Session I: Plenary Papers 1-8
Paper 1: 1:00 PM - 1:20 PM

PREHOSPITAL PLASMA IN INJURED PATIENTS IS ASSOCIATED WITH SURVIVAL PRINCIPALLY IN BLUNT INJURY: RESULTS FROM TWO RANDOMIZED PREHOSPITAL PLASMA TRIALS

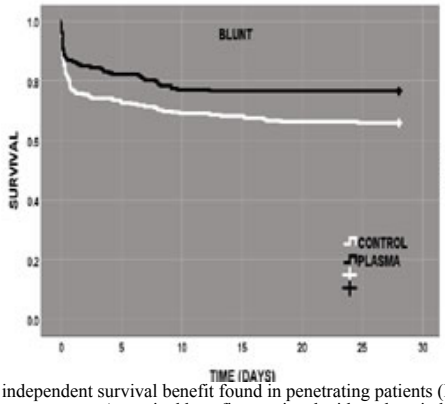
Katherine Reitz MD, Hunter Moore MD, Frank Guyette MD,MPH, Angela Sauaia* Ph.D., Anthony Pusateri* Ph.D., Ernest Moore* MD, Michael Chapman MD, Brian Daley* MD, Richard Miller* MD, Brian Harbrecht* MD, Jeffrey Claridge* MD, Herb Phelan* MD, Joshua Brown MD, Jason Sperry* MD,MPH, University Of Pittsburgh

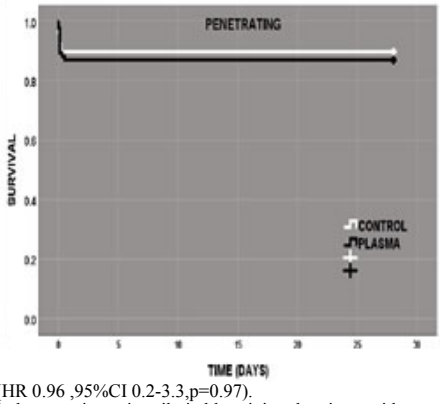
Invited Discussant: Donald Jenkins, MD

Introduction: Recent evidence demonstrated that prehospital plasma in patients at risk of hemorrhagic shock was safe for ground transport and resulted in a 28-day survival benefit for air medical transport patients. Whether any beneficial effect of prehospital plasma varies across injury mechanism remains unknown. We sought to characterize prehospital plasma across blunt and penetrating injury with the hypothesis that a survival benefit would be apparent irrespective of injury mechanism.

Methods: We performed a secondary analysis using a preplanned harmonized dataset derived from two recent prehospital plasma randomized trials. Two units of prehospital plasma were provided in both trials as compared to standard care resuscitation. Identical inclusion/exclusion criteria and primary/secondary outcomes were employed for the trials. Prehospital time, arrival shock parameters and 24-hour transfusion requirements were compared across plasma and control groups stratified by mechanism of injury.Stratified survival analysis and Cox hazard regression were performed to determine the independent survival benefits of plasma across blunt and penetrating injury.

Results: Plasma and cotrol arm comparisons for both trials demonstrated excellent randomization. Blunt patients had higher injury severity, were older and had a lower GCS. Arrival indices of shock and transfusion requirements over 24 hours across plasma and control arms for blunt and penetrating patients were similar. The percentage of patients with a prehospital time less than 20 mins was significantly higher for penetrating patients relative to blunt injured patients (26.7%% vs 11.4%, p<0.01). A generalized estimating equations model accounting for intra-trial cluster effects and multiple confounders was used to test for interaction between mechanism of injury (blunt vs. penetrating) and randomization group (plasma vs control) and was highly significant (interaction p<0.01). Stratified Kaplan-Meier curves (Figure) demonstrated a significant separation for blunt injured patients (n=501, p=0.01) with no separation demonstrated for penetrating injured patients (n=125, p=0.62) Stratified Cox hazard regression verified, after controlling for all important confounders, that prehospital plasma was associated with a 35% lower independent hazard for 28 day mortality in blunt injured patients (HR 0.65 ,95% CI 0.45-0.93, p= 0.02) with no





independent survival benefit found in penetrating patients (HR 0.96 ,95%CI 0.2-3.3,p=0.97).

Conclusion: A survival benefit associated with prehospital plasma exists primarily in blunt injured patients with no benefit shown in penetrating trauma patients. No detrimental effects attributable to plasma are demonstrated in penetrating injury. These results have important relevance to military and civilian trauma systems. It remains unknown if prehospital plasma is beneficial in penetrating patients in different prehospital environments such as prolonged field care situations. Using data derived from two civilian randomized prehospital plasma trials, a 28-day survival benefit is principally demonstrated in blunt injured patients only.

Session I: Plenary Papers 1-8
Paper 2: 1:20 PM - 1:40 PM

SELF-EXPANDING FOAM VS. PRE-PERITONEAL PACKING FOR EXSANGUINATING PELVIC HEMORRHAGE

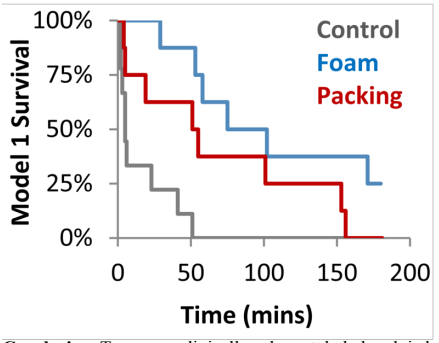
David R. King* MD, Ahmed E. Elsharkawy MD, Ahmed I. Eid MD, Michael J. Duggan DVM, John Beagle BS, April Mendoza MD,MPH, Noelle Saillant MD, Martin G. Rosenthal MD, Haytham M. Kaafarani* MD,MPH, Peter Fagenholz MD, John O. Hwabejire MD,MPH, Quynh P. Pham BS, PhD, Shawn Gelsinger BS, M.S., Michael Fornaciari BS, Upma Sharma BS, PhD Harvard Medical School/ Massachusetts General Hospital

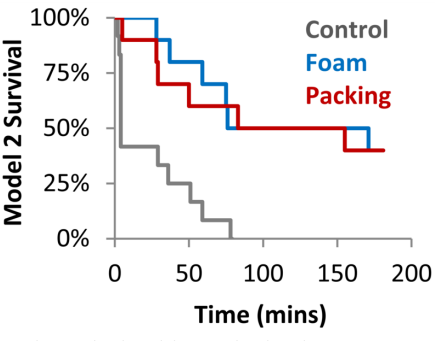
Invited Discussant: John Harvin, MD

Introduction: Mortality for pelvic fracture patients presenting with hemorrhagic shock ranges from 21-50%. The objective of this study was to develop a reproducible, lethal, and clinically-relevant pelvic hemorrhage animal model with and without bony fracture for evaluating therapeutic interventions. ResQFoam, a novel, self-expanding foam, has previously been described in the pre-clinical literature to significantly decrease mortality in large-animal models of abdominal exsanguination. We hypothesized that percutaneously-administered ResQFoam could decrease mortality in exsanguinating pelvic hemorrhage with and without bony fracture relative to control and pre-peritoneal packing.

Methods: Two pelvic hemorrhage models were developed using non-coagulopathic Yorkshire swine. Pelvic hemorrhage model #1: bilateral, closed-cavity, major vascular retro-peritoneal hemorrhage without bony pelvic fracture. After injury, animals received resuscitation (control, n=9), underwent pre-peritoneal pelvic packing using laparotomy pads (n=8), or received ResQFoam (n=8) injected into the pre-peritoneal space. The interventions were initiated post-injury when the mean arterial pressure (MAP) declined below 30 mmHg. Pelvic hemorrhage model #2: unilateral, closed-cavity retro-peritoneal hemorrhage injury (with intra-peritoneal communication) combined with complex pelvic fracture. After injury, animals received resuscitation (control, n=12), pre-peritoneal packing (n=10), or ResQFoam injection (n=10) into the pre-peritoneal space 1 min post-injury. In both models, animals were monitored for 3 hrs or until death.

