

Scientific Session I - Raymond H. Alexander MD Resident Paper Competition

Paper 1
January 13, 2021
11:10 am Eastern

ULTRA-MASSIVE TRANSFUSION OUTCOMES IN A MODERN ERA: AN EAST MULTICENTER STUDY

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M. Chance Spalding, DO, PhD, FACS*, Aimee LaRiccia, DO*, Khaled Taghlabi, MBBS,
Christopher A. Guidry, MD*, Satya Dalavayi, MD, Jessica Reynolds, MD*, Heather Lesch, MD,
Yee Wong, MD*, Liz Penaloza, MD, Kaushik Mukherjee, MD, MSCI, FACS*, Jordan M. Kirsch, DO*,
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Daniel C. Cullinane, MD*, Asanthi Ratnasekera, DO, FACOS*, Sirivan S Seng, MD, Joshua Gish, MD*,
Joshua P. Hazelton, DO, FACS*, Sarabeth Spitzer, MD, John C Kubasiak, MD*,
Khaled Abdul Jawad, MD, Gabriel Ruiz, MD*, Pranaya Terse, BA, Claire Hardman, RN, BSN,
Xian Luo-Owen, MD PhD, Anquonette Stiles, DC, MPH, Brendan Pearce, BS, Kimberly Tann, BS,
Alexander Fields, PhD, Ellicott Matthay, PhD, Jonathan Esensten, MD PhD, Ashok Nambiar, MD,
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Presenter: Zachary A Matthay, MD

Discussant: CPT Patrick McCarthy, MD

Objectives: Despite widespread institution of balanced resuscitation massive transfusion protocols, survival remains low and resource consumption high for patients with traumatic hemorrhage receiving ultra-massive transfusion (>20 units[u] packed red blood cells[pRBCs] in 24 hours[h]). Given this, we aimed to identify factors associated with mortality for trauma patients receiving ultra-massive transfusion during a modern era.

Methods: An EAST sponsored multicenter retrospective study of 400 trauma patients from 15 trauma centers who received >20u pRBCs in 24h was performed (2010-2020). Multivariate logistic regression and Classification and Regression Tree Analysis (CART) were used to identify clinical characteristics associated with mortality.

Results: The 400 patients were young (median age 37), male (81%), severely injured (median injury severity score 34), in shock (median shock index 1.1, base excess -13), and were transfused a median of 29u pRBCs, 23u of plasma(FFP), and 24u of platelets(PLT). Mortality was high (46% 24h; 67% in-hospital). Transfusion ratios of RBC:PLT>1.5:1 (37% of patients) and RBC:FFP>1.5:1 (36% of patients) were independently associated with death at 24h (both p<0.01; Figure 1). CART identified that severe head injury, resuscitative thoracotomy (RT), and thrombocytopenia were associated with low likelihood of survival to discharge (12%, 16%, and 30%), while absence of severe head injury and RT, and presence of higher platelet counts were associated with the highest likelihood of survival (66%; Figure 2).

Conclusions: Despite modern balanced resuscitation protocols, over 1/3 of trauma patients receiving ultra-massive transfusion are transfused RBC:FFP or RBC:PLT ratios >1.5:1, with increased associated mortality. Maintaining focus on balanced ratios during ultra-massive transfusions with attention to blood product allocation for patients with brain injury or RT is critical in the context of blood shortages.

Effect of Transfusion Ratios on 24hr and In-Hospital Mortality

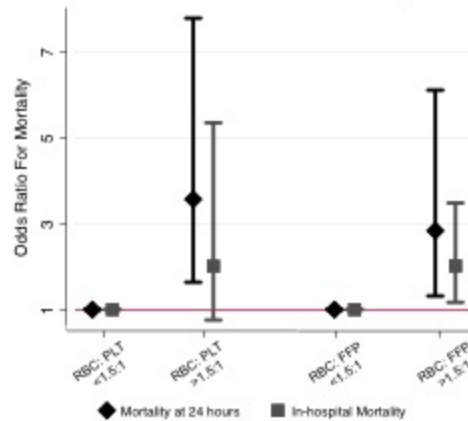


Figure 1. Odds ratios (OR) with 95% confidence intervals for RBC:PLT and RBC:FFP ratios $>1.5:1$ compared to ratios $<1.5:1$. ORs for RBC:PLT $>1.5:1=3.57$ ($p<0.01$, 24hr mortality) and 2.01 ($p=0.16$, in-hospital). ORs for RBC:FFP $>1.5:1=2.84$ ($p<0.01$, 24hr mortality) and 2.02 ($p=0.01$, in-hospital). Covariates controlled for: age, ISS, mechanism, base deficit, resuscitative thoracotomy, crystalloid, and recruiting center.

Classification and Regression Tree Model for Survival to Discharge

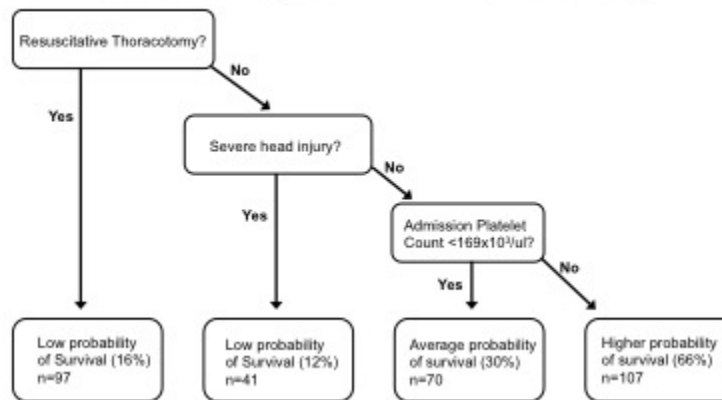


Figure 2. CART Model predictive for survival to discharge for patients receiving ultra-massive transfusion. Gini coefficient used to determine splits with 10 fold cost complexity pruning to develop the trimmed tree. Data divided into a training (90%) and a test set (10%) for validation. Area under the receiver operator characteristic curve=0.78. Severe head injury=abbreviated injury scale >4 .

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Paper 2
January 13, 2021
11:25 am Eastern

FFP MAINTAINS NORMAL COAGULATION WHILE PCC INDUCES A HYPERCOAGULABLE STATE IN A PORCINE MODEL OF PULMONARY CONTUSION AND HEMORRHAGIC SHOCK

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Oregon Health and Science University

Presenter: Alexandra L Dixon, MD MPH

Discussant: Julia Coleman, MD, MPH

Objectives: Moderate injury can lead to a coagulopathy. Fresh frozen plasma (FFP) corrects coagulopathy by means of a balanced array of clotting factors. We sought to compare the late effects of FFP and a prothrombin complex concentrate (PCC) on the coagulopathy of trauma using a porcine model of pulmonary contusion (PC) and hemorrhagic shock (HS) designed to evaluate the organ protective effects of these treatments.

Methods: Female Yorkshire swine (40-50kg) were randomized to receive PC+HS or control (instrumented and uninjured). A blunt PC was created using a captive bolt gun. To induce HS, a liver crush injury was performed. 80min after injury, swine were treated with 25 U/kg PCC, 1U FFP or 50mL lactated Ringer's vehicle in a blinded manner. Arterial blood samples were drawn every 6h. Swine were euthanized 48h post-injury. Data were analyzed by Pearson χ^2 , ANOVA and Kruskal-Wallis tests with Tukey's or Mann-Whitney U tests for post hoc analysis.

Results: 27 swine received PC+HS, 3 groups of 9/group received PCC, FFP or vehicle. 9 were non-injured controls. When compared to control, PC+HS swine had significantly shortened R time at 6, 36 and 42h, decreased LY30 at 12h, shortened K time at 30h and reduced α angle at 42h (Figure 1). PC+HS swine showed significant differences between treatment groups in K and α angle at 3h, LY30 at 12 and 18h, and MA at 12, 18 and 30h (Figure 2). Post hoc analysis was significant for higher α angle in PCC vs vehicle at 3h, higher MA in PCC vs vehicle at 12 and 18h, and higher LY30 in PCC vs vehicle at 18h ($p<0.017$) with no significant differences between FFP and vehicle.

Conclusions: Severe injury with HS induced a coagulopathy in swine. While FFP restored normal coagulation following injury, PCC induced more rapid clot propagation and stronger clot formation in injured animals.

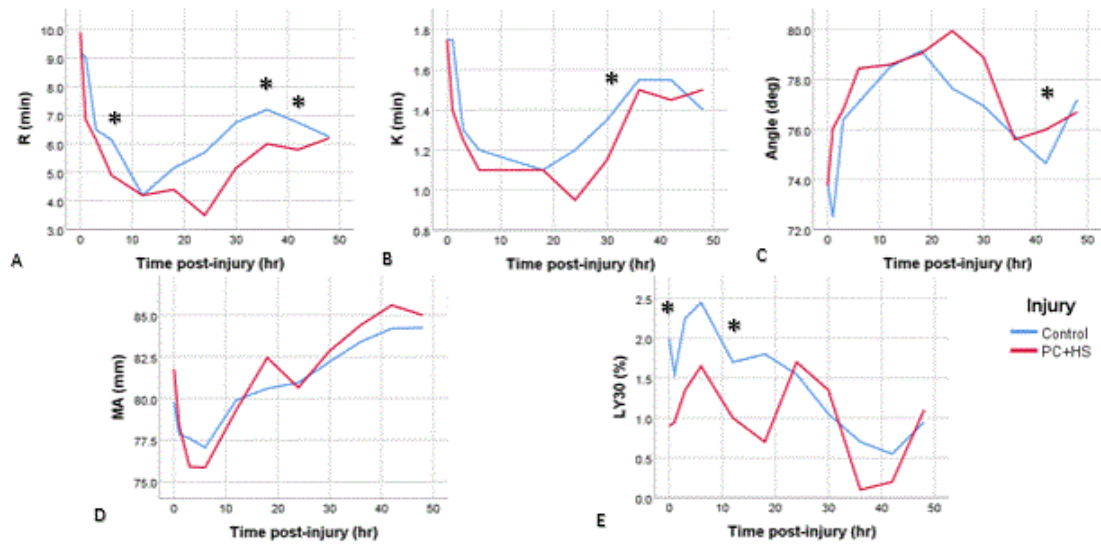


Figure 1. Thromboelastography values for control vs PC+HS treated with vehicle. 1A) R time; 1B) K time; 1C) Angle; 1D) MA; 1E) LY30. *, $p < 0.05$

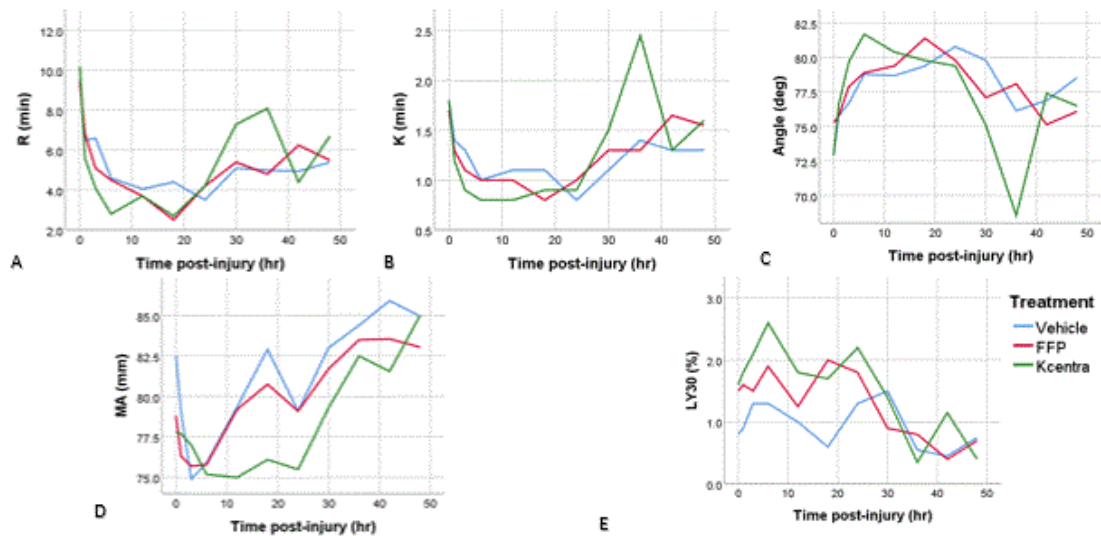


Figure 2. Thromboelastography values for PC+HS swine. 2A) R time; 2B) K time; 2C) Angle; 2D) MA; 2E) LY30. *, $p < 0.05$

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Paper 3
January 13, 2021
11:40 am Eastern

DOSE-DEPENDENT ASSOCIATION BETWEEN BLOOD TRANSFUSION AND NOSOCOMIAL INFECTIONS IN TRAUMA PATIENTS: A SECONDARY ANALYSIS OF PATIENTS FROM THE PAMPER TRIAL

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Brian J. Daley, MD, MBA*, Richard S. Miller, MD*, Brian G. Harbrecht, MD*,
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Presenter: Husayn A Ladhani, MD

Discussant: Zachary Warriner, MD

Objectives: The objective of our study was to examine the association between blood transfusion and nosocomial infections in patients who participated in the PAMPer trial and were randomized to receive plasma or standard of care. We hypothesized that transfusion of packed red blood cells (PRBCs) will be associated with the development of nosocomial infections in a dose-dependent fashion.

Methods: We performed a secondary analysis of prospectively-collected data of patients in the PAMPer trial who survived at least 3 days. Demographics, injury characteristics, and number of units of PRBCs and other blood products transfused were obtained to evaluate outcomes. Two logistic regression models were utilized to evaluate the association between nosocomial infection and 1) any transfusion of PRBCs and 2) quantity of PRBCs. Both models were adjusted for patient age, sex, and injury severity score (ISS).

Results: 399 patients were included: age 46 (IQR 29-59), ISS 22 (IQR 12-29), 73% male, 80% blunt mechanism, and 40 (10%) deaths. 93 (23%) developed nosocomial infections, including pneumonia (n=67), bloodstream infections (n=14), CAUTI (n=10), SSTI (n=8), Clostridium difficile colitis (n=7), empyema (n=6), and complicated intraabdominal infections (n=3). Nearly 80% (n=307) of patients received PRBCs; 12% received cryoprecipitate, 69% received plasma, and 27% received platelets. Patients who received any PRBCs had more than a two-fold increase in nosocomial infections (OR 2.37, 95% CI 1.14-4.94, $p=0.040$). The number of PRBCs given was also associated with development of nosocomial infection (OR 1.06, 95% CI 1.02-1.10, $p=0.001$).

Conclusions: Trauma patients in the PAMPer trial who received a transfusion of at least one unit of PRBCs incurred a two-fold increased risk of nosocomial infection, and the risk of infection was dose-dependent.

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Paper 4
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11:55 am Eastern

WHOLE BLOOD (WB) RESUSCITATION RESTORES INTESTINAL PERFUSION AND INFLUENCES GUT MICROBIOME (GM) DIVERSITY

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Presenter: Jaclyn Yracheta, MD

Discussant: Samuel Carmichael, MD, MS

Objectives: Gut dysbiosis (an imbalance in the GM) occurs after trauma with transfusion potentially minimizing disturbances. We hypothesize that gut hypoperfusion following trauma causes dysbiosis and that WB resuscitation mitigates these effects.

Methods: Anesthetized rats (n=4 per group) underwent sham (S; laparotomy), polytrauma (P; laparotomy, liver and skeletal muscle crush injuries and femur fracture), P and 40% hemorrhage (PH) and PH with WB resuscitation (PH-WB). WB (20% estimated blood volume) from donor rats was transfused 1hr post-trauma. Baseline cecal mesenteric tissue oxygen (O₂) concentration was measured (PreSens Microx 4) following laparotomy and at 1 and 2hrs post-trauma. Fecal samples were collected pre-injury and at euthanasia (2hrs). Microbial DNA was purified and 16s rRNA sequencing for bacterial classification completed. Diversity analysis and taxonomic assignment were performed using the QIIME Greengenes 16S rRNA database (OTUs; 97% similarity). Alpha- and β -diversity were estimated using observed species metrics. Permutational analysis of variance was performed for overall significance.

Results: In the PH rats, an average decline of 33% \pm 4.6 was seen in the mesenteric tissue O₂ concentration at 1hr without improvement by 2hrs post-injury. Following WB, tissue O₂ concentration was restored to near baseline by 2hrs post-injury (2.2% \pm 1.1 difference). There was no change in tissue O₂ concentration in the S or P rats. The β -diversity differed among groups for all measured indices (p<0.05) with the spatial median of hemorrhaged rats more similar compared to non-hemorrhage. There was no difference in α -diversity between groups. *Lactobacillus* was enriched in PH-WB.

Conclusions: Mesenteric hypoperfusion after trauma and hemorrhage is restored with limited WB resuscitation. The GM following hemorrhage differs from non-hemorrhaged rats with further differences in animals receiving WB.

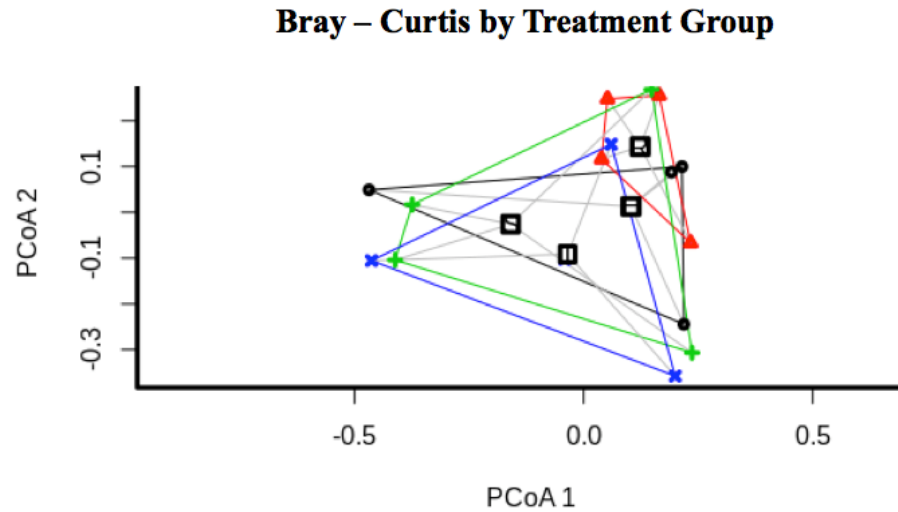


Figure 1. β -diversity by treatment group represented by a Bray-Curtis PCA plot. **Green** – Sham group (S), **Blue** – Polytrauma group (P), **Black** – Polytrauma with 40% hemorrhage (PH), **Red** – Polytrauma, 40% hemorrhage followed by WB resuscitation (PH-WB). Boxes indicate spatial median. PERMANOVA indicated significant group effect that is attributed to differences in spatial median.

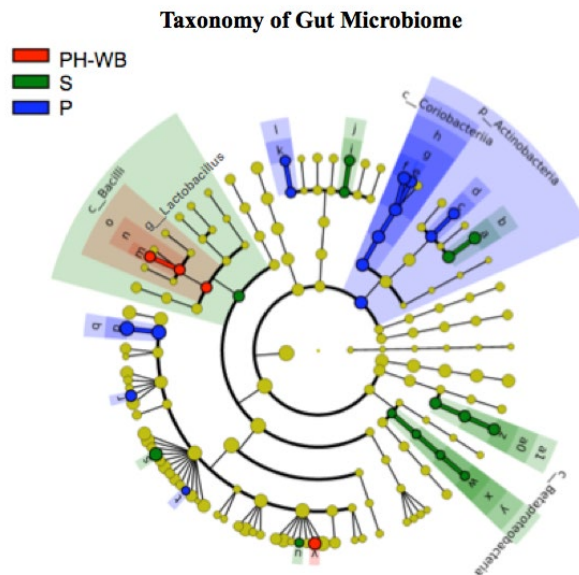


Figure 2. Taxonomic representation for all groups showing Lactobacillus enriched in the PH-WB group.

