxaparin (LVX) dosing is inferior to weight-based, anti-Xa targeted dosing regimens for venous thromboembolism (VTE) prophylaxis in trauma patients. Despite this, many trauma guidelines support standard low-dose LVX (30mg BID) in patients with traumatic brain injury (TBI) for fear of expansion of intracranial hemorrhage (ICH) and adverse neurological outcomes. We hypothesized that weight-based, anti-Xa targeted dosing is safe and effective in trauma patients with TBI.

**Methods:** We retrospectively reviewed TBI patients admitted to a Level I trauma center from 2015-2022. Patients were cleared to start LVX 48 hours after stable CT head. TBI patients who received weight-based LVX (50-59kg, 30mg BID; 60-99kg, 40mg BID;  $\geq 100$ kg, 50mg BID) and had a peak anti-Xa level assessed (3-5 hours after  $\geq 3^{\text{rd}}$  dose, goal 0.2-0.4 IU/mL) were included. Charts were reviewed to assess for ICH expansion after initiation of LVX.

**Results:** Of the 557 TBI patients included, 434 (77.9%) received 40mg BID and 58 (10.4%) received 50mg BID. There were eight instances (1.4% of total patients) of ICH expansion. One patient (1.5%) in the 30mg cohort developed ICH expansion; they also had a supra-prophylactic anti-Xa level. Seven patients (1.6%) in the 40mg cohort developed expansion (OR 1.05, 95% CI [0.13, 8.67],  $p=0.48$ ); none of these patients were supra-prophylactic. No patients in the 50mg cohort developed ICH expansion after LVX initiation.

	<b>30mg BID</b>	<b>40mg BID</b>	<b>50mg BID</b>	<b>p-value</b>
Number (% total)	65 (11.7%)	434 (77.9%)	58 (10.4%)	
<b>Anti-Xa Results</b>				
Anti-Xa [median (IQR)]	0.28 (0.21–0.36)	0.28 (0.22–0.35)	0.24 (0.20–0.33)	0.207
% Anti-Xa in-range	70.8%	68.9%	72.4%	0.837
<b>ICH Expansion</b>				
Expansion of ICH on Enoxaparin	1 (1.5%)	7 (1.6%)	0 (0%)	0.623

**Conclusion:** In this single center pilot study, weight-based LVX dosing did not result in significant ICH expansion, directly challenging current VTE prophylaxis guidelines for patients with TBI. These results should serve as a platform for multi-center prospective data collection to ultimately determine the safety and efficacy of weight-based LVX prophylaxis regimens in TBI patients.

## DEVELOPING A NATIONAL TRAUMA RESEARCH ACTION PLAN: RESULTS FROM THE VASCULAR RESEARCH GAP DELPHI SURVEY

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**Introduction:** The recent National Trauma Research Action Plan (NTRAP) was designed to identify high-priority research questions in trauma care. The objective of this study was to review vascular specific research questions within the NTRAP review.

**Methods:** Experts in trauma care were recruited to identify current gaps in research and use a consensus-driven Delphi survey approach to determine the priority of unanswered research questions. Participants ranked each question as low, medium, or high priority with consensus defined as  $\geq 60\%$  of participants in agreement. Priority level was determined based on the arithmetic mean Delphi score.

**Results:** 7,345 research questions were generated by NTRAP. Of those questions, 247 vascular-specific research questions were identified via a validated Search Strategy of which 167 (68%) questions met consensus. Of the questions meeting consensus, 24 (14%) questions were high priority, 141 (84%) were medium priority, and 2 (1%) were low priority.

**Conclusion:** 24 high priority vascular trauma research questions were generated by the NTRAP Research Priority Panel. Future research funding should be focused towards addressing these important questions.

**Table 1.** Top Five High-Priority Vascular Trauma Research Questions with the Highest Arithmetic Mean of the Delphi Scores

<b>1) Pediatric Trauma:</b> For pediatric trauma patients with possible neck injury, is there an optimal screening tool for determining which patients require a CT angiogram to rule out vascular injury?
<b>2) Personnel/Staffing:</b> Does a surgical team lead by a broadly trained General Trauma/ACS surgeon have equivalent limb salvage rates as compared to a specialty team with vascular/orthopedics/plastics specialists for major extremity trauma?
<b>3) Open Pelvic Fractures:</b> In adult patients with open pelvis fractures, does routine use of angio embolization versus OR exploration and fixation improve outcomes in patients with evidence of pelvic fracture associated bleeding?
<b>4) Impact of Hybrid Trauma Bay:</b> Does the use of a hybrid OR improve outcomes in trauma patients with pelvic fractures?
<b>5) Endovascular:</b> What is the long-term success rate of endovascular treatment for traumatic injury? What are the long-term outcomes of endovascular interventions on young trauma patients?