Results: For model # 1, both foam and packing showed significant survival advantage compared to controls, with foam demonstrating better outcomes than packing. Median survival times were 5, 53, and 89 minutes in control, packing, and foam groups, respectively. Survival at 1 hour was 71% for foam compared to 0% in the control and 43% in the packing group (p=0.0001 and 0.2178, respectively); survival at 3 hours was 29% for foam compared to 0% in both the control and packing groups (p=0.0001 and 0.094, respectively). Foam treatment facilitated hemodynamic stabilization and resulted in significantly less hemorrhage relative to control and packing groups (20.8±5.8 g/kg vs. 30.5±3.8 g/kg and 31.9±6.1 g/kg, respectively, p=0.001). For model #2, foam and packing prolonged survival. Median survival times were 4, 76 and 83 minutes in the control, foam, and packing groups, respectively. Survival at 1 hour was 70% for foam and 60% for packing, compared to only 8% in the control group (p=0.0013 and 0.0074, respectively); at 3 hours, survival with foam and packing group were both 50% vs 0% in controls (p=0.0018 and 0.0034, respectively). Both interventions increased MAP compared to the controls and reduced hemorrhage from 37.5±7.2 g/kg in controls to 29.1±9.0 g/kg and 28.4± 8.1 g/kg in the foam and packing groups, respectively (p=0.054).





Conclusion: Two new, clinically-relevant, lethal, pelvic hemorrhage animal models were developed. Percutaneous injection of ResQFoam into the pre-peritoneal space improved survival relative to controls, and similar or better survival benefit and outcomes were achieved compared to standard pre-peritoneal pelvic packing.

Session I: Plenary Papers 1-8
Paper 3: 1:40 PM - 2:00 PM

SURVIVAL BENEFIT FOR PELVIC TRAUMA PATIENTS UNDERGOING RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA: RESULTS OF AAST, AORTIC OCCLUSION FOR RESUSCITATION IN TRAUMA AND ACUTE CARE SURGERY (AORTA) REGISTRY

John K. Bini* MD, Claire Hardman RN, Jonny Morrison* MD,Ph.D., Thomas M. Scalea* MD, Laura J. Moore* MD, Jeanette M. Podbielski RN, CCRP, Kenji Inaba* MD, Alice Piccinini* MD, David S. Kauvar* MD, Jeremy Cannon* MD, Mark Seamon* MD, Chance Spalding* DO,Ph.D., Chuck Fox* MD, Ernest E. Moore* MD, Joseph J. Dubose* MD, Wright State University

Invited Discussant: James Haan, MD

Introduction:Aortic occlusion (AO) to facilitate the acute resuscitation of trauma and acute care surgery patients in shock remains a controversial topic. (1-6). Resuscitative Endovascular balloon occlusion of the aorta (REBOA) is an increasingly deployed method of AO. We hypothesized that in patients with non-compressible hemorrhage below the aortic bifurcation, the use of REBOA instead of open AO may portent a significant survival benefit.

Methods:The AAST, Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery (AORTA) registry prospectively identified 1494 patients requiring AO from 45 level 1 and 4 level 2 centers. Presentation, intervention and outcome variables were collected and analyzed to compare REBOA and open AO in patients with non-compressible hemorrhage below the aortic bifurcation.

Results: From December 2014 to January 2019, 217 patients with Zone 3 REBOA or Open AO who required pelvic packing, pelvic fixation or pelvic angio-embolization were identified. 109 AO patients with injuries isolated to below the aortic bifurcation were captured (REBOA, 84; open AO, 25); 68.8% were male, and 93.6% were blunt injuries. Patients with intra-abdominal or thoracic sources of bleeding, above deployment zone 3 were specifically excluded from analysis. Excluding patients who arrived with CPR in progress, presenting base deficit, lactate, and SBP were not significantly different between the REBOA group and the open AO group. Admission GCS was lower in the open AO group (p=.003). Overall mortality was lower in the REBOA group (35.17% vs 80.00%, p <.001). Excluding patients who arrived with CPR in progress, the REBOA group had lower mortality (33.33% vs. 68.75%, p = 0.008). When stratified based on presenting SBP either <60 or >/= 60, the patients in the REBOA group had lower mortality in both groups (SBP<60, 28.57% vs 66.67%, p =0.500); (SBP>/=60, 33.80% vs. 69.23%, p=0.020). In the REBOA group, 9 patients had complications secondary to vascular access (need for surgical closure of arteriotomy, patch angioplasty, limb ischemia, distal embolization, amputation). None of the vascular access complications resulted in limb loss or long-term disability. Of the survivors, complications including MOF, ALI, pneumonia, AKI, and need for dialysis, were not significantly different between groups. Overall hospital length of stay, ICU length of stay, and PRBC use were not significantly different between groups.

Conclusion: The AAST AORTA registry is the largest ongoing prospective attempt to capture data regarding AO. This study specifically looked at the application of REBOA for patients with exsanguinating hemorrhage below the aortic bifurcation. Our data show a clear survival advantage in patients who undergo REBOA as a means of AO compared to open AO. The survival advantage seen with REBOA was accomplished without increasing systemic complications. We conclude that REBOA should be strongly considered for patients in hemorrhagic shock secondary to pelvic trauma vice open AO.

Session I: Plenary Papers 1-8
Paper 4: 2:00 PM - 2:20 PM

LONG-TERM OUTCOMES AFTER VIOLENCE-RELATED TRAUMA: A MULTI-CENTER COHORT STUDY

Manuel Castillo-Angeles MD,MPH, Juan Herrera-Escobar MD,MPH, Alexander Toppo BS, Sabrina Sanchez MD, Haytham M. Kaafarani MD,MPH, Ali Salim* MD, Adil Haider* MD,MPH, Deepika Nehra MD, Brigham and Womens Hospital

Invited Discussant: Amy Goldberg, MD

Introduction: Violence continues to be a significant public health burden, but little is known about the long-term outcomes of these patients. Our goal was to determine the impact of violence-related trauma on long-term functional and psychosocial outcomes.
Methods: We identified trauma patients with moderate to severe injuries (ISS≥9) treated at one of 3 level 1 trauma centers. These patients were asked to complete a survey over the phone between 6-12 months after injury evaluating both functional and psychosocial outcomes (SF-12, T-QoL, PTSD screen, chronic pain, return to work). Patients were classified as having suffered a violent injury if the mechanism of injury was a stab, gunshot or assault. Self-inflicted wounds were excluded. Adjusted logistic regression models were built to determine the association between a violent mechanism of injury and long-term outcomes.
Results: 1,902 patients moderate-to-severely injured patients were successfully followed, of whom 162 (8.5%) were victims of violence. For the victims of violence: mean age was 35 years (SD15.3), 84% were male and 55.6%were black. 33.3% reported newly needing help with at least one activity of daily living after the violence-related event. 55/109 (50.4%) of patients who were working prior to their injury had not yet returned to work. 43.3%screened positive for PTSD and 52.5% reported chronic pain. On multivariate analysis, a violent mechanism was significantly associated with PTSD (OR 2.33, 95% Confidence Interval 1.43–3.80, p=0.001), but not associated with chronic pain, return to work or functional outcomes.

Variable	Odds ratio (95% Confidence interval)			
	PTSD	Functional Limitation	No return to work	Chronic Pain
Violence-related trauma (Ref: non-violent)	2.33 (1.43 – 3.80)	1.32 (0.84 – 2.10)	0.98 (0.54 – 1.76)	0.99 (0.62 – 1.57)

* Adjusted for: Age, gender, race, education level, insurance status, comorbidities, AIS.

Conclusion: The physical and mental health burden after violence-related trauma is not insignificant. Further work is needed to identify intervention strategies and social support systems that may be beneficial to reduce this burden.