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Paper 5
January 13, 2021
12:10 pm Eastern

ASSOCIATION BETWEEN PEDIATRIC TRAUMA CENTER CARE AND MOTOR VEHICLE CRASH DEATH IN CHILDREN: AN ECOLOGIC ANALYSIS OF US COUNTIES

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Michael L. Nance, MD*, Mark J. Seamon, MD, FACS*
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Presenter: James P. Byrne, MD, PhD

Discussant: Perna Ladha, MBBS

Objectives: Geographic access to pediatric trauma center (TC) care is highly variable across the US. We hypothesized that pediatric TCs are associated with lower rates of motor vehicle crash (MVC) mortality in children at the US county-level.

Methods: Counties were classified by the highest level of TC care available for children (<15 years): 1) pediatric TC, 2) adult level I/II, 3) adult level III, or 4) no TC. Pediatric deaths on US public roads over a 5-year period (2014-2018) were identified from the NHTSA Fatality Analysis Reporting System. Hierarchical negative binomial modelling measured the relationship between highest level of care and pediatric MVC mortality rate at the county-level, adjusted for age/sex strata, helicopter EMS, traffic safety laws, and population density. The proportion of deaths occurring prehospital was a secondary outcome.

Results: Over the study period 3,067 children died from MVCs. We identified 188 pediatric TCs in 141 counties. Access to pediatric TCs varied markedly with population density (**Figure 1**). After risk-adjustment, counties with pediatric TCs had significantly lower rates of pediatric MVC mortality than those with no TC (**Table 1**): 0.6 vs. 3.2 deaths/100,000 child-yrs; RR 0.59 (95%CI 0.40–0.87). In counties without pediatric TCs, adult level I/II TCs provided comparable risk reduction. Only counties with pediatric TCs were associated with significantly lower risk of fatalities occurring in the prehospital environment (RR 0.61; 95%CI 0.52–0.73).

Conclusions: At the US county-level, pediatric TCs are associated with lower rates of MVC death among children. Where pediatric TCs are absent, adult level I/II TCs appear to provide comparable risk reduction. Lower rates of prehospital death in counties with pediatric TCs may reflect integration of the local system to achieve rapid stabilization in the field and transport to definitive specialist care.

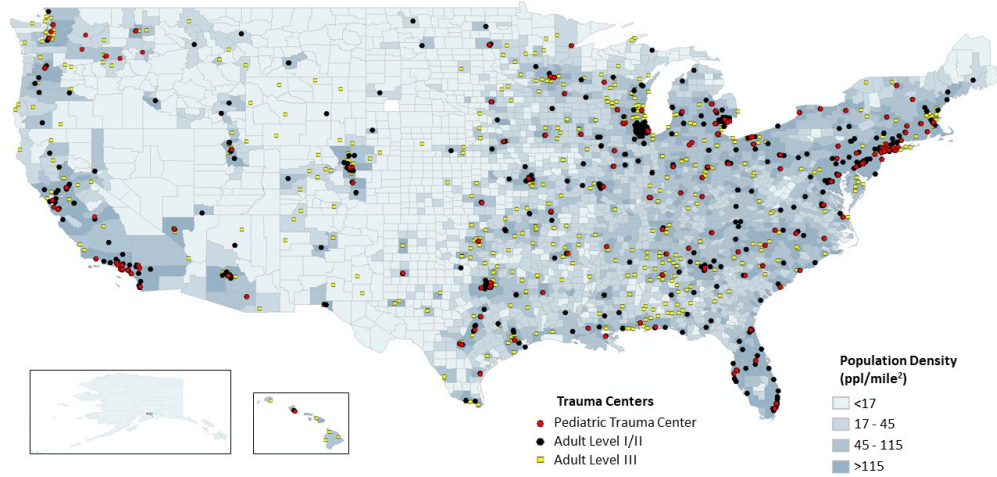


Figure 1. Map of US counties. Trauma centers are shown. Counties are color-weighted for population density quartile. Demonstrated is the strong correlation between access to pediatric trauma care and population density, indicating poor access in rural regions.

Table 1. Characteristics of US counties by highest level of TC care present

County Characteristic	Highest Level of Trauma Center Care within County			
	Pediatric TC (n = 141)	Level I/II (n = 207)	Level III (n = 286)	No TC (2,508)
Distance to Pediatric TC, median km (IQR)	5 (3 – 9)	79 (39 – 142)	99 (55 – 157)	110 (69 – 173)
Population density, median ppl/mile ² (IQR)	823 (353 – 1669)	318 (116 – 622)	87 (33 – 199)	32 (12 – 71)
Mean MVC mortality, deaths/100,000 child-yrs (±STD)	0.6 (± 1.2)	1.0 (± 3.0)	1.6 (± 5.9)	3.2 (± 25)
Adjusted RR for MVC mortality, (95%CI)	0.59 (0.40 – 0.87)	0.67 (0.49 – 0.92)	0.88 (0.68 – 1.14)	Reference
Prehospital deaths, average % (±STD)	35 (± 39)	44 (± 45)	54 (± 48)	52 (± 48)
Adjusted RR for prehospital death, (95%CI)	0.61 (0.52 – 0.73)	0.92 (0.77 – 1.09)	1.05 (0.89 – 1.24)	Reference

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Paper 6
January 13, 2021
12:25 pm Eastern

ANTITHROMBIN III AFTER TBI IMPROVES MORRIS WATER MAZE PERFORMANCE, RECOVERING CUED AND SPATIAL LEARNING

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Perelman School of Medicine, University of Pennsylvania

Presenter: Mohamed Alaaeldin Elsaadani, MD

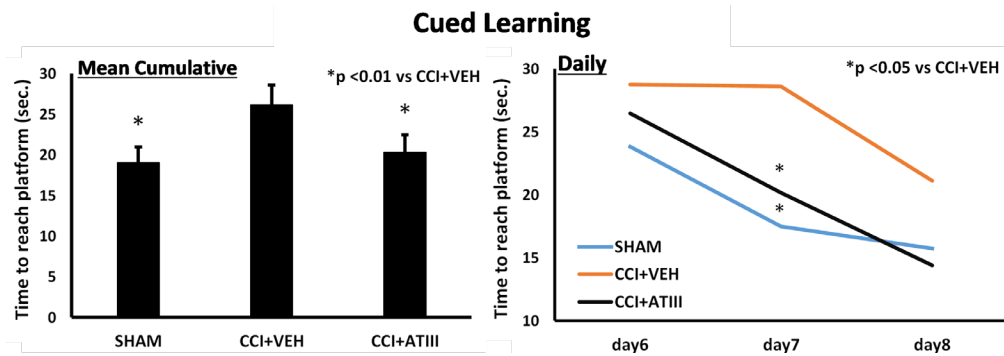
Discussant: Jonathan Parks, MD

Objectives: Neuroinflammation and cerebral edema following severe TBI affect subsequent cognitive recovery. Independent of its anticoagulant effects, antithrombin III (ATIII) has been shown to block neurovascular inflammation after severe TBI, reducing cerebral endothelial-leukocyte interactions and decreasing blood-brain barrier permeability. We hypothesized that ATIII administration after TBI would improve post-TBI cognitive recovery, specifically learning, and memory.

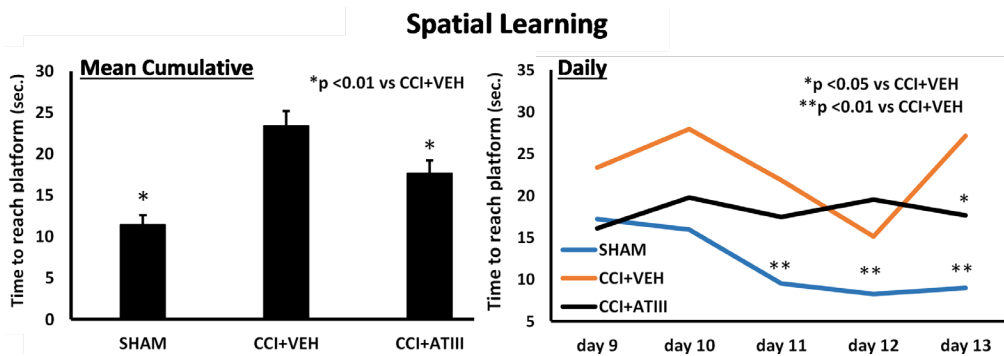
Methods: Fifteen CD1 male mice were randomized to severe TBI (controlled cortical impact, CCI: 6 m/sec velocity, 1 mm depth, 3 mm diameter) or sham craniotomy (SHAM) and received intravenous ATIII (250 IU/kg) or vehicle (VEH: saline) 15 min and 24h after TBI. Animals underwent Morris Water Maze testing 6-14 days later consisting of cued learning trials (platform visible), spatial learning trials (platform invisible, spatial cues present), and probe (memory) trials (platform removed, spatial clues present). Intergroup differences were assessed by the Kruskal-Wallis test ($p < 0.05$).

Results: Morris water maze testing demonstrated that cumulative cued learning (Mean time in sec. to reach the platform on day 6-8) was worst in CCI+VEH ($26.1 \pm 2.4s$) and improved in the CCI+ATIII group ($20.3 \pm 2.1s$, $p < 0.01$, Figure 1). Non-cued spatial learning was also worst in CCI+VEH animals ($23.4 \pm 1.8s$) but improved with ATIII ($17.6 \pm 1.5s$, $p < 0.01$, Figure 2). In probe trials, ATIII treatment failed to significantly improve memory ability. SHAM animals demonstrated significantly better learning and memory than did CCI counterparts across all trials ($p < 0.05$).

Conclusions: ATIII improves neurocognitive recovery weeks after TBI. This improvement is particularly related to improvement in learning but does not appear to support memory. The promise of enhanced learning offers hope for complementary therapy to improve recovery in TBI patients.



Cued Learning Trials: Cumulative cued learning demonstrated significant differences between CCI+ATIII and CCI+VEH groups in the time taken to reach the platform, with CCI+ATIII animals taking significantly less time to reach the platform than CCI+VEH animals ($p < 0.01$). This difference was most pronounced on the 7th day after injury ($p < 0.05$).



Spatial Learning Trials: Cumulative spatial learning demonstrated significant differences between CCI+ATIII and CCI+VEH groups in the time taken to reach the platform, with CCI+ATIII animals taking significantly less time to reach the platform than CCI+VEH animals ($p < 0.01$). This difference was most pronounced on the 13th day after injury ($p < 0.05$).

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Paper 7
January 13, 2021
12:40 pm Eastern

**ASSESSING THE EFFECT OF THE EAST GUIDELINE ON UTILIZATION OF SPINAL MRI IN THE
OBTUNDED ADULT BLUNT TRAUMA PATIENT OVER TIME**

Mihir Chaudhary, MD*, Elliott R. Haut, MD, PhD, FACS*, Joe Canner, BS, MHS
University of California San Francisco

Presenter: Mihir Chaudhary, MD

Discussant: Jeanette Zhang, MD

Objectives: We hypothesized that spinal MRI use in obtunded adult blunt trauma patients would decrease following publication of EAST guidelines in 2015 suggesting restricted indications for spinal MRI in this population.

Methods: We performed a retrospective review of the National Trauma Data Bank (NTDB) from 2007 to 2017. Blunt trauma patients 18 years and older with a Glasgow Coma Scale (GCS) of 8 or less, Abbreviated Injury Score (AIS) of the head of more than 3 and intubated for at least 72 hours were included. A multivariable logistic regression of the likelihood of undergoing spinal MRI was used to control for confounding variables and assess the impact admission year on a patient's likelihood of undergoing spinal MRI. A p-value of 0.05 was defined as significant.

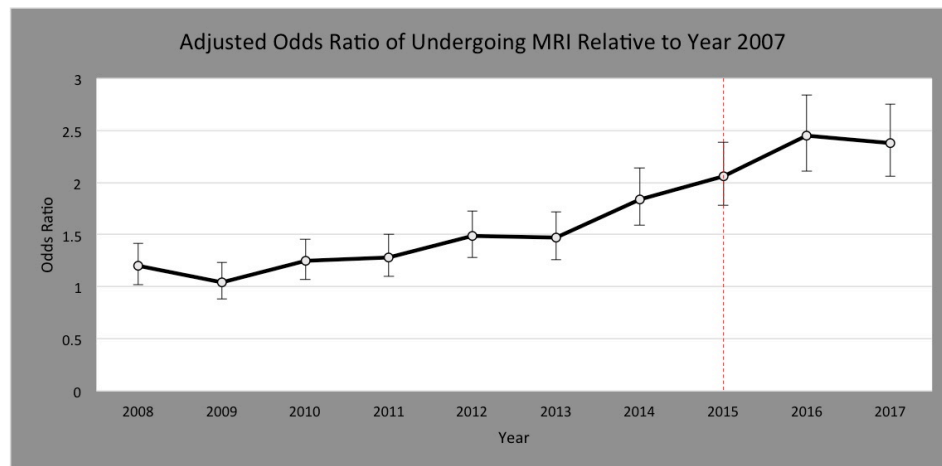
Results: 75,204 patients from 530 trauma centers were included. Patients older than 65, Hispanic patients, uninsured patients and patients suffering from non-motor vehicle collisions were less likely to undergo spinal MRI. Community and non-teaching hospitals were more likely to use spinal MRI relative to university hospitals. Level I trauma centers were more likely to utilize spinal MRI relative to Level II trauma centers. Controlling for age, gender, race, insurance status, injury mechanism, ISS, GCS, GCS motor, hospital teaching status and trauma center level, patients seen after 2015 (the year EAST guidelines were released) had a higher odds ratio (OR) of receiving spinal MRI relative to those seen before 2015 (OR 1.68, 95% CI 1.60 – 1.77). Each year was associated with significantly increased OR of undergoing spinal MRI compared to the year prior (OR 1.10, 95% CI 1.09 – 1.11).

Conclusions: Spinal MRI use has been increasing since 2007 in adult obtunded trauma patients despite 2015 EAST guidelines suggesting restrictive use in this group. Future work should aim to decrease this unnecessary and expensive procedure.

Figure 1: Patient-level predictors of MRI use in obtunded, adult trauma patients					
	OR (95% CI)	P value		OR (95% CI)	P value
Admission year			Mechanism		
2007	(Ref)		Motor Vehicle Collision	(Ref)	
2008	1.20 (1.02 – 1.42)	0.029	Fall	0.60 (0.56 – 0.64)	<0.01
2009	1.04 (0.88 – 1.23)	0.637	Pedestrian	0.75 (0.63 – 0.89)	<0.01
2010	1.25 (1.07 – 1.46)	<0.01	Struck by object	0.61 (0.54 – 0.69)	<0.01
2011	1.28 (1.10 – 1.50)	<0.01	Other blunt	0.89 (0.81 – 0.98)	0.017
2012	1.49 (1.28 – 1.73)	<0.01	ISS		
2013	1.47 (1.26 – 1.72)	<0.01	1 – 8	(Ref)	
2014	1.84 (1.59 – 2.14)	<0.01	9 – 15	1.08 (0.65 – 1.80)	0.765
2015	2.06 (1.78 – 2.39)	<0.01	16 – 24	1.13 (0.69 – 1.87)	0.626
2016	2.45 (2.11 – 2.84)	<0.01	25 – 75	1.24 (0.75 – 2.05)	0.395
2017	2.38 (2.06 – 2.75)	<0.01	GCS (ED)		
Age			3	(Ref)	
18 – 24	(Ref)		4	1.13 (0.95 – 1.35)	0.162
25 – 34	1.02 (0.95 – 1.10)	0.589	5	1.18 (0.95 – 1.46)	0.131
35 – 44	1.01 (0.94 – 1.10)	0.729	6	1.29 (1.08 – 1.55)	<0.01
45 – 54	0.96 (0.89 – 1.04)	0.299	7	1.26 (1.03 – 1.54)	0.023
55 – 64	0.96 (0.88 – 1.05)	0.372	8	1.30 (1.06 – 1.61)	0.013
65 – 74	0.82 (0.74 – 0.91)	<0.01	GCS Motor (ED)		
75 – 84	0.63 (0.55 – 0.71)	<0.01	1	(Ref)	
85+	0.64 (0.52 – 0.79)	<0.01	2	0.80 (0.66 – 0.97)	0.024
Gender			3	0.86 (0.70 – 1.07)	0.171
Male	(Ref)		4	0.77 (0.64 – 0.93)	<0.01
Female	1.02 (0.97 – 1.08)	0.440	5	0.90 (0.73 – 1.11)	0.348
Race			6	0.91 (0.58 – 1.43)	0.692
White	(Ref)				
Black	1.03 (0.95 – 1.11)	0.500			
Hispanic	0.83 (0.77 – 0.90)	<0.01			
Other	0.89 (0.80 – 0.89)	0.028			
Insurance					
Yes	(Ref)				
No	0.78 (0.73 – 0.84)	<0.01			

Patient-level predictors of MRI use in obtunded, adult trauma patients

Odds ratio of undergoing spinal MRI for various patient-level variables



Change in Spinal MRI Utilization in the Adult Obtunded Blunt Trauma Patient Over Time

Red line indicates year 2015 when EAST guidelines were released

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Paper 8
January 13, 2021
12:55 pm Eastern

NOVEL TRAUMA COMPOSITE SCORE IS SUPERIOR TO INJURY SEVERITY SCORE IN PREDICTING MORTALITY ACROSS ALL AGES

Robert C. Keskey, MD, Mark Slidell, MD, MPH*, Nicole Pierce, PhD, RN, Henry Biermann, BS, Justin Cirone, MD*, Tanya L. Zakrison, MD, MPH, FRCSC, FACS*, Kenneth L Wilson, MD, FACS*, Jennifer Cone, MD, MHS*, David A. Hampton, MD, MEng*
University of Chicago

Presenter: Robert C. Keskey, MD

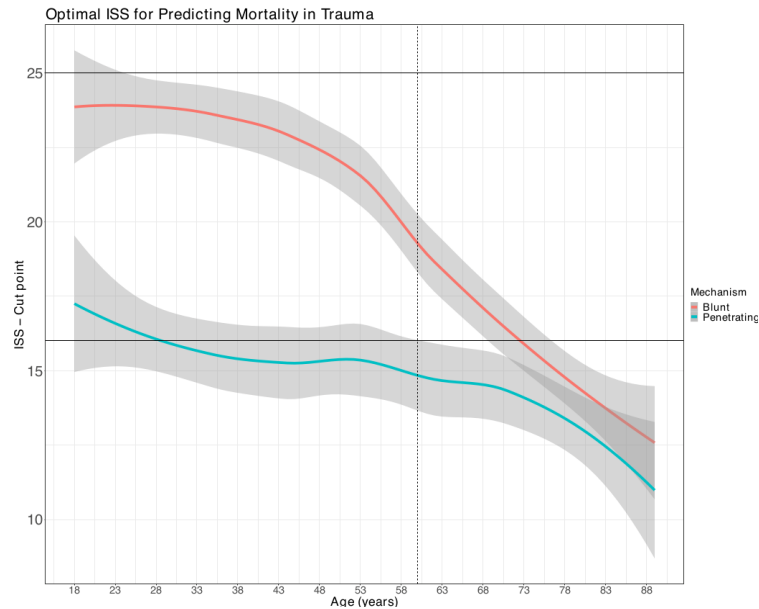
Discussant: Nicole Toscano, MD

Objectives: Injury severity score (ISS) is a widely used metric for trauma research and center verification; however, it does not account for age-related physiologic parameters. We hypothesized that a novel age-based injury severity metric would better predict mortality.