## EMERGENCY VASCULAR REPAIRS IN TRAUMA: PREDICTORS OF POOR PROGNOSIS AND A NOVEL SCORING SYSTEM

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**Introduction:** Vascular injuries comprise 1-2% of all trauma patients and predictors of morbidity or mortality are unclear. The purpose of this study was to establish predictors of revascularization failures, and compare repairs performed by trauma- and vascular-trained surgeons.

**Methods:** We performed a single-institution, case-control study of consecutive patients with traumatic arterial injuries who underwent open repair between 2016 and 2021. Multivariable logistic regression was used to investigate covariates impacting the primary composite outcome of repair failure/revision, amputation, or in-hospital mortality.

**Results:** Among 165 patients, median age was 34 (IQR 23-46), 149 (90%) were male, 67 (41%) were African American, and 99 (60%) suffered penetrating injury. Popliteal (46%) and superficial femoral (44%) arterial injuries were most common. Interposition graft/bypass was the most frequent repair (n=107, 65%). Primary outcome was observed in 24 (15%) patients, including 7 (4%) repair failures/revisions, 13 (8%) amputations, and 10 (6%) in-hospital mortalities. Cases were more likely to have blunt injury (67% vs. 36%,  $p=0.006$ ), higher median mangled extremity severity score (MESS; 9 vs. 6,  $p<0.001$ ), same-day laparotomy (33% vs. 12%,  $p=0.013$ ), same-day orthopedic procedure (67% vs. 43%,  $p=0.028$ ), and anterior tibial (29% vs. 10%,  $p=0.017$ ) or tibioperoneal (42% vs. 12%,  $p=0.001$ ) injuries. Two independent predictors of the outcome were identified using multivariable analysis – MESS  $> 8$  (OR: 19.4, 95%CI: 5.82 - 64.5,  $p<0.001$ ) and same day laparotomy or orthopedic procedure (OR: 6.81, 95%CI: 1.70 - 27.2,  $p=0.007$ ). Of note, repair outcomes were similar between operating surgeon specialties. A novel composite scoring system was developed by combining MESS score, same-day procedure, mechanism of injury, and injury location. This system demonstrated a sensitivity of 100% with a score of 0 and a specificity of 95% with a score  $> 3$ .

**Conclusions:** We have demonstrated that surgical outcomes following traumatic lower extremity arterial repairs are similar between trauma- and vascular-trained surgeons. Additionally, we have developed a novel predictive scoring system that may be used to counsel patients and their families as well as guide future management.

## GETTING TO THE HEART OF BLUNT CARDIAC INJURY

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**Introduction:** In 2012, guidelines were published establishing screening criteria for blunt cardiac injury (BCI). However, these criteria (abnormal EKG or elevated troponin) may be overly broad, resulting in unnecessary testing. Additionally, the impact of EKG abnormalities and troponin elevation on clinical outcomes remains undefined.

**Methods:** Five-year (2016-2020) retrospective study of BCI in consecutive sternal fracture patients surviving >24h. Mechanism of injury (MOI), demographic, and outcome data were collected from the trauma registry. 12-lead electrocardiogram and cardiac enzyme data were also collected. Patients screened positive for BCI if they had an abnormal EKG or troponin within the first 24h. Patients were then dichotomized by BCI screening status, and multivariable logistic regression was used to determine the association between EKG changes, troponin elevation, and mortality. Zero-inflated and negative binomial generalized linear models were used to model the effect of BCI on hospital and ICU lengths of stay (LOS).