Session I: Plenary Papers 1-8
Paper 5: 2:20 PM - 2:40 PM

PLASMA RESUSCITATION WITH ADJUNCTIVE PERITONEAL RESUSCITATION REDUCES ISCHEMIC INTESTINAL INJURY FOLLOWING HEMORRHAGIC SHOCK

Jason W. Smith* MBA,MD,Ph.D., Jessica Schucht MD, Brian Harbrecht* MD, Logan Bond MD, Glen A. Franklin* MD, Paul J. Matheson Ph.D., University of Louisville

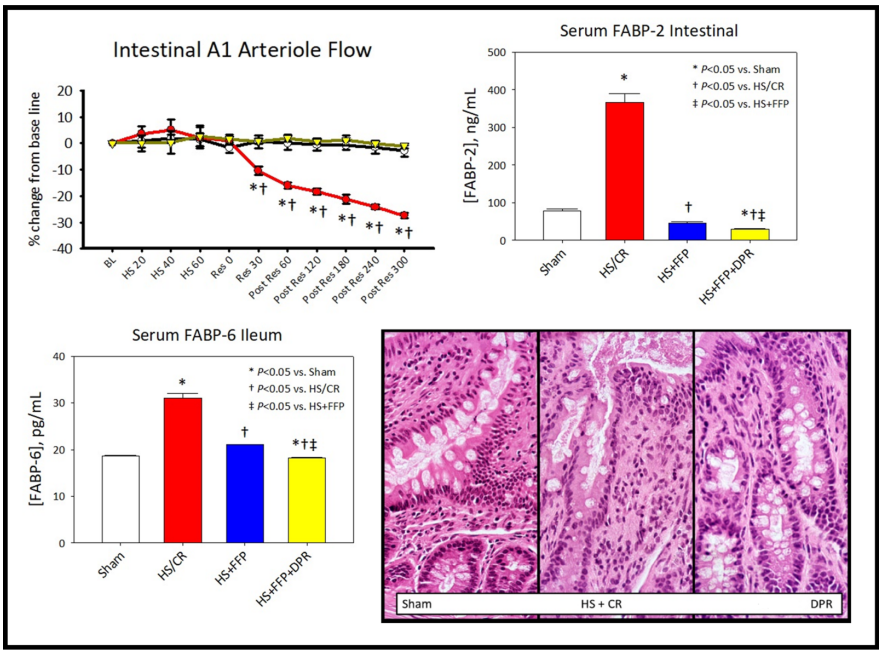
Invited Discussant: Stephen Cohn, MD

Introduction: Ischemia-reperfusion injury to the intestine during hemorrhagic shock (HS) and subsequent resuscitation leads to damage to the intestine, intestinal barrier breakdown and is the inciting factor for inciting for multiple organ dysfunction syndrome in a subset of trauma patients. Hemostatic resuscitation with blood product may not completely restore or protect the GI tract following. We postulated that resuscitation with DPR combined with FFP would result in improved intestinal blood flow and decreased intestinal injury compared to conventional methods of resuscitation.

Methods:Using a previously published HS protocol Sprague Dawley rats underwent HS and were assigned to one of 5 resuscitation groups (n = 7): ***Sham*;** HS+ crystalloid resuscitation ***CR*** (shed blood plus 2 volumes crystalloid resuscitation); ***HS+CR+DPR*** (intraperitoneal (IP) dialysis fluid); ***HS+FFP*** (shed blood plus 2 volumes FFP); and ***HS+DPR+FFP*** ((IP) dialysis fluid, 2 volumes FFP). Laser Doppler flowmetry of the bowel, serum samples free fatty acid binding proteins (FABP), and H&E and immunohistochemistry (IHC) staining were used to assess the intestinal injury and blood flow after HS. P-values >0.05 were considered significant.

Results: Following HS, the addition of DPR to either resuscitation modality led to increased intestinal blood flow. (Figure 1) At 4 hours after HS and resuscitation, FABP2 (intestine and colon) and FABP6 (ileal) were elevated in the CR group and reduced in both the FFP and the DPR groups. Intestinal cell nuclear thinning, denuded intestinal villi and disruption of the intestinal cell lamina propria was identified within 4 hours of HS-induced ischemic injury in both the FFP and the CR groups with the CR group being worst. Combination therapy with FFP and DPR demonstrated minimal to no cell injury in H&E and IHC graded samples and a significant reduction in FABP levels following. (Figure 4)

Conclusion: HS leads to ischemic-reperfusion injury of the intestine, both FFP and DPR reduced intestinal damage, and combination therapy alleviated most signs of organ injury. Combination therapy with DPR to restore intestinal blood flow following shock could be an essential method of reducing morbidity and mortality after trauma.



Session I: Plenary Papers 1-8
Paper 6: 2:40 PM - 3:00 PM

RADIOGRAPHIC PREDICTORS OF THERAPEUTIC OPERATIVE INTERVENTION AFTER BLUNT ABDOMINAL TRAUMA: THE RAPTOR SCORE

Dina M. Filiberto MD, Muhammad O. Afzal MD, John P. Sharpe MD, Catherine Seger MD, Sridhar Shankar MD, Martin A. Croce* MD, Timothy C. Fabian* MD, Louis J. Magnotti* MD, University of Tennessee Health Science Center - Memphis

Invited Discussant: Lillian Kao, MD, MS

Introduction: Bowel and mesenteric injuries are rare in patients following blunt abdominal trauma. These injuries represent a diagnostic challenge, often presenting in a delayed fashion. Computed tomography (CT) imaging has become a mainstay in the work-up of the stable trauma patient. Yet, the role of CT in diagnosing those injuries requiring operative intervention remains controversial. The purpose of this study was to identify radiographic predictors of therapeutic operative intervention in patients after blunt abdominal trauma.

Methods: All patients with a discharge diagnosis of a mesenteric injury after blunt trauma were identified over a 5-year period. A radiologist, blinded to the patients' management and outcome, reviewed the admission CT scan to identify potential predictors of bowel and/or mesenteric injury. Patients were then stratified by operative intervention [therapeutic laparotomy (TL) vs. non-therapeutic laparotomy (NTL)] and compared. Multivariable logistic regression (MLR) analysis was performed to determine independent predictors of TL. All potential predictors included in the initial regression model were assigned one point and a score based on the number of predictors was calculated: The Radiographic Predictors of Therapeutic Operative Intervention (RAPTOR) Score. Youden's index was used to determine the optimal RAPTOR score.

Results: 151 patients were identified. 114 (76%) patients underwent operative intervention. Of these, 75 patients (66%) underwent TL. There were no missed injuries in patients managed non-operatively. Multifocal hematoma, acute arterial extravasation, bowel wall hematoma, bowel devascularization, fecalization, free air and fat pad injury, identified as potential predictors of bowel and/or mesenteric injuries on univariable analysis, were included in the initial MLR model and comprised the RAPTOR score. The optimal RAPTOR score was identified as ≥ 3, with a sensitivity, specificity and positive predictive value of 67%, 85% and 86%, respectively. MLR identified acute arterial extravasation (OR 3.8; 95%CI 1.2-4.3), bowel devascularization (OR 14.5; 95%CI 11.8-18.4) and fat pad injury (OR 4.5 95%CI 1.6-6.2) as independent predictors of TL following blunt abdominal trauma (AUC 0.91).

Conclusion: CT imaging remains vital in assessing for potential bowel and/or mesenteric injuries following blunt abdominal trauma. The RAPTOR score provides a simplified approach for those patients that may benefit from early operative intervention. In fact, this score could potentially represent an invaluable tool in the management of blunt trauma patients without a clear indication for laparotomy but at risk for blunt bowel and/or mesenteric injuries.

Session I: Plenary Papers 1-8
Paper 7: 3:00 PM - 3:20 PM

DISPROPORTIONALLY LOW NIH FUNDING FOR TRAUMA RESEARCH: THE CALL FOR A NATIONAL INSTITUTE OF TRAUMA

Nina E. Glass MD, Julia Riccardi BA, Nicole I. Farber BS, Stephanie Bonne* MD, David H. Livingston* MD, Rutgers New Jersey Medical School