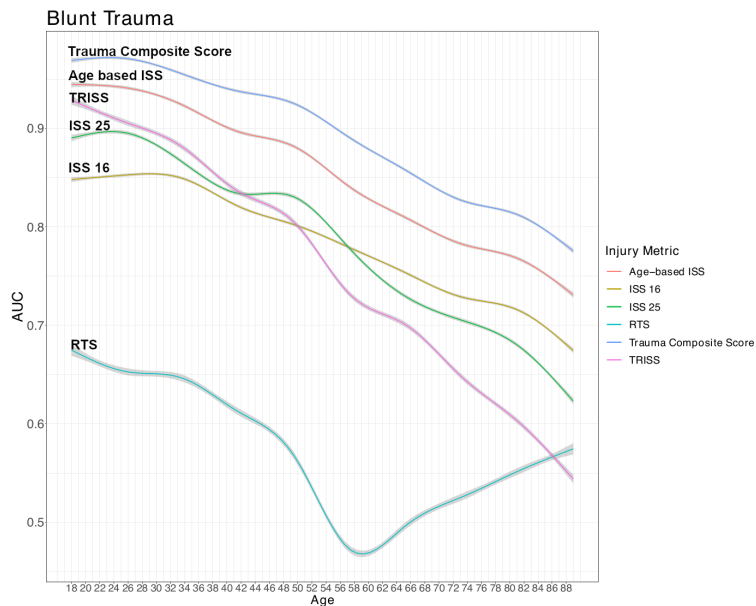
Methods: Adult patients (≥ 18 y) sustaining blunt (BT) or penetrating (PT) trauma were abstracted from the 2010-2016 National Trauma Data Bank. Admission vitals, GCS, ISS, mechanism, and outcomes were analyzed. Patients with incomplete/non-physiologic vital signs were excluded. For each age: 1) a cut point analysis was used to determine the ISS with the highest specificity and sensitivity for predicting mortality and 2) a linear discriminant analysis was performed using ISS, ISS >16 , TRISS, and RTS to compare each scoring system's mortality prediction. A novel injury severity metric, the trauma component score (TCS), was developed for each age using significant ($p<0.05$) variables selected from AIS scores, GCS, vital signs, and gender. Receiver operator curves were developed and the areas under the curve (AUC) were compared between the TCS and other systems.

Results: 777,794 patients were studied (BT: 91.1%; PT: 8.9%). BT patients were older ($53.6y \pm 21.3$ vs $34.4y \pm 13.8$), had higher ISS scores (11.1 ± 8.5 vs 8.5 ± 8.9), and lower mortality (2.9% vs 3.4%) than PT patients ($p<0.05$). When assessing the entire PT and BT cohort the optimal ISS cut point was 16. The optimal ISS was between 20 and 25 for BT under 60y. Over 60y, the optimal BT ISS steadily declined as age increased. PT's cut point was ≤ 16 for all ages assessed. When the injury metrics were compared by AUC, our novel TCS more accurately predicted mortality across all ages in both BT and PT ($p<0.001$).

Conclusions: ISS is a poor mortality predictor in older patients and those sustaining penetrating trauma. The age-based TCS is a superior metric for mortality prediction across all ages.



Optimal ISS cut point for predicting mortality - The optimal ISS for predicting mortality by age and mechanism (blunt versus penetrating) is demonstrated above. The two horizontal lines indicate an ISS of 25 (top line) and an ISS of 16 (bottom line). The vertical dotted line is at age 60.



Predictive capabilities of TCS versus other injury metrics in blunt trauma. Linear discriminant analysis was performed to determine the ability of each injury metric to predict mortality for each age. Area under the curve (AUC) represents the predictive ability of each individual metric which are represented by each individual line.

Scientific Session I - Raymond H. Alexander MD Resident Paper Competition

Paper 9
January 13, 2021
1:10 pm Eastern

FUTILE TRAUMA TRANSFERS: AN INFREQUENT BUT COSTLY COMPONENT OF REGIONALIZED TRAUMA CARE

Craig J. Follette, DO, Bachar N. Halimeh, MBBS, Annelise Chaparro, Medical Student,
Alan Shi, Medical Student, Robert D. Winfield, MD, FACS*
University of Kansas Health System

Presenter: Craig J. Follette, DO

Discussant: Jacinta Robenstine, MD

Objectives: Appropriate interfacility transfers are a key component of highly functioning trauma systems but transfer of unsalvageable patients can overburden the resources of higher-level centers. We sought to identify the occurrence and associated reasons for futile transfers within our trauma system, hypothesizing that futile transfers were frequent and costly.

Methods: Utilizing prospectively collected data in our health system's transfer center database as well as the trauma registry, a retrospective cohort study was conducted to identify patients who underwent interfacility transfer to our ACS-Verified Level I Trauma Center. We examined adult patients from June 2017-June 2019 who died, had comfort measures implemented, discharged, or went to hospice care within 48 hours of admission without major operation, endoscopic, or radiologic intervention. Futility was defined as death or hospice discharge within 48 hours of transfer without major operative, endoscopic, or radiologic intervention.

Results: 1,241 patients transferred to our facility during the study period, with 407 patients having a length of stay 48 hours or less. 18 (1.5%) met criteria for futility. Futile patients were older and more severely injured, with more severe injuries occurring in the head, chest, and abdomen (Table 1). Combining transport costs with hospital charges, each futile transfer was estimated to cost \$56,396 [IQR:41,889-106,393] with a total cost exceeding \$1.7 million. Extrapolating our data to the estimated 33,000 trauma transfers annually in the U.S., the cost of futile transfers in the American trauma system would conservatively exceed 27 million dollars yearly.

Conclusions: Futile transfers are a small but costly component of trauma transfer volume. Identifying patients whose conditions preclude the benefit of transfer due to futility and developing appropriate support for referral facilities will significantly improve overall experience while appropriately allocating health care resources to those who would benefit.

	Futile (N =18)	Non-Futile (N = 302)	p-Value
Age (median)	75	61	.018
Gender N, (%)			.142
- Male	9 (50)	202 (66.9)	
ISS (median)	21	8.00	< 0.00
AIS (median)			
- Abdomen	4.00	1.00	.004
- Chest	3.00	2.00	.024
- External	No Data	1.00	N/A
- Face	1.00	2.00	.546
- Head	4.00	3.00	.017
- Lower Extremity	1.00	2.00	.457
- Upper Extremity	1.00	2.00	.517
- Neck	No data	3.00	N/A
- Spine	4.00	3.00	.017

Table 1. Characteristics of Futile Transfer Patients and Non-futile Transfer Patients.

Scientific Session II - Cox-Templeton Injury Prevention Paper Competition

Paper 10
January 13, 2021
4:30 pm Eastern

BANG FOR THE BUCK: THE IMPACT OF POLITICAL FINANCIAL CONTRIBUTIONS ON FIREARM LAWS

Dane Scantling, DO, MPH*, Elinore J Kaufman, MD*, Allyson M. Hynes, MD*,
Daniel N. Holena, MD, MSCE*, Mark J. Seamon, MD, FACS*
University of Pennsylvania

Presenter: Dane Scantling, DO, MPH

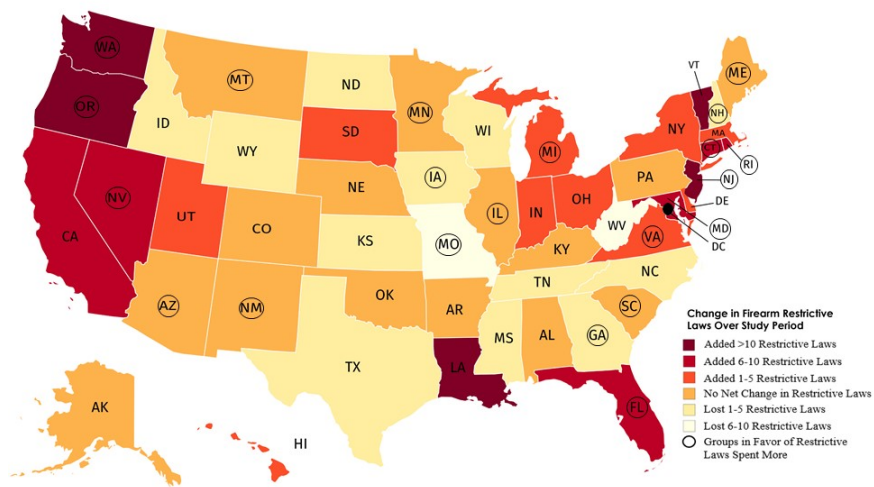
Discussant: Jessica Beard, MD

Objectives: 100,000 Americans are shot annually and 39,000 die. State gun laws restricting firearm sales and use have repeatedly been shown to decrease firearm deaths, yet little is known about what impacts their passage or repeal. We hypothesized that spending by pro-firearm restriction (P-FR) groups and mass shootings the year prior would increase state firearm restrictive laws (FRL).

Methods: We acquired 2013-2018 state data on anti-firearm restriction (A-FR) and P-FR spending (lobbying, campaign, independent, total expenditures) from the National Institute on Money in Politics, government representation from the National Conference of State Legislatures and mass shootings from the Mass Shooter Database of the Violence Project. Firearm death, suicide and homicide rates were obtained from the CDC WISQARS and FBI UCR databases. FRL were obtained from the State Firearms Law Database. A univariate panel linear regression with fixed effect for state was performed with yearly change in FRL from 2013 as the outcome while adjusting for government control by one political party. Variables with $p < 0.2$ were considered for multivariable regression.

Results: Over the study, 22 states gained and 13 lost FRL (44% vs 26%, $p = 0.090$). A-FR groups outspent P-FR groups in 28 states ($p = 0.320$). P-FR lobbying expenditures correlated with an increase in FRL ($\beta 9.02 \times 10^{-6}$, 95% CI 3.30×10^{-6} to 1.00×10^{-5} , $p = 0.002$). When P-FR groups outspent A-FR groups, FRL increase was largest ($\beta 1.42$, 95% CI 0.63 to 2.21, $p = 0.001$). While mass shootings or firearm death rates had no effect on FRL, states that repealed FRL or stayed the same had more than double the median rate of increase in firearm deaths per 100,000 over the study period (2.3 vs 1.1, $p = 0.010$).

Conclusions: Increased political spending by groups in favor of restrictions on firearm sales and use had the greatest effect in increasing FRL even when accounting for the underlying political landscape.



Map of United States depicting the change in firearm restrictive laws (FRL) and comparative spending of pro and anti-firearm restriction groups.

Scientific Session II - Cox-Templeton Injury Prevention Paper Competition

Paper 11
January 13, 2021
4:45 pm Eastern

STOP THE FALL: IDENTIFYING THE 50% OF GERIATRIC TRAUMA PATIENTS WITH SIGNIFICANT VISION LOSS

James M. Bardes, MD*, Kenneth Conley Coleman, DO*, James Donovan, MS2 WVU School of Medicine*,
Alexander Albuquerque, Alison M. Wilson, MD, FACS*,
John Nguyen, MD, Daniel J. Grabo, MD, FACS*, Allison Bardes, MD
West Virginia University

Presenter: James M. Bardes, MD

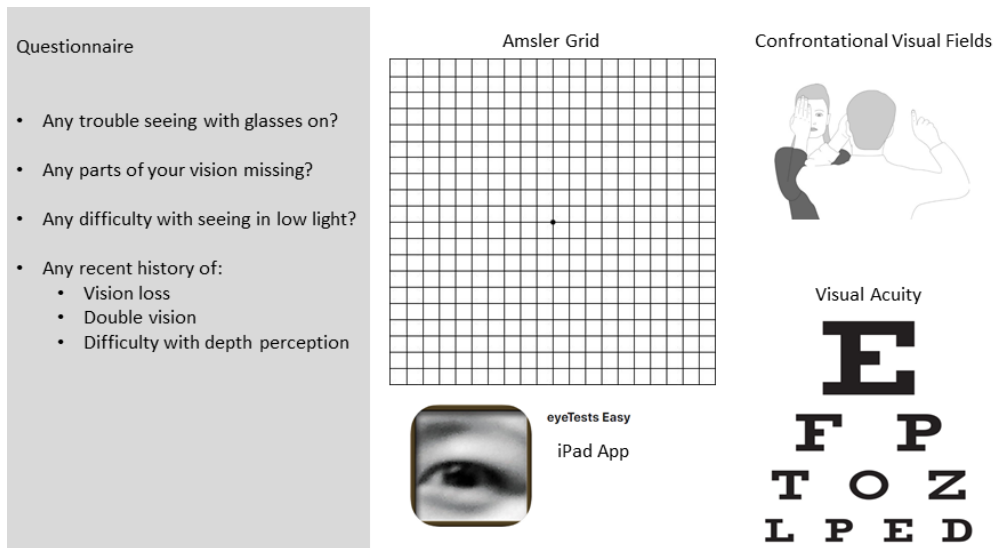
Discussant: Melike Harfouche, MD

Objectives: Visual health is closely linked to fall risk. The CDC estimates 29% of older adults will fall yearly, and 38% will need medical treatment. With shifting US demographics, trauma services must adapt new strategies for injury prevention. This study aimed to: 1) evaluate the prevalence of undiagnosed or undertreated visual disease in the trauma population, 2) determine if a trauma provider exam (TPE) can reliably screen for vision disease using a commercial app and questionnaire.

Methods: This prospective study included patients over age 60 on the trauma service from Jun 2019-May 2020. Components of the TPE are shown in Figure 1. Ophthalmology performed a dilated exam as the gold standard for comparison. The primary outcome was significant abnormal vision (SAV) found on exam. Fisher exact test and logistic model were used in the data analysis, statistical significance was set at $p < 0.05$.

Results: Enrollment completed with 96 patients. Mean age was 75, and fall (79%) was the most common mechanism of injury. SAV is common: undiagnosed disease found in 39% and undertreated in 14%. TPE was 94% sensitive and 92% specific for SAV cases. Congruence between TPE and optho exam was highest in pupil exam (86%), visual fields (58%), and amsler grid (52%). On univariate analysis of the TPE, an abnormal amsler ($p=0.004$), abnormal visual field ($p=0.15$), and difficulty in low light ($p=0.16$), were commonly identified in patients with SAV. Multivariate analysis (Table 1) found a combination of abnormal amsler and visual field defect were significantly associated with SAV (OR 4.1, $p=0.03$).

Conclusions: Unrecognized visual health deficits are present in 53% of geriatric trauma patients. The addition of a TPE screening can identify abnormalities in most cases. This identifies high fall risk older adults who may benefit from formal ophthalmology referral. A longitudinal study is planned to show efficacy in fall and injury prevention.



Trauma Provider Exam. Questionnaire items (grey background), and the components utilized on the digital app (white background) are shown. Any abnormality on TPE was considered a positive screen for SAV.

Multivariate Analysis	odds ratio	lower95%	upper95%	p
Abnormal Amsler and Visual Field	4.105	1.143	14.748	0.031
Age	1.063	1.002	1.127	0.044
Sex	1.440	0.529	3.920	0.475
Vision Loss	1.171	0.306	4.485	0.818
Double Vision	0.626	0.169	2.323	0.484
Difficulty with Depth	1.583	0.447	5.614	0.477
Missing Portions of Vision	0.361	0.098	1.332	0.126
Difficulty in Low Light	0.546	0.203	1.473	0.232
Vision Trouble with Glasses	1.108	0.352	3.488	0.861
Trauma Specific Frailty Score	1.029	0.750	1.411	0.860
TPE Distance Acuity	1.461	0.514	4.148	0.477
TPE Near Acuity	0.896	0.306	2.620	0.841

Multivariate analysis of the trauma provider exam.

Scientific Session II - Cox-Templeton Injury Prevention Paper Competition

Paper 12
January 13, 2021
5:00 pm Eastern

EAST'S ANNUAL DISTRACTED DRIVING OUTREACH EVENT: A MULTI-YEAR EVALUATION AND LESSONS LEARNED.

Julius D. Cheng, MD, MPH*, Lisa Allee Barmak, MSW, LICSW*, Keouna Pather, MD,
Shannon Marie Foster, MD, FACS*, Hee Soo Jung, MD, FACS*, Marie L. Crandall, MD, MPH*
University of Rochester School of Medicine and Dentistry

Presenter: Julius D. Cheng, MD, MPH

Discussant: Margaret Lauerman, MD

Objectives: Objectives: Every day, over eight people die from distracted driving (DD)-related crashes and young drivers are at very high risk. There has been little success in finding cost-effective education strategies that demonstrate sustained reductions in risky behaviors. We evaluated the effect of the Eastern Association for the Surgery of Trauma Injury Control and Violence Prevention Committee's single-day intervention programs for at-risk youth on knowledge and attitudes about DD.

Methods:

Methods: A full-day DD prevention program was developed and deployed at two high schools during successive years. The high schools varied in socioeconomic factors (private vs public) between years. Multiple educational formats, including lectures, videos, and computer simulation were used. Matched pre-/post-intervention surveys were collected from students to determine response to educational format and perceptions. Summary statistics at each point were obtained. Bivariate analysis of survey results was conducted to assess change in responses over time points.

Results: Results: 797 matched pre- and post-event surveys from both years demonstrated an immediate post-intervention attitude change in cellphone use while driving ("Use cellphone never": 34.8% to 69.4% in 2015, $p<0.001$; "Read text never": 58.4% to 71.1% in 2016, $p<0.001$). Long-term results in 2015 demonstrated lack of durability by 6 weeks post-intervention ("Use cellphone never": 69.4% to 45.3%, $p<0.001$), especially in males (baseline 35.7%, 6-week 35.8%, $p=NS$). Private school students preferred simulation more (51.3% vs 37.5%, $p=0.002$), while public students preferred video presentations more (53.5% vs 46.7% private, $p=NS$)

Conclusions: Conclusion: Attitudes toward DD remains problematic for young drivers. Much effort is placed on education aimed at behavioral changes. More research is needed to identify effective interventions with more durability.

Scientific Session II - Cox-Templeton Injury Prevention Paper Competition

Paper 13
January 13, 2021
5:15 pm Eastern

THE ABSENCE OF CROSSING GUARDS INCREASES THE RISK OF AUTO-PEDESTRIAN CRASHES IN SCHOOL AGE CHILDREN

Chad H. Morrison, DO, Laura Gryder, MA, Ty Olson, MD, Douglas R. Fraser, MD, FACS*,
Allison G. McNickle, MD*, Syed Saquib, MD*, Joseph T. Carroll, MD*, Samantha A Slinkard, MPH,
Deborah A. Kuhls, MD*, Paul J. Chestovich, MD, FACS*
UNLV School of Medicine

Presenter: Chad H. Morrison, DO

Discussant: Rachel Rodriguez, MD

Objectives: The purpose of this study was to examine the rates of pediatric auto-pedestrian crashes (APC) and determine ages and time periods of greatest risk. In our county school district crossing guards are limited and only required for elementary age children. We hypothesized that APC occur more frequently on school days, and in children without consistent crossing guard support.