**Results:** Of 959 sternal fracture patients, 464 (48%) screened positive for BCI. Demographics and MOI were similar between groups. Patients screening positive experienced more ventilator days (0[0-2] vs 0[0-0]), longer ICU LOS (0[0-7] vs 0[0-2] days) and hospital LOS (7[3-17] vs 4[2-9] days), and greater mortality (40[9%] vs 10[2%]; all  $p < 0.0001$ ). After controlling for confounders, screening positive for BCI remained associated with increased mortality. However, only ST segment abnormalities were associated with this risk (OR 3.1, 95%CI 1.4-6.7,  $p = 0.004$ ). Troponin elevation was not associated with an increased risk of mortality, but initial and 48h peak troponin were both associated with increased ICU LOS (RR 1.19, 95%CI 1.06-1.34,  $p = 0.004$ ) and hospital LOS (RR 1.14, 95%CI 1.06-1.23,  $p < 0.0001$ ) (FIGURE).

**Conclusion:** In patients with sternal fracture, nearly half screened positive for BCI. Increased mortality was primarily associated with ST segment abnormalities, while troponin elevations were associated with increased ICU and hospital LOS. Revised screening criteria, including a consideration of specific EKG abnormalities, may help physicians better focus treatment efforts.



## THE 59TH TEMPORARY INTRAVASCULAR SHUNT OFFERS SURGEONS AN UPGRADE FROM CURRENTLY AVAILABLE VASCULAR SHUNTS

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**Introduction:** In the context of extremity trauma, the use of Temporary Intravascular Shunts (TIVS) has become more commonplace because of the flexibility it provides surgeons in emergency environments. Since their inception, the design of these devices has not changed significantly. The aim of this study was to test a novel TIVS designed by the 59<sup>th</sup> Medical Wing against industry standard to evaluate patency and the value of new modifications in a large animal model.

**Methods:** Twelve female anesthetized swine (60kg - 80kg) underwent a 20% controlled hemorrhage and administration of heparinized saline to undergo hemodilution. All swine underwent an open retroperitoneal approach to access the left iliac artery. The left iliac was opened as the intended site for placement of the shunt devices. Six swine received a standard Sundt shunt, and six swine received the 59<sup>th</sup> TIVS shunt which included an additional side port. Quantitative flow data from a distal artery was collected for twelve-hours. At completion, an angiogram was performed to confirm patency of the shunt and distal flow.

**Results:** Out of the twelve animals in the study, all animals survived shunt placement and the twelve-hour ICU period. The 59<sup>th</sup> TIVS group had 100% patency by flow analysis and angiography. The average flow rate among the six novel intravascular shunts was  $145.67 \pm 45.62$  ml/min. In comparison, all six Sundt shunts also maintained patency, with an average flow rate of  $91.50 \pm 26.51$  ml/min. Analysis was performed on the distal flow data using an unpaired t-test, which calculated the p value as 0.03.

**Conclusion:** Using this swine model, the 59<sup>th</sup> TIVS proved comparable in terms of patency compared to the standard Sundt shunt. The addition of the side port to the novel intravascular shunt provides additional utility including immediate angiography, pressure measurement, and medication infusion. The 59<sup>th</sup> TIVS offers surgeons more flexibility to manage vascular injury with similar durability to current shunts.

## OPERATING THEATER VERSUS EMERGENCY ROOM RESUSCITATION – AN ANALYSIS OF A FLY-BY PROTOCOL EFFECTS ON MORTALITY

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**Introduction:** The prompt initiation of resuscitation and control of hemorrhage leads to improved survival but optimal methods to achieve rapid treatment remains elusive. We, therefore, sought to determine if bypassing the trauma bay to perform resuscitative measures in the operating room were associated with improved outcomes in critically injured patients compared to those patients initially managed in the trauma bay.

**Methods:** Trauma patients admitted from 2017 to 2022 at a level 1 trauma center serving a rural population who spent less than 10 minutes in the ER (Fly-by) were propensity score matched to those who spent 10 or more minutes in the ER (Delay). The two groups were matched on injury mechanism, ISS, age and sex. Regression analysis was then performed to provide the odds of death based on whether patients were actually treated as Fly-by patients or not.

**Results:** After matching there were 131 patients in each group. Delay patients were more than 5 times more likely to die compared to Fly-by patients (OR= 5.24,  $p<0.001$ ). Among the control variables, we found that patients who had higher mortality had a higher ISS score (OR = 1.057,  $p<0.001$ ).

**Conclusion:** In the setting of rural trauma and prolonged transport times, a “fly-by” protocol maybe still be useful in reducing mortality. Further studies are needed to identify which treatment elements delivered in the operating room resuscitation are associated with these improved outcomes.

