Paper #1 January 18, 2023 8:30 am

BLOOD COMPONENT RESUSCITATIVE STRATEGIES TO MITIGATE ENDOTHELIOPATHY FOLLOWING HEMORRHAGIC SHOCK

Matthew R. Baucom, MD, Taylor Wallen, MD*, Allison Amman, MD, Nick Weissman, BS, Lisa England, RVT, Rebecca Schuster, MS, Timothy A. Pritts, MD, PhD*, Michael Goodman, MD* University of Cincinnati

Presenter: Matthew R. Baucom, MD

Discussant: Rosemary Kozar, MD, PhD - R Adams Cowley Shock Trauma Center

Objectives: Resuscitation with plasma components has been shown to improve endotheliopathy induced by hemorrhagic shock, but the optimal resuscitation strategy to preserve the endothelial glycocalyx has yet to be defined. The aim of this study was to determine if resuscitation with whole blood (WB), packed red blood cells (RBC), platelet rich plasma (PRP), platelet poor plasma (PPP), or balanced RBC:PRP (1:1) would best minimize endothelial damage following shock.

Methods: Male C57BL/6 mice were hemorrhaged to a goal MAP of 25 mm Hg for one hour. Unshocked sham mice served as controls. Mice were then resuscitated with equal volumes of lactated Ringer's (LR), WB, RBC, PRP, PPP, or 1:1 and then sacrificed at 1-, 4-, or 24-hours (n=5). Serum was analyzed for syndecan-1 concentration. Lungs underwent syndecan-1 immunostaining and lung injury scores were calculated after H&E stains. Proteolytic cleavage of the endothelial glycocalyx was assessed by MMP-9 and heparanase activity levels in homogenized lung tissue.

<u>Results:</u> Serum syndecan-1 levels were significantly decreased at 4- and 24-hours following resuscitation with WB, RBC, and PRP compared to LR (**Figure 1**). Early elevation in lung syndecan-1 staining was noted in LR treated mice following shock while WB and PPP treated animals displayed late elevation (**Figure 2**). Lung injury scores were significantly elevated 4 hours after resuscitation with LR (4.54 ± 1.48), PRP (5.96 ± 0.67), and PPP (4.59 ± 1.95) compared to WB (1.47 ± 0.76). No significant differences were noted in MMP-9 activity. Heparanase activity was increased in mice resuscitated with RBC at 1 and 24 hours vs. LR.

Conclusions: Resuscitation with WB following hemorrhagic shock reduces endothelial syndecan-1 shedding and mitigates lung injury. Further research will be necessary to determine which WB components provide optimal and sustained systemic, pulmonary, and endothelial benefit.



Figure 1: Serum syndecan-1 levels following hemorrhagic shock and resuscitation.



Figure 2: Lung syndecan-1 immunostaining following hemorrhagic shock and resuscitation.

Paper #2 January 18, 2023 8:45 am

PATIENTS WITH BOTH TRAUMATIC BRAIN INJURY AND HEMORRHAGIC SHOCK BENEFIT FROM RESUSCITATION WITH WHOLE BLOOD

Gabrielle E. Hatton, MD, MS*, Jason Brill, MD, Brian Tang, MD, Krislynn Mueck, MD, MPH, MS*, Christopher Cameron McCoy, MD*, Lillian Kao, MD MS, Bryan A. Cotton, MD, MPH University of Texas Health Science Center at Houston

Presenter: Gabrielle E. Hatton, MD, MS

Discussant: Carrie Sims, MD - The Ohio State University

Objectives: Hemorrhagic shock in the setting of traumatic brain injury (TBI) reduces cerebral blood flow and doubles mortality. The optimal resuscitation strategy for hemorrhage in the setting of TBI is unknown. We hypothesized that, among patients presenting with concomitant hemorrhagic shock and TBI, resuscitation including whole blood (WB) is associated with decreased overall and TBI-related mortality when compared to patients receiving component (COMP) therapy alone.

Methods: An *a priori* subgroup of prospective, observational cohort study of injured patients receiving emergency-release blood products for hemorrhagic shock is reported. Adult trauma patients presenting 11/2017-9/2020 with TBI, defined as a Head Abbreviated Injury Scale of ³ 3, were included. WB group patients received any cold-store low-titer Group O WB units. The COMP group received fractionated blood components alone. Overall and TBI-related 30-day mortality, favorable discharge disposition (home or rehabilitation), 24-hour blood product utilization, and ventilator days were assessed. Univariate and inverse probability of treatment-weighted multivariable analyses were performed.

<u>Results:</u> Of 564 eligible patients, 341 received WB. Patients who received WB had a higher injury severity score (median 34 vs 29), lower scene blood pressure (104 vs 118), and higher arrival lactate (4.3 vs 3.6, all p<0.05). Univariate analysis noted similar overall mortality between WB and COMP; however, weighted multivariable analyses found WB was associated with decreased overall mortality, TBI-related mortality, and decreased 24-hour blood product utilization. (**Table**) Favorable discharge disposition and ventilator days were not associated with WB compared to COMP therapy.

<u>Conclusions</u>: In patients with concomitant hemorrhagic shock and TBI, WB transfusion was associated with decreased overall mortality, TBI-related mortality, and blood product utilization.

	Univariate			Weighted, Multivariable		
Outcome of Interest	COMP (N=223)	WB (N=341)	Р	WB Odds Ratio (95% Conf. Interval)	Р	
24 Hour Blood Products, Units	4 (2-9)	4 (1-12)	0.07	0.91 (0.87-0.95)*	<0.001	
30-Day Overall Mortality	39%	44%	0.32	0.70 (0.50-0.97)	0.03	
30-Day TBI-Related Mortality	22%	15%	0.06	0.52 (0.35-0.77)	<0.001	
Favorable Discharge Disposition	35%	29%	0.13	1.08 (0.79-1.47)	0.64	
Ventilator Days (Survivors)	2 (1-7)	1 (1-5)	0.77	0.95 (0.89-1.02)#	0.20	

Paper #3 January 18, 2023 9:00 am

PLATELET-INSPIRED SYNTHETIC NANOPARTICLES IMPROVE HEMOSTASIS AND HEMODYNAMICS IN A RABBIT MODEL OF ABDOMINAL HEMORRHAGE

Amudan J. Srinivasan, MD, Zachary Secunda, BS, Roberto I. Mota-Alvidrez, MD, Norman Luc, MS, Dante Disharoon, PhD, Baylee Traylor, BS, Christa Pawlowski, PhD, Joshua B. Brown, MD, MSc, FACS*, Michael Bruckman, PhD, Anirban Sen Gupta, PhD, Matthew D. Neal, MD University of Pittsburgh Medical Center

Presenter: Amudan J. Srinivasan, MD

Discussant: Alica Mohr, MD - University of Florida

Objectives: Early platelet transfusion is associated with decreased mortality in traumatic hemorrhage. However, donor supply constraints and rapid expiry limit potential platelet usage. SynthoPlate (SP) is a platelet-inspired synthetic nanoparticle designed by surface-decorating liposomes with peptides that mimic injury-site platelet adhesion to vWF and collagen, as well as fibrinogen-mediated platelet aggregation. SP has shown hemostatic benefit in murine, rodent and porcine hemorrhage models. We evaluated hemostasis and hemodynamic effects of SP in a rabbit model of abdominal hemorrhage.

<u>Methods</u>: 23 adult male New Zealand white rabbits (2.5-3.5kg) were pretreated with either buffer, control particles (CP), or SP. Under general anesthesia with invasive monitoring, rabbits underwent laparotomy with standardized splenic and hepatic injury. Hemodynamics were monitored for 30 minutes and blood loss was quantified. Blood counts, aggregometry, and catecholamine assays were performed at multiple timepoints. Analysis used ANOVA and post-hoc Tukey testing with α =0.05.

<u>Results:</u> Rabbits in the SP (n=7) group had significantly lower weight-normalized blood loss compared to both buffer (n=8) and CP (n=8) animals (21.1 vs 33.2 vs 40.4 g/kg, p<0.001). Areas under the curve (AUC) for mean arterial and systolic pressure were calculated to evaluate hemodynamics over time. SP animals had higher systolic AUC compared to buffer and CP animals (1589 vs 1353 vs 1172mmHg*min, p=0.01), though post-hoc differences were only significant for the SP:CP comparison (p=0.01). Platelet counts, catecholamine levels, and aggregometry were similar between groups.

<u>Conclusions</u>: SP pretreatment reduced blood loss and improved hemodynamic metrics in a rabbit model of abdominal hemorrhage. SP has potential in trauma as an intravenous hemostatic platelet surrogate with donor-independent availability and scalable manufacture.



Figure 1: Normalized blood loss and platelet counts. A: Total intraperitoneal blood loss normalized by animal weight. B: Platelet counts at pre-intervention, post-intervention, and post-polytrauma timepoints. Data are presented as individual data points, error bars denote mean +/- SEM.



Figure 2: Systolic and mean arterial pressure (MAP) following polytrauma. Mean values for systolic pressure (A) and MAP (C) from the start of the polytrauma are graphed with shaded regions denoting +/- 1 SEM. Areas under the curve (AUC) were calculated for individual systolic pressure (B) and MAP (D) tracings to evaluate hemodynamics over time and are displayed as mean +/- SEM.

Paper #4 January 18, 2023 9:15 am

TXA DOES NOT AFFECT LEVELS OF TBI-RELATED BIOMARKERS IN BLUNT TBI WITH ICH

Lea Hoefer, MD, Ann M. Polcari, MD, MPH, MSGH*, Susan E. Rowell, MD, MBA, MCR*, Martin A. Schreiber, MD, FACS*, Tanya L. Zakrison, MD, MPH, FRCSC, FACS*, Andrew J. Benjamin, MD, MS* University of Chicago

Presenter: Lea Hoefer, MD

Discussant: Michael Vella, MD - University of Rochester

Objectives: Brain specific biomarkers such as glial fibrillary acidic protein (GFAP), ubiquitin C-terminal hydrolase L1 (UCH-L1), and microtubule-associated protein-2 (MAP-2) have been identified as tools for diagnosis in traumatic brain injury (TBI). TXA has been shown to decrease mortality in patients with ICH, yet the effect of TXA on these biomarkers is unknown. We sought to determine whether TXA affects levels of GFAP, UCH-L1, and MAP-2, and to identify whether biomarker levels are associated with mortality in patients receiving TXA.

Methods: Patients enrolled in the prehospital TXA for TBI trial had GFAP, UCHL-1 and MAP-2 levels drawn at 0 and 24 hours post injury(n=422). Patients with intracranial hemorrhage (ICH) from blunt trauma with a GCS <13 and SBP >90 were randomized to placebo, 2g TXA bolus, or 1g bolus + 1g/8hrs TXA infusion. Associations of TXA and biomarker change over 24 hours were assessed with multivariate linear regression. Association of biomarkers with 28-day mortality was assessed with multivariate logistic regression models. All models were controlled for age, GCS, ISS, and AIS head.

<u>Results:</u> Administration of TXA was not associated with a change in biomarkers over 24 hours postinjury. Changes in biomarker levels were most closely associated with AIS head and age (Table 1). On admission, higher GFAP (OR 1.75, CI 1.31-2.38, p<0.001) was associated with increased 28-day mortality. At 24 hours post injury, higher levels of GFAP (OR 2.09, CI 1.37-3.30, p<0.001 and UCHL-1(OR 2.98, CI 1.77-5.25, p<0.001) were associated with mortality. A change in UCH levels from 0 to 24 hours post-injury was also associated with increased mortality (OR 1.68, CI 1.15-2.49, p<0.01) (Table 2).

<u>Conclusions</u>: Administration of TXA does not impact change in GFAP, UCHL-1, or MAP-2 during the first 24 hours after blunt TBI with ICH. Higher levels of GFAP and UCH early after injury may help identify patients at high risk for 28-day mortality.

Table 1: Impact of patient factors and treatment group on change in biomarker levels over first 24 hours

Variable	Coefficient	2.5-97.5% CI	P value
Δ GFAP level from admission to 24 hours			
post injury			
ISS	-0.0099	-0.0248- 0.0050	0.19288
Age	0.0074	0.0003- 0.0145	0.04123 *
Max AIS head	-0.2389	-0.4100.0678	0.00634 **
Qualifying GCS	-0.0025	-0.0478- 0.0428	0.91346
2g TXA bolus	-0.1189	-0.4262-0.1883	0.44701
1g TXA bolus +1g	-0.0504	-0.375- 0.2745	0.76041
Δ UCH level from admission to 24 hours			
post injury			
ISS	0.9827	-0.02810.0069	0.001279**
Age	1.0135	0.0083-0.01845	<0.001***
Max AIS head	1.2740	0.1203-0.3641	0.000112**
Qualifying GCS	0.9719	-0.0608-0.0037	0.082890
2g TXA bolus	0.9508	-0.2693-0.1684	0.650654
1g TXA bolus +1g	0.8831	-0.3557-0.1071	0.291589
Δ MAP level from admission to 24 hours			
post injury			
ISS	-0.0392	-0.05540.0229	<0.001***
Age	-0.0110	-0.01880.0033	0.0053**
Max AIS head	0.3829	0.1960-0.5698	<0.001***
Qualifying GCS	-0.0015	-0.0509-0.04799	0.9533
2g TXA bolus	0.0439	-0.2915 -0.3784	0.7968
1g TXA bolus +1g	-0.1525	-0.5073 – 0.2023	0.3984

*** p<0.001. ** p<0.01. * p<0.05 All biomarker levels log-adjusted

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	OR	2.5-97.5% CI	P value
ED admission (n=422)			
Age	1.05	1.028-1.073	<0.001***
ISS	1.032	0.995-1.073	0.091
AIS head	1.378	0.825-2.332	0.22
Qualifying GCS	0.733	0.663-0.846	<0.001 ***
2g TXA bolus	0.443	0.192-1.000	0.053
1g+1g TXA	0.477	0.203-1.093	0.084
GFAP	1.75	1.314-2.380	<0.001 ***
UCH	1.085	0.699-1.696	0.717
MAP	1.24	0.941-1.671	0.134
24 HRs post injury (n=364)			
Age	1.039	1.012-1.068	.0057 **
ISS	1.020	0.975-1.061	0.356
AIS head	2.180	1.258-4.066	0.0085 **
Qualifying GCS	0.778	0.651-0.918	0.004 **
2g TXA bolus	0.639	0.242-1.684	0.362
1g+1g TXA	0.790	0.288-2.150	0.644
GFAP	2.088	1.369-3.298	0.00097 ***
UCH	2.984	1.766-5.246	< 0.001 ***
MAP	0.778	0.540-1.112	0.171
∆ 0-24 hours (n=346)			
Age	1.035	1.013-1.059	0.0023**
ISS	1.044	1.006- 1.084	0.0224*
AIS head	2.137	1.271- 3.752	0.0055**
Qualifying GCS	0.800	0.684- 0.923	0.0032**
2g TXA bolus	0.685	0.288-1.637	0.3909
1g+1g TXA	0.810	0.323-2.018	0.6507
Δ GFAP	0.939	0.709-1.251	0.6603
Δ UCH	1.683	1.146-2.487	0.0079**
Δ MAP	0.792	0.5667-1.091	0.1618

Table 2 – Factors influencing 28d mortality in patients with blunt TBI and ICH

*** p<0.001. ** p<0.01. * p<0.05 All biomarker levels log-adjusted

Paper #5 January 18, 2023 9:30 am

AGE-RELATED CHANGES IN THROMBOELASTOGRAPHY PROFILES IN INJURED CHILDREN

Katrina M. Morgan, MD, Barbara A. Gaines, MD*, Christine M. Leeper, MD, MS* University of Pittsburgh Medical Center

Presenter: Katrina M. Morgan, MD

Discussant: James Bardes, MD - West Virginia University

<u>Objectives</u>: The role of age in mediating coagulation characteristics in injured children is not well defined. We hypothesize that thromboelastography (TEG) profiles are unique across pediatric age groups.

<u>Methods</u>: Consecutive trauma patients <18 years from a level I pediatric trauma center database from 2016-2020 with admission TEG were identified. Children were categorized by age according to NICHD categories (infant: ≤1 year, toddler: 1-2 years, early childhood: 3-5 years, older childhood: 6-11 years, adolescent: 12-17 years). TEG values were compared across age groups using Kruskal Wallis and Dunn's tests. Analysis of covariance was performed controlling for sex, injury severity score (ISS), admission Glasgow Coma Score (GCS), and shock.

<u>Results:</u> In total, 726 subjects were identified; 69% male, median(IQR) ISS=12(5-25), and 83% blunt mechanism. On univariate analysis, there were significant differences in TEG α -angle (p<0.001), TEG-MA (p=0.004), and TEG-LY30 (p=0.01) between groups. In post-hoc tests, the infant/neonate group had significantly greater α -angle (median(IQR)=77(71-79)) and MA (median(IQR)=64(59-70)) compared to other groups, while the adolescent group had significantly lower α -angle (median(IQR)=71(67-74)), MA (median(IQR)=60(56-64)) and LY30 (median(IQR)=0.8(0.2-1.9)) compared to other groups (Figure). There were no significant differences between toddler, early childhood, and middle childhood groups. On multivariate analysis, the relationship between age group and TEG values (angle, MA and LY30) persisted after controlling for sex, ISS, GCS, and shock.

<u>Conclusions</u>: Age-associated differences in TEG profiles across pediatric age groups exist. Further pediatric-specific research is required to assess whether the unique profiles at extremes of childhood may translate to differential clinical outcomes or responses to therapies.



Median thromboelastography values by National Institute of Child Health and Human Development age categories (infant: \leq 1 year, toddler: 1-2 years, early childhood: 3-5 years, older childhood: 6-11 years, adolescent: 12-17 years). Infants had a significantly greater α -angle and maximum amplitude; adolescents had a significantly lower α -angle, maximum amplitude and LY30 compared to the other groups.

Paper #6 January 18, 2023 9:45 am

STATISTICAL POWER OF RANDOMIZED CONTROLLED TRIALS (RCT) IN THE FIELD OF TRAUMA SURGERY

Arthur Berg, DO, Abbasali Badami, MD*, John M. Reynolds, MLIS, AHIP*, Gerd Daniel Pust, MD*, Jonathan P. Meizoso, MD, MSPH*, Louis R. Pizano, MD*, Nicholas Namias, MBA, MD*, D. Dante Yeh, MD, MHPE, FACS, FCCM, FASPEN* Ryder Trauma Center -University of Miami Miller School of Medicine

Presenter: Arthur Berg, DO

Discussant: Rachael Callcut, MD, MSPH - UC Davis

<u>Objectives</u>: To conduct a bibliometric study investigating the prevalence of underpowered RCTs in Trauma Surgery.

Methods: A medical librarian conducted a formal search strategy of RCTs in trauma published from 2010-2019. Data extracted included study type (superiority, inferiority, and equivalence trials), sample size calculation, and power analysis. Post hoc calculations were performed using a power of 80% and an alpha level of 0.05. Effect size was defined as standard deviation or odds ratio (OR) for mean and proportion primary endpoints, respectively, and quantified as small, medium, or large using previously published definitions. Superiority and inferiority trials were classified as single-tail and equivalence trials were calculated as two tail studies. If the type of study wasn't specified, it was classified based on hypothesis.

<u>Results</u>: In total, 118 RCT's from over 20 journals from multiple continents were examined and were most commonly equivalence trials (49%) (Table). A total of 70% were found to have $\hat{a} \in \mathbb{C}$ positive $\hat{a} \in \mathbb{C}$ findings consistent with their hypothesis. When evaluating the integrity of each publication sample size calculation, 47% of journals did not report how they calculated their intended sample size. Of those that did include sample size calculation, 25 (43%) did not meet their target enrollment. When examining post hoc power, 35%, 49%, and 56% were adequately powered to detect a small, medium, and large effect size respectively.

<u>Conclusions</u>: A concerningly large proportion of recently published RCT's in trauma surgery 1) do not report a priori sample size calculations, 2) do not meet enrollment targets, and 3) are not adequately powered to detect even large effect sizes. There exists opportunity for improvement of trauma surgery study design, conduct, and reporting.