Methods: Retrospective review of APC patients <18 years-old brought to our urban pediatric trauma center from January 2011 to November 2019. Data abstracted included date/time of arrival, demographics and injury data. School district calendars were utilized to compare school days vs. non-school days. T-test was used with $p < .05$ considered significant. Frequency of APC by hour of the day was plotted overall, for school vs non-school days and for four age groups: age 0-4, 5-9, 10-13 and 14-17.

Results: There were 440 pediatric APC in the study period. Frequency of all APC was greater on school days (0.174 vs 0.101, RR 1.72, $p < .001$), and APC with ISS > 15 (0.039 vs 0.024, $p = 0.014$, RR 1.67, 95% CI 1.10-2.56). APC showed the highest frequency between 0800-1000 and 1500-2000. Comparing school day to non-school day the youngest group, age 0-5, had no significant difference in APC frequency (0.021 vs 0.014, $p = .129$), but APC frequency was significantly higher on school days in all other age groups: 5-9 (0.036 vs 0.019, RR 1.89, $p = .0134$), 10-13 (0.055 vs 0.024, RR 2.29, $p < .001$), and 14-17 (0.061 vs 0.044, RR 1.39, $p = .045$).

Conclusions: All school age children are at higher risk of APC on school days. The age 10-13 group, with sparse crossing guard support, had a 129% increase in APC frequency on school days, with spikes during travel to and from school. This study supports the Pedestrian Safety Task Force in our county as they lobby for crossing guards for middle school age children, and educational outreach for students, schools and parents.

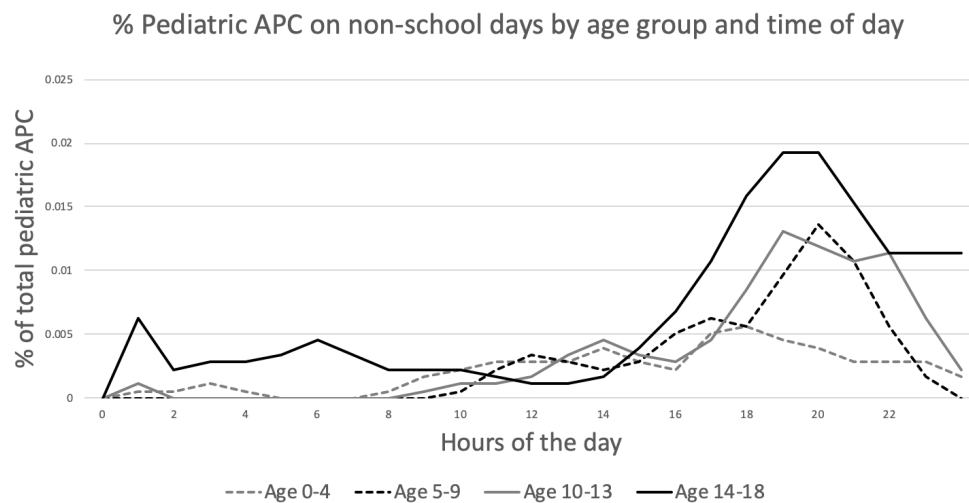


Fig.1 Weighted average percentage of total pediatric APC on non-school days by age group

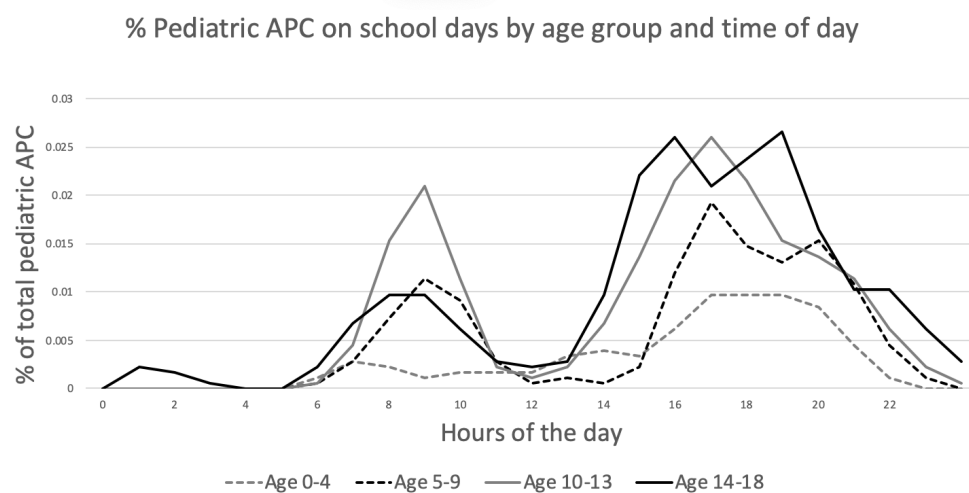


Fig. 2 Weighted average percentage of total pediatric APC on school days by age group

Scientific Session II - Cox-Templeton Injury Prevention Paper Competition

Paper 14
January 13, 2021
5:30 pm Eastern

FIREARM HOMICIDE MORTALITY IS INFLUENCED BY STRUCTURAL RACISM IN U.S. METROPOLITAN AREAS

August Houghton, BS, Leia Saltzman, PhD, Nicholas Burley, BS, Terence Byrne, BS, Danielle Tatum, Ph.D., Eman Toraih, MD, Olan Jackson-Weaver, PHD, Patrick McGrew, MD*, Juan C. Duchesne, MD, FACS, FCCP, FCCM*, Sharven Taghavi, MD, MPH, MS*
Tulane University School of Medicine

Presenter: August Houghton, BS

Discussant: Ashley Hink, MD, MPH

Objectives: Metropolitan cities in the United States (US) suffer from higher rates of gun violence. However, the specific structural factors associated with increased gun violence are poorly defined. We hypothesized that firearm homicide mortality (FHM) in metropolitan cities would be impacted by black-white segregation index (SI).

Methods: This cross-sectional analysis evaluated 51 US metropolitan statistical areas (MSAs) using data from 2013-2017. Several measures of structural racism were examined, including the Brookings Institute's black-white SI. Demographic data was derived from the US Census Bureau, US Department of Education, and US Department of Labor. Crime data and FHM rates were obtained from the Federal Bureau of Investigation and the Centers for Disease Control. Spearman's Rho and linear regression were performed.

Results: FHM was associated with multiple measures of structural racism and racial disparity, including white-black SI, unemployment rate, poverty rate, single parent household, percent black population, and crime rates (Figure). In regression analysis (Table), percentage black population ($b=0.41$, $p<0.001$) and black-white segregation index ($b=0.41$, $p<0.001$) exhibited the strongest associations with FHM. Percent children living in single-parent households ($b=0.37$, $p=0.006$) was also associated with higher FHM. Firearm legislation scores were associated with lower FHM ($b=-0.20$, $p=0.02$). High school and college graduation rates were not associated with FHM and were not included in the final model.

Conclusions: Firearm homicide mortality disproportionately impacts communities of color and is associated with measures of structural racism, such as white-black SI. Public health interventions targeting gun violence must address these systemic inequities. Furthermore, given the association between FHM and single-parent households, intervention programs for at-risk youth may be particularly effective.

	White-Black Segregation Index	Population-Weighted Density	Black Population (%)	Unemployment Rate	Principal City Poverty Rate	HS Graduation Rate	Bachelor Degree (%)	Children In Single-Parent Household	Overall Crime Rate	Property Crime Rate	Violent Crime Rate	Firearm Homicide Mortality Rate
White-Black Segregation Index	1.00											
Population-Weighted Density		1.00										
Black Population (%)			1.00									
Unemployment Rate			0.46	1.00								
Poverty Rate	0.64		0.31	0.38	1.00							
HS Graduation Rate						1.00						
Bachelor Degree (%)				-0.34			1.00					
Children In Single-Parent Household			0.41	0.51	0.55		-0.71	1.00				
Overall Crime Rate	-0.36						-0.29	0.29	1.00			
Property Crime Rate	-0.44						-0.29		0.97	1.00		
Violent Crime Rate			0.32	0.31			-0.43	0.39	0.66	0.51	1.00	
Firearm Homicide Mortality Rate	0.29	-0.30	0.71	0.46	0.36		-0.44	0.61	0.44	0.37	0.66	1.00
State Legislative Rank	0.29	0.53	-0.31				0.37		-0.51	-0.55	-0.36	-0.51

Fig. 1 Spearman's rho correlation was used. Only significant ($p < 0.05$) correlation coefficients are shown. (HS: High School)

Independent factors	Standardized Beta	95% confidence interval		P value
		Lower limit	Upper limit	
Black-White Segregation Index	0.41	0.19	0.62	<0.001
% Black Population	0.41	0.22	0.61	<0.001
Children in Single-Parent Households	0.37	0.11	0.62	0.006
Firearm Legislation Ranking	-0.20	-0.36	-0.03	0.02
Property Crime Rate	0.22	0.00	0.43	0.02
Poverty Rate	-0.20	-0.45	0.05	0.12

Table 1. Social factors independently associated with firearm homicide mortality

Mean-centered linear regression analysis was applied using best subsets regression. $R = 0.89$ and adjusted $R^2 = 0.76$ for the overall model of homicide mortality rates.

Scientific Session II - Cox-Templeton Injury Prevention Paper Competition

Paper 15
January 13, 2021
5:45 pm Eastern

TRAFFIC STOPS DO NOT PREVENT TRAFFIC DEATHS

Anuja L Sarode, MPH, Vanessa P. Ho, MD, MPH, FACS*, Katelynn Bachman, MD, Philip Linden, MD, Alaina M Lasinski, MD*, Matthew L Moorman, MD, MBA, FACS, FAWM, FCCM, Christopher Towe, MD, University Hospitals Cleveland Medical Center

Presenter: Anuja L Sarode, MPH

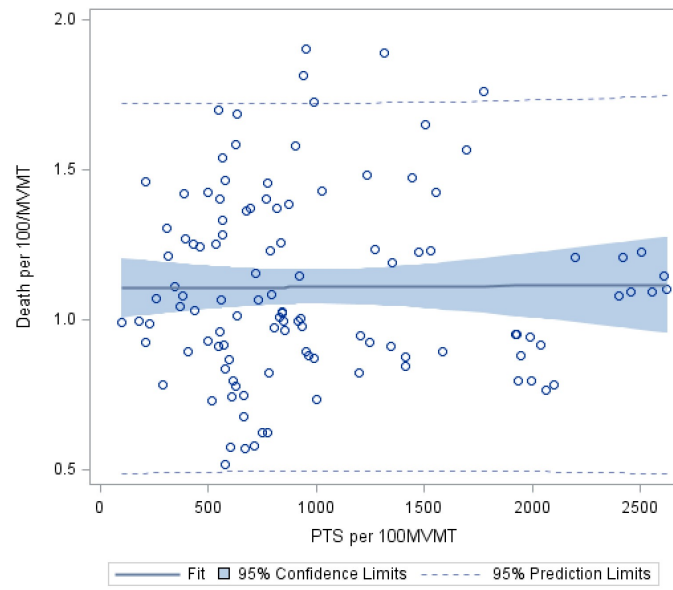
Discussant: Leah Tatebe, MD

Objectives: Amid growing calls for police reform, it is imperative to reassess whether police actions designed to improve public safety are associated with injury prevention. The purpose of this study is to examine the relationship between the frequency of police traffic stops (PTS) and motor vehicle crash (MVC) deaths at the state level. We hypothesize that increased PTS would not be associated with reduced MVC deaths.

Methods: We retrospectively analyzed PTS and MVC deaths at the state level from 2012-2015. PTS data were from 30 state patrols from the Stanford Open Policing Project. MVC death data were from the Federal Highway Administration Office of Highway Policy Information. All data were adjusted per 100 million vehicle miles traveled (MVMT) and were analyzed as state-level time series cross-sectional data. The dependent variable was MVC deaths/100MVMT and the independent variable was number of PTS/100MVMT. We performed unadjusted linear regression analysis and panel data analysis adjusting for random and fixed state effects and accounting for changes over time.

Results: 30 state patrols with 114 combined years were analyzed, with a total of 83,862,795 PTS. The PTS rate varied by state and year. Nebraska had the highest PTS (2,622/100MVMT in 2012), while Michigan had the lowest (98/100MVMT in 2012). MVC deaths also varied by state and year, with the highest death rate occurring in Montana in 2013 (1.9/100MVMT) and the lowest in Massachusetts in 2015 (0.5/100MVMT). After accounting for year and state-level variability, no association was found between the number of PTS and the MVC death rate in neither a random effects model ($p=0.972$) nor a fixed effects model ($p=0.973$).

Conclusions: State patrol traffic stops are not associated with reduced MVC deaths. Strategies to reduce death from MVC should consider alternative strategies, such as motor vehicle modifications, community-based safety initiatives, or improved access to health care.



Scatter plot of state PTS vs. MVC deaths (unadjusted line).

Scientific Session III - Resuscitation

Paper 16
January 13, 2021
4:30 pm Eastern

PREHOSPITAL END TIDAL CARBON DIOXIDE AS A PREDICTOR OF MASSIVE TRANSFUSION: AN EAST MULTICENTER STUDY

Eric M. Campion, MD, FACS*, Alexis Cralley, MD, Ron C. Buchheit, MD, Austin T. Brown, MD, M. Chance Spalding, DO, PhD, FACS*, Aimee LaRiccía, DO*, Scott Moore, MD, Kimberly Tann, BS, John Leskovan, DO*, Maraya Camazine, BS, MS*, Stephen L. Barnes, MD*, Banan Otaibi, BS, Joshua P. Hazelton, DO, FACS*, Lewis E. Jacobson, MD, FACS*, Jamie Williams, MSML, BSN, RN, CCRP, Roberto Castillo, DO, MPH*, Nakosi J. Stewart, MD, Joel B. Elterman, MD*, Linda Zier, RN, Michael Goodman, MD*, Nora Elson, Jason Miner, Claire Hardman, RN, BSN, Carolijn Kapoen, BSc, April E. Mendoza, MD, MPH*, Morgan Schellenberg, MD, MPH*, Elizabeth Benjamin, MD PhD, Glenn K. Wakam, MD, Hasan B. Alam, MD, Lucy Z. Kornblith, MD*, Rachael A. Callcut, MD, MSPH, FACS*, Lauren E. Coleman, MD, David V. Shatz, MD*, Sigrid Burruss, MD FACS, Ann C. Linn, MD, Lindsey Perea, DO*, Madison Morgan, BS, Thomas J. Schroepel, MD*, Zachery Stillman, MS, Matthew M. Carrick, MD*, Mario F. Gomez, DO*, John D. Berne, MD*, Robert McIntyre C., MD, Shane Urban, BSN, RN*, Jeffry Nahmias, MD, MHPE, FACS*, Mitchell Cohen, MD FACS*, Ernest Eugene Moore, MD*, Kevin McVane, MD, Clay Cothren-Burlew, MD FACS
Denver Health Medical Center

Presenter: Eric M. Campion, MD, FACS

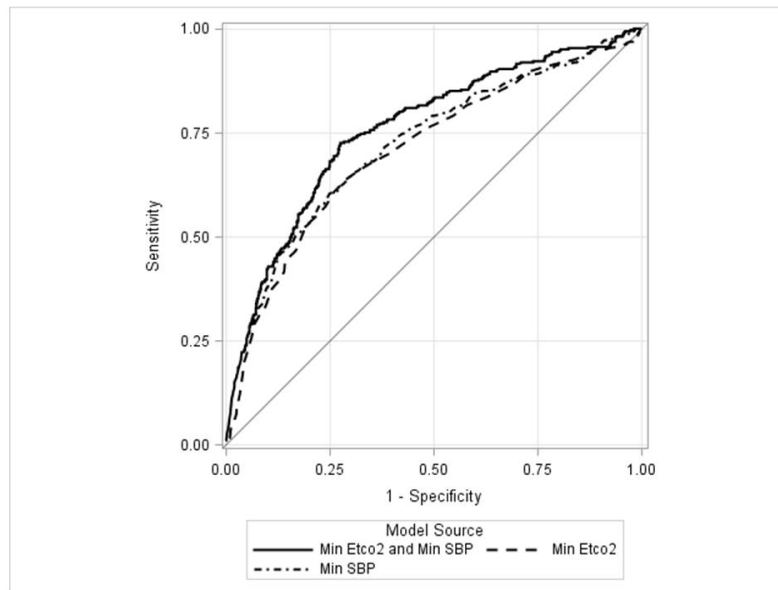
Discussant: Benjamin Moran, MD

Objectives: Prehospital trauma triage is limited by a lack of accurate markers of hemorrhagic shock. Small single center studies have suggested that low levels of expired end tidal carbon dioxide (ETCO₂) may correlate with outcomes such as mortality and massive transfusion. ETCO₂ is a rapid non-invasive test utilizing technology currently present in most large ambulance systems across the country. We hypothesized that prehospital ETCO₂ would be predictive of massive transfusion.

Methods: Retrospective multicenter trial across 24 trauma centers evaluated all adults that had undergone prehospital intubation after traumatic injury. Univariate analysis was chi square or Wilcoxon rank sum test. Receiver operating curves(ROC) were constructed and areas under the ROC(AUROC) were compared. Massive transfusion(MT) defined as >10 units of red blood cells or death in first 6 hours. Index created by rounding and combining the coefficients of logistic regression. Youden index(YI) used to define cutoffs. P<0.05 deemed significant.

Results: 1338 patients were included for analysis. Median age was 41(IQR 27-58)years and 75.1% of patients were male. Median ISS was 25 (IQR 14-33) MT rate was 24.8% and mortality rate was 47.8%. ETCO₂ was predictive of MT with an AUROC of 0.71(95%CI 0.67-0.74) with a YI of 25mmHg. However, when compared to the predictive value of lowest systolic blood pressure(SBP) there was not a significant difference with an AUROC of 0.72 (95%CI 0.69-0.75) with a YI of 80mmHg. We then evaluated SBP and ETCO₂ in combination creating an index(4xlowest ETCO₂ + lowest SBP) and found that it significantly increased the accuracy over either marker alone with an AUROC of 0.76(95%CI 0.72-0.79) and YI=191mmHg. p<0.05(figure)

Conclusions: Prehospital ETCO₂ is predictive of MT in a cohort of intubated trauma patients. A combination of ETCO₂ and SBP is more predictive than either alone.



Index combining Lowest End Tidal Carbon Dioxide and Lowest Systolic Blood Pressure
vs either marker alone. $P < 0.05$

Scientific Session III - Resuscitation

Paper 17
January 13, 2021
4:45 pm Eastern

CAN RH+ WHOLE BLOOD BE SAFELY USED AS AN ALTERNATIVE TO RH- PRODUCT? AN ANALYSIS OF EFFORTS TO IMPROVE THE SUSTAINABILITY OF A HOSPITAL'S LOW TITER GROUP O WHOLE BLOOD PROGRAM

Cameron McCoy, MD, Kelsey Montgomery, MD, Madeline Cotton, David Meyer, MD, MS*,
Charles E. Wade, PhD, Bryan A. Cotton, MD, MPH
University of Texas Health Science Center at Houston

Presenter: Cameron McCoy, MD

Discussant: John Kubasiak, MD

Objectives: Low-titer group O whole blood (LTO-WB) has recently gained popularity in US trauma centers for the acute resuscitation of hemorrhagic shock. However, limited supplies of Rh- product prevent implementation and strain sustainability at many trauma centers. We set out to identify whether Rh+ LTO-WB could be safely substituted for Rh- product, regardless of patient's Rh status.