Invited Discussant: William Cioffi, MD

Introduction: Injury is the leading cause of death in young Americans up to age 46. Despite this chilling statistic, funding for trauma is well below that of other conditions, such as cardiovascular disease and cancer. Previous analyses demonstrating disproportionately low NIH funding for trauma were based on administrative reviews which likely overestimate the true proportion of trauma funding. Without accurate data, policy makers cannot make informed decisions and the status quo will never change. We hypothesized that NIH funding for trauma is lower than previously reported. The lack of a dedicated home for trauma research results in diffusion of grants across the NIH and hampers effective funding opportunities.
Methods: The NIH Research Portfolio Online Reporting Tools Expenditures and Results database was initially screened using a keyword search of over 20 terms including 'trauma', 'injury', 'shock', 'MVC' and excluding terms like 'cancer', 'congenital', 'autism' to capture all possible trauma-related and exclude obvious non-trauma grants. The title, abstract, and project terms of all grants which screened positive were reviewed using an inductive coding schema to positively identify trauma-related grants. An expert panel was used to adjudicate any ambiguity.
Results: 50,137 NIH grants were awarded in FY2016; 6,676 (13%) were captured by our initial screen. Of these, only 1,888 (28%) were found to be trauma research representing 3.7% of all NIH grants. Of the total $25 billion NIH research budget only $720 million (2.9%) was awarded for trauma research. Trauma related grants were awarded from 24 institutes with a range of funding from 0.01% (NCI) to 11% (NINDS and NIAMS). Approximately 4% of investigator initiated (e.g. R01, R21) and 4.5% of training grants (e.g. K23, K08) were trauma related. Of note, the awards with the highest proportion containing trauma related research were large multidisciplinary longitudinal grants including 30% of P60 centers, and 15% of P01 projects and U19 agreements. <100 trauma-related grants were awarded to Departments of Surgery.
Conclusion:This review provides the most detailed analysis of NIH trauma-related funding to date. The disproportionately low percentage of funding, spread across NIH Institutes and Centers, results in a diffusion of purpose and makes advocating for trauma research nearly impossible. Compared to the burden of disease and current goal of zero preventable deaths this dearth of federal funding is shameful. These data demonstrate a need for the creation of a National Institute of Trauma at the NIH.

Session I: Plenary Papers 1-8
Paper 8: 3:20 PM - 3:40 PM

DELAYED SPLENECTOMY IN PEDIATRIC SPLENIC INJURIES: IS CONSERVATIVE MANAGEMENT OVERUSED?

Zaid Haddadin MD, Kamil Hanna MD, Lourdes Castanon MD, Mohammad Hamidi MD, Lynn Gries MD, Narong Kulvatunyou MD, Ashley Northcutt MD, Andrew Tang MD, Bellal Joseph* MD, University of Arizona - Tucson

Invited Discussant: Margaret Knudson, MD

Introduction: Non-operative management (NOM) of pediatric splenic injuries has become the mainstay of treatment. The long-term failure rate of NOM is not well established. The aim of our study was to evaluate the NOM failure rate and ascertain the predictors of delayed splenectomy upon readmission in pediatric splenic injuries.

Methods: The (2011-2014) National Readmission Database was queried for all patients <18y admitted with an isolated splenic injury. Patients were stratified into 3 groups: splenectomy, angioembolization, and NOM. Outcome measures were the rates of readmission, blood-transfusion and delayed splenectomy. Multivariable logistic and Cox regression were performed to determine the predictors of delayed splenectomy upon readmission.

Results: A total of 9,506 patients with splenic injuries were identified. Mean age was 14±4y. Most patients underwent NOM 7,318 (77%), 1,541 (16.2%) underwent splenectomy, and 647 (7%) angioembolization. High-grade splenic injuries (grades 4-5) were more common among splenectomy 1,133 (74%) and angioembolization 445 (69%) patients relative to NOM patients 3,017 (48%);($p<0.001$). Overall, 589 (6%) were readmitted within 6 months with a median time to readmission of 12[5-23] d. The angioembolization and NOM groups had higher readmission rates (12% and 8% vs. 5%; $p<0.001$), and blood-transfusion rates (6.8% and 6.4% vs. 2%; $p<0.001$) compared to the splenectomy group. The rate of delayed splenectomy was 15% (7.2% of NOM vs. 5.3% of angioembolization patients; $p=0.026$). Predictors of delayed splenectomy were high-grade-injury (OR 3.37[2.25-4.17]; $p=0.029$), blood-transfusion (OR 1.92[1.17-2.40]; $p=0.039$), and NOM (OR 5.65[3.37-6.39]; $p=0.041$) relative to angioembolization. Median time to splenectomy was shorter in the NOM group vs. angioembolization (14d vs. 58d); (aHR 6.22[1.53-9.24]; $p=0.034$).

Conclusion: One in seven children had failure of conservative management for splenic injuries and underwent a delayed splenectomy within 6-months after discharge. NOM and angioembolization demonstrate a temporary benefit. Better selection of candidates for conservative management must be performed.

Session V: Canizaro Papers 9-14
Paper 9: 7:30 AM - 7:50 AM

EXTRACORPOREAL SUPPORT FOR TRAUMA: A TRAUMA QUALITY IMPROVEMENT PROJECT (TQIP) ANALYSIS IN PATIENTS WITH ARDS

Aaron Strumwasser* MD, MSc., Alice Piccinini MD, Bryan Love MD, Reynold Henry MD, Brad Allen MD, Kenji Inaba* MD, Kazuhide Matsushima* MD, Meghan Lewis MD, Peter Gruen MD, Demetrios Demetriades* MD,Ph.D., LAC+USC Medical Center

Invited Discussant: David Zonies, MD, MPH

Introduction: Extracorporeal membrane oxygenation (ECMO) for patients with severe traumatic ARDS is debated. We sought to determine whether trauma surgeons' experience with ECMO demonstrates improved outcomes in ARDS using the trauma quality improvement project (TQIP) institutional registry.
Methods: The TQIP database was queried for all patients that underwent ECMO and those patients that possessed a diagnosis of ARDS from 2013-2016. Exclusion criteria included an abbreviated injury score (AIS) score of 6 in any of the body regions, systolic blood pressure (SBP) or heart rate (HR) of 0, history of CHF or arrest, transfers into the hospital, HLOS < 72 hours, patients leaving against medical advice, or patients with missing data. A propensity score analysis was used in non-ECMO patients to delineate patients at high risk of death from severe ARDS (1:1 performed without replacement, nearest neighbor method, caliper 0.2, corrected for age, gender, HR, SBP, Glasgow Coma Score (GCS), injury severity score (ISS), and abbreviated injury score (AIS) in the following regions – head, face, neck, chest, abdomen, pelvis, extremity, external). Survival characteristics were compared between the ECMO population (97 patients) and the non-ECMO population (N = 1,266 patients) using Cox Regression. Secondary outcomes such as hospitalization (HLOS), ICU length-of-stay (LOS) and ventilation days stratified for patient demographics (age, gender, ISS, body region), timing of ECMO and anticoagulation status were compared. Data is represented as median [IQR 25-75%], mean ± SD or %, as appropriate. Univariate comparisons were made via unpaired Student's t-test or Mann-Whitney U test for continuous variables and Chi Square analysis or Fisher Exact for categorical variables with p values less than 0.05 deemed significant.
Results: Survival characteristics are shown between the two groups (Figure 1). Compared to the non-ECMO population, the ECMO population tended to be younger (35 [22-51] vs. 56 [36-68] years, p<0.01), had lower SBP (118 [90-137] vs. 130 [103-152] mmHg), higher HR (108 [88-129] vs. 96 [79-116] BPM, p<0.01), higher median GCS scores (median 14 [3-15] vs. 9 [3-15], p=0.03), with equal injury severity overall (27 [17-34] vs. 27 [19-38], p=0.3). The ECMO population had fewer severe head injuries (29 vs. 63%, p<0.001) and more severe thoracic injuries (76 vs. 60%, p=0.001), with all other injured regions being the same between groups (p>0.1 for all). Among ECMO survivors, patients that underwent ECMO earlier (<7 days) had shorter HLOS (33±27 vs. 47±23 days,
p=0.01), shorter ICU LOS (24±17 vs. 39±16 days, p=0.0001) and fewer ventilator days (21±18 vs. 33±14 days, p=0.003). Compared to survivors that did not undergo ECMO, there was no difference in HLOS (29±22 vs. 33±27 days, p=0.3) or ventilator days (17±14 vs. 21±18 days, p=0.1), but prolonged ICU LOS was observed (24±17 vs. 20±13 days, p=0.04) in the ECMO population. There were no outcome differences with respect to anticoagulation status (p>0.1) or type of anticoagulation used (p>0.1) in the ECMO population.
Conclusion: ECMO may portend improved survival from severe ARDS at the expense of prolonged ICU LOS. Early ECMO in a younger population with severe thoracic injuries may be the optimal patient demographic. Prospective study is warranted.