	N=118
Continent	
North America	49%
South America	1%
Asia	35%
Africa	0
Europe	18%
Australia	4%
Trial registration (%)	53%
Multicenter (%)	26%
Industry sponsored (%)	6%
Study type (%)	
Superiority	42%
Inferiority	8%
Equivalence	49%
A priori sample size calculation (%)	53%
Achieved target enrollment (%)	57%
Study Conclusion (%)	
Positive	70%
Negative	31%
Post hoc power	
Small effect size	35%
Medium effect size	49%
Large effect size	56%

Paper #7 January 18, 2023 10:30 am

RECLAIMING THE MANAGEMENT OF COMMON DUCT STONES IN ACUTE CARE SURGERY

Maggie E. Bosley, MD, Aravindh Ganapathy, MD, Lucas Neff, MD, Michaela Gaffley, MD, Fadi Syriani, BS, Carl Westcott, MD, Preston R. Miller III, MD*, Andrew Nunn, MD* Wake Forest Baptist Medical Center

Presenter: Maggie E. Bosley, MD

Discussant: Catherine Velopulos, MD, MS - University of Colorado Anschutz

Objectives: Acute care surgery (ACS) is well positioned to manage choledocholithiasis at the time of laparoscopic cholecystectomy, but barriers to laparoscopic common bile duct exploration (LCBDE) include experience and the perceived need for specialized equipment. As such, LCBDE is generally relegated to the "enthusiast." However, a simplified, effective LCBDE technique could drive wider adoption in the speciality most often managing these patients. To determine efficacy and safety, we sought to compare our initial experience with a simple, fluoro-guided, catheter-based LCBDE approach during lap cholecystectomy (LC) to LC with endoscopic retrograde cholangiopancreatography (ERCP).

<u>Methods:</u> We reviewed ACS patients who underwent LC+LCBDE or LC+ERCP (pre-/postoperative) at a tertiary care center over the last 3 years. Demographics, outcomes, and length of stay were compared on an intention to treat basis. LCBDE was performed via our previously described technique using wire/catheter seldinger techniques under fluoroscopic guidance with flushing or balloon dilation of the sphincter as needed.

<u>**Results:**</u> 116 patients were treated for choledocholithiasis with half receiving LCBDE. Group demographics were similar. The success rate of catheter-based LCBDE was 72.4%. LOS was reduced for the LC+LCBDE group compared to the LC+ERCP group (60.9+5.82 vs 95.1+5.10 hrs, p <0.0001). Of note there were no intra- or postoperative complications in the LCBDE group. One quarter of ERCP patients required a 3rd procedure for stent removal.

<u>Conclusions</u>: A simplified catheter-based approach to LCBDE is safe and associated with decreased LOS when compared to ERCP. This approach may help facilitate wider LCBDE utilization by ACS providers who are well positioned to perform timely management of choledocholithasis in the OR.

Paper #8 January 18, 2023 10:45 am

MULTICOMPARTMENTAL TRAUMATIC INJURY INDUCES SEX-SPECIFIC ALTERATIONS IN THE GUT MICROBIOME

Jennifer A Munley, MD, Lauren S. Kelly, MD*, Erick Pons, BS, Preston Coldwell, BS, Kolenkode Kannan, PhD, Gwendolyn Gillies, MD, Philip Efron, MD*, Ravinder Nagpal, PhD, Alicia M. Mohr, MD* University of Florida

Presenter: Jennifer A Munley, MD

Discussant: Susannah Nicholson, MD, MS - Univ of TX Health Science Ctr at San Antonio

Objectives: Previous preclinical studies have demonstrated an altered gut microbiome after traumatic injury; however, the impact of sex on dysbiosis remains unknown. We hypothesized that the "pathobiome" phenotype induced by multicompartmental injuries and chronic stress is host sex specific with unique microbiome signatures.

Methods: Male and proestrus female Sprague-Dawley rats (n=8/group) aged 9-11 weeks were subjected to either polytrauma (PT) (lung contusion, hemorrhagic shock, cecectomy, bifemoral pseudofractures), PT plus 2-hours daily chronic restraint stress (PT/CS) or naïve controls. Fecal microbiome was measured on days 0 and 2 using high-throughput 16S rRNA sequencing and QIIME2 bioinformatics analyses. Microbial alpha diversity was assessed using Chao1 (number of different unique species) and Shannon (species richness and evenness) indices. Beta-diversity was assessed using principle coordinate analysis. Pairwise comparisons were performed in 'R' software package, with significance defined as p<0.05 between males versus females.

<u>Results:</u> PT reduced alpha diversity (Chao1) within 2-days post intervention, with a significant decrease in males compared to females (p<0.05). Beta diversity also differed significantly between males and females after PT (p = 0.01). At day 2, the microbial composition in PT females was dominated by *Ruminococcus* and PT/CS females by *Muribaculaceae*; whereas both PT and PT/CS males demonstrated elevated levels of *Bilophila*.

<u>Conclusions</u>: Multicompartmental trauma induces significant alterations in microbiome diversity and taxa, but these signatures differ by host sex. These findings suggest that sex is an important biological variable that may influence outcomes after severe trauma and critical illness.



Figure 1. Microbial composition of male (M) and female (F) rats by cohort (naïve, PT – polytrauma, and PT/CS – polytrauma with chronic stress) at day 2.



Figure 2. Beta diversity represented by principle coordinate analysis comparing males and females in each group at day 2.

Paper #9 January 18, 2023 11:00 am

PECTIN BASED BIOLOGIC VELCRO EFFECTIVELY SEALS TRAUMATIC SOLID ORGAN AND SMALL BOWEL INJURIES

James Williams, MD, Beau Prey, MD, Andrew Francis, MD, Michael Weykamp, MD, Betty Liu, MD, Michael Lallemand, MD*, Steven Mentzer, MD, John P Kuckelman, DO Madigan Army Medical Center

Presenter: James Williams, MD

Discussant: Joseph D. Forrester, MD, MSc - Stanford University

Objectives: Injuries to the liver and small bowel are common in poly trauma. While there are currently a variety of accepted operative techniques to expeditiously manage such injuries, morbidity and mortality remains high. Pectin polymers have previously been shown to effectively seal visceral organ injuries through physiochemical entanglement with the underlying glycocalyx. We sought to compare the standard of care for the management of penetrating liver and small bowel injuries with a proprietary pectin based bioadhesive patch.

Methods: 15 adult male swine underwent a laparotomy with identification of the left medial lobe of the liver. A laceration was made sharply and animals were randomized to 1 of 3 treatment arms: packing with laparotomy pads (N=5), suture repair (N=5), or pectin patch repair (N=5, Figure 1). Following 2 hours observation blood was evacuated from the abdominal cavity and weighed. A full thickness small bowel injury was then created and animals randomized to either a two-layer sutured repair (N=7) or pectin patch repair (N=8, Figure 2). The repaired segment of bowel was then pressurized with saline until the repair failed and the burst pressure recorded.

<u>Results:</u> Blood loss following pectin patch repair was similar to sutured liver repair (33 vs 26 ml, p=0.258). On one-way ANOVA there was no statistical difference between groups regarding post-repair blood loss (121ml packing, p=0.05). Post repair small bowel burst pressures were similar between pectin and sutured repair (234 vs 224 mmhg, p=0.43).

<u>Conclusions</u>: Pectin-based bioadhesive patch performed similarly to standard of care for the management of liver laceration and full thickness bowel injuries. Further testing is warranted to better assess the biodurability of a pectin patch repair as it may offer a rapid and simple option to effectively temporize traumatic intra-abdominal injuries.



A: Liver laceration. B: Pectin patch repair.



A: Full thickness bowel injury. B: Pectin patch repair.

Paper #10 January 18, 2023 11:15 am

RIB INJURY AFTER BLUNT TRAUMA IS ASSOCIATED WITH INCREASED LONG TERM OPIOID USAGE

Avanti Badrinathan, MD, Scott Martin, PhD, Aria Bassiri, MD, Vanessa P. Ho, MD, MPH, FACS*, Sami Kishawi, MD*, Matthew L. Moorman, MD, MBA, FACS, FAWM, FCCM*, Philip Linden, MD, Chris Towe University Hospitals Cleveland Medical Center

Presenter: Avanti Badrinathan, MD

Discussant: Tareq Khierbek, MD, ScM - Brown University

<u>Objectives</u>: The rate of long-term opioid use among rib fracture patients is unknown. We hypothesize that opioid naïve patients with rib fracture are at high risk for chronic opiate use.

Methods: We performed a retrospective study (Oct 2015- June 2022) of the TriNetX database, which includes EMR data for ~89 million patients from 58 US health systems. Adult blunt trauma patients with at least 1 rib fracture and no previous opioid use were included. Primary outcome was opioid use at 1-3, 3-6, and 9-12-months post-injury. Patient demographics were compared to determine characteristics associated with chronic (>3 months) opioid use following rib fractures. Patients with rib fracture were also compared to blunt trauma patients without rib fracture in a 1:1 propensity matched cohort to determine if rib fracture was a risk factor for chronic opiate use.

Results: We identified 45,286 opioid- naïve adults with rib fracture, of whom 27,637 (61%) received opioid pain management. Acute opioid use was associated with younger age, male, white race, and no history of tobacco/alcohol use. The rate of opiate use at 1-3, 3-6, and 9-12 months were 12.5%, 8.1%, and 6.4% respectively. Chronic use was associated with younger age, female, and a history of substance use (figure). In a propensity matched comparison of blunt trauma patients with and without rib fractures, patients with rib fracture were more likely to use opiates acutely (OR 2.38 (95%CI 2.28-2.48)) and chronically (OR 1.55 (95%CI 1.48-1.62) figure). At 9-12 months, patients with rib fractures were also more likely to have a diagnosis of "opiate use disorder" (OR 2.15 (95%CI 1.61-2.87)).

Conclusions: Relative to other blunt traumas, patients with rib fractures are more likely to receive opioids initially and up to 12 months post-injury. Risk factors for long-term narcotic use include younger age, female gender, and white race.



Figure 1: Opioid use trend by months post-injury

Paper #11 January 18, 2023 11:30 am

REBOA AND RESUSCITATIVE THORACOTOMY ARE ASSOCIATED WITH SIMILAR OUTCOMES AFTER TRAUMATIC CARDIAC ARREST

Ezra Koh, MD, Erin Fox, PhD, Charles E. Wade, PhD, Thomas M. Scalea, MD, FACS, FCCM*, Charles Fox, MD, Ernest Eugene Moore, MD*, Bryan C. Morse, MS, MD*, Kenji Inaba, MD, Eileen M. Bulger, MD, FACS*, David E Meyer, MD, MS* University of Texas Health Science Center at Houston

Presenter: Ezra Koh, MD

Discussant: Larry Lottenberg, MD - Florida Atlantic University School of Medicine

<u>Objectives</u>: Resuscitative endovascular balloon occlusion of the aorta (REBOA) is an alternative to resuscitative thoracotomy (RT) in hemorrhagic shock. However, its use in traumatic cardiac arrest remains undefined.

Methods: Secondary analysis of the Department of Defense multicenter Emergent Truncal Hemorrhage Control study of trauma patients in hemorrhagic shock due to noncompressible torso hemorrhage arising below the diaphragm. All data in the first 24 hours were collected by direct observation. Patients undergoing REBOA or RT after cardiac arrest in the emergency department were analyzed. Baseline variables and hospital outcomes were compared. Due to group imbalances at baseline, propensity scores were used to perform an inverse probability of treatment weighted (IPTW) analysis. Logistic regression was used to compare mortality between groups in the weighted sample.

<u>Results:</u> 454 patients were enrolled at six US level 1 trauma centers. Of these, 72(16%) underwent REBOA or RT following cardiac arrest. REBOA patients were older (46 ± 20 vs 35 ± 14 years, p=0.02) with more blunt trauma (21[81%] vs 21[46%], p=0.008) and less severe abdominal injuries (AIS Abd 3[2-3] vs 4[2-4], p=0.045). AIS Head, AIS Chest, and rates of prehospital CPR were similar (TABLE 1). Time from arrival to aortic occlusion, AO, (20[12-33] vs 8[6-11] min, p<0.001) and from AO decision to success (7[5-10] vs 4[3-6] min, p=0.001) were longer for REBOA. REBOA patients received more red blood cells and plasma in the ED, but 24-hour blood products, unadjusted mortality (23[88%] vs 43[93%], p=0.78), and time from arrival to death (96 vs 49 min, p=0.12) were similar (TABLE 2). After IPTW, mortality risk remained the same between groups (RR 0.97, 95%CI 0.86-1.09, p=0.56).

<u>Conclusions</u>: Despite controlling for baseline variables and injury severity, REBOA was not associated with a survival or transfusion advantage over RT in traumatic cardiac arrest.

Variable	REBOA	RT	p Value
Age	46 (20)	35 (14)	0.022
Male Gender	16 (62%)	36 (78%)	0.212
White Race	13 (50%)	21 (46%)	0.913
Penetrating Mechanism	5 (19%)	25 (54%)	0.008
Prehospital CPR	10 (38%)	24 (52%)	0.382
AIS Head	2 (0-3)	0 (0-3)	0.465
AIS Chest	3 (3-4)	3 (2-4)	0.825
AIS Abdomen	3 (2-3)	4 (2-4)	0.046
AIS Extremity	3 (2-4)	3 (0-3)	0.039
ISS	27 (12)	33 (17)	0.282

TABLE 1. Baseline characteristics dichotomized by treatment group (REBOA vs RT). Discrete data are presented as median (IQR). Continuous data are presented as mean (SD). Categorical data are presented as n (%). CPR = cardiopulmonary resuscitation; AIS = abbreviated injury score; ISS = injury severity score.

Variable	REBOA	RT	p Value
RBC ED, units	4.5 (3-7)	2.5 (2-4.75)	0.007
Plașma ED, units	3 (0.5-5)	1 (0-3)	0.032
RBC 24 hours, units	15 (5-31)	10 (3-32)	0.185
Plasma 24 hours, units	8 (5-26)	7 (2-25)	0.211
Time from arrival to AO, min	20 (12-33)	8 (6-11)	< 0.001
Time from AO decision to success, min	7 (5-10)	4 (3-6)	0.001
Time from arrival to death, min	96 (30-305)	49 (17-173)	0.118
Mortality	23 (88%)	43 (93%)	0.767

TABLE 2. Hospital outcomes dichotomized by treatment group (REBOA vs RT). Discrete data are presented as median (IQR). Continuous data are presented as mean (SD). Categorical data are presented as n (%). RBC = red blood cells; AO = aortic occlusion.

Paper #12 January 18, 2023 11:45 am

SCANNING THE AGED TO MINIMIZE MISSED INJURY, AN EAST MULTICENTER TRIAL

Sami Kishawi, MD*, Joseph O'Brien, BA, Asanthi M Ratnasekera, DO, FACS*, Sirivan S. Seng, MD*, Trieu Hai Ton, DO, Christopher Butts, PhD, DO, FACOS, FACS*, Alison Muller, MSPH, Bernardo F. Diaz, MD*, Gerard A. Baltazar, DO, FACOS, FACS*, Patrizio Petrone, MD PhD MPH MHSA FACS, Tulio Brasileiro Silva Pacheco, MD, Shawna L. Morrissey, DO*, Timothy Chung, DO, Jessica Biller, DO, Lewis E. Jacobson, MD, FACS*, Jamie Williams, MSML, BSN, RN CCRP, Cole Nebughr, Pascal O. Udekwu, MD, MBA, MHA*, Kimberly Tann, BS, Charles Piehl, BA, Jessica Veatch, MD*, Thomas Capasso, Eric Kuncir, MD MS FACS, Lisa M. Kodadek, MD*, Samuel M. Miller, MD*, Defne Altan, BA, Caleb J. Mentzer, DO*, Nicholas Damiano, BS, MA, Rachel Burke, BS, Angela Earley, MD, FACS, Stephanie Doris, DO, Erical Villa, DO, Michael Wilkinson, MD, Jacob Dixon, MD, Esther Wu, MD, FACS, Melissa Whitmill, MD, FACS*, Brandi Palmer, MS, Karen Herzing, MSN, RN, Tanya Egodage, MD*, Jennifer Williams, MD, James M. Haan, MD*, Kelly Lightwine, MPH, Kristin P Colling, MD*, Melissa Harry, PhD, MSW, Jeffry Nahmias, MD, MHPE, FACS, FCCM*, Erika Tay, MD, Joseph Cuschieri, Christopher Hinojosa, AB, Vanessa P. Ho, MD, MPH, FACS* MetroHealth Medical Center

Presenter: Sami Kishawi, MD

Discussant: Krista Haines, DO - Duke University

<u>Objectives</u>: Variations in imaging practices in the workup of geriatric trauma patients may lead to missed injuries. We hypothesized that specific patient or trauma factors are associated with delayed injury diagnosis, defined as injuries not found on initial imaging workup.

Methods: We prospectively enrolled blunt trauma patients aged 65+ from 11/2020-12/2021 at eighteen Level I and II trauma centers and excluded ED deaths. Demographics, presenting history, physical exams, and diagnostic imaging performed at initial evaluation were collected. Abbreviated injury scale (AIS) codes listed at discharge were used to determine injuries to the head, cervical spine and neck, chest, abdomen, pelvis, and thoracic/lumbar spine, corresponding to body regions assessed by CT. Injured patients who did not initially receive the CT scans corresponding to their listed injuries were defined as having a delayed injury diagnosis. Logistic regression analysis identified factors associated with delayed diagnoses.

<u>Results:</u> Of 5,468 patients, median age was 79 [IQR 71-86], 55% were female, and 65% sustained a ground-level fall. Nearly 80% (n=4,320) were injured and mortality was 4.5%. The most common initial imaging studies were CT Head (92%) and CT C-Spine (89%). Close to 9% (n=480) of subjects had delayed injury diagnoses, most often involving the thoracic and lumbar spine and the vasculature or soft tissue of the neck (Table 1). In adjusted logistic regression, trauma consults, transfers from outside facilities, and primary language other than English or Spanish were associated with increased risk of delayed injury diagnosis (Table 2).

Conclusions: Nearly one in ten geriatric blunt trauma patients sustained injuries in body regions not imaged on initial workup. Vigilance is needed for transfers, consults, and foreign language speakers. Decision tools to reduce variation in imaging practices may minimize risk of missed injury in this vulnerable population.

Body Region	Corresponding CT Scan	CT Scan Initially Ordered, n (%)	Patients with Injuries, n (%)	Delayed injury diagnoses, n
Head	CT Head	5,040 (92.2%)	1,042 (19.1%)	13
Neck (Spine)	CT C-Spine	4,850 (88.7%)	446 (8.2%)	10
Neck (Vascular, soft tissue)	CTA Neck	723 (13.2%)	42 (0.7%)	16
Chest	CT Chest	3,472 (63.5%)	988 (18.1%)	76
Abdomen/Pelvis	CT Abd/Pel	3,498 (64.0%)	406 (7.4%)	41
Back	CT T/L-Spine	1,159 (21.2%)	592 (10.8%)	353

Table 1. Imaging characteristics and c	delayed injury diagnoses (n=5,468).
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	Odds Ratio	95% Conf. Int.	<i>p</i> -value
Age	0.984	0.967-1.00	0.053
Gender			
Male	(ref)		
Female	1.123	0.861-1.466	0.390
Activation Level			
Full	(ref)		
Limited	0.755	0.539-1.057	0.102
Consult	1.675	1.118-2.510	0.012
Origin			
Scene	(ref)		
Transfer	1.541	1.154-2.059	0.003
Language			
English	(ref)		
Spanish	0.262	0.035-1.931	0.189
Other	2.524	1.016-6.268	0.046
Unknown	2.020	1.095-3.726	0.024
Functional Status			
Independent	(ref)		
Partly dependent	0.458	0.292-0.720	0.001
Fully dependent	1.841	0.842-4.025	0.126
Unknown	0.603	0.362-1.004	0.052
Dementia	0.476	0.262-0.863	0.014
Loss of Consciousness	1.029	0.836-1.267	0.788
Intoxication (EtOH ≥50 mg/dL)	0.710	0.412-1.223	0.217
Distracting Injury	1.323	0.847-2.064	0.218

Table 2. Adjusted logistic regression demonstrating odds of delayed injury diagnosis.

Paper #13 January 19, 2023 1:30 pm

EMERGENCY DEPARTMENT VERSUS OPERATING ROOM INTUBATION OF PATIENTS UNDERGOING IMMEDIATE HEMORRHAGE CONTROL SURGERY

Zachary Dunton, BS MPH, Mark J. Seamon, MD, FACS*, Madhu Subramanian, MD*, Jeffrey K. Jopling, MD, MSHS*, Mariuxi C Manukyan, MD*, Alistair J Kent, MD, MPH*, Joseph V. Sakran, MD, MPH, MPA, FACS*, Kent Stevens, MD, Elliott R. Haut, MD, PhD, FACS*, James P. Byrne, MD, PhD* Johns Hopkins School of Medicine

Presenter: Zachary Dunton, BS MPH

Discussant: Douglas Schuerer, MD - Washington University School of Medicine

<u>Objectives</u>: Among patients that require hemorrhage control surgery, premature intubation in the ED can exacerbate shock and precipitate extremis. We hypothesized that intubation in the ED (EDI) vs. operating room is associated with adverse outcomes at both the patient and hospital-levels.