Methods: Following IRB approval, all trauma patients receiving prehospital or ED transfusion of uncrossed, emergency release LTO-WB (11/17-10/19) were evaluated. Patients were first divided into those who received Rh- vs. Rh+ product. Serial hemolysis panels (3-hr, 24-hr, 48-hr), transfusion reactions, and outcomes were compared. Patients were then further divided by their Rh status. Statistical analysis was performed using STATA 12.1, with statistical significance set at $p < 0.05$.

Results: 637 trauma patients received emergency release LTO-WB. Of these, 448 received Rh+ product, while 189 received Rh- LTO-WB. Patients receiving Rh+ product were more likely to be male (81 vs. 70%) and have lower field blood pressure (median 99 vs. 109) and GCS (median 7 vs 12); all $p < 0.05$. There were no differences in hemolysis labs, transfusion reactions, complications, or survival. We then separated patients by Rh status (577 Rh+, 70 Rh-). Rh- patients were older (median age 54 vs 39), more likely to be female (57 vs 26%), and to have sustained blunt trauma (92 vs. 70%) than their Rh+ counterparts; all $p < 0.05$. There were no differences in hemolysis labs, transfusion reactions, complications, or survival between Rh+ and Rh- patients (TABLE).

Conclusions: Rh+ LTO-WB appears to be a safe alternative to Rh- product for the resuscitation of hemorrhagic shock, in both Rh+ and Rh- patients. Use of Rh+ product may help trauma centers implement and sustain their LTO-WB programs.

	Rh+ LTO WB (n=448)			Rh- LTO WB (n=189)		
	Rh+ patient (n=407)	Rh- patient (n=41)	p-value	Rh+ patient (n=170)	Rh- patient (n=19)	p-value
Transfusion reactions	1.0%	0.0%	0.520	2.6%	0.0%	0.476
Renal failure	9.1%	4.0%	0.270	7.1%	14.3%	0.267
Sepsis	25%	15%	0.153	26.9%	21.4%	0.606
VTE	6.0%	3.8%	0.564	5.5%	0.0%	0.291
ARDS	3.5%	0.0%	0.223	3.2%	7.1%	0.376
Hosp free days	9 (0, 22)	12 (0, 21)	0.616	12 (0, 23)	11 (0, 20)	0.985
ICU free days	20 (0, 28)	22 (0, 27)	0.896	25 (4, 28)	19 (0, 24)	0.082
Vent free days	26 (0, 30)	28 (0, 29)	0.764	29 (14, 30)	27 (0, 30)	0.398
30-day Survival	74%	71%	0.595	78%	79%	0.935

Scientific Session III - Resuscitation

Paper 18
January 13, 2021
5:00 pm Eastern

FOUR-FACTOR PROTHROMBIN COMPLEX CONCENTRATE IN ADJUNCT TO WHOLE BLOOD IN TRAUMA-RELATED HEMORRHAGE: DOES WHOLE BLOOD REPLACE THE NEED OF FACTORS?

Muhammad Khurrum, MD, Letitia Bible, MD*, Mohamad Chehab, MD, Samer Asmar, MD,
Narong Kulvatunyou, MD*, Lourdes Castanon, MD*, Andrew L. Tang, MD*,
Michael Ditillo, DO, FACS*, Bellal Joseph, MD, FACS*
The University of Arizona

Presenter: Muhammad Khurrum, MD

Discussant: Andrew Young, MD

Objectives: The use of whole-blood (WB) for the treatment of hemorrhagic shock and coagulopathy is increasing in civilian trauma patients. Four-factor prothrombin complex concentrate (4-PCC) in adjunct to component therapy showed improved outcomes in trauma patients. The aim of our study is to evaluate the outcomes of trauma patients who received 4-PCC+WB compared to WB alone.

Methods: We performed a three-year (2015–2017) analysis of the ACS-TQIP database. All adult (age ≥ 18 years) trauma patients who received WB were included. Patients on preinjury anticoagulants were excluded. Patients were stratified into two groups: 4-PCC+WB versus WB alone and matched in a 1:2 ratio using propensity score matching. We matched for demographics, vitals, injury parameters, comorbidities, and level of trauma centers. Outcome measures were packed red blood cells (pRBC), plasma and platelets transfused, hospital and ICU length of stay (LOS) among survivors, and mortality.

Results: A total of 252 patients (4-PCC+WB, 84; WB alone, 158) were matched. Mean age was 47 ± 21 years; 63% were males; median ISS was 27 [21–43], and 85% had blunt injuries. Four-PCC+WB was associated with a decreased requirement for pRBC (5 vs. 8 units; $p = 0.01$) and FFP (3 vs. 6 units; $p = 0.02$) transfusion compared to WB alone. Patients who received 4-PCC+WB had a lower ICU LOS (5 days vs. 8 days, $p = 0.03$). There was no difference in the platelet transfusion ($p = 0.72$), hospital LOS (0.58), and in-hospital mortality ($p=0.72$) between the two groups.

Conclusions: Our study demonstrates that the use of 4-PCC as an adjunct to WB is associated with a reduction in transfusion requirements and ICU LOS compared to WB alone in the resuscitation of trauma patients. Further studies are required to evaluate the need for factor replacement in adjunct to WB in the resuscitation of trauma patients.

Scientific Session III - Resuscitation

Paper 19
January 13, 2021
5:15 pm Eastern

EAST MCT: COMPARISON OF PRE-INJURY ANTITHROMBOTIC USE AND REVERSAL STRATEGIES AMONG SEVERE TBI PATIENTS

Brian K. Yorkgitis, DO, FACS*, Thomas J. Schroepel, MD*, Cassandra Decker, BA, Matthew R. Noorbakhsh, MD*, Frances Philp, MS, Nikolay Bugaev, MD*, Antony Tatar, Melody Bellora, BS, Kaushik Mukherjee, MD, MSCI, FACS*, Adrian W. Ong, MD*, Alison Muller, MLS, MSPH, Asanthi Ratnasekera, DO, FACOS*, Christine Powel, CRNP, Sharven Taghavi, MD, MPH, MS*, Kristen Nordham, BS, Matthew M. Carrick, MD*, Victor Portillo, MD, FACS*, James M. Haan, MD*, Kelly L. Lightwine, MPH, Lawrence Lottenberg, MD*, Robert Borrego, MD*, Danielle Tatum, Ph.D., Emily Bird, Daniel C. Cullinane, MD*, Laura Cullinane, John D. Berne, MD*, Dalier R. Mederos, MD, CCRP, Thomas Z. Hayward III, MD*, Andrew J. Kerwin, MD*, Yohan Diaz-Zuniga, CCRC, Ian Tfirm, MPH, Marie L. Crandall, MD, MPH*
University of Florida College of Medicine - Jacksonville

Presenter: Brian K. Yorkgitis, DO, FACS

Discussant: Jamie Tung, MD

Objectives: Trauma teams are often faced with patients on antithrombotic drugs which is challenging when bleeding occurs. We sought to compare the effects of different antithrombotic medications on injury severity and hypothesized that antithrombotic reversal would not improve mortality in severe TBI patients.

Methods: An EAST sponsored prospective, multi-centered, observational study of 15 trauma centers was performed. Patient demographics, injury burden, comorbidities, antithrombotic agents, and reversal attempts were collected. Outcomes of interest were head injury severity and in-hospital mortality.

Results: Analysis was performed on 2913 patients. The majority of patients were on aspirin (ASA, 46.0%). Patients on a platelet chemoreceptor blocker (P2Y12) had the highest mean injury severity score (ISS, 9.12 ± 8.12). Patients taking warfarin + ASA had the highest mean head anatomic injury score (AIS 1.23 ± 1.62) (Table 1). On risk adjusted analysis, warfarin + ASA was associated with a higher head AIS (OR 2.10; 95% CI, 1.19-2.44) after controlling for injury severity score (ISS), Charlson Comorbidity Index (CCI), initial Glasgow Coma Score (I-GCS) and initial systolic blood pressure (I-SBP) (Table 2). Among patients with severe TBI (head AIS > 3) on antiplatelet therapy, reversal with desmopressin (DDAVP) and/or platelet transfusion did not improve survival (87.2% reversal vs 93.0% none, $p=0.11$). In severe TBI patients taking Xa inhibitors who received fresh frozen plasma (FFP) or prothrombin complex concentrate (PCC), survival was not improved (100% reversal vs 95.1% none, $p=1.00$).

Conclusions: In severe TBI patients on antiplatelet agents or Xa inhibitors reversal attempts appear to confer no mortality benefit. Among patients taking preinjury antithrombotic therapy, combination therapy was associated with severity of head injury with ASA + warfarin possessing the greatest risk.

Table 1. Patient Information and Injury

	ASA	ASA + P2Y12 Inhibitor	P2Y12 Inhibitor	Warfarin	ASA + Warfarin	Xa Inhibitor	Xa Inhibitor +ASA	p
n	1338 (46.0%)	386 (13.3%)	199 (6.8%)	320 (11.0%)	115 (4.0%)	393 (13.5%)	160 (5.5%)	
Age (mean, SD)	73.8±12.6	74.61±11.34	73.47±12.47	75.31±13.57	76.41±11.18	75.77±12.73	76.04±11.00	0.005
CCI (mean, SD)	4.4±2.2	5.11±2.31	5.12±2.40	4.57±2.21	5.38±2.46	4.63±2.31	5.10±2.21	<0.0001
Sex (male)	672 (50.22%)	232 (60.1%)	99 (49.75%)	184 (57.5%)	71 (61.74%)	195 (49.62%)	87 (54.38%)	-
ISS (mean, SD)	8.1±7.5	9.00±7.34	9.12±8.12	8.56±7.31	7.29±7.39	7.78±7.01	7.68±7.06	0.022
Head AIS (mean, SD)	0.92±1.46	1.21±1.63	1.19±1.64	1.07±1.59	1.23±1.62	0.91±1.39	1.15±1.63	0.013
GCS (mean, SD)	14.5±1.7	14.35±2.21	13.96±2.66	14.53±1.68	14.51±1.79	14.58±1.54	14.20±2.49	0.08
SBP (mean, SD)	146.9±30.0	145.34±29.73	144.92±29.47	143.89±28.06	141.47±28.77	141.27±28.51	137.47±27.35	0.002
In-hospital Mortality	44 (3.29%)	16 (4.13%)	4 (2.01%)	15 (4.69%)	2 (1.74%)	26 (6.62%)	6 (3.75%)	0.042

ASA- aspirin, P2Y12 Inhibitor- clopidogrel, prasugrel, ticagrelor, Xa Inhibitor- apixaban, rivaroxaban, CCI- Charlson Comorbidity Index, ISS- Injury Severity Score, AIS- Abbreviated Injury Scale, GCS- Glasgow Coma Scale (initial hospital), SBP- systolic blood pressure (initial hospital)

Table 2. Multivariable Logistic Regression of Antithrombotic Therapies Increasing Head Injury Severity

	OR (95% CI)
ASA + P2Y12	1.444 (1.24-1.856)
ASA + Warfarin	2.102 (1.398-3.161)
ASA + XA inhibitor	1.703 (1.188-2.44)
P2Y12 Inhibitor	1.261 (0.901-1.765)
Warfarin	1.257 (0.957-1.652)
XA Inhibitor	1.126 (0.862-1.471)

ASA- aspirin (reference), P2Y12 Inhibitor- clopidogrel, prasugrel, ticagrelor, Xa Inhibitor- apixaban, rivaroxaban

Scientific Session III - Resuscitation

Paper 20
January 13, 2021
5:30 pm Eastern

IS CEREBRAL PERFUSION MAINTAINED DURING FULL AND PARTIAL REBOA IN HEMORRHAGIC SHOCK CONDITIONS?

Derek A Benham, MD, Richard Calvo, PhD, Matthew Car, MD, Lyndsey Wessels, MD, Andrew Schrader, DVM, Joseph Lee, BS, Michael J Krzyzaniak, MD*, Matthew J. Martin, MD, FACS*
Naval Medical Center San Diego

Presenter: Derek A. Benham, MD

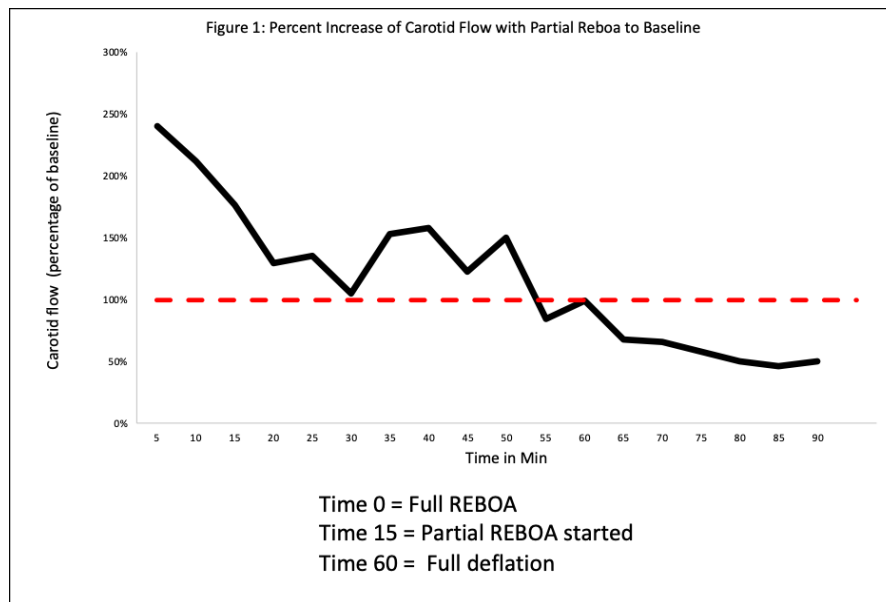
Discussant: Madhu Subramanian, MD

Objectives: Partial resuscitative endovascular balloon occlusion of the aorta (pREBOA) is a technology that occludes aortic flow and allows for controlled deflation and restoration of varying distal perfusion. Carotid artery flow rates (CFR) during partial deflation are unknown. Our aim was to measure CFR with the different pREBOA balloon volumes, and correlate those to the proximal mean arterial pressure (PMAP) and a handheld pressure monitoring device (COMPASS).

Methods: Ten swine underwent a hemorrhagic injury model with carotid and iliac arterial pressures monitored via arterial lines. Carotid and aortic flow rates were monitored with doppler flow probes. A COMPASS was placed to monitor proximal pressure. The pREBOA was inflated for 15 mins then partially deflated for an aortic flow rate of 0.7L/min for 45 mins. It was then completely deflated. PMAPs and CFR were measured and correlation was evaluated. Correlation between CRF and COMPASS measurements was evaluated.

Results: CFR increased 240% with full inflation. CFR was maintained at 100-150% of baseline across a wide range of partial deflation. After full deflation, CFR transiently decreased to 45-95% of baseline. There was strong positive correlation ($r>0.85$) between CFR and PMAP after full inflation, and positive correlation with partial inflation ($r>0.7$). CFR had strong correlation with the COMPASS with full REBOA ($r>0.85$) and positive correlation with pREBOA ($r>0.65$).

Conclusions: CFR is increased in a hemorrhagic model during full and partial inflation of the pREBOA, and correlates well with PMAP. Carotid perfusion appears maintained across a wide range of pREBOA deflation and could be readily monitored with a handheld portable COMPASS device instead of a standard arterial line setup.



Percent Increase of Carotid Flow with Partial Reboa Compared to Baseline

Scientific Session III - Resuscitation

Paper 21
January 13, 2021
5:45 pm Eastern

COMBATting ISCHEMIA REPERFUSION INJURY FROM RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA (REBOA) USING ADENOSINE, LIDOCAINE AND MAGNESIUM: A PILOT STUDY

Jeff Conner, MD, Daniel T Lammers, MD, Tori Holtestaul, MD, Ian Jones, MD, John P. Kuckelman, DO,
Hayley Letson, PhD, BSc, Geoffrey Dobson, Ph.D, MSc, Matthew J Eckert, MD*, Jason Bingham, MD
Madigan Army Medical Center

Presenter: Jeff Conner, MD

Discussant: Ryan Dumas, MD

Objectives: REBOA, a minimally invasive alternative to resuscitative thoracotomy, has been associated with significant ischemia reperfusion injury (IRI). Resuscitation strategies utilizing adenosine, lidocaine, and magnesium (ALM) have been shown to mitigate similar inflammatory responses in hemorrhagic and septic shock models. This study examined the effects of ALM on REBOA-associated IRI using a porcine model.

Methods: Animals underwent a 20% controlled hemorrhage followed by 30 minutes of supraceliac balloon occlusion. They were randomized to one of three groups: control (n=5), 2 hour (n=5) or 4 hour (n=5) interventional ALM infusions during reperfusion. ALM cohorts received a post hemorrhage ALM bolus followed by their respective ALM infusion upon systemic reperfusion. Primary outcomes for the study were global markers of ischemia and hemodynamic parameters.

Results: ALM cohorts demonstrated a significant improvement in lactate, base deficit, and pH in the first hour following systemic reperfusion (Table 1). At study endpoint, continuous ALM infusion over 4 hours resulted in an overall improved lactate clearance when compared to the 2-hour and control cohorts (Figure 1). No differences in hemodynamic parameters were noted between ALM cohorts and controls. Subset analysis of the 4 hour and 2 hour ALM cohorts demonstrated a significantly ($p = 0.02$) lower heart rate in the 4 hour infusion (mean = 85, 95% CI 72 - 98) compared to the 2 hour infusion (mean 128, 95% CI 87 - 170) without a significant difference in mean arterial pressure at 4 hours after systemic reperfusion.

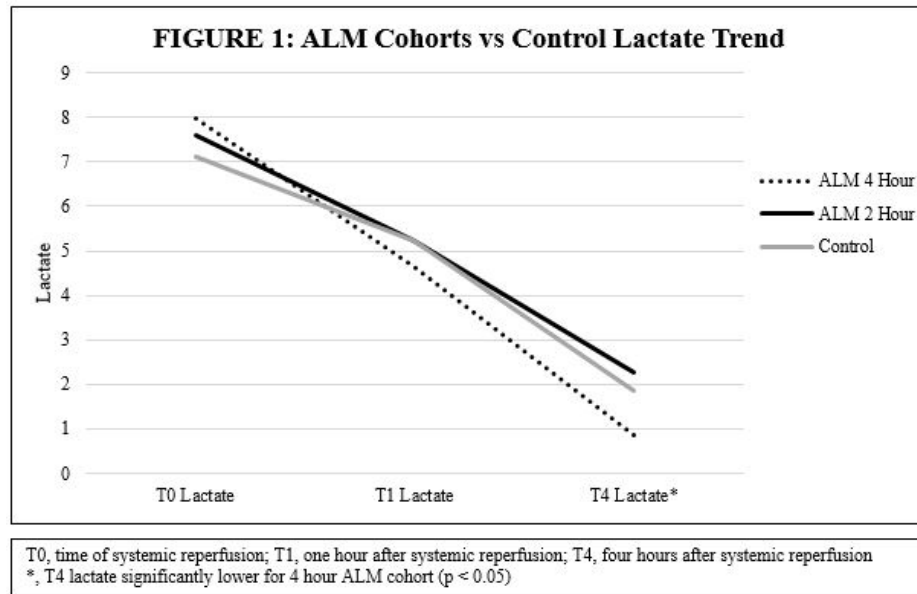
Conclusions: ALM may prove beneficial in mitigating the effects of ischemia reperfusion injury seen from REBOA, as evidenced by physiologic improvements early during resuscitation. Despite this, further refinement should be sought to optimize treatment strategies.