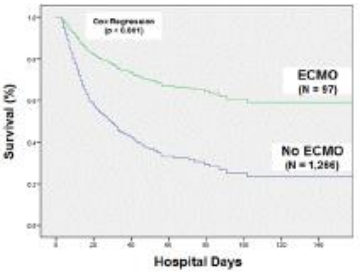


Figure 1: Survival characteristics of matched ARDS populations treated with and without ECMO. In a subgroup analysis of patients matched for age, injury severity, gender, HR, SBP, GCS, and AIS (body regions – head, neck, face, chest, abdomen, pelvis, spine extremity, and external) the patients that underwent ECMO for ARDS had superior survival compared to patients that underwent conventional management for ARDS.

Session V: Canizaro Papers 9-14
Paper 10: 7:50 AM - 8:10 AM

UNDERSTANDING THE MAKEUP OF A GROWING FIELD: A COMMITTEE ON TRAUMA SURVEY OF THE NATIONAL NETWORK OF HOSPITAL-BASED VIOLENCE INTERVENTION PROGRAMS

Stephanie Bonne* MD, Ashley Hink MD,MPH, Lisa Allee MSW, Katie Bakes MD, Peter Burke* MD, Thomas Duncan* DO, Joel Fein MD,MPH, Tamara Kozyckyj MPH, David Shapiro* MD, Pina Violano MPH,Ph.D., Deborah Kuhls* MD, Rochelle Dicker* MD, UCLA David Geffen School Of Medicine

Invited Discussant: Glen Tinkoff, MD

Background: Hospital Based Violence Intervention programs (HVIPs) are becoming an increasingly prevalent injury prevention strategy in trauma centers nationwide. HVIPs practice and public health approach to violence intervention. Variation in services provided, practice patterns, funding sources, or populations served by these programs is not widely known. This study aims to raise awareness of the characteristics of these programs and better identify opportunities and gaps across HVIPs.

Methods: The 38 member programs of the National Network of Hospital Based Violence Intervention Programs (NNHVIP) were invited to participate in a Qualtrics-Based online survey administered by NNHVIP in coordination with the ACS Committee on Trauma. Survey questions were both discreet and quantitative in nature as well as open-ended, allowing qualitative analysis of responses. Quantitative responses were reported with simple descriptive statistics using Microsoft Excel. Qualitative analysis was performed by coding open-ended responses, identifying and describing commonly reported themes until theoretical saturation was achieved.

Results: 38 programs completed the survey (100%). The most common demographics served are aged 18-45. Individuals older than age 45 rarely meet programs' inclusion criteria. Programs most commonly serve African-Americans. All programs respond to street violence and adolescent violence, as this is the focus of participating HVIPs. Some respond to domestic violence, sexual violence, or sex trafficking. Child abuse and elder abuse are rarely included. 85% of programs provide case management > 3 years. Programs with higher levels of funding (>$300,000 per year) were more likely to be funded by government funding, while lower funded programs were by grants, foundations or direct philanthropy. The largest barrier to starting or sustaining a program was consistent funding, with lack of resources for addressing risk factors or mental health as secondary barriers. Qualitative analysis revealed themes including concern over funding, staffing, and the adequacy of support and related services. For programs that had overcome hurdles, the importance of hospital buy-in and secure funding were sited. Programs value NNHVIP for advocacy, networking, and technical support. Many mentioned the importance of demonstrating evidence-based outcomes to justify continued funding .

Conclusion: HVIPs focus on violence in communities and provide case management based on the needs of local populations. Case management provides mentorship and addresses social determinants of health. There is opportunity to expand HVIPs to include more sexual and domestic violence programming, and develop models to serve victims of child and elder abuse similarly utilizing a public health approach. Successful program development requires stable funding, adequate staffing models and buy-in from hospitals and staff. Physicians can provide oversight and guide evaluation of HVIPs. Continued education for physicians about the HVIP model, advocacy for program funding through fee for service policy initiatives, program evaluation and expansion of NNHVIP is essential to further expand these efforts into a nationwide best practice.

Session V: Canizaro Papers 9-14
Paper 11: 8:10 AM - 8:30 AM

RANDOM FOREST MODEL PREDICTS ACUTE KIDNEY INJURY AFTER TRAUMA LAPAROTOMY

Rondi Gelbard* MD, Hannah Hensman BA, Seth Schobel Ph.D., Vivek Khatri Ph.D., Cameron W. Paterson MD, Christopher J. Dente* MD, Timothy G. Buchman* MD,Ph.D., Allan Kirk MD,Ph.D., Eric Elster* MD, Emory University

Invited Discussant: Jordan Weinberg, MD

Introduction: Despite advances in the management of critically ill patients, the incidence of acute kidney injury (AKI) remains high among trauma patients. Given the morbidity and mortality associated with AKI, we sought to examine the value of predictive modelling for identifying risk factors for the development of AKI.

Methods: Clinical and molecular biomarker data were collected from patients undergoing exploratory laparotomy for abdominal trauma at a Level 1 trauma center between 2014 and 2017. Serum samples were collected within 24 hours after injury. AKI was defined as either (1) Increase in serum creatinine level of $\geq$0.3 mg/dL or $\geq$1.5 times baseline, (2) decrease in GFR by 50%, or (3) urine output < 0.5 mL/kg per hour for $\geq$6 hours. Machine learning algorithms were employed to develop a model predicting AKI. Random forest (RF) was performed and features were selected using recursive variable elimination. The model was trained and tested with 145 records using leave-one-out cross validation.

Results: One hundred and forty-five patients were included (median age: 31, median ISS: 18). The incidence of AKI was 27.6% (40/145), diagnosed a median of 2 days (IQR: 0-13 days) post-injury. Overall mortality was 2% (1 AKI vs 2 non-AKI, p = 1.0). Infectious complications were more common among AKI patients (10/40, 25%, versus 10/105, 9.5%; p = 0.03). A total of 17/40 (42.5%) AKI patients progressed to Stage 3 and 3/40 (7.5%) required renal replacement therapy. The final RF model resulted in three features (Sequential Organ Failure Assessment (SOFA) Score, Serum Monocyte Chemoattractant Protein-1 (MCP1), and serum Vascular endothelial growth factor (VEGF)) that predicted AKI with an area under the curve (AUC) of 0.739, a sensitivity of 0.817, and a specificity of 0.607. A logistic regression model with the RF final features predicted with an AUC of 0.722, a sensitivity of 0.769, and a specificity of 0.642.

Conclusion: Biomarkers may have diagnostic utility in the early identification of patients at risk of post-traumatic AKI. Future iterations of modeling will require accounting for the different etiologies of AKI, as well as breaking down the SOFA score to remove the creatinine component and assess overall contribution of the score components to our predictive accuracy. Further refinement and validation of the model could lend to the development of clinical decision support tools to guide resuscitation strategies and care bundles aimed at preventing AKI.

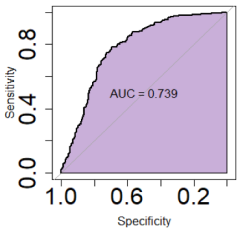


Figure 1. Receiving operator characteristic curve for the random forest AKI model.

Session V: Canizaro Papers 9-14
Paper 12: 8:30 AM - 8:50 AM

ACUTE RESPIRATORY DISTRESS SYNDROME (ARDS) AFTER TRAUMA: STILL HIGHLY MORBID AND MORTAL

George Kasotakis* MD,MPH, Krista Haines DO, Cory Vatsaas MD, Amy Alger* MD, Steven Vaslef* MD,Ph.D., Kelli Brooks* MD, Sean Montgomery* MD, Suresh Agarwal* MD, Duke University

Invited Discussant: Pauline Park, MD

Introduction: ARDS is an infrequent, yet morbid complication in injury victims. With the current project we sought to estimate trends in its incidence, determine clinically relevant outcomes, and identify risk factors for ARDS and related mortality.
Methods: The national TQIP dataset (2010-2014) was queried, after exclusion of patients who expired/had a length of stay (LOS) <48 hours. Demographics, injury characteristics and outcomes were compared between patients who developed ARDS and those who did not. Logistic regression models were fitted for the development of ARDS and mortality respectively, adjusting for age, gender, race, severity of neurologic injury, overall injury severity, presenting hypotension, mechanism of injury, blood products transfused and pre-existing comorbidities.
Results: Out of the 808,195 TQIP patients, 165,244 were excluded. Incidence of ARDS decreased over the study years (3% to 1.1%, p<0.001), but related mortality increased (18.9% to 21%, p=0.001). ARDS patients spent on average an additional 14.710.3 days in the hospital, 9.77.9 in the ICU, and 6.69.4 on mechanical ventilation (all p<0.001). Older age, male gender, African American race, and interestingly pre-injury steroids increased risk for ARDS, while blood product transfusions did not (table). Only age, male gender, lower GCS and higher ISS predicted mortality among ARDS patients.
Conclusion: Although the incidence of ARDS after trauma appears to be improving slightly, mortality has increased. As risk factors for ARDS or mortality are not easily modifiable, the need to develop treatments for the syndrome cannot be overemphasized.