<u>Methods</u>: Patients undergoing immediate surgery for hemorrhage control at level 1 or 2 trauma centers were identified (NTDB 2017-19). To minimize confounding, patients dead-on-arrival, undergoing ED thoracotomy, or with clinical indications for intubation (severe head/neck/face injury or GCS≤8) were excluded. Two analytic approaches were used. First, hierarchical logistic regression measured the risk-adjusted association between EDI and mortality. Secondary outcomes included ED dwell time, units of blood transfused, and major complications (cardiac arrest, ARDS, AKI, sepsis). Second, center-level analysis explored whether hospital tendency for EDI was associated with adverse outcomes.

Results: 9,667 patients treated at 253 trauma centers met inclusion criteria. Patients were predominantly young men (median age, 33 years) that suffered penetrating injuries (71%). Median GCS was 15. One-in-five (20%) patients underwent EDI. After risk-adjustment, EDI was associated with increased risk of mortality, longer ED dwell time, greater blood transfusion, and major complications (**Table**). Center-level analysis identified significant variation in use of EDI not explained by differences in patient case-mix (**Figure**). Compared to low EDI centers, patients treated at high EDI centers were significantly more likely to suffer in-hospital cardiac arrest (6 vs. 4%; adjusted OR 1.46; 95%CI 1.04-2.03).

<u>Conclusions</u>: ED intubation of patients that undergo hemorrhage control surgery is associated with adverse outcomes. Where feasible, intubation should be deferred in favor of rapid resuscitation and transport to operating room.

	ED Intubation (n = 1,972)	OR Intubation (n = 7,695)	OR/RR (95% CI)
Primary Outcome			
Overall mortality	17%	7%	1.9 (1.6 – 2.3)
Secondary Outcomes			
Median ED dwell time	31 mins	22 mins	1.2 (1.2 – 1.3)
Median RBC transfusion at 4h	6 units	4 units	1.2 (1.2 – 1.3)
Major complications			
Cardiac arrest with CPR	10%	4%	1.7 (1.4 – 2.2)
AKI	6%	4%	1.5 (1.1 – 1.9)
ARDS	3%	1%	1.6 (1.1 – 2.3)
Sepsis	3%	2%	1.3 (0.9 – 1.8)



Figure. Caterpillar plot of trauma center risk-adjusted odds of ED intubation. Significant variation observed is not attributable to measured differences in patient characteristics.

Paper #14 January 19, 2023 1:45 pm

CHARACTERIZATION OF FATAL BLUNT INJURIES USING POST-MORTEM COMPUTED TOMOGRAPHY

Jeremy H. Levin, MD*, Peter M Hammer, MD*, Scott D Steenburg, MD, FASER Indiana University

Presenter: Jeremy H. Levin, MD

Discussant: Jordan Estroff, MD - George Washington University

Objectives: Rapid triage of blunt agonal trauma patients is necessary to maximize survival, but autopsy is uncommon, slow, and rarely informs resuscitation guidelines. Post-mortem computed tomography (PMCT) can serve as an adjunct to autopsy in guiding blunt agonal trauma resuscitation. The aim of this novel pilot study is to characterize injury patterns in fatal blunt trauma to better inform resuscitation practices.

Methods: Retrospective cohort review of trauma decedents over a 9 year period who died at or within 1 hour of arrival following blunt trauma and underwent non-contrasted PMCT. Primary outcome was the prevalence of major injury defined as potential exsanguination (e.g., cavitary injury, long bone, pelvic fractures), TBI, and cervical spine injury. Secondary outcomes were significant pneumothoraces (PTX) and misplaced airway devices. Patients were grouped by pre- vs in-hospital arrest. Univariate analysis was used to identify differences in injury patterns including poly-cavitary injury.

<u>Results:</u> 80 decedents were included with average age 48.9 years, 68% male, average ISS 42.3 ± 16.3, and most common mechanism motor vehicle accidents (67.5%) with no significant differences in demographics. Prehospital traumatic arrest occurred in 62 (77.5%) decedents while 18 (22.5%) arrived with pulse (table 1). The most common major injuries were TBI (41.3%), long bone fractures (25%), significant hemoperitoneum (22.5%), and cervical spine injury (18.8%). Secondary outcomes included moderate/large PTX (18.8%) and 5% esophageal intubation rate. There were no significant differences in primary or secondary outcomes, and no differences in poly-cavitary injury pattern (table 2).

Conclusions: Fatal blunt injury patterns do not vary between pre-/in-hospital arrest decedents. High rates of pneumothorax and endotracheal tube misplacement should prompt mandatory chest decompression and confirmation of tube placement in all blunt arrest patients.

Table 1: Decedent Demographics and Injury Patterns

		Overall	Pulseless	Pulse	
		(N = 80)	(n = 62)	(n = 18)	р
	Age (years)	48.9 +/- 21.7	49.9 +/- 20.5	45.8 +/- 25.6	0.5
	Sex (Male, %)	56 (68.3%)	43 (69.4%)	13 (72.2%)	0.82
	Mechanism of Injury (%)				0.03
3	Fall	3 (3.8%)	0 (0%)	3 (16.7%)	
ial d	MVC	54 (67.5%)	42 (67.7%)	12 (66.7%)	
L.	MCC	5 (6.3%)	4 (6.5%)	1 (5.6%)	
ion	ATV	1 (1.5%)	1 (1.6%)	0 (0%)	
Jer (Ped Struck	12 (15%)	10 (16.1%)	2 (11.1%)	
-	Crush/Machinery	5 (6.3%)	5 (8.1%)	0 (0%)	
	Injury Severity Score	42.3 +/- 16.3	42.1 +/- 16.4	42.6 +/- 16.3	0.09
	Arrived Pulseless	62 (77.5%)			
	Traumatic Brain Injury	33 (41.3%)	29 (46.8%)	4 (22.2%)	0.06
	Herniation	9 (11.3%)	9 (14.5%)	0 (0%)	0.09
	Cervical Spine Injury	15 (18.8%)	12 (19.4%)	3 (5.6%)	0.8
	Airway				
	Endotracheal Intubation	26 (32.5%)	18 (29%)	8 (44.4%)	0.22
	Pre-hospital Endotracheal intubation	34 (42.5%)	26 (41.9%)	8 (44.4%)	0.85
	Malpositioned ETT	12 (15%)	9 (14.5%)	3 (6.7%)	0.82
	Esophageal intubation	4 (5%)	3 (4.8%)	1 (5.6%)	0.9
	Chest Trauma				
	Moderate/Large Pneumothorax	29 (36.3%)	23 (37.1%)	6 (33.3%)	0.82
SE .	Moderate/Large Hemothorax	18 (22.5%)	16 (25.8%)	2 (11.1%)	0.35
tte	Pneumothorax without chest tube	15 (18.8%)	12 (19.4%)	3 (16.7%)	0.8
Pa	Abdominal Trauma				
È.	Splenic laceration	15 (18.8%)	11 (17.7%)	4 (22.2%)	0.67
÷	Liver lacertion	6 (7.5%)	3 (4.8%)	3 (6.7%)	0.09
1	Moderate/Large Hemoperitoneum	18 (22.5%)	11 (17.7%)	7 (38.9%)	0.06
	Pelvic/Retroperitoneal Trauma				
	Any pelvic fracture	26 (32.5%)	19 (30.6%)	7 (38.9%)	0.51
	APC III	1 (1.3%)	1 (1.6%)	0 (0%)	0.59
	LC III	5 (6.3%)	4 (6.5%)	1 (5.6%)	0.89
	Vertical Shear	0 (0%)	0 (0%)	0 (0%)	
	Extremity Trauma				
	Any long bone	20 (25%)	13 (21%)	7 (38.9%)	0.12
	Unilateral femur	15 (18.8%)	10 (16.1%)	5 (27.8%)	0.17
	Bilateral femur	3 (3.8%)	3 (4.8%)	0 (0%)	0.34

pedastrian, ETT: endotracheal tube, APC: anterior/posterior compression, LC: lateral compression

Decedent demographics and injury patterns

Table 2: Cavitary and Poly-Injury Patterns

		Overall	Pulseless	Pulse	
		(N = 80)	(n = 62)	(n = 18)	р
Cavity	Abdominal Cavity	24 (30%)	18 (29%)	5 (27.8%)	0.73
	Retroperitoneum/Pelvis	33 (41.3%)	24 (38.7%)	9 (50%)	0.39
	Thoracic Cavity	38 (47.5%)	32 (51.6%)	6 (33.3%)	0.17
	Long Bones	27 (21.3)	12 (19.4%)	5 (27.8%)	0.44
Multi-cavity	No Cavitary Injury	17 (21.3%)	13 (21%)	4 (22.2%)	0.9
	Solitary Cavitary Injury	26 (32.5%)	21(33.9%)	5 (27.8%)	0.63
	Two Cavity Injury	27 (33.8%)	21(33.9%)	6 (33.3%)	0.97
	Three Cavity Injury	8 (10%)	5 (8.2%)	3 (16.7%)	0.28
	Four Cavity Injury	2 (2.5%)	2 (3.2%)	0 (0%)	0.44
Mixed System	Isolated TBI	6 (7.5%)	4 (5%)	2 (11.1%)	0.51
	Isolated Cervical Spine Injury	0 (0%)	0 (0%)	1 (5.6%)	
	Isolated TBI and Cervical Spine Injury	4 (5%)	4 (6.5%)	0 (0%)	
	TBI & Solitary Cavity	9 (11.3%)	6 (9.7%)	3 (16.7%)	0.44
	TBI & Two Cavities	11 (13.8%)	10 (12.5%)	1 (5.6%)	0.25
	TBI & Three Cavities	3 (3.8%)	2 (3.2%)	1 (5.6%)	0.65

TBI: traumatic brain injury

Cavitary and poly-injury patterns

Paper #15 January 19, 2023 2:00 pm

BURN EXCISION WITHIN 48 HOURS PORTENDS BETTER OUTCOMES THAN STANDARD MANAGEMENT

 Walter A. Ramsey, MD, Christopher O'Neil, MD, Rebecca A. Saberi, MD MSPH, Gareth P. Gilna, MD, Shevonne Satahoo, MD, Joyce I. Kaufman, MD, Carl I. Schulman, MD, MSPH*, Nicholas Namias, MBA, MD*, Kenneth Proctor, PhD, Louis R. Pizano, MD*
Ryder Trauma Center, University of Miami Miller School of Medicine

Presenter: Walter A. Ramsey, MD

Discussant: Alisa Savetamal, MD - Bridgeport Hospital/ Connecticut Burn Center

Objectives: Previous studies have debated the optimal time to perform excision and grafting of second- and third-degree burns. The present consensus is that excision should be performed before the sixth hospital day. We hypothesize that patients who undergo excision within 48 hours have better outcomes.

Methods: The Trauma Quality Improvement Project (TQIP) dataset was used to identify all patients with at least 10% total body surface area (TBSA) second- and third-degree burns from years 2017-2019. Patients with other serious injuries (any AIS >3), severe inhalational injury, pre-hospital cardiac arrest, and interhospital transfers were excluded. ICD-10 procedure codes were used to ascertain time of first excision. Patients who underwent first excision within 48 hours of admission (early excision) were compared to those who underwent surgery 48-120 hours from admission (control). Propensity score matching was performed to control for age and TBSA burned.

<u>Results</u>: 2,270 patients (72% male) were included in the analysis. Median age was 37 (23-55) years. Early excision was associated with shorter hospital length of stay (LOS), and ICU LOS (Table 2). Complications including deep venous thrombosis, pulmonary embolism, all venous thromboembolism, ventilator-associated pneumonia, and catheter-associated urinary tract infection were significantly lower with early excision. There was no significant difference in mortality.

<u>Conclusions</u>: Performance of excision within 48 hours is associated with shorter hospital LOS and fewer complications than standard therapy. We recommend taking patients for operative debridement and temporary or, when feasible, permanent coverage within 48 hours. Prospective trials should be performed to verify the advantages of this treatment strategy.

	Early Excision (Within 48 Hours) n = 1,135 (50%)	Control (48-120 Hours) n = 1,135 (50%)	
Age*	36 (22-54)	38 (23-55)	
Female	317 (28)	323 (29)	
TBSA 10-19%	722 (64)	722 (64)	
TBSA 20-29%	207 (18)	207 (18)	
TBSA 30-39%	82 (7)	82 (7)	
TBSA 40-89%	123 (11)	123 (11)	
TBSA >89%	1 (0)	1 (0)	

TABLE 1: DEMOGRAPHICS

*Reported as median (interquartile range)

TABLE 2: OUTCOMES

	Time from Arrival					
	Within 48 Hours n = 1,135 (50%)	Within 48-120 Hours n = 1,135 (50%)	p-value			
	Clinical Outcomes					
Hospital Length of Stay*	12 (5-26)	16 (11-28)	<0.001			
ICU Length of Stay*	8 (3-22)	11 (5-22)	<0.001			
Mortality	69 (6)	54 (5)	0.164			
	Complications					
Deep Venous Thrombosis	12 (1)	24 (2)	0.044			
Pulmonary Embolism	1 (0)	8 (1)	0.039			
Venous Thromboembolism	12 (1)	28 (3)	0.011			
Ventilator-Associated Pneumonia	38 (3)	57 (5)	0.047			
Catheter-Associated Urinary Tract Infection	13 (1)	27 (2)	0.026			

*Reported as median (interquartile range)

Paper #16 January 19, 2023 2:15 pm

AUTOMATED RIB FRACTURE DETECTION AND CHARACTERIZATION ON COMPUTED TOMOGRAPHY SCANS USING COMPUTER VISION

Jeff Choi, MD, MSc*, Sathya Edamadaka, David Brown, BSc, David A Spain, MD, FACS*, Joseph D. Forrester, MD, MSc*, Jeff Choi, MD, MSc* Stanford University

Presenter: Jeff Choi, MD, MSc

Discussant: Patrick Greiffenstein, MD - LSU Health Science Center-New Orleans

Objectives: Rib fractures comprise diverse injury patterns; quantifying number and displacement of rib fractures are critical for clinical decision-making (e.g. surgical stabilization). Unfortunately, manually characterizing each rib fracture is tedious and limiting care planning and precision research. We developed a computer vision model using publicly-available data that automates rib fracture detection and percent displacement computation on chest computed tomography (CT) scans.

Methods: We developed and validated our model using the publicly-available RibFrac dataset (5,000 radiologist-annotated rib fractures from 660 chest CT scans; 64%-12%-24% train-validation-test sets). We developed a deep learning UNet segmentation model to detect rib fractures using class reweighting to account for dataset imbalance (few CT slices comprising fractures). After detecting fractures, deterministic calculations quantified percent displacement (0 [non-displaced] to >100% [> one rib-width displaced]). Model performance was measured using binary DICE score, the most popular medical image segmentation metric (range 0 to 1.0, describing the overlap of predicted and actual fractures).

<u>Results:</u> Our model achieved a test set binary DICE score of 0.88, the highest performance among rib fracture detection models currently available. With class reweighting, our model's area under the receiver operating characteristic curve was 0.99. Qualitative analysis confirmed our model computes percent displacement accurately for various rib fracture patterns (Figures).

Conclusions: We developed a computer vision model automating rib fracture detection and percent displacement computation. To our knowledge, our model is first to quantify percent displacement. Open-source code and data are publicly-available to advance the frontier of personalized rib fracture management and precision research.



Figure 1. A) Convolutional UNet architecture for the deep learning computer vision model. B) Leftexample input CT scan (rotated 90 degrees) and model-detected rib fracture; Right- analyzed, preprocessed CT scan section after individual fracture segments were detected.



Figure 2. A) Percent displacement calculated for rib fracture in Fig 1, aggregated across several CT scan slices to account for 3-dimension volume. Predicted displacement > 100%. B) Percent displacement calculated for a different fracture with roughly 50% displacement.

Paper #17 January 19, 2023 2:30 pm

PATIENT-REPORTED OUTCOMES IN TRAUMA: WHAT IS IMPORTANT TO INJURED PATIENTS?

Jason S. Hutzler, MD, Marc D. Trust, MD*, Tatiana Carla Pereira Cardenas, MD, MS, FACS*, Joseph J. DuBose, MD*, Jayson Aydelotte, MD*, James Bradford, Sadia Ali, MPH, Chloe Ng-wing-sheung, MPH, Lawrence Brown, PhD, Carlos V.R. Brown, MD* University of Texas at Austin Dell Medical School

Presenter: Jason S. Hutzler, MD

Discussant: Amy Krichten, MSN, RN, CEN, TCRN - PA Trauma Systems Foundation

Objectives: Traditionally, outcomes in trauma have been quantified by objective measures such as mortality and length of hospital stay. With increased survival after injury, focus has shifted to quality-of-life measures. Patient-reported outcomes (PROs) have become a valuable focus for improving quality of care in specific subsets of disease. However, little has been published about PROs specific to the trauma population. This study aims to identify important factors to injured patients in the sub-acute period to guide efforts to develop PRO measures specific for trauma patients.

Methods: Between 2019 and 2022, all trauma patients admitted to our Level I trauma center were prospectively screened for inclusion. All adult patients who met inclusion criteria and agreed to answer survey questions were included. Study participants were surveyed using open-ended questions to determine their most important concerns. These questions were "What are your biggest concerns?" and "What is important to you?". The responses were evaluated for common themes.

<u>Results</u>: Responses from 548 patients were collected. The responses were generally related to four major categories of concern. 62% of patients were concerned with specific aspects of their physical recovery, such as ability to recover, mobility, and time to recovery. 14% were most concerned with the socioeconomic aspects of their trauma, including cost of care, family concerns, and ability to work, and 10% had psychosocial concerns such as communication and safety. Other concerns (14%) were variable.

Conclusions: Our findings show that for most trauma patients, primary concerns are related to physical recovery. Efforts to develop and utilize PROs should focus on measures that relate to physical recovery as a marker for quality of life. However, psychosocial and socioeconomic concerns were not uncommon, and these factors should be accounted for when developing PROs specific to trauma patients.

Category n (%)	Physical Recovery 341 (62)	Socioeconomic 75 (14)	Psychosocial 55 (10)	Other 77 (14)
Subcategory n (% of primary category)	Ability to Recover 133 (39)	Financial 26 (35)	Communication 38 (69)	No Concerns 34 (44)
	Mobility 60 (18)	Family 34 (45)	Safety 17 (31)	Other 43 (56)
	Time to Recovery 43 (13)	Work 15 (20)		
	Pain Control 34 (10)			
	Overall Health 27 (8)			
	ADL's 23 (7)			
	Survival 10 (3)			
	Cosmesis 11 (3)			

Categories of Survey Responses

Paper #18 January 19, 2023 2:45 pm

TIMING OF REGIONAL ANALGESIA IN GERIATRIC BLUNT CHEST WALL INJURY

Jefferson Proaño-Zamudio, MD, Dias Argandykov, MD, Angela Renne, BS, Anthony Gebran, MD, Joep J. J. Ouwerkerk, BSc, Ander Dorken Gallastegi, MD, George Velmahos, MD, PhD, MSEd, Haytham Kaafarani, MD, MPH*, John O. Hwabejire, MD, MPH* Massachusetts General Hospital

Presenter: Jefferson Proaño-Zamudio, MD

Discussant: Sabrina Sanchez, MD, MPH - Boston Medical Center

Objectives: Rib fractures represent a typical injury pattern in the elderly and are associated with respiratory morbidity and mortality. Regional analgesia (RA) modalities are adjuncts for pain management, but the optimal timing for their initiation remains understudied.

<u>Methods</u>: We performed a retrospective review of the TQIP 2017-2019 database. We included patients ≥65 years old admitted with blunt chest wall trauma who received RA. We divided patients into two groups: 1) Early RA (within 24 hours of admission) and 2) Late RA (>24 hours). Patients who remained inpatient for less than 24 hours or had severe thoracic visceral injuries were excluded. The outcomes evaluated were ventilator-associated pneumonia (VAP), unplanned ICU admission, unplanned intubation, survival with discharge to home, and length of stay (LOS). Univariable analysis and multivariable logistic regression adjusting for patient and injury characteristics, trauma center level, and respiratory interventions were performed.