TABLE 1. Lactate, pH and base excess for control and ALM cohorts: baseline to one hour after reperfusion

	Control					ALM				
	B	PH	T0	T1	Δ	B	PH	T0	T1	Δ
Lactate	1.27	1.73	7.11	5.23	1.88	1.49	2.03	7.82	4.90	2.91*
pH	7.52	7.49	7.28	7.39	0.10	7.53	7.50	7.25	7.41	0.15*
Base Excess	8.60	7.80	-2.40	2.20	4.6	9.78	8.44	-3.89	2.89	6.78*

B, baseline; PH, post hemorrhage; T0, time of systemic reperfusion; T1, 1 hour after reperfusion; Δ, change in value from T0 to T1.
 *, p < 0.05 compared to control group

Lactate, pH and base excess for control and ALM cohorts: baseline to one hour after reperfusion



ALM cohorts vs control lactate trend over 4 hours of systemic reperfusion

Paper 22
January 14, 2021
12:15 pm Eastern

**THE BURDEN OF READMISSION AFTER DISCHARGE FROM
NECROTIZING SOFT TISSUE INFECTION**

Eman Toraih, MD, Mohammad Hussein, MD, Danielle Tatum, Ph.D., Adin Reisner, Emad Kandil, MD,
Mary Killackey, MD, Juan C. Duchesne, MD, FACS, FCCP, FCCM*, Sharven Taghavi, MD, MPH, MS*
Tulane University School of Medicine

Presenter: Eman Toraih, MD

Discussant: Laura Brown, MD

Objectives: The need for extensive surgical debridement with necrotizing soft tissue infections (NSTI) may put patients at high risk for unplanned readmission. However, there is a paucity of data on the burden of readmission in patients afflicted with NSTI. We hypothesized that unplanned readmission would significantly contribute to the burden of disease after discharge from initial hospitalization.

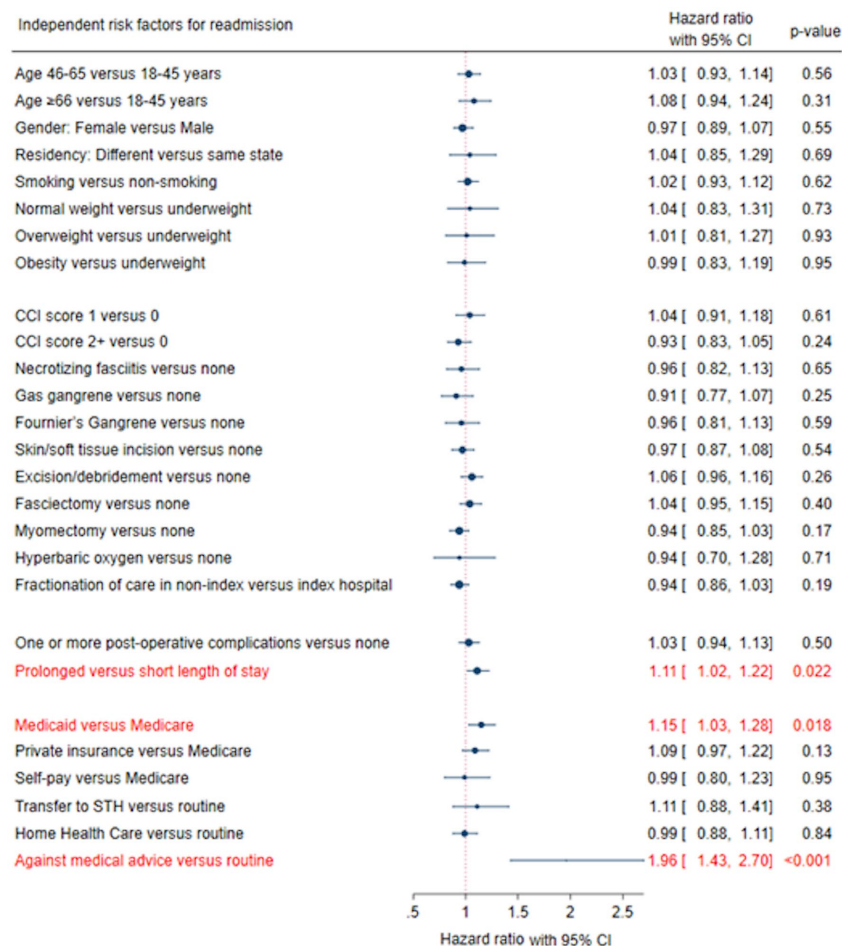
Methods: The National Readmission Database (NRD) was used to identify adults undergoing debridement for NSTI hospitalizations from 2010 to 2017. Risk factors for 90-day readmission were assessed by Cox proportional hazards regression.

Results: There were a total of 82,738 NSTI admissions during the study period, of which 25,076 (30.3%) underwent 90-day readmissions. Median time to readmission was 25 days (IQR 9-49). Patients requiring readmission were older, were less likely to be smokers, more likely to be diabetic, had higher Charlson Comorbidity Index, were more likely to have a complication on index hospitalization, and had longer length of stay on index hospitalization (table). On logistic regression, prolonged length of index stay >2 weeks (OR: 1.11, 95%CI: 1.02-1.22, p=0.02), Medicaid (OR: 1.15, 95%CI: 1.03-1.28, p=0.02), and leaving against medical advice (OR: 1.96, 95%CI: 1.42-2.70, p<0.001) were independent risk factors for readmission (figure). Median cost of a readmission was \$10,543. Readmission added 174,640 hospital days to episodes of care over the study period, resulting in an estimated financial burden of \$1.4 billion. Specifically, mechanical ventilation (\$75 million), amputation (\$49 million), and upper gastrointestinal endoscopy (\$12 million) were the costliest expenditures at readmission, accounting for more than one-third of the readmission expenditures.

Conclusions: Unplanned readmission due to NSTI is common and costly. Interventions that target patients at highest risk for readmission may help decrease the burden of disease.

	Not Readmitted (%)	Readmitted (%)	p-value
Age 18-45	16177 (28.1)	4425 (22)	<0.001
Age 45-65	29956 (52)	10615 (52.7)	<0.001
Age >65	11530 (20)	5084 (25.3)	<0.001
Female	20840 (36.1)	7914 (39.3)	<0.001
Smoker	16420 (28.5)	5310 (26.4)	<0.001
History of Diabetes	33908 (58.8)	12882 (64.0)	<0.001
Charlson Comorbidity Index of 3 or more	13718 (23.8)	8240 (40.9)	<0.001
Hyperbaric Oxygen Therapy	798 (1.4)	257 (1.3)	0.23
Post-operative Complications on Index Hospitalization	29211 (50.7)	11895 (59.1)	<0.001
Median Length of Stay (IQR)	12 (7-21)	15 (9-25)	<0.001

A comparison of patient characteristics readmitted and non-readmitted patients.



Logistic regression examining variables associated with mortality.

Scientific Session IV - Emergency General Surgery/Trauma

Paper 23
January 14, 2021
12:30 pm Eastern

LONG-TERM SURVIVAL IN HIGH-RISK OLDER ADULTS FOLLOWING EMERGENCY GENERAL SURGERY

Matthew P. Guttman, MD, Bourke W Tillmann, MD, Avery B. Nathens, MD, PhD, MPH*, Refik Saskin, MSc,
Susan Bronskill, PhD, Ajie Huang, MSc, Barbara Haas, MD, PhD*
Sunnybrook Health Sciences Center

Presenter: Matthew P. Guttman, MD

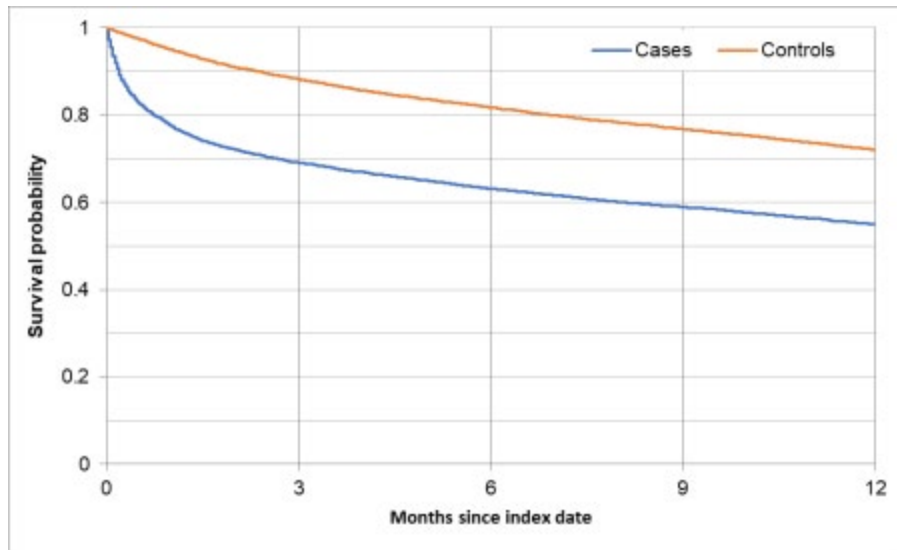
Discussant: Thomas Shoultz, MD

Objectives: Emergency general surgery (EGS) conditions are increasingly common among nursing home residents. While such patients have a high risk of in-hospital mortality, long-term outcomes in this group are not known, which may have implications for goals of care discussions. In this study, we evaluate long-term survival among nursing home residents admitted for EGS conditions.

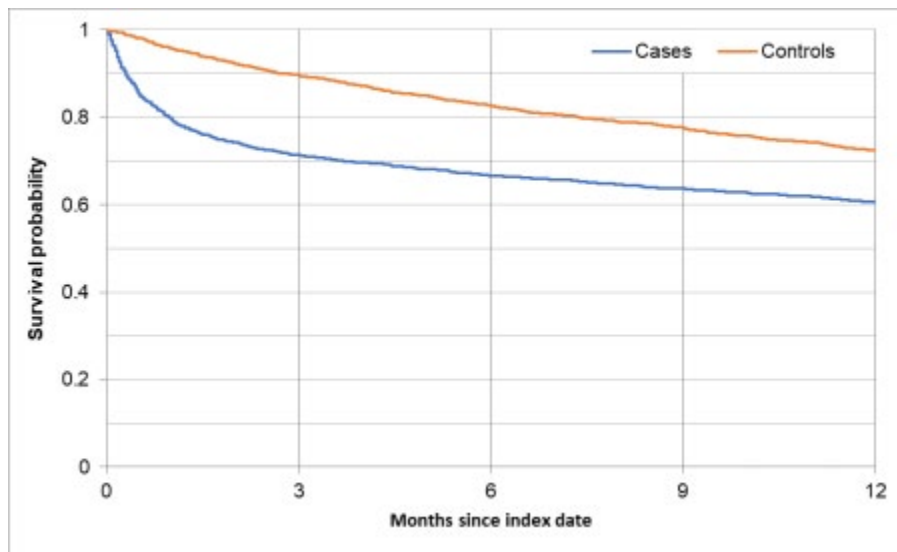
Methods: We performed a population-based, retrospective cohort study of nursing home residents (age \geq 65) admitted for 1 of 8 EGS diagnoses (appendicitis, cholecystitis, strangulated hernia, bowel obstruction, diverticulitis, peptic ulcer disease, intestinal ischemia, or perforated viscus) from 2006-2018 in a large regional health system. The primary outcome was 1-year survival. To ascertain the effect of EGS admission independent of baseline characteristics, patients were matched to nursing home residents without an EGS admission based on demographics and baseline health. Kaplan-Meier analysis and Cox models were used to evaluate survival across groups.

Results: 7,942 nursing home residents admitted with an EGS diagnosis were identified and matched to controls. Mean age was 85 years. One quarter of patients underwent surgery and 18% died in hospital. At 1 year, 55% of cases were alive, compared to 72% of controls ($p<0.001$). Among those undergoing surgery, 61% were alive at 1 year, compared to 72% of controls ($p<0.001$). Survival analysis showed cases had more than twice the risk of death in the 6 months following admission (HR 2.41 [95% CI 2.26-2.56]) compared to controls, after which the risk of death returned to baseline.

Conclusions: Although their risk of in-hospital mortality is high, most nursing home residents admitted for an EGS diagnosis survive at least one year. While nursing home residents presenting with an EGS diagnosis should be cited realistic odds for the risk of death, long-term survival is achievable in the majority of these patients.



Kaplan-Meier curves for overall cohort



Kaplan-Meier curves for subgroup undergoing surgery

Scientific Session IV - Emergency General Surgery/Trauma

Paper 24
January 14, 2021
12:45 pm Eastern

AN INTEGRATIVE MODEL USING FLOW CYTOMETRY IDENTIFIES NOSOCOMIAL INFECTION AFTER TRAUMA

Rondi Gelbard, MD*, Hannah Hensman, Seth Schobel, PhD, Vivek Khatri, PhD, Carl Rosene, 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

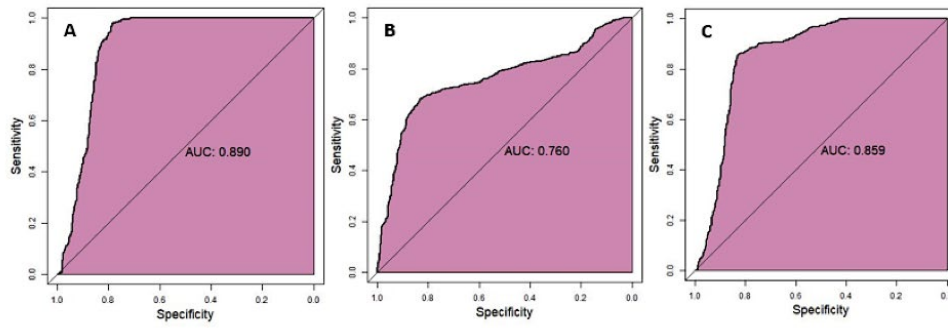
Discussant: Letitia Bible, MD

Objectives: Flow cytometry (FCM) is a rapid diagnostic tool for monitoring immune cell function. We sought to determine if assessment of cell phenotypes using standardized FCM could be used to identify nosocomial infection after trauma.

Methods: Prospective study of trauma patients at a Level 1 center from 2014-2018. Clinical and FCM data were collected within 24h of admission. Random forest (RF) models were developed to estimate the risk of severe sepsis (SS), organ space infection (OSI) and ventilator-associated pneumonia (VAP). Variables were selected using backwards elimination and models were validated with leave-one-out.

Results: 138 patients were included (median age 30y (23-44), median ISS 20 (14-29), 76% (105/138) black, 60% (83/138) gunshots). The incidence of SS was 8.7% (12/138), OSI 16.7% (23/138), and VAP 18% (25/138). The final RF SS model resulted in 5 variables (RBCs transfused in first 24h, absolute CD56- CD16 lymphocyte, CD4+ T cell, and CD56 bright natural killer (NK) cell count, and frequency of CD16+ CD56+ NK cells) that identified SS with AUC 0.89, sensitivity 0.98, and specificity 0.78. The final RF OSI model resulted in 4 variables (RBC in first 24h, shock index, CD16+ CD56+ NK cell count, and frequency of CD56 bright NK cells) that identified OSI with AUC 0.76, sensitivity 0.68, and specificity 0.82. The RF VAP model resulted in 6 variables (SOFA score, ISS, CD4-CD8- T cell count, and frequency of CD16- CD56- NK cells, CD16- CD56+ NK cells, and CD19+ B lymphocytes) that identified VAP with AUC 0.86, sensitivity 0.86, and specificity 0.83.

Conclusions: Combined clinical and FCM data can assist with early identification of post-traumatic infections. The presence of NK cells supports the innate immune response that occurs during acute inflammation. Further research is needed to determine the functional role of these innate cell phenotypes and their value in predictive models immediately after injury.



Receiving operator curve for the RF model of (A) Severe Sepsis, (B) Organ Space Surgical Site Infection, and (C) Ventilator Associated Pneumonia.

Scientific Session IV - Emergency General Surgery/Trauma

Paper 25
January 14, 2021
1:00 pm

FACTORS ASSOCIATED WITH STROKE FORMATION IN BLUNT CEREBROVASCULAR INJURY: AN EAST MULTICENTER STUDY

Emily Esposito, DO, Joseph A Kufera, MA, Timothy W Wolff, DO, M. Chance Spalding, DO, PhD, FACS*, Joshua Simpson, MD*, Julie A. Dunn, MS, MD*, Linda Zier, RN, Sigrid Burruss, MD FACS, Paul Kim, BS, Lewis E. Jacobson, MD, FACS*, Jamie Williams, MSML, BSN, RN, CCRP, Jeffrey Nahmias, MD, MHPE, FACS*, Areg Grigorian, MD, Laura Harmon, MD*, Anna Gergen, MD, Matthew Chatoor, MBBS*, Rishi Rattan, MD*, Andrew J. Young, MD, FACS*, Jose L. Pascual, MD, PhD, FRCS(C), FACS, FCCM*, Jason Murry, MD*, Adrian W. Ong, MD*, Alison Muller, MLS, MSPH, Rovinder S. Sandhu, MD*, Rachel Appelbaum, MD*, Nikolay Bugaev, MD*, Antony Tatar, Khaled Zreik, MD, MS, FACS*, Leah Hustad, CCRC, Mark J. Lieser, MD*, Shenequa Deas, MPH, Deborah M. Stein, MD, MPH, FACS, FCCM*, Thomas M. Scalea, MD, FACS, FCCM*, Margaret H. Lauerman, MD*
R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine

Presenter: Emily Esposito, DO

Discussant: Jill Streams, MD

Objectives: Known stroke risk factors after blunt cerebrovascular injury (BCVI) are ill-defined. We hypothesized that factors associated with stroke for vertebral artery (VA) and internal carotid artery (ICA) BCVI include medical therapy (ie: aspirin), radiographic features, and protocolization of care.

Methods: A 16 center, prospective, observational trial was undertaken. Stroke risk factors were analyzed for VA and ICA BCVI, then compared using global p-values with Breslow-Day test of homogeneity, Van Elteren global test, or logistic regression. BCVI were graded on the standard 1-5 scale. Data was from the initial hospitalization.

Results: 777 BCVIs were included. VA risk factors for stroke included: medical therapy during the hospital stay, initial BCVI grade, BCVI grade evolution, BCVI resolution, percent luminal stenosis (LS), presence of LS, intraluminal thrombus (IT) evolution, new IT formation, IT resolution, pseudoaneurysm (PSA) evolution, and new PSA development (all $p \leq .01$). ICA risk factors for stroke included: use of a management protocol, medical therapy during the hospital stay, initial BCVI grade, BCVI grade evolution, BCVI resolution, percent LS, presence of LS, LS evolution, presence of IT, IT evolution and new IT formation (all $p \leq 0.05$). Global p-values noted a significant difference in risk factors between VA and ICA BCVI for use of a management protocol ($p=0.02$), BCVI grade ($p<0.001$), percent LS ($p<0.001$), and LS evolution ($p=0.03$).

Conclusions: Stroke risk differs between ICA and VA injuries. Evolution of BCVI grade and radiographic features beyond BCVI grade (IT, LS, PSA) impact stroke risk. Medical therapy guided by a protocol likely decreases stroke rate but these relationships are dynamic and complex. Ongoing evaluation is necessary to provide optimal care.