ARDS	Odds Ratio	P-value
Age (decade)	1.03 (1.00-1.04)	0.002
Male gender	1.32 (1.22-1.43)	<0.001
Afr. Am.	1.16 (1.04-1.29)	0.008
EMS GCS	0.89 (0.88-0.90)	<0.001
Steroids	1.92 (1.40-2.64)	<0.001
Blunt mechanism	0.97 (0.85-1.12)	0.723
ISS	1.05 (1.05-1.05)	<0.001
PRBC Units (24h)	1.00 (1.00-1.01)	0.870
FFP Units (24h)	1.00 (1.00-1.01)	0.665
PLT Units (24h)	1.00 (1.00-1.01)	0.051
Cryo Units (24h)	1.00 (1.00-1.01)	0.890

Session V: Canizaro Papers 9-14
Paper 13: 8:50 AM - 9:10 AM

A GLIMPSE INTO THE STATE OF GENDER TRENDS IN THE TRAUMA COMMUNITY: CURRENT APPRAISAL AND OPPORTUNITIES

Shannon M. Foster* MD, Jennifer K. Davis* MD, Catherine G. Velopulos MD, Stephanie Bonne* MD, D'Andrea Joseph* MD, Heena Santry* MD, Jamie J. Coleman* MD, Rachael Callcut* MD, Reading hospital

Invited Discussant: Roxie Albrecht, MD

Introduction: Although women have traditionally been underrepresented in the surgical disciplines, there has been no in-depth contemporary analysis of the current state of women in the Trauma field. We aimed to understand the gender distribution of membership, leadership opportunities, and scientific contributions to annual meetings within professional organizations.
Methods: Retrospective collection of membership, leadership, presentation and publication from 2016-18 was completed for the American Association for the Surgery of Trauma (AAST), the Eastern Association for the Surgery of Trauma (EAST), and Western Trauma Association (WTA). Gender was assigned based on self-identification in demographic information, established relationships, or public sources.
Results: Women remain underrepresented in the field of Surgical Critical Care with only 28.1% of those ascertaining American Board of Surgery certification self-identifying as female. The proportion of females holding membership in EAST was comparable (29.4%), slightly lower for WTA (19.0%), and lowest for AAST (13.3%, $p<0.05$). In contrast, AAST had the highest proportion of women participants in in executive leadership (AAST 32.5%, WTA 19.0%; EAST 18.8%) and WTA the highest for committee chairs (WTA 33.3%, AAST 27.8%, EAST 20.5%). AAST had the most significant increase in executive leadership over the last 3 years (AAST 28.6% to 41.6%). The largest gap area of academic underrepresentation was for invited lectureships/masters/panelists and senior author scientific contributions (Table).
Conclusion: Fewer women than men pursue careers in the trauma field. Continuing to provide mentorship, leadership, and scientific recognition opportunities is an important component of increasing gender diversity in our field. We must continue to promote, sponsor, recognize, invite, and elect 'her'.

	AAST	EAST	WTA	p-value
Membership	13.3%	29.4%	19.0%	<0.0001
Executive leadership	32.5%	18.8%	19.0%	0.397
Board of Directors	-	16.7%	22.2%	0.586
Committee chairs	27.8%	20.5%	33.3%	0.566
Committee members	23.1%	27.9%	28.6%	0.056
Oral presenters	40.2%	36.6%	34.4%	0.558
Senior author	20.0%	27.6%	13.2%	0.022
Invited discussants	20.0%	31.7%	n/a	0.023
Moderators	31.0%	20.6%	22.6%	0.479
Invited Speakers/Masters/Panelists	17.9%	23.7%	23.5%	0.793
QS posters/talks	39.6%	30.1%	-	0.026
QS discussants/moderators	23.2%	25.0%	-	0.79

Session V: Canizaro Papers 9-14
Paper 14: 9:10 AM - 9:30 AM

WHO RETURNS HOME AFTER ADMISSION FOR FALL? PATIENT FACTORS RELATED TO RESIDENCY ONE YEAR LATER

Vanessa P. Ho* MD,MPH, Amy S. Kelley MD, MSHS, David F. Warner Ph.D., Jeffrey A. Claridge* MD, MS, Siran M. Koroukian Ph.D., METROHEALTH MEDICAL CENTER

Invited Discussant: Stephanie Savage, MD

Introduction: Falls represent 78% of blunt trauma in older patients. Long-term prognostication for fall survivors is not well-described. We hypothesize fall survivors living at home one year after admission have different baseline factors than those living in a facility or those who died.

Methods: We identified community dwelling patients admitted for fall (ICD9 E880-888) in 2011-2012 from the Medicare Current Beneficiary Survey (MCBS), a longitudinal health survey with participants interviewed serially over four years. We measured baseline disease conditions and functional status, including activities of daily living (ADLs) and instrumental ADLs (IADLs), from the survey prior to the fall. We identified residency location and dates of residency changes from subsequent interviews. We compared patients living at home one year post-admission to those living in a facility or who died. We assessed association between pre-fall factors and home status using chi-square or Kruskal-Wallis tests. We constructed a Kaplan-Meier curve to illustrate the timing of transitions to home.

Results: Of 145 patients, one year after admission for fall 93 (64%) were home, 18 (12%) were in a facility, and 32 (22%) had died. Younger age, ability to shop, and ability to pay bills independently, were associated with increased odds of living at home (all $p<0.05$). Other characteristics were not significantly associated with residence status one year after admission. Among patients who were not living at home one year post-fall, more than half had transitioned to a facility or had died within 60 days.

Conclusion:Two-thirds of community-dwelling older adults admitted after a fall were living at home one year later. Younger age and factors suggesting ability to live independently at baseline (shopping and paying bills) were positively associated with maintaining community residence.



Session VII: Papers 15-17
Paper 15: 10:20 AM - 10:40 AM

THE IMPACT OF INTERHOSPITAL TRANSFER ON MORTALITY BENCHMARKING AT LEVEL III AND IV TRAUMA CENTERS: A STEP TOWARDS SHARED MORTALITY ATTRIBUTION IN A STATEWIDE SYSTEM

Daniel N. Holena* MD, MSCE, Elinore J. Kaufman MD, MSHP, Justin Hatchmonji MD, Thomas Wasser Ph.D., M K. Delgado MD, MS, Douglas J. Wiebe Ph.D., Brendan G. Carr MD, MSHP, Patrick M. Reilly* MD, University of Pennsylvania

Invited Discussant: Peter Fischer, MD, MSc

Introduction:Many injured patients presenting to level III & IV trauma centers will be transferred to level I & II centers, but the way in which these interhospital transfers influence benchmarking at level III & IV centers has not been described. We hypothesized that the apparent O:E mortality ratio at level III & IV centers is influenced by the time at which mortality is measured in transferred patients
Methods:We conducted retrospective study of all adult patients presenting to Level III & IV trauma centers in a single-state trauma system from 2008-2017, excluding burns. We used probabilistic matching on dates and patient characteristics to generate a linked dataset for patients transferred from Level III & IV centers to Level I & II centers. We summed patient-level predicted mortality from ASCOT models to generate center-level expected mortality, which was then compared to observed mortality at the time of discharge from the level III & IV center (O^1) or observed mortality at the time of discharge from the level III & IV center for non-transferred or the time of discharge from the level I & II center for transferred patients (O^2).
Results:In total, 9,336 presented to 11 Level III & IV trauma centers over the study period (92% white 49% female, 96% blunt mechanism, ISS 8 IQR (6-15). Of these, 4,118 (44%) were transferred to Level I & II centers. Based on ASCOT modeling, expected mortality in the overall cohort was 526 (5.6%). A total of 355 (3.8%) patients died during the study period, of which 176 (49.6%) patients died at the initial level III & IV centers (O^1). For all level III & IV centers, including post-transfer mortality for transferred patients in addition to observed mortality in non-transferred patients (O^2) resulted in worse apparent O:E ratios (Table) and resulted in significant differences in O:E ratios for the overall cohort (O^1:E 0.33, 95% CI 0.28-0.38 vs O^2:E 0.67, 95% CI 0.60-0.74).