<u>Results:</u> 2,292 patients were included. The mean(SD) age was 75.3(6.9), and 52.8% were male. The median ISS(IQR) was 13(9-17). The Early RA group had a decreased incidence of unplanned intubation (2.9% vs 5.4%, p=0.002), unplanned ICU admission (4.8% vs 8.3%, p<0.001), and shorter mean LOS (5.6 days vs 6.5 days, p=0.003). There were no significant differences in the development of VAP. In multivariable analysis, early RA was associated with decreased odds of unplanned intubation, unplanned ICU admission, and increased odds of discharge to home (Figure 1).

<u>Conclusions</u>: Early regional analgesia initiation is associated with improved outcomes in old blunt chest wall injury. Geriatric trauma care bundles targeting early initiation of regional analgesia have the potential to decrease complications and resource use.



Figure 1. Outcomes of Early RA compared to Late RA.

Paper #19 January 19, 2023 3:00 pm

EARLY CAREER ACUTE CARE SURGEONS' WORK PRIORITIES AND PERSPECTIVES: A MIXED-METHODS ANALYSIS

Patrick B Murphy, MD, MPH, MSc*, Jamie J. Coleman, MD, FACS*, Rachel S. Morris, MD*, Morgan Maring, David Deshpande, Juan F. Figueroa, MD, Courtney Pokrzywa, MD, Marc A. de Moya, MD* Medical College of Wisconsin

Presenter: Patrick B Murphy, MD, MPH, MSc

Discussant: Scott Sagraves, MD - Baylor Scott & White Medical Center-Temple

<u>Objectives:</u> Understanding the expectations of early career acute care surgeons (EC-ACS) will help clarify practice and employment models that will attract high-quality surgeons and sustain our workforce. This study aims to outline the clinical and academic preferences and priorities of fellows and EC-ACS when selecting their first job.

Methods: A survey on clinical responsibilities, employment preferences, work priorities and compensation was distributed to fellows and acute care surgeons in the first five years of practice. Agreeable respondents underwent virtual semi-structured interviews. Both quantitative and thematic analyses were used to describe current responsibilities and perspectives.

Results: 167 of 471 surgeons responded (35%), the majority of whom were assistant professors (62%) within the first 3 years of practice (80%). Median desired clinical volume was 24 clinical weeks and 48 call shifts per year. Top priorities cited in choosing a job were geography, schedule, and culture (Figure 1). There were discrepancies in current and desired practice types and operative volumes (Table 1). 36% of respondents stated their operative volume was less than desired. In our qualitative interviews we identified several themes. Interviewees were polarized on the role of elective surgery, desired transparency surrounding scheduling and expectations, and identified uncertainty about ideal employment and compensation. Three phenotypes of EC-ACS were identified based on preferred service, model preference, and the role of elective surgery.

Conclusions: Understanding the perspectives of early career surgeons entering the workforce is important. There is currently no standard workload or practice model in the field of acute care surgery. The wide variety of operative expectations, practice and schedule preferences, and academic aspirations emphasizes the need for transparency to ensure both employer and employee satisfaction.


Figure 1: Top five job characteristics identified by early career acute care surgeons

	Early Career Surgeons (n = 167)					
Variable	ariable Current Desired					
Type of Practice						
Service Based	120 (72%)	102 (61%)				
Shift Based	37 (22%)	59 (35%)				
Annual Operative Volume						
< 100	15 (10%)	3 (2%)				
100 - 200	47 (32%)	30 (20%)				
200 - 300	52 (35%)	26 (25%)				
300 - 400	26 (17%)	36 (25%)				
> 400	9 (6%)	12 (8%)				

Table 1: Current versus desired practice type and operative volume for early career acute care surgeons

Scientific Session III - Potpourri

Paper #20 January 19, 2023 3:15 pm

UTILITY OF CT THORACOLUMBAR SPINAL RECONSTRUCTION IMAGING IN BLUNT TRAUMA

Abhishek Swarup, MD*, Rachel L. Choron, MD, FACS*, John Park, Alexander Cong, Christopher Amro, MD Rutgers Robert Wood Johnson Medical School

Presenter: Abhishek Swarup, MD

Discussant: Rachel L. Warner, DO - University of Florida-Jacksonville

Objectives: Fractures of the thoracolumbar (TL) spine are common in trauma and may cause neurologic damage, pain, and reduced quality of life. With CT chest/abdomen/pelvis (CAP) advances, identification of these injuries has improved. TL reconstructions from CT CAP prevent added radiation and are used to screen for TL fractures. The purpose of this study is to determine if we are over utilizing reformatted TL images. We hypothesized that reformatted TL images do not identify additional clinically significant injuries or change outcomes.

<u>Methods</u>: We performed a retrospective review of patients admitted to a Level 1 Trauma Center (2016-2021). Patients ≥18 with TL fractures diagnosed on CT CAP with/without CT TL reformats were included. Data/outcomes were collected from the medical record and trauma registry. Appropriate statistical analysis was performed, and significance was defined as p<0.05.

<u>Results:</u> 494 patients with TL fractures had both CT TL/CAP. There were 1394 TL fractures on CT TL and 1265 fractures on CT CAP. Significantly more transverse process fractures were identified on CTTL than CAP (p<0.01). Other fracture discrepancies were not significant. No unstable fractures were missed on CT CAP. 66 patients with TL fractures had CT CAP only. Significantly more MRIs were performed in those with both CTCAP&TL (198 vs 9, p<0.05). Spine consultation (89%vs67%, p<0.01) and operative fixation(11%vs2%, p=0.01) were also associated with TL reformats. TL reconstructions were not correlated with differences in mortality, neurologic deficits, or adverse outcomes.

Conclusions: CTCAP alone is sufficient to identify clinically significant TL fractures without impacting neurologic outcomes, morbidity, or mortality. Clinically insignificant injuries on CTTL are associated with increased MRIs and the potential for inefficient use of resources. Selective TL reformats for operative planning or at spine surgeon discretion may optimize care utilization.

		T Spine	pine L Spine				
Fracture Type	CT Thoracic Spine	Not Detected on CTCAP	р	CT Lumbar Spine	Not Detected on CTCAP	р	
Transverse Process	263	21	<0.01	485	44	<0.01	
Spinous Process	75	0	0.50	22	3	0.23	
Vertebral Body	303	46	0.30	160	5	0.06	
Burst	11	2	0.48	21	4	0.11	
Facet	21	0	1	5	3	0.17	
Pedicle	6	2	0.45	7	2	0.45	
Other	11	2	0.48	4	0	0.45	
Total	690	73	1	704	61	1	

TABLE 1: FRACTURE PATTERN DATA

*CAP= CHEST/ABDOMEN/PELVIS

Outcomes	CT-CAP AND TL Spine	CT-CAP ONLY	Р
Hospital Length of Stay (days)	7.15	6.56	0.68
ICU Length of Stay (days)	2.66	2.05	0.57
Ventilator Days (days)	1.29	2.48	0.61
Imaging (%)			
CT Chest	482 (98)	66 (100)	0.38
CT Abdomen/Pelvis	479 (97)	64 (97)	1
CT Thoracic Spine	477 (97)		
CT Lumbar Spine	473 (96)		
MRI Thoracic Spine	102 (21)	3 (5)	< 0.01
MRI Lumbar Spine	96 (19)	6 (9)	0.046
MRI resulting in discharge delay (%)	33 (7)	3 (5)	0.79
Spine Consult (%)	441 (89)	44 (67)	<0.01
Neurologic deficits on admission	45 (9)	3 (5)	0.27
Neurologic deficits on discharge	5 (11)	2 (3)	0.19
Unstable fracture (%)	51 (10)	3 (5)	0.18
Operative fixation (%)	52 (11)	1 (2)	0.01
Disposition (%)		11111	10533
Home	246 (50)	34 (52)	0.89
Acute Rehabilitation	119 (24)	14 (21)	0.76
Subacute Nursing Facility	83 (17)	13 (20)	0.60
Long Term Acute Care Hospital	5 (1)	0(0)	1
Morgue	31 (6)	2 (3)	0.41
Other	10 (2)	3 (4)	0.19
Spine Injury Rehabilitation (%)	30 (2)	3 (5)	0.79
Mortality (%)	31 (6)	2 (3)	0.41

TABLE 2: OUTCOMES DATA

Paper #21 January 19, 2023 1:30 pm

STEPPING-ON STEPS-UP: EVALUATION OF THE STEPPING-ON FALL PREVENTION PROGRAM

Laurie Lovedale, MPH, Shane Urban, BSN, RN*, Robyn Wolverton, MSN RN CEN TCRN, Kathleen Flarity, DNP, PhD, CEN, CFRN, FAEN, FAAN, Michael W. Cripps, MD, FACS*, Catherine G. Velopulos, MD, MHS, FACS* UCHealth University of Colorado Hospital

Presenter: Laurie Lovedale, MPH

Discussant: Lisa Allee, MSW, LICSW - Boston Medical Center

<u>**Objectives:**</u> One third of people \geq 65 year-old will experience a fall each year, and the elderly account for nearly 70% of fall-related deaths. We sought to evaluate improvement in fall risk and fear of falling in participants of our fall prevention program.

<u>Methods</u>: We have been offering Stepping-On since 2017, a low cost, low resource 7-week fall prevention program for those ≥ 65 , or those who fear falling. The Timed-Up-and-Go (TUG) test is a validated tool used to assess the impact of Stepping-On pre-and post-participation. Participants start the test in a chair, stand, walk 10 feet, turn around, return, and sit down, with total time to complete recorded. A TUG time ≥ 12 seconds has previously been defined to represent a higher risk for falling. TUG test is assessed at the first class (TUG1) and at the end of the program (TUG2). Fear of falling is measured with a 1-10 scale at session one and upon completion.

<u>Results:</u> From 1/2017-1/2020 172 people completed Stepping-On. 130 (75%) had both a TUG1 and TUG2 time, and 57% of those (n = 75/130) had both pre and post program fear of falling scale. 97 (74.6%) were initially identified as high-risk (TUG1 time \geq 12).

We used paired Wilcoxon Rank Sum to compare TUG1 and TUG2 times and pre/post fear of falling. TUG2 time decreased by approximately one second (-0.91, 95% CI -0.53, -1.32, p < 0.01), and their fear of falling decreased by -1.49 units (95% CI -2.0, -0.5, p < 0.01). There was a 17.6% relative risk reduction in the number of participants classified as high-risk of falling, with NNT of 7.6.

<u>Conclusions</u>: Stepping-On significantly 1) reduced risk for falling measured by TUG time and resulted in a decreased number of participants categorized as high risk, and 2) reduced participants' fear of falling.

Due to the low cost and low resource needs of the program, trauma centers should consider adding Stepping-On as an essential injury prevention program.

N=130	Time	Median Δ	р	% High Risk (TUG≥12)
TUG1 (n=130)	13.98 [11.95,17.91]	-		74.6
TUG2 (n=130)	12.86 [10.81,16.79]	-0.91 [-1.32,-0.53]	< 0.01	61.5
N=75	1-10 scale	Median Δ	р	
Fear of Falling (pre)	6 [3.25,7.75]	-		
Fear of Falling (post)	5 [3.00,7.00]	-1.49 [-2.0,-0.49]	< 0.01	

Table: Pre- and Post- Assessments of Stepping On



Figure: Change in risk level as measured by Pre/Post TUG times

Paper #22 January 19, 2023 1:45 pm

A NOVEL TOOL TO IDENTIFY COMMUNITY RISK FOR FIREARM VIOLENCE: THE FIREARM VIOLENCE VULNERABILITY INDEX (FVVI)

Ann M. Polcari, MD, MPH, MSGH*, Lea Hoefer, MD, Jennifer Cone, MD, MHS*, Mark B. Slidell, MD, MPH*, Tanya L. Zakrison, MD, MPH, FRCSC, FACS*, Andrew J. Benjamin, MD, MS* University of Chicago

Presenter: Ann M. Polcari, MD, MPH, MSGH

Discussant: Rebecca Plevin, MD - University of California, San Francisco

Objectives: Vulnerability indices have been used in several fields to provide standard frameworks for identifying at-risk groups in times of crisis. Firearm violence in the U.S. is a public health crisis, yet currently no tool exists to predict which communities are at-risk for high rates of shootings and firearm-related homicides. We sought to create a Firearm Violence Vulnerability Index (FVVI) to forecast urban neighborhood risk for gun violence.

Methods: Open-access 2015-2022 shooting incident data from Chicago, New York City, Philadelphia, Los Angeles, and Baltimore was merged on census tract with 30 social and economic factors from the 2020 American Community Survey (ACS) 5-year estimates. The dataset was split into training (80%) and test (20%) sets; Baltimore data was withheld for a validation set. XGBoost, a decision-tree-based machine learning algorithm, was used to construct a model predicting rates of firearm violence by census tract.

<u>Results</u>: A total of 56,136 shooting incidents over 3,203 census tracts were used to build the model and 17,452 over 198 for validation. The model had strong predictive power for shooting incidence at the census tract level (test set r^2 =0.70, RMSE=3.5). The most predictive feature was household income (Figure 1). The modelâ€[™]s predictability (r^2 =0.62, RMSE=4.2) was validated in Baltimore (Figure 2).

Conclusions: The FVVI accurately predicts gun violence in urban communities at a granular geographic level. FVVI can be used to understand disparities in firearm violence and identify communities in most need of risk-reduction efforts. The model can be easily updated over time with new ACS data releases, meaning it may display future changes in rates of violence as community compositions shift. Dissemination of this tool may aid in prevention program planning, resource allocation, and enhance academic research related to firearm violence.



Figure 1. Feature importance scores demonstrating the effect each social and economic factor had on the FVVI model.



Figure 2. Choropleth maps of (A) Shooting incidents per 1000 population by census tract in Baltimore between 2015 and 2022 compares to (B) FVVI risk prediction score.

Paper #23 January 19, 2023 2:00 pm

PROJECT INSPIRE PILOT STUDY: A HOSPITAL-LED, COMPREHENSIVE INTERVENTION REDUCES GUN VIOLENCE AMONG JUVENILES DELINQUENT OF GUN CRIMES

Ashley Y. Williams, MD*, Antwan Hogue, M.D., Edmond Naman, JD., Curtis Graves, BA, Andrew Haiflich, MBA, MSN, RN, Jonathan Bernard, MD., Jon D. Simmons, MD* University of South Alabama

Presenter: Ashley Y. Williams, MD

Discussant: Julius Cheng, MD, MPH - University of Rochester Medical Center

Objectives: Gun violence disproportionately affects young, black males, but the impact extends to families and communities. Those at highest risk are teens delinquent of gun crimes. While there is no nationally accepted juvenile rate of recidivism, previous literature reveals rearrest rates from 50-80% in high-risk youth, and some reports show up to 40% of delinquent juveniles are incarcerated in adult prisons before the age of 25. We hypothesize that Project Inspire, a hospital-led, comprehensive intervention, reduces recidivism among high-risk teens.

Methods: Led by a level 1 trauma center, key community stakeholders including the juvenile court, city, and city police department joined forces to create a community-wide program aimed at curbing gun violence in high-risk individuals. Participants, aged 13-18, are selected by the juvenile gun court. They underwent a rigorous 3-week program with a curriculum incorporating the following: trauma-informed training and confidence building, educational/professional development, financial literacy, entrepreneurship, and career-specific job shadowing and mentorship. Rates of recidivism were measured annually.

<u>Results:</u> Project Inspire has hosted 2 classes in 2018 and 2019, graduating 9 participants aged 14-17 years. 67% were black. All were males. At 1 year, none of the graduates reoffended. At 2 years, 1 participant reoffended. At 3 years, no additional participants reoffended. No graduate reoffended as a juvenile. Thus, the overall rate of recidivism for Project Inspire is 11% to date. 89% of graduates received a diploma, GED, or obtained employment.

<u>Conclusions</u>: Project Inspire is a hospital-led initiative that effectively reduces recidivism among juveniles delinquent of gun crimes. This sets the framework for trauma centers nation-wide to lead in establishing impactful comprehensive, community-based violence intervention strategies.

Paper #24 January 19, 2023 2:15 pm

DEVELOPMENT OF A NOMOGRAM TO IDENTIFY PATIENTS AT RISK OF SELF-HARM AFTER TRAUMA

Andrew H. Tran, MD*, Chris Towe, Esther S. Tseng, MD, FACS*, Sarah Benuska, PhD, Mary Joan Roach, Douglas Gunzler, PhD, Vanessa P. Ho, MD, MPH, FACS* MetroHealth Medical Center

Presenter: Andrew H. Tran, MD

Discussant: D'Andrea Joseph, MD - NYU-Langone Long Island

Objectives: Traumatic injury can induce negative psychological consequences such as post-traumatic stress disorder and depression. We hypothesized that life-altering injury patterns (defined as traumatic brain injury, amputation, or spinal cord injury) and prior psychiatric symptoms (including mood disorders or prior self-harm) would be associated with readmission for self-harm.

Methods: We studied trauma survivors admitted Jan-Sept 2017 from the Nationwide Readmissions Database; 90-day readmissions were identified. The outcome of interest was an ICD-10 code for intentional self-harm at the first readmission. Factors from the index admission were extracted, including age, male sex, life-altering injury patterns, psychiatric diagnosis (none, 1, or >1), self-harm at the index admission, and injury mechanism. Factors associated with increased likelihood of a self-harm readmission were identified via a survey-weighted multivariable logistic regression and were used to generate a nomogram.

<u>Results:</u> Of 826,337 trauma survivors, 143,114 (16.8%) were readmitted within 90 days. Self-harm occurred in 4,393 (3.1%) of first readmissions. Traumatic brain injury, amputation, and spinal cord injury were not associated with self-harm at readmission. Patients with >1 psychiatric diagnosis and index admission self-harm accounted for nearly half of self-harm readmissions (n=2,160, 49%); these patients had an unadjusted readmission rate of 8%, nearly 25-fold higher than the remainder of the population (0.3%; p<0.05). In regression analysis, assault, psychiatric diagnosis, male sex, age<65, and index admission self-harm were associated with readmission for self-harm (Table, Figure).

<u>Conclusions</u>: Prior psychiatric diagnosis and self-harm were strongly associated with future self-harm, but life-altering injury patterns were not. High risk patients can be identified at the index trauma admission using a nomogram to inform treatment.

Index Admission Factor	Odds Ratio	95% CI	p-value
Age <65 (ref: Age ≥ 65)	3.23	2.88-3.62	< 0.0001
Male (ref: Female)	1.23	1.14-1.31	< 0.0001
Self-Harm	7.22	6.62-7.89	< 0.0001
Psychiatric Dx (ref = None)	3 9		
One	2.43	2.05-2.88	< 0.0001
More than One	10.26	8.98-11.71	<0.0001
Assault	1.18	1.03-1.35	0.02

Table. Survey-Weighted Logistic Regression



Paper #25 January 19, 2023 2:30 pm

FIREARM LEGISLATION - THE ASSOCIATION BETWEEN NEIGHBORING STATES AND CRUDE DEATH RATES

Majid Chammas, MD, Gerd Daniel Pust, MD*, Jonathan P. Meizoso, MD, MSPH*, Rishi Rattan, MD*, Nicholas Namias, MBA, MD*, Marie L. Crandall, MD, MPH, FACS*, D. Dante Yeh, MD, MHPE, FACS, FCCM, FASPEN* University of Miami Miller School of Medicine

Presenter: Majid Chammas, MD

Discussant: Stephanie Bonne, MD - Hackensack University Medical Center

<u>Objectives</u>: We aim to study the association between neighboring states' firearm legislation with firearm-related crude death rate (CDR).

Methods: The CDC Web-based Injury Statistics Query and Reporting System (WISQARS) was queried for adult all-intent (accidental, suicide, and homicide) firearm-related CDR among the 50 states from 2012 to 2020. States were divided into five cohorts based on the Giffords Law Center Annual Gun Law Scorecard (A, B, C, D, and F) (Figure 1), and two groups were constructed: *Strict* (A, B, and C) and *Lenient* (D and F). We examined the effect of 1) a single incongruent neighbor, defined as "Different" if the state is bordered by \geq 1 state with a grade score difference >1, and 2) the average grade of all neighboring states, defined as "Different" if the average of all neighboring states resulted in a grade score difference >1.

<u>Results</u>: Strict states with similar average neighbors had significantly lower CDR compared to Strict states with different average neighbors while Lenient states with similar average neighbors had significantly higher CDR compared to Lenient states with different average neighbors (Table 1). Lenient states surrounded by all similar Lenient states had the highest CDR, which was significantly higher than Lenient states with ≥1 different neighbor. However, Strict states with ≥1 different neighbor did not have higher CDR compared to Strict states surrounded by all similar Lenient states with ≥1 different neighbor.