Paper 26
January 14, 2021
1:15 pm

**A MULTICENTER STUDY OF SURGICAL STABILIZATION OF RIB FRACTURES IN
OCTOGENARIANS AND BEYOND – WHAT ARE THE OUTCOMES?**

Fredric M. Pieracci, MD, MPH, Kiara Leasisa, MD, Matthew C. Hernandez, MD, Brian D. Kim, MD, FACS*,
Emily F. Cantrell, MD*, Zachary M. Bauman, DO, MHA*, Scott Gardner, PA, Sarah Majercik, MD, MBA, FACS*,
Erika Tay, MD, Evert Eriksson, MD, FACS, FCCP*, Matthew Barnes, MD, D. Benjamin Christie, III, MD*,
Sean Dieffenbaugher, MD, Sebastian Schubl, MD*, Tom White, MD, Andrew R. Doben, MD*
Denver Health Medical Center

Presenter: Fredric M. Pieracci, MD, MPH

Discussant: Linda Dultz, MD, MPH

Objectives: Prospective studies of surgical stabilization of rib fractures (SSRF) have excluded elderly patients, and no study has exclusively addressed the ≥ 80 year old sub group. We hypothesized that SSRF is associated with improved outcomes in trauma patients ≥ 80 years old.

Methods: Multicenter case control study involving eight academic trauma centers. Patients who underwent SSRF from 2015-2020 were matched 1:2 to controls by study center, age, and injury severity score. Patients with chest abbreviated injury score (AIS) < 3 , head AIS > 2 , death within 24 hours, and desire for no escalation of care were excluded. Multivariable logistic regression evaluated the independent association of SSRF with outcomes.

Results: Of 360 patients, 133 (36.9%) underwent SSRF. Compared to non-operative patients, SSRF patients were more severely injured and more likely to receive loco-regional anesthesia (Table). The median time to surgery was 2.6 days, operative time 129 minutes, number of plates 5, and there were no re-operations. There were 31 hospital deaths among the entire sample (8.6%). After controlling for the differences listed in the Table, SSRF was independently associated with a 59% reduction in likelihood of mortality (odds ratio (OR) 0.41, 95% C.I. [0.24, 0.69], $p < 0.01$), and a 34% reduction in likelihood of discharge on any narcotics (OR 0.66, 95% C.I. [0.48, 0.90], $p = 0.01$). Patients who underwent SSRF were also more likely to be discharged to acute rehabilitation vs. home (OR 1.20, 95% C.I. [1.07, 1.35], $p = 0.03$).

Conclusions: Patients selected for SSRF were substantially more injured vs. those managed non-operatively. Despite this, SSRF was independently associated with decreased mortality. With careful patient selection, SSRF should be considered a viable treatment option in octogenarian/nonagenarians with or without a flail segment.

Variable	SSRF (n=133)	Non-operative (n=227)	p
Age (years)	84 (80-100)	86 (80-99)	0.01
Male	81 (60.9%)	116 (51.1%)	0.07
Body mass index (kg/m ²)	27 (24-29)	25 (23-28)	<0.01
Injury severity score	14 (4-57)	13 (4-34)	<0.01
Pre-injury anti platelets/coagulants	85 (63.9%)	109 (48.0%)	0.10
Fall	80 (60.2%)	181 (79.7%)	<0.01
Intra-cranial hemorrhage	13 (9.8%)	5 (2.2%)	<0.01
Glasgow Coma Score	15 (3-15)	15 (3-15)	0.41
Blunt pulmonary contusion 18 score	2 (0-13)	0 (0-9)	<0.01
Number of rib fractures	9 (1-30)	5 (1-17)	<0.01
RibScore	3 (0-6)	1 (0-6)	<0.01
Flail segment	76 (57.1%)	36 (16.0%)	<0.01
Additional urgent procedure	24 (18.0%)	27 (11.9%)	0.11
Loco-regional anesthesia	8 (3.5%)	85 (64.4%)	<0.01

Comparison of demographics, injury severity, and loco-regional anesthesia between SSRF and non-operative patients.

Scientific Session IV - Emergency General Surgery/Trauma

Paper 27
January 14, 2021
1:30 pm

INTERNAL FIXATION WITH A FULLY RESORBABLE POLY (ESTER UREA) SHELL PROMOTES EARLY BONE FORMATION AND FUNCTIONAL RECOVERY: A PILOT STUDY

Joseph Fernandez-Moure, MD, MS*, Jeffrey Van Eps, MD, Suresh Agarwal, Jr., MD*,
Ennio Tasciotti, PhD, Matthew Becker, PhD
Duke University Medical Center

Presenter: Joseph Fernandez-Moure, MD, MS

Discussant: Elinore Kaufman, MD

Objectives: Traumatic injury in civilians result in 3700 major amputations yearly. Currently no good solutions exist for mangled extremities with critically sized defects (CSD), often requiring amputation. Poly (ester urea) (PEU) is an amino acid based resorbable polymer with mechanical properties similar to cortical bone. We sought to determine if PEU was capable of stabilizing a tibial CSD and promoting bone formation. We hypothesized that internal fixation (ORIF) with a PEU shell mimicking the functional properties of cortical bone would provide early stability, bone growth, and functional recovery in an ovine tibial CSD model.

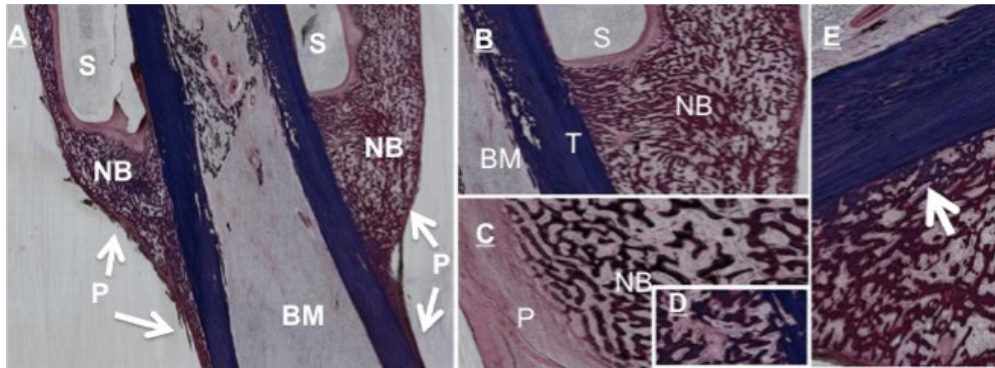
Methods: Using FEA simulation a PEU shell was designed for ORIF and tested using cadaveric static and dynamic testing. Adult Suffolk sheep underwent creation of a 3cm tibial CSD and ORIF using a Synthes plate or PEU shell. Animals underwent 3D CT and X-ray at 4wk and 6mo post operatively. Gait analysis was performed using a Vicon MX motion capture system to assess functional recovery. Following 6mo animals tibiae were harvested and bone formation characterized using Masson Trichrome.

Results: At 4wk and 6mo, total new bone volume and new cortical bone volume were significantly increased compared to controls and baseline. Histology confirmed imaging findings of complete implant ossification and bridging of new bone from the PEU shell to native bone. These findings translated to early mobilization and gait stability at 4wk and full ambulatory recovery at 8wk.

Conclusions: Mangled extremities with CSD are difficult to manage and often require amputation. Herein, we provide the first demonstration of ORIF with a fully resorbable PEU shell capable of early CSD stabilization, complete ossification to native bone, and early functional recovery in an ovine CSD model. This represents a first step toward limb salvage through bone stabilization and regeneration.



Posterolateral view of tibia. Xray (A) and 3D CT (B) following ORIF. 3D CT at 4 weeks (C) and 6 months (D). Axial CT at 6mo (E) postoperatively, note full circumferential bone regeneration with no remaining defect. Graphical representation of new bone quantification after 4 weeks and 6 months implantation (F).



Masson's Trichrome stain showing early ossification (NB) seen encasing the PEU shell (A) at 4wk post implant. Endochondral ossification in the newly forming bone (B) in comparison to the native tissue (inset D). Areas of fusion were confirmed at the interface of native tibia, PEU shell and new bone (E, white arrow). (P: Periosteum; NB: new bone; S: shell; T: native tibia; BM: medullar cavity).

Scientific Session V - Trauma Systems

Paper 28
January 14, 2021
12:15 pm Eastern

TRAUMA AND NON-TRAUMA DAMAGE CONTROL LAPAROTOMY: THE DIFFERENCE IS DELIRIUM (DATA FROM THE EAST SLEEP-TIME MULTICENTER TRIAL)

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Loma Linda University Medical Center

Presenter: Kaitlin McArthur, BS

Discussant: Molly Douglas, MD

Objectives: Damage control laparotomy (DCL) for the critically injured is well established, however related studies are lacking on non-trauma patients. We hypothesized that, non-trauma (NT) patients are older than trauma (T) patients with more comorbidities, and thus would have higher mortality and lower proportion of delirium-free/coma-free ICU (DF/CF-ICU) days after DCL.

Methods: We reviewed retrospective data from 15 centers in the EAST SLEEP-TIME trial, including age, comorbidities (Charlson Comorbidity Index[CCI]), diagnosis, operative intervention, and outcomes. We performed standard parametric testing between T and NT DCL cohorts.

Results: Of 567 patients, NT cohort was older (58.9 ± 15.8 vs 39.7 ± 17.0 years, $p < 0.001$), more likely female (45.5% vs 22.1%, $p < 0.001$), and had higher CCI (4.7 ± 3.3 vs 1.1 ± 2.2 , $p < 0.001$). Diagnoses for NT cohort were diverse (Figure 1). Penetrating trauma rate was 48.8%. Similarities and differences for operative procedures are indicated in Figure 2. The number of takebacks was similar overall (1.7 ± 2.2) as well as time to first takeback (32.0 hrs), duration of bowel discontinuity (48.0 hrs) and time to primary fascial closure (63.2 hours, achieved in 73.5% [18.7% died before PFC, 7.8% survived without PFC]). Hospital, ICU, and ventilator days were similar, as were rates of dehiscence, evisceration, reoperation, and mortality (31.0% NT, 29.8% T). Need for dialysis (36.6% vs 14.1%, $p < 0.001$) and postoperative abdominal sepsis (40.1% vs 17.1%, $p < 0.001$) were higher in NT. T had similar hours of sedation (89.9 ± 154.9 vs 65.5 ± 81.1 hrs, $p = 0.065$) and opioids (106.9 ± 166.8 vs 96.7 ± 112.4 hrs, $p = 0.514$), but a lower proportion of DF/CF-ICU days (51.1% vs 73.7%, $p = 0.029$).

Conclusions: Despite similar use of opioids and sedatives in both groups the trauma group had a higher incidence of delirium.

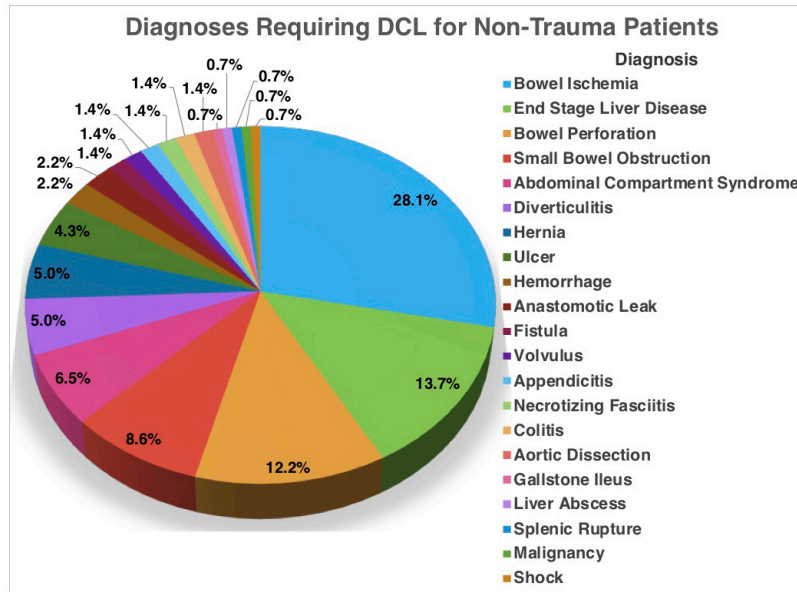
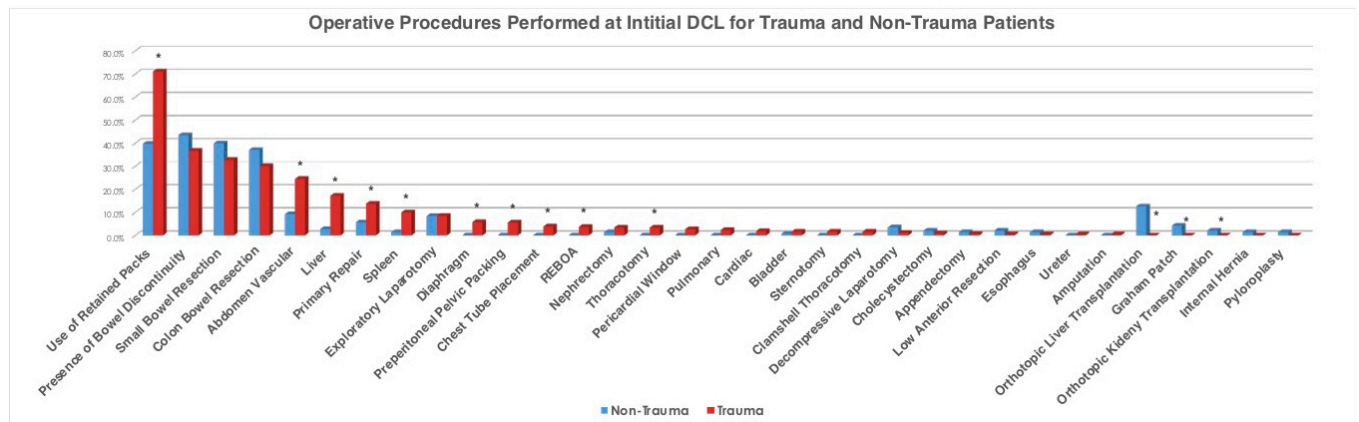


Figure 1. Most common diagnoses requiring DCL for non-trauma include bowel ischemia (28.1%), end stage liver disease (13.7%), bowel perforation (12.2%), small bowel obstruction (8.6%), abdominal compartment syndrome (6.5%), diverticulitis and hernia (both 5.0%).



Operative procedures performed for non-trauma (blue, left bar) and trauma (red, right bar) patients. Procedures that were performed at statistically significantly different rates between groups are marked with an asterisk.

Scientific Session V - Trauma Systems

Paper 29
January 14, 2021
12:30 pm Eastern

A COMPREHENSIVE ANALYSIS OF UNDERTRIAGE IN A MATURE TRAUMA SYSTEM USING GEOSPATIAL MAPPING

George O. Maish III, MD*, Michael Horst, PhD, Madison Morgan, BS, Eric H. Bradburn, DO, MS, FACS*,
Alan D. Cook, MD*, Frederick Rogers, MD, MS, FACS*
Penn Medicine Lancaster General Health

Presenter: George O. Maish III, MD

Discussant: Esther Tseng, MD

Objectives: The correct triage of trauma patients to trauma centers (TCs) is essential. We sought to determine the percentage of patients who were undertriaged (UTR) within the Pennsylvania (PA) trauma system and spatially analyze areas of UTR in PA for all age groups: pediatric, adult and geriatric. We hypothesized that there would be certain areas that had high UTR for all age groups.

Methods: From 2003-2015, all admissions from the Pennsylvania Trauma Systems Foundation (PTSF) registry and those meeting trauma criteria (ICD-9: 800-959) from the Pennsylvania Health Care Cost Containment Council (PHC4) database were included. Admissions were divided into age groups: pediatric (>15y), adult (15-64y) and geriatric (≥65y). All pediatric trauma cases were included from the PTSF and PHC4 registry, while only cases with ISS>9 were included in adult and geriatric age groups. UTR was defined as patients not admitted to pediatric TCs (n=6) or Level I/II adult TCs (n=27) divided by the total number of patients from the PHC4 database. ArcGIS Desktop and GeoDa were used for geospatial mapping of UT with a spatial empirical Bayesian smoothed UTR by Zip Code Tabulation Area (ZCTA) and Stata for statistical analyses.

Results: There were significant percentages of UTR for all age groups (Table 1). One area of high UTR for all age groups had TCs and large non-trauma centers (NTCs) in close proximity. There were high rates of undertriage for all ages in rural areas, specifically in the upper central regions of PA, with limited access to TCs.

Conclusions: It appears there are two patterns leading to undertriage. The first is in areas where TCs are in close proximity to large competing NTCs which may lead to inappropriate triage. The second has to do with lack of access to TCs. Geospatial mapping is a valuable tool that can be used to ascertain where trauma systems should focus scarce resources to decrease UTR.

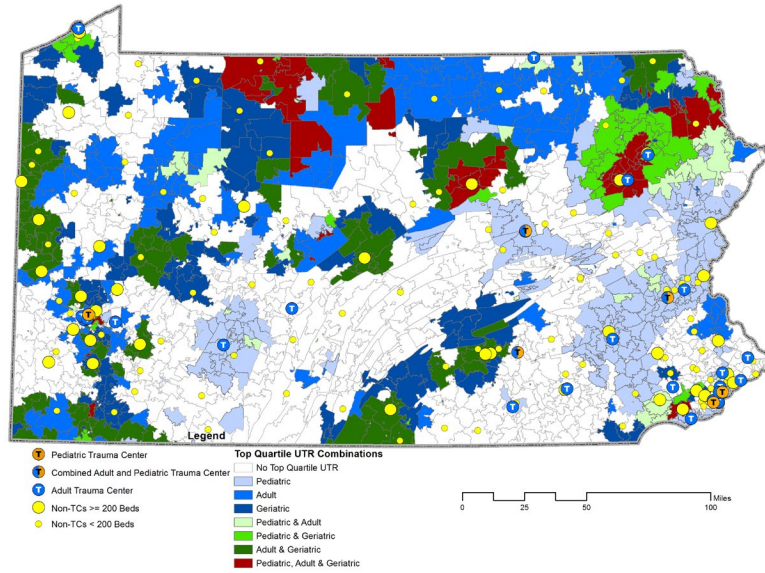


Figure 1. Combinations of Top Quartile Pediatric All ISS Cases UTR, Adult ISS>9 UTR and Geriatric ISS>9 UTR

Age Group	ZCTA (n=1,798) Median (Q1-Q3) Smoothed Percent Undertriaged
Pediatric (age <15 years) All ISS	37.3 (21.6-46.2)
Adult (age 15-64 years) ISS > 9	22.9 (16.9-28.3)
Geriatric (age ≥65 years) ISS > 9	50.0 (36.2-59.7)

Table 1. Statewide Undertriage Percentages By Age Group

Scientific Session V - Trauma Systems

Paper 30
January 14, 2021
12:45 pm Eastern

DERIVATION AND VALIDATION OF THE TRAUMA OUTCOMES PREDICTOR (TOP): AN ARTIFICIAL-INTELLIGENCE-BASED, INTERACTIVE AND USER-FRIENDLY CALCULATOR TO PREDICT OUTCOMES IN TRAUMA PATIENTS

Lydia Maurer, MD, Dimitris Bertsimas, PhD, Majed El Hechi, MD, Hamza Tazi Bouardi, MS, Mohamed El Moheb, MD, Katerina Giannoutsou, BA, Daisy Zhou, Ph.D., Jack Dunn, PhD, George Velmahos, MD, PhD, MEd, Haytham Kaafarani, MD, MPH*
Massachusetts General Hospital

Presenter: Lydia Maurer, MD

Discussant: Caroline Park, MD, MPH

Objectives: Risk assessment tools often treat patients' risk factors as linear and additive. We aimed to use AI technology to design and validate a nonlinear risk calculator for trauma patients.