Institution	N	Observed Deaths (Level III/IV) (O1)	Observed Deaths (Final Discharge) (O2)	Expected Deaths (Σ (1-ASCOT) (E)	O1/E	O2/E	Δ O/E
1	43	0	1	2.27	0	0.44	0.44
2	360	5	12	21.18	0.24	0.57	0.33
3	723	9	21	38.05	0.24	0.55	0.31
4	222	3	9	11.82	0.25	0.76	0.51
5	413	5	13	18.94	0.26	0.69	0.43
6	151	3	6	11.31	0.27	0.53	0.26
7	976	18	36	65.09	0.28	0.55	0.27
8	658	12	25	42.55	0.28	0.59	0.31
9	5378	110	214	293.83	0.37	0.73	0.36
10	344	8	14	17.1	0.47	0.82	0.35
11	68	3	4	4.41	0.68	0.91	0.23
Total	9336	176	355	526.54	0.33	0.67	0.34

Conclusion: The apparent O:E mortality ratio at level III & IV centers is influenced by the time at which mortality is measured in transferred patients. To provide fair and accurate benchmarking for both level III & IV centers and identify opportunities across the continuum of the trauma system, a system of shared attribution for outcomes of transferred patients should be devised.

Session VII: Papers 15-17
Paper 16: 10:40 AM - 11:00 AM

IS NBATS-2 UP TO THE TASK? ACTUAL VS PREDICTED PATIENT VOLUME SHIFTS WITH THE ADDITION OF ANOTHER TRAUMA CENTER

Jennings H. Dooley BS, Bradley M. Dennis* MD, Louis J. Magnotti* MD, John P. Sharpe MD, Oscar D. Guillamondegui* MD, Martin A. Croce* MD, Peter E. Fischer* MD, Vanderbilt University Medical Center

Invited Discussant: Robert Winchell, MD

Introduction: The American College of Surgeons Committee on Trauma recently modified the Needs-Based Assessment of Trauma Systems tool in an attempt to better quantify the impact of an additional trauma center to a region (NBATS-2). While this tool has been tested theoretically, it has not yet been validated. The purpose of this study was to apply NBATS-2 to a system where an additional trauma center was added to compare predicted versus actual patient volumes.

Methods: All injured patients transported from the scene by ground from 2012-2018 were collected from the trauma registry of the initial (legacy) center. Injury location, injury rate adjusted for population growth, and demographics were analyzed by zip code. Spatial modeling was conducted using ArcGIS 10.6.1 to estimate the closest center. One level 1 trauma center existed in the PRE period (2012-2014) while in the POST period (2016-2018) an additional level 2 center was active. Notably EMS destination guidelines did not change from the PRE to POST period and favored the level 1 center for severely-injured patients (ISS >15). NBATS-2 predicted volume in the POST period was compared to the actual volume received at the level 1 center.

Results: A total of 4,068 injured patients were identified across 14 counties. In the PRE period, 72% of the population and 90% of the injuries were within a 45-minute driving distance of the legacy trauma center (Fig.1). In the POST period 75% of the total population and 90% of the injuries were within 45 minutes of either trauma center (Fig. 2). The POST predicted volume of severely-injured patients of the legacy level 1 center based on closest facility was 434 but the actual number was 809. For minor injuries (ISS ≤ 15) the difference was even more profound at 1,677 actual vs. 581 predicted to the legacy level 1 center.

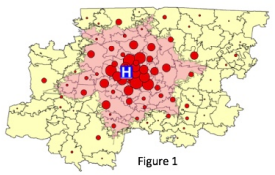


Figure 1

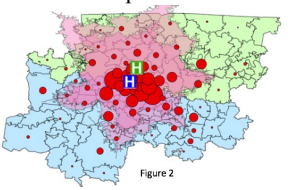
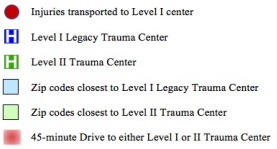


Figure 2



Conclusion: NBATS-2 failed to predict the volume changes of the legacy trauma center after the addition of another center to the region. Without a change in EMS destination guidelines this finding was not surprising for severely-injured patients. However, the 288% increase in volume of minor injuries was unexpected. NBATS-2 must be refined for local factors including EMS relationships and educational campaigns by a legacy center to maintain volume.

Session VII: Papers 15-17
Paper 17: 11:00 AM - 11:20 AM

OUTCOMES IN ISOLATED TBI: THERE'S MORE TO IT THAN 'RIGHT PLACE, FIRST TIME'

Henry O. Nnajiuba MD, MSc BSc, Elaine Cole Ph.D., Karim Brohi* Centre For Trauma Sciences, QMUL

Invited Discussant: Deborah Stein, MD, MPH

Introduction: Traumatic brain injury (TBI) patients benefit from rapid diagnosis, early neurosurgery and neurocritical care. Trauma systems utilise triage tools to facilitate timely access to specialist trauma care for TBI patients. Overtriage of those who could potentially be safely treated in their local hospitals is associated with reduced efficiency, higher costs and poorer patient experience. The overall objective of this study was to determine outcomes of patients with isolated TBI managed within an inclusive trauma system and to determine the independent effect of initial triage decisions on outcome.

Methods: We conducted a three-year retrospective registry study of all adults (>15 years) admitted to hospitals within the London Major Trauma System (LMTS) with an isolated moderate-severe TBI (AIS head ≥ 3, AIS all other body regions <3) from January 1st 2014. The LMTS is an inclusive urban trauma system serving over 10 million people and comprising of four 'Level 1-equivalent' Major Trauma Centres (MTCs) and 35 'Level 2/3-equivalent' Trauma Units (TUs). Patients were divided into those who had required invasive neurocritical intervention and those who were managed conservatively. Within the neurocritical group we compared outcomes for patients directly admitted to MTCs with those transferred in from TUs (NC-DIRECT vs NC-TRANSFER). Within the conservative group we compared outcomes between MTC patients and non-transferred TU patients (CONS-MTC vs CONS-TU). Multivariable regression models analysed independent relationships between patient factors, levels of care and outcomes.

Results: A total of 6200 patients with moderate-severe isolated TBI were treated by the LMTS over the study period with 12% receiving neurocritical care. Overall unadjusted mortality rates were 16% and 10% (p=0.02) for NC-DIRECT and NC-TRANSFER respectively (Fig. 1). After adjusting for injury characteristics, adult (age 16-69) neurocritical patients had equivalent mortality outcomes, whilst elderly (age 70+) NC-DIRECT patients had twice the mortality risk of elderly NC-TRANSFER (OR 2.42, p=0.04) (Fig. 2). Unadjusted mortality rates for CONS-MTC exceeded CONS-TU (13% vs 9%, p<0.01) (Fig. 3) although regression analysis showed no significant difference in mortality risk between triage groups in either age cohort (Fig. 4).

Fig. 1) 30-day mortality (NC group)

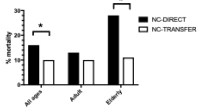


Fig. 2) Independent effect of direct MTC admission on **30-day mortality (NC group)**

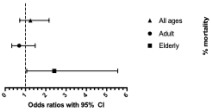


Fig. 3) 30-day mortality (CONS group)

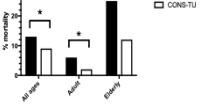
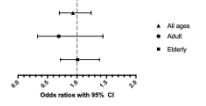


Fig. 4) Independent effect of MTC admission on **30-day mortality (CONS group)**



Conclusion: This study has demonstrated that isolated TBI patients requiring secondary transfer for neurocritical care do not experience an increased mortality risk compared to patients admitted directly to MTCs. This is contingent on the ability of TUs to monitor and rapidly transfer patients requiring escalated levels of care. Patients who only require conservative treatment experience no survival benefit from being triaged to MTCs. Our data suggests that within this isolated TBI population more patients can be safely managed at their local hospitals thus balancing system patient flow and improving patient experience by keeping them closer to their social support networks.