Conclusions: Strict states with similar average neighbors had the lowest CDR whereas Lenient states with all similar Lenient neighbors had the highest CDR. We report a lopsided neighboring effect whereby Lenient states may benefit from at least 1 Strict neighbor while Strict states may be adversely affected only when surrounded by mostly Lenient neighbors. These findings may assist policymakers regarding the efficacy of their own state's legislation in the context of incongruent neighboring states.



Figure 1 - United States map with Giffords Law Center Gun Law Scorecard Grades

-	All Similar	1 Different	P-value
Strict *	3.14 [1.91-5.38]	3.39 [2.17-5.35]	0.50
Lenient †	6.52 [5.09-8.96]	5.19 [3.85-6.61]	<.001
	Similar Average	Different Average	P-value
Strict	2.98 [1.91-5.06]	3.87 [2.37-5.94]	.02
Lenient	6.02 [4.56-8.11]	4.70 [3.95-5.35]	.002

* Giffords Law Center Annual Gun Law Scorecard (A, B, C)

+ Giffords Law Center Annual Gun Law Scorecard (D and F)

Table 1 - Median Crude Death Rates (CDR)

Paper #26 January 19, 2023 2:45 pm

HISTORY REPEATS ITSELF: IMPACT OF MENTAL ILLNESS ON HOSPITAL REENCOUNTERS AND VIOLENT REINJURY AMONG FEMALE VICTIMS OF INTERPERSONAL VIOLENCE

Miriam Neufeld, MD, MPH, Enzo Plaitano, BSc, Megan Janeway, MD, Dane R. Scantling, DO, MPH*, Timothy Munzert, MSW LICSW, Lisa Allee Barmak, MSW, LICSW*, Sabrina Sanchez, MD, MPH* Boston University School of Medicine

Presenter: Miriam Neufeld, MD, MPH

Discussant: Susan Kartiko, MD, PhD - George Washington University

Objectives: Mental illness (MI) is prevalent among individuals injured from interpersonal violence (IPV) impacting both patients and healthcare systems. Cycles of reinjury and subsequent hospital visits only amplify these impacts. The relationship between pre-existing MI and violent reinjury among women has not been fully characterized. Our objective was to determine if risk of hospital reencounter –all-cause and violent re-injury- was associated with pre-existing MI at time of index injury among female victims of IPV.

<u>Methods:</u> We included all females(≥15y) presenting to a level I trauma center (2002-2019) with IPV injury alive at discharge (N=1056). Exposure was presence of pre-existing MI. Outcomes were hospital reencounters and mean number of encounters within the 1st year. Odds of reencounter for those with and without pre-existing MI were compared with multivariable logistic regression. Mean total visits were compared with multivariable negative binomial regression. P-value of<0.05 considered significant.

<u>Results</u>: 404 women (38.3%) had pre-existing MI at time of index injury. Of these, 63.9% had at least one reencounter compared to 45.7% of those without and had a higher mean number of encounters[4.9(6.5) vs 2.6(3.0), p<0.0001]. Odds of all-cause reencounter for those with pre-existing MI was nearly twice of those without[aOR 1.81(1.36,2.42), p<0.0001]. 11% of patients with pre-existing MI experienced violent reinjury compared to 4.9% of those without and had more than three times the odds of violent reinjury[aOR 3.52(1.57,7.930), p=0.002].

<u>Conclusions</u>: Among female victims of IPV, pre-existing MI is associated with significantly increased risk of both hospital reencounter and violent reinjury within the 1st year. Addressing MI is critical to reducing the burden of trauma on patients and the healthcare system, and ongoing prevention efforts to reduce violent reinjury.

Outcome	No	No. (%) Unadjusted model		6) Unadjusted model Adjusted model		odel
	Mental illness (n=404)	No mental illness (n=652)	OR (95% CI)	p-value	OR (95% CI)	p-value
All-cause reencounter	258 (63.86)	298 (45.71)	2.10(1.63,2.71)	<0.0001	1.81 (1.36,2.42)	<0.0001
Violent reinjury	44 (10.99)	32 (4.91)	2.37 (1.48,3.80)	0.0004	-	-
*Drug/alcohol use No drug/alcohol use	-	-	-	-	0.80 (0.42,1.53) 3.52 (1.57,7.93)	0.51 0.002

Table 2. Proportion and odds of repeat ED visit or hospitalization for any reason and for violent reinjury within one year of index injury for those with and without pre-existing mental illness.

 *When looking specifically at violent reinjury, mental illness found to interact with drug/EtOH use. Therefore, the cohort was stratified by drug/EtOH use in the adjusted model.

Paper #27 January 20, 2023 7:45 am

SIMILAR RATE OF VENOUS THROMBOEMBOLISM AND FAILURE OF NON-OPERATIVE MANAGEMENT FOR EARLY VERSUS DELAYED VTE CHEMOPROPHYLAXIS IN ADOLESCENT BLUNT SOLID ORGAN INJURIES: A PROPENSITY-MATCHED ANALYSIS

Areg Grigorian, MD, Sebastian Schubl, MD*, Lourdes Swentek, MD*, Cristobal Barrios, MD*, Michael E Lekawa, Dylan Russell, MD, Jeffry Nahmias, MD, MHPE, FACS, FCCM* University of California Irvine

Presenter: Areg Grigorian, MD

Discussant: Matthew E. Kutcher, MD, MS - University of Mississippi Medical Center

Objectives: Early initiation of venous thromboembolism (VTE) chemoprophylaxis in adults with blunt solid organ injury (BSOI) has been demonstrated to be safe but this is controversial in adolescents. We hypothesized that adolescent patients with BSOI undergoing non-operative management (NOM) and receiving early VTE chemoprophylaxis (eVTE) (< 48-hours) have a decreased rate of VTE and similar rate of failure of NOM, compared to similarly matched adolescents receiving delayed VTE chemoprophylaxis (dVTE) (> 48-hours).

Methods: The 2017-2019 TQIP database was queried for adolescent (12-17-years of age) patients with BSOI (liver, kidney and/or spleen) undergoing NOM. Patients with traumatic brain injury, pre-trauma anticoagulation/coagulopathy, undergoing exploratory-laparotomy upon arrival, transferred from another hospital, or who died/discharged within48-hours were excluded. We compared eVTE versus dVTE using a 1:1 propensity-score model, matching for age, comorbidities, BSOI grade, injury severity score, hypotension on arrival and need for transfusions.

<u>Results:</u> From 1,022 cases, 417 (40.8%) adolescents received eVTE. After matching, there was no difference in matched variables (all p>0.05). Both groups had a similar rate of VTE (dVTE 0.6% vs. eVTE 1.7%, p=0.16), mortality (dVTE 0.3% vs. eVTE 0%, p=0.32) and failure of NOM (eVTE 5.9% vs. dVTE 5.6%, p=0.87).

<u>Conclusions</u>: The rate of VTE in adolescent trauma is exceedingly rare. Early VTE chemoprophylaxis in adolescent BSOI does not increase the rate of failing NOM. However, unlike adult trauma patients, adolescent patients with BSOI receiving eVTE have a similar rate of VTE and mortality rate, compared to adolescents receiving dVTE.

Table 1. Demographics for 1:1 Propensity-score matched patients of early and delayed VTE chemoprophylaxis

	eVIE	dVTE	
Characteristic	(n=358)	(n=358)	p-value
Age, year, median (IQR)	16 (1)	16 (1)	1.000
Male, n (%)	201 (56.1%)	215 (60.1%)	0.289
Comorbidities, n (%)	5231-570. B.S.		
Hypertension	1 (0.3%)	1 (0.3%)	1.000
ADHD	15 (4.2%)	19 (5.3%)	0.482
Psychiatric illness	14 (3.9%)	15 (4.2%)	0.850
Smoker	29 (8.1%)	20 (8.4%)	0.892
Substance abuse	18 (5.0%)	18 (5.0%)	1.00
Diabetes	1 (0.3%)	3 (0.8%)	0.316
Angiography, n (%)	18 (5.0%)	18 (5.0%)	1.000
Hypotensive on admission, n (%)	15 (4.2%)	16 (4.5%)	0.854
Received PRBC transfusion within 4-hours, n (%)	60 (16.8%)	60 (16.8%)	1.000
ISS, median (IQR)	21 (13)	19 (13)	0.601
Injury, n (%)			
Kidney	102 (28.5%)	101 (28.2%)	0.934
Spleen	202 (56.4%)	187 (52.2%)	0.260
Liver	165 (46.1%)	176 (49.2%)	0.410
Pelvic fracture	115 (32.1%)	105 (29.3%)	0.418
Long bone fracture (humerus, femur,	126 (35.2%)	125 (34.9%)	0.938
tibia/fibula)			
AIS-Abdomen grade, n (%)			0.833
2	167 (46.6%)	172 (48.0%)	
3	111 (31.0%)	100 (27.9%)	
4	59 (16.5%)	63 (17.6%)	
5	21 (5.9%)	23 (6.4%)	

VTE = venous thromboembolism, ADHD = attention-deficit hyperactivity disorder, PRBC = packed red blood cells, ISS = injury severity score, AIS

Table 2. Outcomes for 1:1 Propensity-score matched patients of early and delayed VTE chemoprophylaxis

	eVTE	dVTE	
Characteristic	(n=358)	(n=358)	p-value
Complications, n (%)			
VTE	6 (1.7%)	2 (0.6%)	0.155
Deep vein thrombosis	4 (1.1%)	1 (0.3%)	0.178
Pulmonary embolism	3 (0.8%)	1 (0.3%)	0.316
LOS, days, median (IQR)	9 (7)	6 (6)	< 0.001
ICU, days, median (IQR)	4 (3)	3 (3)	0.164
Failed NOM, n (%)	21 (5.9%)	20 (5.6%)	0.872
Mortality, n (%)	0	1 (0.3%)	0.317
VTF	atou ICII - internetive same unit NOL	I - non anorativa manag	a mant

VTE = venous thromboembolism, LOS = length of stay, ICU = intensive care unit, NOM = non-operative management

Paper #28 January 20, 2023 8:00 am

TRANSFUSION-RELATED COST COMPARISON OF TRAUMA PATIENTS RECEIVING WHOLE BLOOD VERSUS COMPONENT THERAPY

Angelo V. Ciaraglia, MD, John C. Myers, MD, Maxwell A. Braverman, DO*, John Barry, BS, Brian J. Eastridge, MD*, Ronald M. Stewart, MD, FACS*, Susannah Nicholson, MD, MS, FACS*, Donald H. Jenkins, MD, FACS* University of Texas Health Science Center, San Antonio, TX

Presenter: John C. Myers, MD

Discussant: Linda Dultz, MD, MPH - UT Southwestern Parkland Hospital

<u>Objectives</u>: To determine if there is a difference in transfusion-related charges between trauma patients that received low titer O+ whole blood (WB) and component therapy (CT).

Methods: Retrospective review of a prospective database of adult and pediatric trauma patients who received either LTO+WB or CT from time of injury to within 6 hours of arrival. Annual mean charge per unit of blood product were obtained from the regional blood bank supplier. Pediatric and adult patients were analyzed separately and charges were compared on a per unit and per milliliter (mL) basis. Subgroup analysis was performed on severely injured patients (ISS>15) and patients that underwent massive transfusion (MT).

<u>Results:</u> Prehospital WB transfusion began at this institution in January 2018. Compared to previous years, after the initiation of the whole blood transfusion the mean annual charges decreased 17.3% for all blood products and for each component individually (Figure 1). In adults, WB was associated with a significantly lower charge per patient and per mL compared to CT in the emergency department (p<0.001), at 24 hours (p<0.001), and overall (p<0.001). Similar findings were true in the pediatric cohort (all p<0.001). In the severely injured subgroup (ISS > 15), WB was associated with a lower charge per patient and per mL in the ED (p<0.001), at 24 hours (p<0.001), with no difference in the prehospital setting (Figure 2). In patients that met MT criteria, WB was associated with a decreased cost per mL in the ED (p=0.007) and at 24 hours (p<0.001).

<u>Conclusions</u>: With increased use of LTO+WB for resuscitation, cost comparison is of significant importance to all stakeholders. Additionally, LTO+WB is also associated with reduced charges and potentially improved logistics in terms of blood management, especially in a MT. Future analyses may improve resource utilization and potentially benefit overall cost.



Figure 1. Mean annual charges (\$USD) for blood product expenditures before and after initiation of prehospital whole blood transfusion program (January 2018) from 2016-2021.



Figure 2. Comparison of transfusion-related charges in severely injured patients (ISS>15) who received LTO+WB versus balanced component therapy at pre-specified time points. (*) indicating significant difference (p<0.05).

Paper #29 January 20, 2023 8:15 am

DURA VIOLATION IS ASSOCIATED WITH INCREASED PATHOLOGIC HYPERCOAGLUABILITY IN TRAUMATIC BRAIN INJURY PATIENTS

Julia R. Coleman, MD, MPH*, Sanchayita Mitra, BS, Patrick Lutz, BS, Ernest Eugene Moore, MD*, Christopher Silliman, MD, PhD, Mitchell Cohen, MD, FACS* University of Colorado, Aurora

Presenter: Julia R. Coleman, MD, MPH

Discussant: Nicole M. Bedros, MD - Baylor University Medical Center Dallas

Objectives: The coagulopathy of traumatic brain injury (TBI) remains poorly understood. Contradictory descriptions in the literature highlight the distinction between systemic and local coagulation environment, with a classic description of systemic hypercoagulability in TBI patients despite intracranial hypocoagulopathy which is dynamic over time. This perplexing profile has been hypothesized to be due to tissue factor release from the dura. The objective of this study was to assess the dynamic coagulation profile of TBI patients undergoing neurosurgical procedures. We hypothesize that hypercoagulability in TBI is more pronounced after dura violation.

<u>Methods</u>: This is a prospective study of all adult TBI patients at a single, urban, level-1 trauma center who underwent a neurosurgical procedure from 2019 to 2021. Whole blood samples were collected before and then one hour following procedural dura violation. Native and tissue plasminogen activator (tPA) thrombelastography (TEG) were performed.

<u>Results:</u> Overall, 57 patients were included, 42 of whom underwent craniotomy, four underwent extraventricular drain placement, and 10 underwent intracranial bolt. The majority (61%) were male, the median age was 52, and 70% presented after blunt trauma. The median Glasgow Coma Score was 7. Compared to pre-dura violation, post-dura violation blood samples demonstrated hypercoagulability characterized by increased clot strength and decreased fibrinolysis. After dura violation, there was a significant increase in clot strength (median maximum amplitude of 74.4 mm versus 63.5 mm, p<0.0001). Similarly, after dura violation, there was a significant decrease in fibrinolysis (LY60 1.4% versus 2.6%, p=0.04).

<u>Conclusions</u>: After dura violation, a systemic hypercoagulability is observed in TBI patients, characterized by increased clot strength and decreased fibrinolysis.

Paper #30 January 20, 2023 8:30 am

PREDICTIVE VALUE OF EARLY INFLAMMATORY MARKERS IN TRAUMA PATIENTS

Matthew R. Baucom, MD, Taylor Wallen, MD*, Maura Kopchak, BS, Nick Weissman, BS, Rebecca Schuster, MS, Timothy A. Pritts, MD, PhD*, Michael Goodman, MD* University of Cincinnati

Presenter: Matthew R. Baucom, MD

Discussant: Taryn Travis, MD - Medstar Washington Hospital Center

Objectives: In a multicenter study of massively transfused patients, seven key inflammatory biomarkers were found to be associated with the risk of mortality. The aim of this prospective single center study was to further determine which of these early inflammatory markers could predict 30-day mortality amongst all critically injured trauma patients.

Methods: Serum samples were collected at 6-, 24-, and 72-hours from 159 consecutive patients admitted to the ICU following traumatic injury. Inflammatory markers syndecan-1, eotaxin, IL-1ra, IL-6, IL-8, IL-10, IP-10, and MCP-1 were analyzed via multiplex ELISA. Subgroup analysis was performed for patients undergoing massive transfusion (>5 RBCs) or sub-massive transfusion (<RBCs) during the first 6 hours following admission.

<u>Results:</u> Patients enrolled in the study were 52.4 \pm 21.8 years old, 66% male, 82% blunt mechanism of injury, and had a median ISS of 22 [14, 33]. IL-8 and IP-10 were significantly increased at 6 hours post-injury in non-survivors (n=27) (**Figure 1**). Elevated IL-1ra, IL-6, IL-8, IL-10, and MCP-1 at 24-hours post-injury were also associated with 30-day mortality. By contrast, serum syndecan-1 and eotaxin levels were not associated with mortality at any timepoint. Subgroup analysis of patients undergoing sub-massive transfusion (n=56) revealed that IL-8 and IP-10 were significantly increased at 24 hours in 30-day non-survivors. Further analysis of massively transfused patients (n=16) revealed a significant increase in IP-10 at 6- and 24-hours and an increase in MCP-1 at 6 hours in 30-day non-survivors (**Figure 2**).

Conclusions: Early elevation of IL-1ra, IL-6, IL-8, IL-10, IP-10, and MCP-1 in critically ill trauma patients may predict 30-day all-cause mortality. In addition, an early increase in IP-10 and MCP-1 may also predict mortality for massively transfused patients. Further analysis will be completed to create a mortality risk calculator based on these acute serum biomarkers.



Figure 1: Cytokines among all critically ill trauma patients.



Figure 2: Cytokine serum levels in massively transfused critically ill trauma patients.

Paper #31 January 20, 2023 8:45 am

ANALYSIS OF BIG SCORES AND PLATELET INHIBITION IN PATIENTS WITH TRAUMATIC BRAIN INJURIES

Hunter W. Parmer, BS, MD, M. Victoria P. Miles, EMT-P, MD*, Chace Hicks, MD, Lauren E Favors, MD, Meredith Rippy, Andrew Wilson, MS, Abigail Edwards, MD, Kathryn Stewart, BSN, Robert A. Maxwell, MD* University of Tennessee-Chattanooga

Presenter: Hunter W. Parmer, BS, MD

Discussant: Purvi Patel, MD - Loyola University Medical Center

Objectives: Platelet inhibition is known to occur after traumatic brain injury (TBI) and is predictive of bleed progression. The relationship between platelet dysfunction and brain injury guideline (BIG) score, however, is unknown. We hypothesized that the higher the BIG score was, the more likely the patient was to show inhibition to thromboelastography with platelet mapping (TEG-PM).

<u>Methods</u>: A practice management guideline was established calling for a TEG-PM on all adult patients with intracranial bleed. Patients were then categorized per the brain injury guidelines (BIG) as 1/2/3. Data was collected from December 2019 to December 2021. Platelet inhibition was considered to be present if the percent arachidonic acid (AA) or percent adenosine diphosphate (ADP) inhibition was $\geq 60\%$.

<u>**Results:**</u> Over the study period, 768 patients underwent TEG-PM. Those within the BIG 3 score were more likely to have AA (91.1%), ADP (80.8%), and combined AA/ADP (92.0%) platelet inhibition regardless of platelet inhibiting medication. Those with BIG 3 compared to BIG 1 or 2 scores were also noted to be more likely to require neurosurgery (16.3% vs 3.2% and 3.6%), more likely to expire secondary to their TBI (14.1% vs 0% and 0%), and have a higher head AIS (r_s = 0.151).

<u>Conclusions</u>: Our study suggests that BIG score correlates with platelet inhibition and bleed progression regardless of whether patients were taking platelet inhibiting medications. Patient with BIG 1 and 2 injuries have low likelihood of platelet inhibition and platelet mapping studies are not necessary in these patients.