Methods: All patients in the 2010-2016 ACS-TQIP database were included. Demographics, ED vital signs, comorbidities, and injury characteristics (e.g. severity, mechanism) were analyzed using a novel, interpretable AI technology called Optimal Classification Trees (OCTs). OCTs were leveraged in an 80:20 derivation:validation split to train predictive algorithms for blunt and penetrating trauma in-hospital mortality and complications (e.g. acute kidney injury, acute respiratory distress syndrome, deep vein thrombosis, pulmonary embolism, sepsis). A smartphone application was created as the algorithms' interactive and user-friendly interface. Performance was validated using the c-statistic methodology.

Results: A total of 934,053 patients were included. The mean age was 51 years, 37% were female, 91% had blunt trauma, and the mean ISS was 15. Based on the comprehensive OCT algorithms, the Trauma Outcomes Predictor (TOP) smartphone application was created, where the surgeon's answer to a question interactively dictates the subsequent one [Figure 1]. TOP accurately predicted mortality in penetrating injury (c-statistics: 0.95 derivation, 0.94 validation) and blunt injury (c-statistics: 0.89 derivation, 0.88 validation) [Figure 2]. The c-statistics for complications ranged between 0.69 and 0.84.

Conclusions: We suggest TOP as a novel, AI-based, interpretable, accurate, and non-linear risk calculator for predicting outcome in trauma patients. TOP can prove useful for bedside counseling of critically injured trauma patients and their families, and for benchmarking the quality of trauma care.

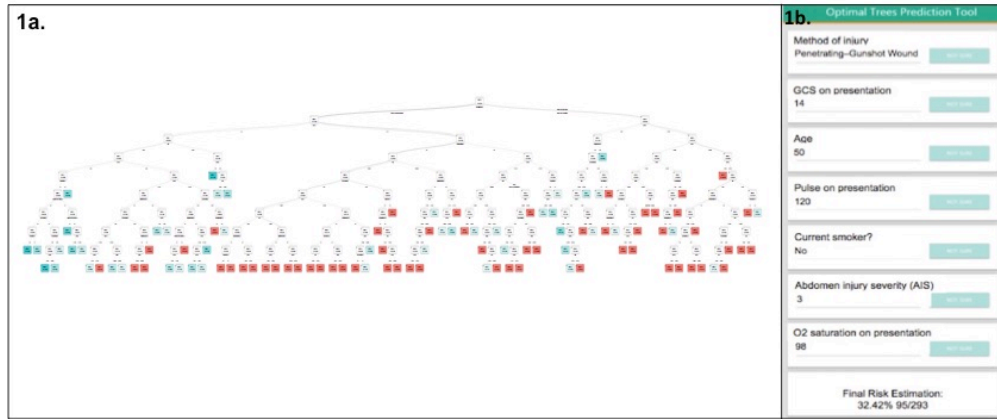


Figure 1: Decision Tree and Interactive Smartphone Application for Trauma Outcome Predictor. 1a) Decision tree for the Trauma Outcome Predictor; 1b) Example patient in interactive smartphone application with estimated percent mortality.

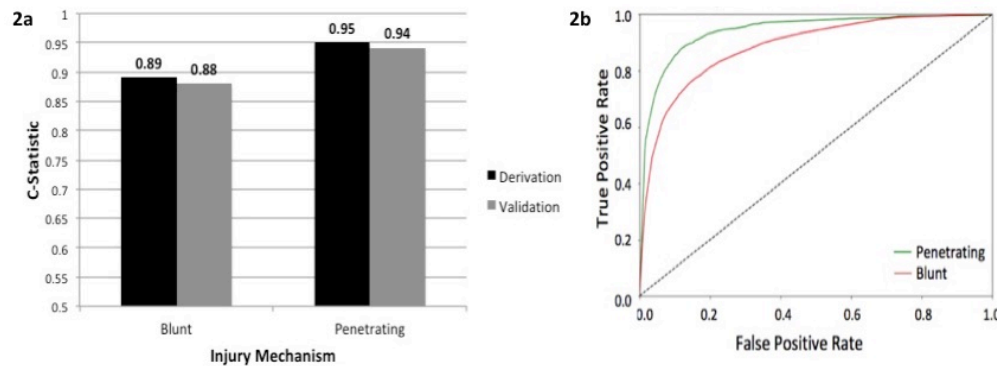


Figure 2: Performance of the Trauma Outcome Predictor. 2a) Area under the Receiver Operator Characteristic curve for the Trauma Outcome Predictor among patients with blunt and penetrating mechanisms in derivation and validation cohorts; 2b) Receiver Operator Characteristic curves for patients with blunt and penetrating mechanisms in the validation cohort.

Scientific Session V - Trauma Systems

Paper 31
January 14, 2021
1:00 pm Eastern

AN EAST MULTICENTER TRIAL EXAMINING PREHOSPITAL PROCEDURES IN PENETRATING TRAUMA PATIENTS

Sharven Taghavi, MD, MPH, MS*, Zoë Maher, MD*, Amy J. Goldberg, MD*, Grace Chang, MD*, Michelle Mendiola, MD, Christofer Anderson, MD, Leah C Tatebe, MD FACS*, Patrick Maluso, MD*, Shariq Raza, MD*, Jane Keating, MD*, Sigrid Burruss, MD FACS, Matthew Reeves, BS, Lauren E. Coleman, MD, David V. Shatz, MD*, Anna Goldenberg-Sandau, DO*, Apoorva Bhupathi, BA, M. Chance Spalding, DO, PhD, FACS*, Aimee LaRicca, DO*, Emily Bird, Matthew R Noorbakhsh, MD*, James Babowice, DO, Marsha C Nelson, MD, MPH, FACS*, Lewis E. Jacobson, MD, FACS*, Jamie Williams, MSML, BSN, RN, CCRP, Michael Vella, MD*, Kate Dellonte, MBA, BSN, RN, Thomas Z. Hayward III, MD*, Emma Holler, BS, Mark J. Lieser, MD*, John D. Berne, MD*, Dalier R. Mederos, MD, CCRP, Reza Askari, MD*, Barbara Okafor, BS, MBA, Elliott R. Haut, MD, PhD, FACS*, Eric Etchill, MD, MPH*, Raymond Fang, MD, FACS*, Samantha L. Roche, MD, Laura Whittenburg, MS, Andrew C. Bernard, MD, FACS*, James M. Haan, MD*, Kelly L. Lightwine, MPH, Scott H. Norwood, MD*, Jason Murry, MD*, Mark A. Gamber, DO, Matthew M. Carrick, MD*, Nikolay Bugaev, MD*, Antony Tatar, Juan C. Duchesne, MD, FACS, FCCP, FCCM*, Danielle Tatum, PhD
Tulane University School of Medicine

Presenter: Sharven Taghavi, MD, MPH, MS

Discussant: Alaina Lasinski, MD

Objectives: Prehospital procedures (PHP) by emergency medical services (EMS) are performed regularly in penetrating trauma patients despite previous studies demonstrating no benefit. We sought to examine the influence of PHP on outcomes in penetrating trauma patients in urban locations where transport to trauma center is not prolonged. We hypothesized that patients without PHP would have better outcomes than those with PHP.

Methods: This was an EAST-sponsored, multicenter, prospective observational trial of adults (18+ years) with penetrating trauma to the torso and/or proximal extremity presenting at 25 urban trauma centers. Impact of PHP and transport mechanism were examined.

Results: Of 2,284 patients, 1,386 (60.7%) underwent PHP. The cohort was primarily African American (n=1,527, 66.9%) males (n = 1,986, 87.5%) injured by gunshot wound (n=1,510, 66.0%) with 25.7% (n=554) having Injury Severity Score (ISS) ≥ 16 . 62.5% (n=1427) were transported by Advanced Life Support (ALS) EMS, 17.2% (n=392) by private vehicle, 13.7 % (n=312) police, and 6.7% (n=153) by Basic Life Support (BLS) EMS. Of the PHP patients, 69% received PHP on scene, 60% received PHP in route, and 29% received PHP both on scene and in route. Initial scene vitals, but not ED vitals, differed between groups. (**Table 1**) Receipt of ≥ 1 PHP increased mortality odds (OR:1.36, 95%CI: 1.01–1.83; p=0.04). Logistic regression showed increased mortality with each PHP, whether on scene or during transport (**Table 2**). Subset analysis revealed intubation (OR: 37.85, 95%CI: 20.10–71.26, p<0.001) and pleural decompression (OR: 3.46, 95%CI: 2.02–5.94, p<0.001) had the highest odds of mortality after adjusting for multiple variables.

Conclusions: PHP in penetrating trauma patients imparts no survival advantage and may be harmful in urban settings, even when performed during transport. Therefore, PHP should be forgone in lieu of immediate transport to improve patient outcomes.

Demographics & Injury	Total n = 2284	No PHP (n = 898, 39.3%)	PHP (n = 1386, 60.7%)	P
Age, years	32.5 (12.4)	31.2 (11.6)	33.3 (12.9)	< 0.001
Injury Severity Score	11.5 (14.7)	10.1 (14.6)	12.4 (14.8)	< 0.001
Chest injury, n (%)	1006 (44.1)	355 (39.6)	651 (47.0)	0.001
Abdominal injury, n (%)	849 (37.2)	299 (33.3)	550 (39.7)	0.002
Pelvic injury, n (%)	329 (14.4)	160 (17.8)	169 (12.2)	< 0.001
Proximal extremity injury, n (%)	1128 (49.4)	489 (54.5)	639 (46.1)	< 0.001
PH vitals				
Systolic blood pressure, mm Hg	121.7 (39.1)	128.0 (32.9)	121.0 (39.6)	0.026
Heart rate, beats per minute	93.8 (30.1)	93.3 (33.0)	93.9 (29.8)	0.498
Glasgow Coma Scale	13.8 (3.4)	14.3 (2.6)	13.7 (3.5)	0.015
ED vitals				
Systolic blood pressure, mm Hg	122.7 (40.7)	122.9 (42.0)	122.4 (39.7)	0.809
Heart rate, beats per minute	90.6 (32.3)	91.4 (31.9)	89.9 (32.6)	0.363
Glasgow Coma Scale	13.7 (3.5)	14.0 (3.2)	13.5 (3.7)	0.010
Emergent surgery	794 (36.1)	251 (28.8)	543 (40.9)	< 0.001
Outcomes				
Length of stay, days	5.0 (8.8)	4.1 (6.6)	5.6 (10.0)	< 0.001
ICU-free days	3.5 (5.6)	3.1 (4.5)	3.8 (6.2)	0.002
Ventilator-free days	4.2 (6.5)	3.6 (5.5)	4.5 (7.1)	0.002
Mortality	213 (9.4)	70 (7.8)	143 (10.3)	0.044

Values are presented as mean (SD) unless otherwise indicated. PHP – pre-hospital procedures; ICU – intensive care unit

Description of patient population and outcome variables

Parameter	Odds ratio	95% CI	P
Age, years	1.028	1.012 – 1.044	0.006
ISS	1.107	1.088 – 1.126	<0.001
ALS transport	Ref		
BLS transport	0.722	0.304 – 1.714	0.460
Police transport	2.155	1.155 – 4.022	0.016
Private vehicle	0.851	0.341 – 2.126	0.730
GSW	4.905	2.600 – 9.256	<0.001
Chest injury	2.304	1.434 – 3.701	0.001
# scene PHP	1.454	1.219 – 1.734	<0.001
# transport PHP	1.337	1.103 – 1.621	0.003

CI – confidence interval; ALS – Advanced Life Support; BLS – Basic Life Support; GSW – gunshot wound; PHP – prehospital injury.

Multivariate logistic regression examining odds of hospital mortality

Scientific Session V - Trauma Systems

Paper 32
January 14, 2021
1:15 pm Eastern

INSULT TO INJURY: NATIONAL ANALYSIS OF LONG-TERM OUTCOMES OF WORKING-AGE TRAUMA PATIENTS

Pooja U. Neiman, MD, MPA, Brandy Sinco, MS, John W. Scott, MD, MPH*
University of Michigan

Presenter: Pooja U. Neiman, MD, MPA

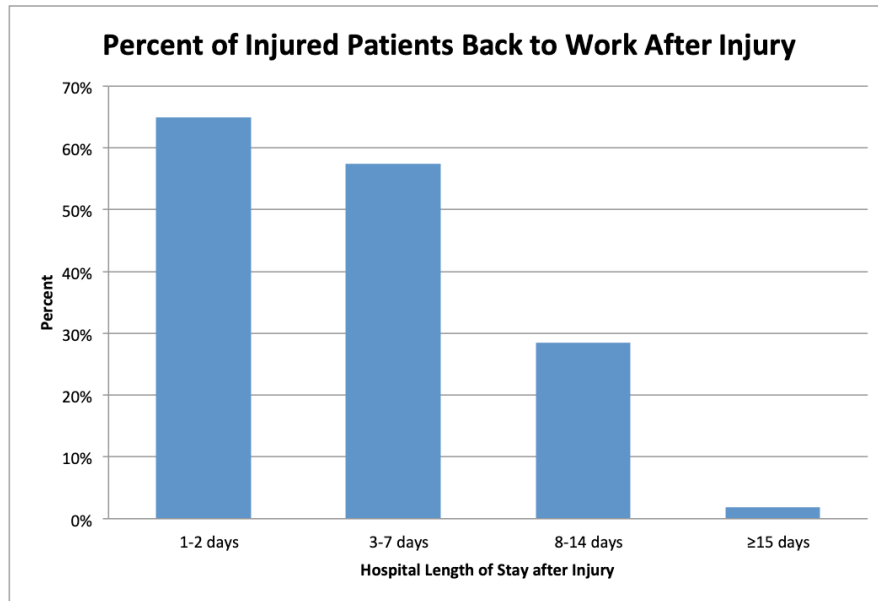
Discussant: Lane Frasier, MD

Objectives: The overwhelming majority of trauma patients in the US survive to hospital discharge. While much of trauma care is rightly focused on improving inpatient survival, the ultimate goal of recovery is to help patients return to their daily lives after injury. However, little is known nationally regarding the long-term burden of injuries of trauma survivors.

Methods: We used the National Health Interview Survey from 2014-2017 to identify working-age trauma patients, ages 18-64, who sustained injuries requiring hospitalization. We then used optimal variable-ratio matching based on year, age, sex, census region, race/ethnicity, income, insurance status, marital status, and family size to identify uninjured respondents. Our primary outcome measure was post-injury return to work among trauma patients. Our secondary outcomes included survey measures of food insecurity, financial toxicity, disability, and loss of functional independence.

Results: We identified a nationally-weighted sample of 1,514,637 working-age trauma patients from 2014-2017. At time of their injury, 49.4% of working age adults were employed and 59.4% of those had returned to work at the time of survey, accounting for 12.3 lost work days per injured adult (IQR: 3.5-26.4 days). Median follow-up time was 50.5 days after injury (IQR: 24.7- 80.3 days). As hospital length of stay increased, return to work fell dramatically. Less than 29% of trauma patients returned to work when hospitalized for >7 days (Figure). When compared to a weighted matched cohort of 4,710,154 uninjured individuals, trauma patients were more than twice as likely to report food insecurity, financial toxicity, disability, and loss of functional independence (Table).

Conclusions: The long-term burden of injury among working-age US trauma survivors is profound—patients report significant limitations in employment, financial security, disability, and functional independence.



Graph displaying the percent of injured patients back to work at the time of survey versus the days spent inpatient in the hospital.

Survey 'Yes' Responses*	Trauma Patients (%)	All Other Patients (%)	Multi aOR** (Ref = Matched cohort)	p-value
Food Insecurity Worried food will run out before money to buy more	38.1	12.6	4.26	<0.0001
Medical Debt Unable to pay current medical bills	39.0	16.6	3.21	<0.0001
Foregone Care Needed health care but did not receive it due to cost	18.2	6.3	3.29	<0.0001
Disability Received disability benefits of any kind	27.6	7.9	4.46	<0.0001
Dependent ADLs Needs assistance with ADLs	17.8	1.0	22.22	<0.0001

*National Health Interview Survey respondents from 2014-2017 answering "Yes" to the categories within the prior 12 months.

**Adjusted for year, age, sex, census region, race/ethnicity, income, insurance status, marital status, and family size

Table representing the percent of National Health Interview Survey respondents from 2014-2017 answering "Yes" to questions regarding food insecurity, financial toxicity, disability, and loss of functional independence (our secondary outcomes) within the prior 12 months compared to their matched non-trauma adults.

Scientific Session V - Trauma Systems

Paper 33
January 14, 2021
1:30 pm Eastern

VARIATION IN NEUROSURGICAL INTERVENTION FOR SEVERE TBI: THE CHALLENGE OF MEASURING QUALITY IN TRAUMA CENTER VERIFICATION

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Objectives: Intracranial pressure monitor (ICPm) procedure rates are a quality metric for American College of Surgeons trauma center verification. However, rates of surgical intervention for traumatic brain injuries (TBI) differ. We hypothesized that ICPm and craniotomy/craniectomy procedure rates for severe TBI vary across the US by geography and institution.

Methods: We identified all patients with a severe TBI (head AIS ≥ 3) from the 2016 Trauma Quality Improvement Program (TQIP) dataset. Patients who received craniotomy or ICPm were identified via ICD codes. Hospital factors included neurosurgeon group size, geographic region, teaching status, and trauma center level. Two multiple logistic regression models were performed identifying factors associated with 1) craniotomy with or without ICPm or 2) ICPm alone. Data are presented as medians [IQR] and odds ratios [95%CI].

Results: We identified 75,690 patients (66.4% male, age 59 [36-77]) with a median ISS of 17 [11-25]. Overall, 4.1% had a craniotomy, and 4.5% had ICPm placement. In an adjusted regression analysis, region of the country was significantly associated with procedure types: compared with the Midwest, hospitals in the West were more likely to use ICPm (OR 1.34 [1.20-1.51]) while Northeastern (OR 0.87 [0.77-0.98]) and Southern (OR 0.85 [0.77-0.94]) hospitals were less likely to perform craniotomies. Hospitals with small neurosurgeon groups (<3) were more likely to place ICPm. Community hospitals are associated with higher odds of craniotomy but lower odds of ICPm placement.

Conclusions: Both geographic differences and hospital characteristics are independent predictors for surgical intervention in severe TBI. This implies that non-patient factors drive procedural decisions, indicating that ICPm rate is not an ideal quality metric.

Table. Factors associated with craniotomy and ICP monitor.

	Craniotomy Odds Ratio (95%CI)	ICP Monitor Odds Ratio (95%CI)
Regions		
Midwest	Reference	Reference
West	1.01 (0.91-1.13)	1.34 (1.2-1.51) **
Northeast	0.87 (0.77-0.98) *	1.10 (0.97-1.25)
South	0.85 (0.77-0.94) **	1.00 (0.90-1.11)
Trauma center level		
Level I	Reference	Reference
Level II	0.84 (0.76-0.93) **	0.86 (0.77-0.96) **
Level III	1.00 (0.57-1.64)	0.90 (0.48-1.57)
Neurosurgeon group size		
1-2 neurosurgeons	1.11 (0.96-1.28)	1.34 (1.16-1.54) **
3-5 neurosurgeons	1.08 (0.99-1.17)	0.93 (0.85-1.01)
6+ neurosurgeons	Reference	Reference
Teaching hospital status		
University	Reference	Reference
Community	1.14 (1.04-1.26) **	0.83 (0.76-0.92) **
Non-teaching	1.07(0.92-1.25)	0.86 (0.73-1.01)
Concordance statistic	0.73	0.86

Adjusted for patient factors including age, demographics, and injury severity; **p<0.01 and *p<0.05.