Table 1: Goodness-of-fit analysis of BIG scores in inhibited groups.^a

+					
	Total	BIG 1	BIG 2	BIG 3	P value
	(n=437)	(n=30)	(n=23)	(n=384)	
AA Inhibited	192 (43.9%)	10 (5.2%)	7 (3.7%)	175 (91.1%)	<.001*
ADP Inhibited	146 (33.4%)	16 (11.0%)	12 (8.2%)	118 (80.8%)	<.001*
AA and ADP Inhibited	99 (22.6%)	4 (4.0%)	4 (4.0%)	91 (92.0%)	<.001*

Abbreviations: AA, Arachidonic acid; ADP, Adenosine diphosphate

^aData are presented as number (%) for categorical variables. *Statistically significant difference (P<.05)

Table 2: Summary of BIG score	distribution amo	ong patients that	required operative
intervention or bleed progression	า. ^a		

+						
			Operative Intervention		Bleed Pro	ogression
		Total (n=768)	No (n=658)	Yes (n=110)	No (n=450)	Yes (n=318)
	BIG 1	62 (8.1%)	60 (96.8%)	2 (3.2%)	53 (85.5%)	9 (14.5%)
	BIG 2	55 (7.1%)	53 (96.4%)	2 (3.6%)	41 (74.5%)	14 (25.5%)
	BIG 3	651 (84.8%)	545 (83.7%)	106 (16.3%)	356 (54.7%)	295 (45.3%)

^aData are presented as number (%) for categorical variables. *Statistically significant difference (P<.05)

Paper #32 January 20, 2023 9:00 am

EARLY POST-TBI TXA PREVENTS BBB HYPERPEMERABILITY INDEPENDENT OF PENUMBRAL LEUKOCYTE MOBILIZATION

 Matthew Culkin, BS, Alfonso Lopez, MD, Anasthasia Georges, Priyanka Bele, MD, Grace Niziolek, MD, Christina Jacovides, MD*, Hailong Song, BA,
 Victoria Johnson, MBChB, PhD, Lewis J. Kaplan, MD, FACS, FCCM, FCCP*, Douglas Smith, MD, Jose L. Pascual, MD, PhD, FRCS(C), FACS, FCCM*
 Department of Surgery, Perelman School of Medicine, University of Pennsylvania

Presenter: Matthew Culkin, BS

Discussant: Susan Rowell, MD, MBA, MCR - University of Chicago

Objectives: Tranexamic acid (TXA) given early but not late after TBI reduces mortality. This may be partly related to a late administered TXA-driven profibrinolysis and increased leukocyte-mediated inflammation. We hypothesized that compared to late administration (24h post-TBI), early TXA (1h post-TBI), blunts penumbral, blood-brain barrier (BBB) endothelial-leukocyte (EC-LEU) interactions and microvascular permeability, in vivo.

Methods: CD1 male mice (n=35) were randomized to severe TBI (Injury, [I] by controlled cortical impact, I: 6m/sec velocity, 1mm depth, 3mm diameter) or sham craniotomy (S) followed by IV saline (P, placebo) at 1h or TXA (30mg/kg) at 1 or 24h. At 48h, *in-vivo* pial intravital microscopy visualized live penumbral EC-LEU interactions and BBB microvascular fluorescent albumin leakage. Neuroclinical recovery was assessed by the Garcia Neurological Test (GNT: motor, sensory, reflex, and balance assessments) and body weight loss recovery at 24 and 48h. ANOVA with Bonferroni correction assessed intergroup differences (p<0.05).

<u>Results</u>: 1-hour but not 24h TXA improved GNT (on day 1 post TBI) compared to placebo (Figure 1). Both TXA administration timings similarly improved 24h weight loss recovery but only 1h TXA significantly improved weight loss recovery at 2 days compared to placebo (p=0.03). No intergroup differences were found in LEU rolling, or adhesion. Compared to untreated injured animals (I+P1), only TXA at 1 hour (I+TXA1) reduced BBB permeability (Figure 2, p=0.04).

<u>Conclusions</u>: Only early post-TBI TXA consistently improves animal neurological recovery markers. TXA preserves BBB integrity, but only when administered early. This effect is independent of endothelial-leukocyte interactions.



The Garcia neurological scale (GNT) assesses daily activities of rodents including motor, sensory, reflex, and balance abilities with a maximum score of 18. Only TXA at 1hr after TBI significantly improved day 1 GNT scores. Rodent body weight loss occurs after TBI and 2 days after TBI, only TXA administered at 1 hour (I+TXA1) significantly improved weight loss recovery.



In vivo penumbral pial intravital microscopy 2 days after TBI. As compared to untreated injured animals (I+P1) only TXA at 1 hour (I+TXA1) reduced microvascular permeability of fluorescent albumin.

Paper #33 January 20, 2023 9:15 am

A RANDOM FOREST MODEL USING FLOW CYTOMETRY DATA IDENTIFIES PULMONARY INFECTION AFTER THORACIC INJURY

Rondi Gelbard, MD, FACS*, Hannah Hensman, Seth Schobel, PhD, Linda Stempora, Christopher J. Dente, MD*, Timothy G. Buchman, MD*, Allan Kirk, MD, PhD, Eric Elster, MD, FACS Emory University School of Medicine

Presenter: Rondi Gelbard, MD, FACS

Discussant: Mark Hoofnagle, MD, PhD - Washington University

Objectives: Thoracic injury can cause impairment of lung function leading to respiratory complications such as pneumonia. There is increasing evidence that central memory T cells of the adaptive immune system play a key role in pulmonary immunity. We sought to explore whether assessment of cell phenotypes using flow cytometry (FCM) could be used to identify pulmonary infection after thoracic trauma.

Methods: We prospectively studied trauma patients with thoracic injuries who survived >48h at a Level 1 trauma center from 2014-2020. Clinical and FCM data from serum samples collected within 24h of admission were considered as potential variables. Random forest (RF) and logistic regression (LR) models were developed to estimate the risk of hospital-acquired and ventilator-associated pneumonia (PNA). Variables were selected using backwards elimination and models were internally validated with leave-one-out.

Results: Seventy patients with thoracic injuries were included (median age 35y (IQR: 25.25 - 51), 62.9% (44/70) male, 61.4% (42/70) blunt trauma). The most common injuries included rib fractures (52/70, 74.3%) and pulmonary contusions (26/70, 37%). The incidence of PNA was 14/70 (20%). Median ISS was similar for patients with and without PNA (30.5 (IQR 22.8 - 39.3) vs 26.5 (IQR 21.8 - 33.3). The final RF model selected three variables (APACHE score, highest pulse rate in first 24h, and frequency of CD4+ central memory (CM) cells) that identified PNA with an AUC of 0.93, sensitivity of 0.91, and specificity of 0.88. A logistic regression with the same features had an AUC of 0.86, sensitivity of 0.76, and specificity of 0.85.

Conclusions: Clinical and FCM data have diagnostic utility in the early identification of patients at risk of nosocomial pneumonia following thoracic injury. Signs of physiologic stress and lower frequency of CM cells appear to be associated with higher rates of pneumonia after thoracic trauma.



Receiver operating characteristic (ROC) curve for the (A) random forest model and (B) logistic regression model.



Histogram of CD4+ CM cells with percentage of pneumonia patients per bin represented by red dots.

Paper #34 January 20, 2023 9:30 am

ARE DATA DRIVING OUR AMBULANCES? LIBERAL USE OF TRANEXAMIC ACID IN THE PREHOSPITAL SETTING.

Alexandra MP Brito, MD*, Madeline Fram, MD Candidate, Gregory R Stettler, MD*, James Winslow, MD, Robert Shayn Martin, MD* Wake Forest University Medical School

Presenter: Alexandra MP Brito, MD

Discussant: Avi Bhavaraju, MD - University of Arkansas for Medical Sciences

Objectives: Current data on tranexamic acid (TXA) supports early administration for severe hemorrhagic shock. Administration by EMS has been facilitated by developing protocols and standing orders informed by these data. In this study, patterns of TXA use by EMS agencies serving a large level 1 trauma center were examined. We hypothesize that current widespread TXA use often includes administration outside of standard and data driven indications.

Methods: The trauma registry at a level 1 trauma center was queried for patients who received TXA in the course of their management. To determine the practice patterns and appropriateness of administration of TXA, patients' physiologic state in the prehospital environment based on EMS records, physiologic state on arrival to hospital, and interventions performed in both settings were examined. More than 20 separately managed EMS systems that administer TXA transport patients from scene to this trauma center, allowing for a broad survey of practices.

<u>Results</u>: From 2016-2021 1089 patients received TXA, with 406 (37.3%) having treatment initiated by EMS services. Of these, the average prehospital systolic blood pressure (SBP) was 108.2mmHg and initial ED SBP was 107.8mmHg. Only 58.4% of these patients received blood transfusion after arrival to this trauma center. Compliance with standard indications are summarized in Table 1. Similar levels of compliance were seen across high volume EMS services.

<u>Conclusions</u>: TXA use has become common in trauma and has been adopted by many EMS systems. However, these results indicate TXA in the prehospital setting is over-used as administration is not being limited to indications that have shown benefit in prior data.

SBP indication standard	Source of SBP indication standard	Percentage of patients NOT meeting standard
<90mmHg	Common practice	70.4
≤75mmHg	Mortality benefit in CRASH-2	85.4
<70mmHg	Mortality benefit in STAAMP Trial	88.1

Table 1. Compliance with standard or data driven indications for TXA.

Scientific Session VI - Multicenter Trials

Paper #35 January 20, 2023 7:45 am

RETHINKING PROTOCOLIZED COMPLETION ANGIOGRAPHY FOLLOWING EXTREMITY VASCULAR TRAUMA: A PROSPECTIVE OBSERVATIONAL MULTICENTER TRIAL.

Grace Niziolek, MD, Jane Keating, MD*, Joanelle A. Bailey, MD, MPH*, Nathan J. Klingensmith, MD*, Alexis M. Moren, MD, MPH*, Fabio Saccomanno, BS, David J. Skarupa, MD, FACS, FCCM*, Anthony Loria, MD, Zoë Maher, MD*, Sarah Ann Moore, MD*, Michael C. Smith, MD*, Robert Jean, MD, Amanda Leung, BA, Kevin M. Schuster, MD, MPH*, Mark J. Seamon, MD, FACS* University of Pennsylvania

Presenter: Grace Niziolek, MD

Discussant: Joseph J. DuBose, MD - Dell School of Medicine, University of Texas-Austin

<u>Objectives</u>: Completion angiography (CA) is commonly utilized following repair of extremity vascular injury and is recommended by the EAST extremity trauma PMG despite limited data. We hypothesized that CA would lead to early recognition of inadequate repairs and sought to determine which patients would benefit from CA.

<u>Methods</u>: This prospective, observational multicenter (18LI, 2LII) analysis included patients ≥15yrs with extremity vascular injuries requiring operative management. Clinical variables and outcomes were compared by CA and indication, then analyzed with respect to with our primary study endpoint, need for secondary vascular intervention.

<u>Results:</u> Of 437 patients, 103 (24%) underwent CA after extremity vascular operative management (Table). Those who underwent CA more often had artery and vein injuries requiring bypass or interposition repairs (all p<0.001) than those who did not undergo CA, although no differences between study group measured outcomes were appreciated. Institutional protocol (71%) was cited as the most common reason to perform CA compared to concern for inadequate repair (29%). When CA patients were compared by these indications, no differences in physiology, injuries, or repairs were appreciated (Table, all p>0.05). Importantly, no patients required redo extremity vascular surgery if CA was performed per institutional protocol; however, 27% required redo vascular surgery if the CA was performed due to a concern for inadequate repair (Figure).

<u>Conclusions</u>: Our data suggests that CA should be used in a case-by-case basis after extremity vascular injury repair based on clinical concerns rather than protocol. Limiting CA to those with concern for inadequate vascular repairs may decrease unnecessary procedures and potential morbidity.

Revision Rate after Completion Angiography by Indication



Differences observed in need for redo vascular surgery based on the indication for completion angiogram.

	Completion A	ngiography At In	itial Surgery	Completion Angiography Indication			
	Performed (n=103)	NOT Performed (n=334)	p value	Institutional Protocol (n=73)	Clinical Concern (n=30)	p value	
Age (years)	27 (22-37)	32 (25-43)	0.013	27 (23-37)	29 (20-36)	0.432	
Male	84%	87%	0.394	85%	80.0%	0.54	
Penetrating injury	62%	55%	0.227	66%	53%	0.238	
Initial SBP (mmHg)	117 (98-140)	126 (96-146)	0.096	118 (95-140)	116 (100-140)	0.466	
MTP activation	24%	25%	0.930	78%	70%	0.385	
Extremity AIS	3 (3-4)	3 (2-4)	0.024	3 (3-4)	3 (3-4)	0.441	
ISS	16 (9-27)	16 (9-24)	0.981	16 (9-26)	13 (9-29)	0.923	
Primary surgeon, trauma	63%	54%	0.099	59%	73%	0.168	
Primary lower extremity injury	84%	75%	0.161	83.6%	85.7%	0.791	
Arterial injury	93%	67%	< 0.001	95%	90%	0.408	
Arterial injury repair type	20/	1.00/		50/	00/		
Primary	3%	16%		2%	0%		
Patch	4%	6%		6%	0%		
Bypass/interposition	/1%	24%	<0.001	00%	81%	0.542	
Shunt	1%	2%		2%	0%		
Ligation	6%	18%		6%	4%		
Venous injury	22%	36%	<0.001	06%	23 %	0.793	
Venous injury repair type							
Primary	26%	23%		23%	33%		
Patch	6%	0%	0020122	9%	0%	1012120	
Bypass/interposition	9%	4%	<0.001	9%	8%	0.866	
Shunt	2%	1%		3%	0%		
Ligation	53%	69%		51%	58%		
Postop therapeutic AC	58%	52%	0.263	64%	43%	0.049	
Postop fasciotomies	13%	8%	0.101	77%	60%	0.087	
Postop amputation	7%	7%	0.969	6%	10%	0.408	
Hospital LOS (days)	12 (7-23)	10 (5-20)	0.192	12 (7-24)	14 (7-21)	0.600	
Hospital survival	95%	95%	0.822	4%	7%	0.583	

Differences in demographics, injury characteristics, surgical management, and in-hospital outcomes based on a) whether or not completion angiography was performed and b) the clinical indication for the completion angiogram.

Scientific Session VI - Multicenter Trials

Paper #36 January 20, 2023 8:00 am

MOVING THE NEEDLE ON TIME TO RESUSCITATION: AN EAST PROSPECTIVE MULTICENTER STUDY OF VASCULAR ACCESS IN HYPOTENSIVE INJURED PATIENTS USING TRAUMA VIDEO REVIEW

Ryan P. Dumas, MD*, Michael Vella, MD*, Amelia W. Maiga, MD, MPH*, Caroline R. Erickson, MD, Brad Dennis, MD, FACS*, Luis T. da Luz, MD, MSc*, Dylan Pannell, MD, Emily Quigley, BSN, Catherine G. Velopulos, MD, MHS, FACS*, Peter Tadeusz Hendzlik, BS*, Nolan Bruce, MD, Alexander Marinica, DO*, Joseph Margolick, MD, FRCSC*, Dale F. Butler, MD, MBA, FACS*, Jordan Estroff, MD*, James A. Zebley, MD*, Ashley Alexander, MD, Sarah Mitchell, MD, Heather M. Grossman Verner, MS, Michael Truitt, MD*, Stepheny Berry, MD*, Jennifer Middlekauff, BSN, Siobhan Luce, MD, David Leshikar, MD, Leandra Krowsoski, MD*, Marko Bukur, MD, FACS*, Nathan M. Polite, DO, FACS, FACOS*, Ashley H. McMann, MD*, Ryan Staszak, MD*, Scott B. Armen, MD, FACS, FCCM*, Tiffany Horrigan, MD, Forrest O. Moore, MD, FACS*, Paul Bjordahl, MD FACS*, Jenny Guido, MD, Sarah Mathew, MD, FACS*, Bernardo F. Diaz, MD*, Jennifer Mooney, MD*, Katherine Hebeler, MD, Daniel N. Holena, MD, MSCE, FACS* University of Texas Southwestern Medical Center

Presenter: Ryan P. Dumas, MD

Discussant: Allyson M. Hynes, MD - University of New Mexico

<u>Objectives:</u> Vascular access in hypotensive trauma patients is challenging. Little evidence exists on the time required and success rates of vascular access types. We hypothesized that intraosseous (IO) access would be faster and more successful than peripheral IVs (PIVs) or central venous catheters (CVCs) in hypotensive patients.

Methods: An EAST prospective multicenter trial was performed; 19 centers provided data. Trauma video review (TVR) was used to evaluate the resuscitations of all hypotensive (SBP <90 mm Hg) patients. Highly granular data from video recordings were abstracted including attempt type, attempt locations, success rates, and procedural duration. Times to completion and success rates were compared. Time to resuscitation initiation and other outcomes were evaluated.

<u>Results:</u> 1,410 access attempts occurred in 581 patients with a median age of 40[27-59], Injury Severity Score of 22[10-34]. 70% of access attempts were successful but were significantly less likely to be successful in females (64% vs. 71%, p=0.01). Median time to any access was 5.0[3.2-8.0] minutes. IO had higher success rates than PIVs or CVCs (93% vs. 67% vs. 59%, p<0.001) and remained higher after subsequent failures (second attempt 85% vs. 59% vs. 69%, p=0.08; third attempt 100% vs 33% vs. 67%, p=0.002). Duration varied by access type (IO 36[23-60]sec; PIV 44[31-61]sec; CVC 171[105-298]sec) and was significantly different between IO vs. CVC (p<0.001) and PIV vs. CVC (p<0.001) but not PIV vs. IO. Time to resuscitation initiation was shorter in patients whose initial access attempt was IO 402 vs. 349 sec (p=0.015).

<u>Conclusions</u>: IO is as fast as PIV and more likely to be successful in hypotensive patients. Patients whose initial access attempt was IO were resuscitated more expeditiously. IO access should be considered a first line therapy for hypotensive trauma patients.



Figure 1: Time to completion and success rates of IV access attempts in hypotensive trauma patients. Abbreviations: IO – Intraosseous; PIV = Peripheral IV; CVC = Central Venous Catheter. * = p<0.001, Kruskal-Wallis test; $\dagger=p<0.001$ Fischer's Exact test.

Scientific Session VI - Multicenter Trials

Paper #37 January 20, 2023 8:15 am

OUTCOMES AMONG TRAUMA PATIENTS WITH DUODENAL LEAK FOLLOWING PRIMARY VS COMPLEX REPAIR OF DUODENAL INJURIES: AN EAST MULTICENTER TRIAL

Rachel L. Choron, MD, FACS*, Amanda Teichman, MD*, Christopher G Bargoud, MD, Jason D. Sciarretta, MD, FACS*, Randi Smith, MD, MPH*, Dustin Hanos, MD, Iman Afif, MD, Jessica H Beard, MD, MPH*, Navpreet K. Dhillon, MD*, Ashling Zhang, Mira Ghneim, MD*, Rebekah J. Devasahayam, MD, FACS *, Oliver L. Gunter, Jr., MD, FACS*, Alison A. Smith, MD, PhD*, Brandi Sun, Chloe S. Cao, Medical Student*, Jessica Reynolds, MD*, Lauren Hilt, Daniel N. Holena, MD, MSCE, FACS*, Grace Chang, MD*, Meghan Jonikas, MD, Karla Echeverria-Rosario, MD*, Nathaniel S. Fung, MD*, Aaron Anderson, MD, Caitlin A. Fitzgerald, MD*, Ryan P. Dumas, MD*, Jeremy H. Levin, MD*, Christine T. Trankiem, MD, FACS *, JaeHee Yoon, MD, MS*, Jacqueline J Blank, MD*, Joshua P. Hazelton, DO, FACS*, Christopher J McLaughlin, MD*, Rami Al-Aref, Jordan M. Kirsch, DO*, Daniel Howard, Dane R. Scantling, DO, MPH*, Kate V. Dellonte, RN, MBA, BSN*, Michael Vella, MD*, Brent Hopkins, Chloe Shell, BA, Pascal O. Udekwu, MD, MBA, MHA*, Evan G Wong, MD, MPH, FRCSC, FACS*, Bellal Joseph, MD, FACS*, Howard Lieberman, MD, Walter A Ramsey, MD, Collin H. Stewart, MD*, Claudia Alvarez, John D. Berne, MD*, Jeffry Nahmias, MD, MHPE, FACS, FCCM*, Ivan Puente, MD*, Joe H. Patton, Jr., MD*, Ilya Rakitin, MD*, Lindsey Perea, DO, FACS*, Odessa Pulido, DO, Hashim Ahmed, MBBS, Jane Keating, MD*, Lisa M. Kodadek, MD*, Jason Wade, Revnold Henry, Martin A, Schreiber, MD, FACS*, Andrew J, Benjamin, MD, MS*, Abid Khan, MD*, Caleb J. Mentzer, DO*, Vasileios Mousafeiris, Francesk Mulita, Shari Reid-Gruner, MD*, Joshua A. Marks, MD*, Christopher Foote, MD, Carlos H Palacio, MD, FACS.*, Dias Argandykov, Haytham Kaafarani, MD, MPH*, Susette Coyle, Marie Macor, Michelle Bover Manderski, PhD MPH, Mark J. Seamon, MD, FACS* Rutgers Robert Wood Johnson Medical School

Presenter: Rachel L. Choron, MD, FACS

Discussant: Sydney Radding, MD - Virginia Commonwealth University

Objectives: Duodenal leak is a feared complication of repair and innovative, complex repairs with adjunctive measures(CRAM) were developed to decrease both leak occurrence and severity when leaks occur. Data on the association of CRAM and duodenal leak is sparse and its impact on duodenal leak outcomes nonexistent. We hypothesized CRAM would 1) be associated with decreased duodenal leak rates and 2) improve recovery and outcomes when leaks do occur.

<u>Methods</u>: A retrospective, multicenter analysis from 35 L1 centers included patients(>14yr) with operative, traumatic duodenal injuries (1/2010-12/2020). The study sample compared duodenal operative repair strategy: primary repair alone(PRA) vs CRAM(any repair plus pyloric exclusion, gastrojejunostomy, triple tube drainage, duodenectomy). Measured study endpoints included duodenal leaks and markers of leak sequelae and recovery.

<u>Results:</u> The sample(n=861) was primarily young(33 years) male(84%) with penetrating injuries(77%); 523 underwent PRA, 338 CRAM. Although CRAM were more critically injured(Table 1) than PRA, CRAM did not correlate with improved leak rates (PRA 8% v CRAM 21%, p<0.001). In turn, adverse outcomes were more common after CRAM with more IR drains, prolonged NPO and LOS, greater mortality, and more 30-day readmissions than PRA(all p<0.05). Importantly, CRAM also had no positive impact on leak recovery(Table 2). There were no differences in number of operations, drain duration, NPO duration, need for IR drainage, HLOS, readmissions or mortality between PRA leak vs CRAM leak patients(all p>0.05). CRAM leaks had longer antibiotic duration, more GI complications and *longer* duration until duodenal leak resolution(all p<0.05).

<u>Conclusions</u>: CRAM did not prevent duodenal leaks and moreover, did not reduce adverse sequelae when leaks did occur. Our results suggest that CRAM is not a protective operative duodenal repair strategy.

Table 1. Clinical variables, entire study sample and duodenal leak subset compared by repair type (PRA vs CRAM)								
	All Patients (n=861)	All Primary Repair Patients (PRA) (n=523)	All Complex Repair Patients (CRAM) (n=338)	p value	All Patients with Duodenal Leaks (n=113)	Duodenal Leaks s/p PRA (n=43)	Duodenal Leaks s/p CRAM (n=70)	p value
Age (mean ± SD)	33 ± 29	32 ± 14	35 ± 43	0.499	39 ± 72	30 ± 12	44 ± 90	0.418
Male	84%	83%	85%	0.405	83%	86%	81%	0.524
Penetrating injury	77%	80%	72%	0.006	81%	88%	77%	0.136
Systolic Blood Pressure (mmHg)	119 [98–137]	121 [99–138]	114 [96–133]	0.024	113 [94–134]	113 [100–131]	112 [93–135]	0.916
Injury Severity Score	22 [14-29]	19 [11-29]	25 [16-30]	0.001	24 [16-29]	22 [16-29]	25 [16–29]	0.941
AIS abdomen	4 [3-4]	4 [3-4]	4 [3–5]	<0.001	4 [3-4]	4 [3-4]	4 [3-4]	0.128
Massive Transfusion Protocol	39%	35%	46%	0.002	44%	37%	49%	0.193
Pancreatic injury	32%	25%	43%	<0.001	39%	23%	49%	0.007
Multiple duodenal Injuries	23%	20%	27%	0.008	34%	35%	33%	0.825
Duodenal injury AAST grade /	18%	21%	15%	0.022	6%	12%	3%	0.103
11	40%	50%	24%	<0.001	38%	49%	31%	0.064
	34%	28%	44%	<0.001	43%	40%	46%	0.520
IV	4%	1%	10%	<0.001	10%	0%	16%	0.006
V	3%	1%	7%	<0.001	3%	0%	4%	0.287

Table 1. Clinical variables, entire study sample and duodenal leak subset compared by repair type (PRA vs CRAM)

PRA = Primary Repair Alone

Table 2. Duodenal injury operative management and outcomes, entire study sample and duodenal leak subset compared by repair type (PRA vs CRAM)								
	All Patients with Operative Duodenal Injuries (n=861)	All Primary Repair Patients (PRA) (n=523)	All Complex Repair Patients (CRAM) (n=338)	p value	All Patients with Duodenal Leaks (n=113)	Duodenal Leaks s/p PRA (n=43)	Duodenal Leaks s/p CRAM (n=70)	p value
Primary Repair Alone (PRA)	61%				38%			
Complex Repairs with Adjunctive Measures (CRAM)	39%				62%			<0.001
Pyloric Exclusion with Gastrojejunostomy			23%				36%	
Duodenectomy with Enteric Anastomosis			22%				16%	
Duodenal Diverticulization			1%				0%	
Retrograde Duodenostomy Tube and Feeding Jejunostomy Tube			4%				7%	
Whipple			11%				11%	
Combination of complex repairs/Other			39%				30%	
Total Number of Abdominal Operations	2 [1-3]	2 [1–3]	2 [1-4]	<0.001	3 [2–7]	3 [2–5]	4 [2–7]	0.084
IR Drain Placement for Duodenal Leak					42%	35%	46%	0.257
Duration of drains (days)	12 [6-29]	11 [5-23]	17 [7-67]	<0.001	38 [15-58]	34 [15-43]	43 [16-66]	0.098
Duration of Antibiotic Therapy (days)					10 [8-21]	9 [7-14]	12 [10–25]	<0.001
Days until fistula/duodenal leak resolution					14 [4-42]	11 [2–19]	21 [6-58]	0.020
Days NPO	8 [5-16]	7 [5–13]	11 [6-21]	<0.001	23 [9-48]	23 [8-38]	22 [10-54]	0.575
GI Related Complication (abscess, GI bleed, ulcer, ileus, abdominal compartment syndrome, EC fistula, anastomotic leak)	43%	39%	50%	0.001	81%	65%	91%	0.001
Hospital Length of Stay (days)	16 [9-30]	14 [8-26]	20 [10-34]	<0.001	38 [22-54]	36 [21-50]	38 [23-48]	0.544
Mortality	11%	9%	15%	0.002	10%	5%	13%	0.201
30-day Readmission	20%	17%	23%	0.003	33%	35%	31%	0.879

CRAM = Complex Repair with Adjunctive Measures

Table 2. Duodenal injury operative management and outcomes, entire study sample and duodenal leak subset compared by repair type (PRA vs CRAM)

PRA = Primary Repair Alone

CRAM = Complex Repair with Adjunctive Measures

Scientific Session VI - Multicenter Trials

Paper #38 January 20, 2023 8:30 am

EARLY VTE PROPHYLAXIS IN SEVERE TRAUMATIC BRAIN INJURY: A PROPENSITY SCORE WEIGHTED EAST MULTICENTER TRIAL

Daniel Kim, MD, Daniel Kim, MD, Sirivan S. Seng, MD*, Hannah Sadek, AGACNP-BC, Alexander Papa, DO, Danielle Lapoint, DO, Christina Jacovides, MD*, Elinore J. Kaufman, MD, MSHP*, Lindsey Perea, DO, FACS*, Christina Monaco, DO, Ilya Shnaydman, MD*, Alexandra Lee, BS, Victoria Lynn Sharp, DO*, Angela Miciura, MD, Eric Trevizo, MD, Martin Rosenthal, MD, Lawrence Lottenberg, MD*, William Zhao, MD, Alicia Kieninger, MD*, Michele Hunt, MSN, Tanya Egodage, MD*, Aleem Mohamed, John Cull, MD, FACS*, Chassidy Balentine, AGNP-BC, MS, TCRN, Michelle Kincaid, MD*, Stephanie Doris, DO, Robert Cotterman, DO*, Sara Seegert, MSN, RN, Lewis E. Jacobson, MD, FACS*, Jamie Williams, MSML, BSN, RN CCRP, Melissa Whitmill, MD, FACS*, Brandi Palmer, MS, Caleb J. Mentzer, DO*, Nicole Tackett, MS, Tjasa Hranjec, MD, MS-CR, FACS, Thomas Dougherty, MD, Shawna L. Morrissey, DO*, lauren donatelli-seyler, DO, Amy Rushing, MD*, Leah C Tatebe, MD, FACS*, Tiffany Nevill, DO, Michel Aboutanos, MD, MPH*, David Hamilton, MD*, Diane Redmond, MSN, Daniel C. Cullinane, MD*, Carolyne Falank, PhD, Mark McMellen, MD*, Christopher T. Duran, MBA, BSN, RN*, Jennifer Daniels, DO, Shana Ballow, DO, FACS, Paula Ferrada, MD, FACS, FCCM, MAMSE* Crozer Chester Medical Center

Presenter: Daniel Kim, MD

Discussant: Christina Colosimo, DO, MS - University of Arizona, Tucson

<u>**Objectives:**</u> Patients with TBI are at high risk of venous thromboembolism events (VTE). We hypothesized that early chemical VTE prophylaxis initiation (≤24 hours of a stable head CT) in severe TBI would reduce VTE without increasing risk of intracranial hemorrhage expansion (ICHE).

Methods: A retrospective review of patients \geq 18 years of age with isolated severe TBI (AIS \geq 3) who were admitted to 24 level 1 and level 2 trauma centers from January 1st 2014 to December 31st 2020 was conducted. Patients were divided into those who did not receive any VTE prophylaxis (NO VTEP), who received VTE prophylaxis \leq 24 hours after stable head CT (VTEP \leq 24) and who received VTE prophylaxis > 24 hours after stable head CT (VTEP>24). Primary outcomes were VTE and ICHE. Covariate balancing propensity score weighting was utilized to balance demographic & clinical characteristics across three groups. Weighted univariate logistic regression models were estimated for VTE & ICHE with patient group as predictor of interest.

<u>Results</u>: Of 3,936 patients, 2,659 met inclusion criteria. VTEP≤24 had a significantly lower incidence of VTE (p<0.001) compared to VTEP>24 and NO VTEP, with no difference in ICHE after VTE prophylaxis initiation (p=0.590) [Table 1]. After propensity score weighting, logistic regression modeling demonstrated VTEP>24 had more than two-fold odds of VTE compared to VTEP≤24 (Table 2; p=0.059). NO VTEP had 31% decreased odds of VTE compared to VTEP≤24 group (p=0.389). In comparison to VTEP≤24, NO VTEP had 36% decreased odds of ICHE (p=0.001) & VTEP>24 had 4% decreased odds of ICHE (p=0.757).

Conclusions: In this large multi-center analysis, there were no significant differences in VTE based on timing of initiation of VTE prophylaxis. Patients who never received VTE prophylaxis had decreased odds of ICHE. Further evaluation of VTE prophylaxis in larger randomized studies will be necessary for definitive conclusions.
	No VTEP (N=1477)	VTEP≤24 (N=395)	VTEP >24 (N=787)	P-Value ¹
Age, Median (Q1, Q3)	66 (50, 81)	64 (45.9, 82)	62 (45, 78)	0.001
Sex, n(%) Female	588 (39.8%)	154 (39.0%)	294 (37.4%)	0.522
Race, n(%) African American	303 (20.5%)	69 (17.5%)	184 (23.4%)	0.013
White	1000 (67.7%)	283 (71.6%)	510 (64.8%)	
Hispanic	88 (6.0%)	14 (3.5%)	36 (4.6%)	
Asian	43 (2.9%)	9 (2.3%)	18 (2.3%)	
Other	43 (2.9%)	20 (5.1%)	39 (4.9%)	
AIS Head, n(%) 3	723 (49.0%)	201 (50.9%)	352 (44.7%)	<0.001
4	455 (30.8%)	124 (31.4%)	220 (28.0%)	
5	299 (20.2%)	70 (17.7%)	215 (27.3%)	
Mechanism of Injury, n(%) Blunt	1435 (97.1%)	384 (97.2%)	752 (95.5%)	0.074
Penetrating	32 (2.2%)	8 (2.0%)	32 (4.1%)	
Mechanism of Blunt Injury, n(%) Fall	1095 (76.4%)	284 (74.2%)	534 (71.0%)	0.023
MVC	126 (8.8%)	33 (8.6%)	58 (7.7%)	
MCC	15 (1.0%)	7 (1.8%)	14 (1.9%)	
Assault	74 (5.2%)	20 (5.2%)	48 (6.4%)	
Auto vs. Peas	38 (2.0%)	11 (2.9%)	41 (5.4%)	0.000
wechanism or Penetrating Injury, n (%)	00 (00 00()	7 (400.09()	22 (400.0%)	0.096
G5W	20 (03.9%)	7 (100.0%)	32 (100.0%)	
ICH characteristics	1 (3.276)	0 (0.0%)	0 (0.0 %)	
ion characteristics	278 (31 3%)	105 (44 1%)	196 (5%)	1
Presence of SAH, n (%)	(n=887)	(n=238)	(n=431)	<0.001
SDH, n (%)	(n=1019)	(n=284)	(n=555)	0.011
SDH > 8mm	348 (34.2%)	72 (25.4%)	193 (34.8%)	
SDH ≤ 8mm	671 (65.8%)	212 (74.6%)	362 (65.2%)	
EDH Bleed > 8mm n (%)	28 (50.9%)	9 (81.8%)	23 (44.2%)	0.076
EDIT Bleed > Onlini, IT (78)	(n=55)	(n=11)	(n=52)	0.070
Presence of IVH, n (%)	36 (2.4%)	8 (2.0%)	29 (3.7%)	0.142
IPH Bleed > 2cm, n (%)	79 (28.2%)	25 (34.7%)	88 (40.2%)	0.019
, ,	208 (17 3%)	63 (20 3%)	100 (32 2%)	
Multifocal contusions, n (%)	(n=1203)	(n=310)	(n=618)	<0.001
Absormal CTA bood p (%)	25 (2.1%)	5 (1.6%)	23 (3.8%)	0.052
Abiloifilai CTA fiead, fi (%)	(n=1203)	(n=306)	(n=609)	0.052
Complications, n (%)	77 (5.2%)	39 (9.9%)	140 (17.8%)	<0.001
UTI, n (%)	29 (2.0%)	19 (4.8%)	35 (4.5%)	<0.001
MI, n (%)	3 (0.2%)	0 (0.0%)	5 (0.6%)	0.149
Unplanned return to OR, n (%)	16 (1.1%)	4 (1.0%)	12 (1.5%)	0.619
Unplanned readmission to the ICU, n (%)	17 (1.2%)	7 (1.8%)	35 (4.5%)	<0.001
Pneumonia, n (%)	17 (1.2%)	11 (2.8%)	55 (7.0%)	<0.001
Time to 1st Stable Head CT, Median (Q1, Q3)	(n=1325)	(n=388)	12 (7.4, 21.9) (n=776)	<0.001
Ime to VIEP from Stable Head CT, Median (Q1, Q3)	-	11 (5.8, 16.5)	44.6 (32.3, 71.7)	
VTE, n (%)	18 (1.2%)	7 (1.8%)	34 (4.3%)	<0.001
DVT, n (%)	16 (1.1%)	4 (1.0%)	26 (3.3%)	<0.001
PE, n (%)	2 (0.1%)	5 (1.3%)	10 (1.3%)	<0.001
ICHE, n (%)	244 (16.5%)	92 (23.3%)	216 (27.5%)	<0.001
ICHE after VTEP, n (%)		10 (2.5%)	26 (3.3%)	0.590
Time to ICHE from VTEP, Median (Q1, Q3)	-	165.1 (71, 177.2) (n=9)	52.0 (32.2, 107.9) (n=25)	0.105
ICU LOS, Median (Q1, Q3)	1 (0, 2) (n=1416)	1 (0, 3) (n=393)	3 (1, 7) (n=781)	<0.001
Hospital LOS, Median (Q1, Q3)	3 (1.9, 5)	4 (2, 8)	8 (4, 14)	<0.001
Ventilator days, Median (Q1, Q3)	0 (0, 0)	0 (0, 0)	0 (0, 3)	<0.001
Mortality, n (%)	73 (4 9%)	(11-393)	(11-773)	
workancy, IT (70)	10(4.970)	10 (0.076)	1	1

Table 1: Demographics and Characteristics of Patients with Severe TBI

Table 2: Summary of Weighted*	Univariate Logistic Regression Model Results for VTE and ICHE in
Severe TBI Patients (N=2,659)	

Model	Outcome*	Predictor	Odds Ratio (95% CI)	p-value
1	VTE	Patient Group		
		No VTEP	0.69 (0.30, 1.59)	0.389
		VTEP >24	2.14 (0.97, 4.72)	0.059
		VTEP ≤24	-Reference-	
2	ICHE	Patient Group		
		No VTEP	0.64 (0.49, 0.83)	0.001
		VTEP >24	0.96 (0.73, 1.26)	0.757
		VTEP ≤24	-Reference-	

CI: Confidence Interval; *Variables included in CBPS weighting were: patient age, admission HR, admission SBP, admission GCS, initial platelet count, hemoglobin, international normalized ratio, PRBC given at admission, FFP given at admission, platelets given at admission, cryo given at admission, TXA given at admission, PCC given at admission, gender, race, AIS, HTN, CAD, DM-1 or DM-2, COPD, CKD, coagulopathy, liver disease, cancer, mechanism of blut nijury, MTP at admission, multiple contusions per lobe, subarachnoid hemorrhage, SAH with abnormal CTA, subdural hematoma > 8mm and presence of intraventricular hemorrhage.

Table 2: Summary of Weighted* Univariate Logistic Regression Model Results for VTE and ICHE in Severe TBI Patients (N=2,659)

Paper #39 January 20, 2023 8:45 am

ANTICOAGULATION IN EMERGENCY GENERAL SURGERY: WHO BLEEDS MORE? THE EAST ACES MULTICENTER TRIAL

Lindsay O'Meara, CRNP*, Ashling Zhang, Jeffrey N. Baum, MD*, Amanda Cooper, MD, Cassie Decker, BS, Jenny Cai, MD*, Daniel C. Cullinane, MD*, Richard D. Catalano, MD*, Nikolay Bugaev, MD*, Christina Feather, MD, Katherine McBride, MD, Valerie Sams, MD*, Pak Shan Leung, MD, MS, FACS*, Devon S Callahan, MD*, Joseph Posluszny, MD*, Jordan Estroff, MD*, Beth Hochman, MD*, Anna Goldenberg-Sandau, DO*, Jeffry Nahmias, MD, MHPE, FACS, FCCM*, Jason D. Pasley, DO, FACS*, Leah Hustad, MD, Jessica Reynolds, MD*, Michael Truitt, MD*, Roumen Vesselinov, PhD, Mira Ghneim, MD* R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine

Presenter: Lindsay O'Meara, CRNP

Discussant: Tasce Bongiovanni, MD, MPP, MHS - Zuckerberg San Francisco General Hospital

<u>Objectives</u>: To determine the intra-operative (IO) and postoperative (PO) bleeding risk in those taking direct oral anticoagulants (DOACs) vs. warfarin and antiplatelet therapy (AC/AP) and requiring urgent/emergent operative intervention in the emergency general surgery (EGS) population.

<u>Methods</u>: This was a prospective observational trial, conducted between 2019-2022, across 21 centers. Inclusion criteria were age \geq 18, confirmed DOAC, AC/AP use within 24 hours of requiring urgent/ emergent abdominal surgical intervention. Chi-squared and ANOVA were used to conduct the analysis.

<u>Results:</u> Of the 413 patients enrolled in the study, 261 (63.2%) reported AC/AP use and 152 (36.8%) reported DOAC use. Patient demographics, indications for surgery, surgical approach, IO and PO transfusion requirements, and bleeding risk are reported in Table 1. The overall bleeding risk was similar between the two groups. The AP/AC group were more likely to have a laparoscopic procedure when compared to the DOAC group (44.4% vs. 31.6%, p=0.01). Conversely, the DOAC were more likely to undergo open procedures (38% vs. 56.6%, p=0.001). There was no difference in the conversion from laparoscopic to open intervention between the two groups. (Table 1) IO transfusion requirements and hemostatic agents use did not differ between the two groups. PO bleeding, transfusion requirements, and hematoma formation, were also similar between the two groups. While there was a trend towards increased mortality in the DOAC group, this did not reach statistical significance

<u>Conclusions</u>: The perioperative bleeding risk in the EGS patients taking DOACs and requiring urgent/emergent intervention is similar to those taking AP and AC. Therefore, acute surgical intervention should not be delayed in the setting of DOAC use.

	AC/AP (n=261)	DOAC (n=152)	p-value
Age, mean (SD)	69.2 (12.5)	71.2 (12.6)	0.12
Female, n (%)	115 (44.1%)	72 (47.4%)	0.51
Indication for surgery, n(%)			
Obstruction/hernia	62 (23.8%)	68 (44.7%)	0.001*
Ischemia/Intestinal arterial ischemia	36 (13.8%)	19 (12.5%)	
Diverticulitis/Infectious colitis/PUD	22 (8.4%)	11 (7.3%)	
Other/Pancreatitis/Bleeding	28 (10.7%)	16 (10.5%)	
Appendicitis/Cholecystitis	113 (43.3%)	38 (25%)	
Surgical approach, n(%)			
Laparoscopic	116 (44.4%)	48 (31.6%)	0.01*
Open	99 (38%)	86 (56.6%)	0.001*
Laparoscopic converted to open	46 (17.6%)	18 (11.8%)	0.12
IO transfusion requirements, n (%)	48 (18.4%)	20 (13.2%)	0.17
PO transfusion requirements, n (%)	42 (16.1%)	30 (19.7%)	0.3
Postoperative bleeding, n(%)	81 (31%)	47 (30.9%)	0.9
Mortality, n (%)	20 (7.7)	20 (13.2)	0.07

Table 1: Demographics, Indication for Surgery, Surgical Approach and Transfusion Requirements, N=413

*AC/AP: Warfarin, anti-platelet; DOAC: direct oral anticoagulant; IO: intra-operative (fresh frozen plasma, packed red blood cells, platelets, cryoprecipitate); PO: post-operative (fresh frozen plasma, packed red blood cells, platelets, cryoprecipitate)

Paper #40 January 20, 2023 9:00 am

DOES FRACTURE FIXATION TECHNIQUE INFLUENCE COGNITIVE OUTCOMES IN TRAUMATIC BRAIN INJURY (TBI)? THE EAST BRAIN VS. BONE MULTICENTER TRIAL

Mira Ghneim, MD*, Ashling Zhang, Joseph A Kufera, MA, Justin Richards, MD, Xi Luo, MD, Jill Watras, MD*, Alison A. Smith, MD, PhD*, Dalier Mederos, MD, Kyle Cunningham, MD, MPH, FACS*, Scott H. Norwood, MD*, Lewis E. Jacobson, MD, FACS*, Lawrence Lottenberg, MD*, William R.C. Shillinglaw, DO*, Jeffry Nahmias, MD, MHPE, FACS, FCCM*, Tanya Egodage, MD*, Pascal O. Udekwu, MD, MBA, MHA*, Julie A. Dunn, MS, MD*, Ariel Santos, MD, MPH, FACS, FCCM*, Katherine McBride, MD, Caleb J. Mentzer, DO*, Thomas J. Schroeppel, MD*, Dirk Johnson, MD*, Cherisse Berry, MD, FACS*, Jessica Reynolds, MD*, Miklosh Bala, MD*, Mark F. Scott, MD, FACS*, Zachary Hickman, MD, Nina E Glass, MD*, Gregory Semon, DO*, Christa Siebenburgen, MD*, Mark J. Lieser, MD*, Nikolay Bugaev, MD*, Deborah M. Stein, MD, MPH, FACS, FCCM* R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine

Presenter: Mira Ghneim, MD

Discussant: Abid Khan, MD - University of Chicago

<u>Objectives</u>: To determine whether lower extremity (LE) fracture fixation technique impacts cognitive outcomes in patients with TBI.

<u>Methods:</u> A prospective observational study was conducted, from 2019-2022, across 29 centers. Inclusion criteria were age ≥18, head abbreviated injury scale (AIS) score>2, and a femur or tibia diaphyseal fracture requiring external fixation (ex-fix), intramedullary nailing (IMN) or open reduction internal fixation (ORIF). Analyses were conducted using ANOVA, Kruskal-Wallis, and multivariable regression models. Cognitive outcome was measured by discharge Rancho Los Amigos Score (RLAS) and change in motor score (MS) between admission and discharge.

<u>Results:</u> Of the 520 patients enrolled, 358 underwent ex-fix, IMN or ORIF as definitive management. Demographics, hospital course and outcomes are shown in Table 1 and 2. Head AIS was similar among all groups. The ex-fix group experienced more severe LE injury (AIS 4-5) compared to the IMN group (16% vs 3%, p=0.01). Time to operative intervention was significantly shorter for the ex-fix group compared to the IMN and ORIF groups. (Table 2) The ORIF group experienced a decrease in MS at discharge more often than the IMN group (13% vs 5%, p=0.02). RLAS distribution was similar across all groups. After adjusting for confounders, LE fixation technique was not significantly associated with RLAS or decreased MS at discharge. Conversely, increasing age, and increasing head AIS score were associated with worse RLAS (OR 1.04, 95%CI 1.02-1.05 and OR 2.2, 95%CI 1.7-2.9) and a decrease in MS at discharge (OR 1.06, 95%CI 1.02-1.09 and OR 3.7, 95%CI 2-7.2).

<u>Conclusions</u>: Cognitive outcomes in TBI are impacted by head injury severity and not fracture fixation technique. Therefore, the strategy of definitive LE fracture fixation may not need to be delayed or modified due to concern for worsening neurologic outcomes in TBI patients.

Table 1: Demographics, Injury	Characteristics,	and Hospital	Course of	Patients	Presenting v	with a TBI and
Concomitant Lower Extremity	Fracture					

	Ex-Fix n=45	IMN n=171	ORIF n=142	p-value
Age, mean (SD)	47.9 (19.3)	39.9 (18.2)	43.8 (18.7)	0.02
Male, n (%)	34 (76.6)	131 (76.6)	101 (71.1)	0.5318
MOI, n (%)				0.6427
Motor vehicle collision	18 (40)	67 (39.2)	49 (34.5)	100000000000000000000000000000000000000
Pedestrian struck	11 (24.4)	46 (26.9)	44 (31)	
Motorcycle collision	10 (22.2)	31 (18.1)	20 (14)	
Other	6 (13.3)	27 (15.8)	29 (20.4)	· · · · · · · · · · · · · · · · · · ·
ISS, n (%)				0.053
<16	4 (9.1)	6 (3.5)	11 (7.8)	
16-24	7 (15.9)	50 (29.2)	49 (34.8)	
>25	33 (75)	115 (67.3)	81 (57.5)	
Head AIS, n (%)				
2-3	24 (55.8)	94 (55.3)	88 (62.4)	0.7176
4-5	18 (42.9)	74 (43.5)	51 (36.2)	
Lower Extremity AIS, n (%)				
2-3	37 (84.1)	165 (96.5)	131 (94.24)	0.0167
4-5	7 (15.9)	5 (2.9)	8 (5.76)	2010/07/07
6	0	1 (0.58)	0	
GCS, n (%)				0.233
3-8	25 (55.6)	95 (55.6)	64 (45.1)	
9-12	10 (22.2)	35 (20.4)	29 (20.4)	
3-15	10 (22.2)	41 (24)	49 (34.5)	
Motor GCS at admission, n (%)				0.0019
1-3	26 (57.8)	69 (40.4)	37 (26.1)	
4-5	10 (22.2)	58 (33.9)	64 (45.1)	
6	9 (20)	44 (25.7)	41 (28.9)	
Femur Fracture, n(%)				0.98
Bilateral	2 (10)	8(7)	6 (8)	0.03450
Left	10 (50)	57 (49.6)	39 (52)	
Right	8 (40)	50 (43.5)	30 (40)	
Tibia Fracture, n(%)				0.039
Bilateral	8 (20.5)	3 (3.9)	6 (6.9)	
Left	15 (38.5)	33 (42.9)	34 (39.1)	
Right	16 (41)	41 (53.2)	47 (54)	

MOI: mechanism of injury, ISS: injury severity score, AIS: abbreviated injury score, GCS: Glasgow Coma Scale

Table 2: Outcomes of Patients Presenting with a TBI and Concomitant Lower Extremity Fra	acture
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	Ex-Fix n=45	IMN n=171	ORIF n=142	p-value
OR ≤ 24 hours, n (%)	32 (71.1)	79 (46.2)	64 (45.1)	0.006
Hour to OR, median (IQR)	15 (8-24)	31 (12-70)	25.5 (12-85)	< 0.001
Hospital LOS, median (IQR)	23 (14-38)	18 (10-30)	17 (9-29)	0.19
ICU LOS, median (IQR)	11 (4-18)	9 (4-16)	8 (3-16)	0.36
Mechanical ventilator, median (IQR)	5 (1-13)	5 (1-13)	5 (1-13)	0.91
RLAS				0.0675
1-3	10 (22.2)	23 (13.5)	19 (13.4)	
4-6	8 (17.8)	56 (32.8)	57 (40.1)	
7-10	27 (60)	92 (53.8)	66 (46.5)	
Decreased Motor GCS at Discharge, n(%)	3 (6.7)	8 (4.7)	19 (13.4)	0.02
Mortality, n (%)	8 (17.8)	12 (7)	11 (7.8)	0.065

OR: operating room, LOS: length of stay, ICU: intensive care unit, RLAS: Ranchos Los Amigos Score

Paper #41 January 20, 2023 9:15 am

CRYSTALLOID VOLUME IS ASSOCIATED WITH SHORT TERM MORBIDITY IN CHILDREN WITH SEVERE TRAUMATIC BRAIN INJURY: AN EASTERN ASSOCIATION FOR THE SURGERY OF TRAUMA MULTICENTER TRIAL POST-HOC ANALYSIS

Taleen A. MacArthur, MD, Adam M. Vogel, MD*, Amy E. Glasgow, M.H.A, Suzanne Moody, MPA, Meera Kotagal, MD, MPH*, Regan Williams, MD, MSE*, Mark L. Kayton, MD*, Emily C. Alberto, MD, Randall S. Burd, MD*, Thomas J. Schroeppel, MD*, Joanne E. Baerg, MD, Amanda Munoz, MD, William B. Rothstein, MD, Laura A. Boomer, MD, Eric M. Campion, MD, FACS*, Caitlin Robinson, MPH, CRA, Rachel M Nygaard, PhD*, Chad J. Richardson,
Denise I. Garcia, MD, MEd, Christian J. Streck, Jr., MD*, Michaela Gaffley, MD, John Petty, MD*, Mark Ryan, MD, Samir Pandya, MD*, Alicia M. Waters, MD, Robert T. Russell, MD, MPH, Brian K. Yorkgitis, DO, FACS*, Jemnnifer Mull, MSN, RN, CCRC, Jeffrey Pence, MD, Matthew T. Santore, MD, Denise B. Klinkner, MD, MEd, Megan Cunningham, MD, Shawn Safford, MD, MAS*, Tanya Trevilian, MSN, RN, CCRN-K, CPN, Christa Black, MPH, Jessica N. Rea, MD, Aaron Jensen, MD, MEd, MS, FACS*, Bethany J. Farr, MD, David P. Mooney, MD*, Bavana Ketha, MD, Melvin S. Dassinger III, MD, Anna Goldenberg-Sandau, DO*, Janika L. San Roman, MPH, Richard A. Falcone, Jr., MD, MPH*, Stephanie F. Polites, MD, MPH*

Presenter: Taleen A. MacArthur, MD

Discussant: Molly Deane, MD - Harbor UCLA Medical Center

<u>Objectives</u>: This study examined the association between crystalloid volume and short-term outcomes during the resuscitation of injured children with severe traumatic brain injury (sTBI).

<u>Methods</u>: We performed a *post-hoc* analysis from a 24-center prospective, observational study of injured children <18 years old (2018-2019) transported from the scene, with elevated age-adjusted shock index on arrival and head Abbreviated Injury Scale (AIS) score ≥3. Timing and volume of resuscitation products were assessed using Fisher's exact t-test, Kruskal-Wallis, and multivariable logistic regression analyses.

<u>Results:</u> There were 154 patients with sTBI and 550 with non-TBI injuries. sTBI patients had lower hemoglobin, higher INR, higher ISS, longer duration of ventilator and ICU use, and more inpatient complications (**Table 1**). sTBI patients received more pre-hospital crystalloid (28% vs.16%, p=.003), \hat{a} ‰¥1 crystalloid boluses (52% vs.24%, p<.001), and blood transfusion (47% vs.13%, p<.001) than non-TBI patients. Among sTBI patients, receipt of ≥1 crystalloid bolus (n=80) was associated with greater ICU need (93% vs.63%, p<.001), longer median ICU (5.5 vs.4 days, p<001) and hospital stay (9 vs.4 days, p<.001), and more in-hospital complications (25% vs. 8.1%, p< .001) than those who received <1 bolus (n=74). These findings persisted after adjustment for injury severity which accounts for other injuries (**Table 2**).

<u>Conclusions</u>: Pediatric trauma patients with sTBI received more crystalloid than those without sTBI despite being more coagulopathic at presentation and requiring more blood products. Excessive crystalloid may be associated with worsened outcomes seen among pediatric sTBI patients who received \geq 1crystalloid bolus. Further attention to an early transfusion approach to resuscitation of children with sTBI is warranted.

	sTBI (Head AIS ≥ 3) n= 154	No TBI (Head AIS< 3) n= 550	p-value
Age (years)	6.0	7.0	.058
Sex (% male) ^	85 (55%)	273 (52%)	.052
Injury type (% blunt)	140 (91%)	459 (87%)	.259
Initial GCS	9.0	15	< .001
ISS	26	5.0	< .001
Initial hemoglobin	11.3	12.4	< .001
INR (mean, SD)	1.4 (0.5)	1.1 (0.2)	< .001
ICU admission	121 (79%)	146 (26%)	< .001
Ventilator requirement	93 (60%)	64 (12%)	< .001
Ventilator days (mean, SD)	8.5 (16)	3.3 (3.1)	.001
Hospital Days (mean, SD)	12.2 (17.4)	4.0 (7.4)	<.001
Any complication	26 (17%)	18 (3.5%)	<.001
In-hospital mortality*	29 (19%)	9 (1.8%)	<.001

Table 1: Demographic and Clinical Characteristics of Patients with Severe Traumatic Brain Injury (STBI) vs. Those without TBI

Table 1: Results presented as median or n (%) unless otherwise specified. ^Sex not available for 24 of the non-TBI patients; *mortality not available for 41 non-TBI patients. GCS = Glasgow coma score, ISS = injury severity score, INR = international normalized ratio, ICU = intensive care unit

Table 2: Multivariable Analysis of Clinical Outcomes in Severe TBI (sTBI) Patients Based
on Crystalloid Volume Administered and Injury Severity

All sTBI Patients (Head AIS ≥ 3) n = 154	Odds Ratio	95% Confidence Interval	p-value
•	ICU A	dmission	
≥ 1 Crystalloid Bolus	5.0	1.8-14.3	.002
ISS	1.1	1.1-1.2	>.001
58	Extended Hospit	al Stay (> 15 Days) *	
≥ 1 Crystalloid Bolus	3.7	1.6-8.9	.002
ISS	1.0	1.0-1.1	.043
0.x 21	Any In-Hospi	tal Complication	
≥ 1 Crystalloid Bolus	3.7	1.4-9.9	.009
ISS	1.0	0.9-1.0	.758

Table 2: ICU = intensive care unit, ISS = injury severity score, *hospital stay of > 15 days is the upper 75th percentile for sTBI patients.

Paper #42 January 20, 2023 9:30 am

WOUND INFECTION RATE AFTER SKIN CLOSURE OF DAMAGE CONTROL LAPAROTOMY WITH WICKS OR INCISIONAL NEGATIVE WOUND THERAPY: AN EAST MULTICENTER TRIAL

John Cull, MD, FACS*, Katherine Pellizzeri, MD*, Daniel C. Cullinane, MD*, Meghan Cochran-Yu, MD, Eric Trevizo, MD, Anna Goldenberg-Sandau, DO*, Ryan Fields, BS, Jordan M. Kirsch, DO*, Jessica K. Staszak, MD, MS*, Jeffrey J Skubic, DO*, Raul Barreda, MD, FACS, William M Brigode, MD*, Faran Bokhari, MD, MBA, FACS, FACP*, Christopher A. Guidry, MD* Prisma Health Upstate

Presenter: John Cull, MD

Discussant: Ali F. Mallat, MD, MS - Cleveland Clinic Foundation

<u>Objectives</u>: To determine if skin closure using wicks or incisional wound vacs after damage control laparotomy (DCL) can be performed safely with acceptable rates of wound infections.

Methods: This is a prospective multicenter observational trial performed by 8 institutions from July 2020 to April 2022. The study included all adult patients who underwent DCL who had their fascia and skin closed with wicks or the use of an incisional wound vac. Patients who died within seven days of their skin closure were excluded. Wound infection was defined as superficial or deep surgical site infections. Patient demographics, mechanism of injury, wound classification, antibiotics given, surgical site infections, interventions, and mortality were collected. Fisher's Exact test was used for categorical data and Wilcoxon Rank Sum test for continuous data. Mean days to closure was assessed using Student's t-test for independent groups. P-value <0.05 was considered indicative of statistical significance.

<u>Results:</u> Of the 257 patients enrolled in the study, 135 patients did not meet inclusion criteria for a total of 122 patients analyzed. Most patients were male (n=77, 63%) with average age of 50.7 years. The average days of the open abdomen was 2.6. A majority of the DCLs were performed on acute care patients (n=77, 63.1%) and 95 patients (77.9%) had a wound classification of contaminated or dirty. Most of the patientsâ \in TM skin were closed with wicks in place (n=82, 67%). There was no difference in infection rate in patients closed with wicks or those with an incisional wound vac. The rate of superficial and deep wound infections was 12.3% (n=15), surgical site occurrence rate was 29.5% (n=36), and organ space 12.3% (n=15).

<u>Conclusions</u>: Primary closure of incisions after damage control laparotomies are feasible with acceptable rates of wound infection.

Characteristic	Wound Infection	Wound Infection	
	No	Yes	p-value
Number of Patients	107	15	
Demographics			
Age – Years	50 (32, 66)	56 (40, 65)	0.495
Gender Male	68 (63.6)	9 (60.0)	0.782
Body Mass Index (kg/m2)	26.9 (23.4, 31.3)	22.1 (21.2, 28.9)	0.169
History/ Comorbidities:			
Current Smoker	28 (26.4)	7 (46.7)	0.131
Alcohol Use disorder	8 (7.6)	3 (20.0)	0.138
Hypertension	42 (39.3)	6 (40.0)	1.000
Diabetes	16 (15.0)	3 (20.0)	0.703
COPD	15 (14.2)	3 (20.0)	0.697
CHF	16 (15.0)	4 (20.0)	0.268
Chronic Renal Failure	9 (8.6)	0	0.600
PAD	11 (10.3)	2 (13.3)	0.662
Myocardial Infarction	10 (9.4)	0	0.610
CVA	5 (4.7)	1 (6.7)	0.553
Disseminated Cancer	4 (3.8)	1 (6.7)	0.490
Dementia	1 (0.9)	1 (6.7)	0.234
Angina	3 (2.8)	2 (13.3)	0.114
Cirrhosis	2 (1.9)	0	1.000
Bleeding disorder	2 (1.9)	1 (6.7)	0.328
Closure Group			
Negative Pressure Wound Therapy	33 (30.8)	7 (46.7)	0.248
Wicks	74 (69.2)	8 (53.3)	
Medical Condition			
Acute Care	65 (60.8)	12 (80.0)	0.252
Trauma	42 (39.3)	3 (20.0)	
Blunt	17	2	
Penetrating	25	1	
Days to Closure:			
Median (25 th , 75th)	2 (1, 3)	3 (2, 3)	0.222
Mean ± SD	2.6 ± 2.9	2.4 ± 1.2	0.639
Wound Class			
Clean	13 (12.2)	2 (13.3)	0.749
Clean contaminated	11 (10.3)	1 (6.7)	
Contaminated	36 (33.6)	7 (46.7)	
Dirty	47 (43.9)	5 (33.3)	

Patient and Clinical Characteristics by Wound Infection

	No. (%) of 122 patients
Surgical Site Infection	
Superficial	10 (8.2)
Deep	5 (4.1)
Organ Space	15 (12.3)
Surgical Site Occurrences	
Seroma	4 (3.3)
Hematoma	6 (4.9)
Skin dehiscence	16 (13.1)
Enteric fistula	4 (3.3)
Fascial dehiscence	6 (4.9)
Procedural Interventions	
Wound opening	17 (13.9)
Wound debridement	4 (3.3)
Percutaneous drainage	20 (16.4)
Negative pressure therapy	22 (18.0)
Mortality	13 (10.7)

Complications and Additional Interventions