Session IXA: Papers 18-26
Paper 18: 2:00 PM - 2:20 PM

EPIDEMIOLOGICAL TRENDS OF SURGICAL CRITICAL CARE ADMISSIONS IN THE UNITED STATES

Victor R. Vakayil MBBS, MS, Nicholas E. Ingraham MD, Alexandria Coughlan MD, Rebecca Freese MS, Elise Northrop BA, Melissa Brunsvold MD, FACS, Kathryn M. Pendleton MD, Anthony Charles* MD,MPH, FACS, Jeffrey G. Chipman MD, FACS, Christopher J. Tignanelli MD, University of Minnesota Dept of Surgery

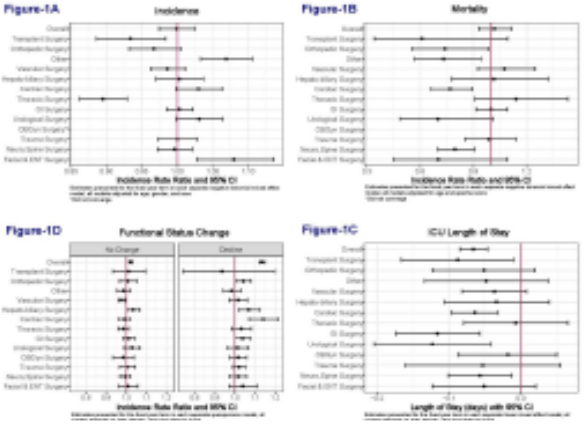
Invited Discussant: Christopher Michetti, MD

Introduction: Epidemiologic assessment of admissions into Surgical Intensive Care Units (SICUs) provides a framework to evaluate healthcare systems efficiency and project future healthcare needs.

Methods We performed a 9-year, US population-based analysis of all adult admissions from 238 SICU's using the prospectively and manually abstracted, Cerner Apache Outcomes database. We stratified patients into 11 epidemiological cohorts and modeled temporal-trends in admission, mortality, ICU length of stay (LOS) and change in functional status (FS) using mixed-effects with hospital-level random intercepts, and quasipoisson models, to obtain risk-adjusted outcomes.

Results: We evaluated 78,054 SICU admissions and observed a significant decrease in transplant and thoracic surgery admissions, with a concomitant increase in ENT and facial reconstructive surgical admissions ($p < 0.05$, Figure-1A) . While overall risk-adjusted mortality following SICU admissions remained stable over the study period (Figure-1B); orthopedic, cardiac, urologic, and neurosurgical mortality declined significantly ($p < 0.05$). Overall ICU-LOS decreased. Cardiac, urologic, gastrointestinal, neurosurgical, and orthopedic admissions noted significant reduction in LOS ($p < 0.05$, Figure-1C). The rate of FS deterioration increased per year, suggesting ICU-related disability increased over the study period (Figure-1D).

Conclusion: Temporal analysis demonstrates a significant change among SICU admissions over the last decade, with decreasing mortality, LOS, and increasing rate of FS deterioration within certain surgical cohorts. Improvement in SICU outcomes may highlight successful quality-improvement initiatives within certain surgical cohorts, while simultaneously identifying cohorts that may benefit from future intervention. Our findings have significant implications in healthcare systems planning including resource and personnel-allocation, education, and surgical training.



Session IXA: Papers 18-26
Paper 19: 2:20 PM - 2:40 PM

RIB FRACTURE TRIAGE PATHWAY DECREASES ICU UTILIZATION, PULMONARY COMPLICATIONS, AND HOSPITAL LENGTH OF STAY

C. Caleb Butts MD, Preston Miller* MD, Andrew Nunn* MD, Adam Nelson MD, Meagan Rosenberg Orhan Yanmis Martin Avery* MD, Wake Forest University School of Medicine

Invited Discussant: Carlos Brown, MD

Introduction:Rib fractures are a major cause of morbidity after blunt trauma. Many patients require ICU care and develop pulmonary complications. Prior studies have identified management strategies that are associated with improved outcome in severely injured rib fracture patients, but a validated triage decision tool to direct which patients warrant ICU admissions is not available. A rib fracture triage and management pathway (TMP) was developed at our institution to standardize care. We hypothesized that this pathway would decrease complications and shorten length of stay (LOS).

Methods:Patient age, number of rib fractures, significant cardiopulmonary co-morbidities, and incentive spirometry volumes were used to determine admission disposition. 648 patients with rib fractures from November 2015 to October 2017 were identified in the trauma registry and patients before (PRE, n=278) and after (POST, n=370) implementation were compared. Patients with severe TBI, that arrived intubated, or that died within 48 hours were excluded.

Results:There was no difference in age, gender, GCS, ISS, predicted incentive spirometry volume or number of rib fractures. POST patients were less frequently admitted to the ICU (64% vs 75%, p=0.003), had fewer pulmonary complications (5.1% vs 10.4%, p=0.01), and had a shorter hospital LOS (6.8 d vs 7.5, p= 0.001) with no difference in mortality (1.6% vs 2.5%, p=0.42) or readmission (0.3% vs. 0.7%, p= 0.4). POST patients were also more likely to be discharged home (81% vs 70%, p=0.0009) with fewer going to skilled nursing facilities (13% vs 21%, p=0.01).

Conclusion:A rib fracture TMP decreases ICU and hospital resource utilization and decreases pulmonary complications without increasing readmissions or mortality. Patients are also more likely to be discharged home which further decreases health care costs.

Session IXA: Papers 18-26
Paper 20: 2:40 PM - 3:00 PM

DOES INTENSIVIST MANAGEMENT OF BRAIN DEAD ORGAN DONORS RESULT IN INCREASED ORGAN YIELD?

Sahaja Atluri MD Student, Jacob Bly MD Student, Maria Iliakova MD, Marissa Mendez MD, Kayla Briggs MD, Melissa Ott RN, Lori Markham RN, Harry Wilkins* MD, Dustin R. Neel MD, Scott S. Johnson MD, Donald G. Vasquez DO, Steven P. Whitt MD, Xi Wang PhD Student, Michael Moncure* MD, Midwest Transplant Network

Invited Discussant: Ali Salim, MD

Introduction: The demand for solid organ transplantation has continued to rise despite stable availability of donated organs. There continues to be an increased number of individuals on the waiting list for various organs. In order to meet the demands, various strategies have been employed by the medical community and organ procurement organizations such as utilizing previously marginal organs and employing critical care management strategies to nurture organs making them viable for procurement. Physicians undergoing intensivist training can offer valuable information on making an organ viable for procurement due to their expertise. The purpose of this study is to determine whether intensivist management of donors increases the number of organs available for transplantation yield from brain dead organ donors.

Methods: Institutional Review Board approval was obtained for this study. De-identified data of consecutive donors from a multi-institutional organ procurement organization (OPO) was reviewed from January 2003 – October 2018. A total of 3,750 donors were analyzed. Organs analyzed include heart, lungs, pancreas, kidneys, En-bloc kidneys, liver, split-livers, and intestine, excluding donation after cardiac death. Our organization engaged intensivist physicians from January 2006 onwards, we compared organs transplanted per donor, total number of organs transplanted, total number of donors, donor age, and transplantation of all organ types before and after intensivist involvement. ANOVA and 2 sample t-test were used for analysis with a p-value of <0.05 deemed statistically significant.

Results: The number of organs transplanted showed statistically significant increase after intensivist involvement for all organs except the intestine and pancreas. The number of donors increased by 73% following intensivist involvement. Donor age was significantly higher post-intensivist involvement (35.83 ± 18.79 vs. 38.89 ± 22.86, p-value=0.0007). The number of organs transplanted per donor increased significantly after intensivist involvement (2.76 ± 1.82 vs 2.94 ± 1.89, p-value=0.038).

Conclusion: Our data suggest an increase in organs transplanted per donor may be associated with the involvement of a critical care specialist. Our study is retrospective in nature and included several evolving management strategies incorporated as guidelines suggested by our intensivists. The significant increase in donor age following intensivist involvement may be evidence that intensivists were able to coordinate with ICU and OPO teams to salvage organs for transplantation that may have been previously discarded. A logical next step may be to perform a randomized prospective multi-institution trial comparing traditional OPO coordinator management to OPO coordinators with intensivist involvement in order to validate this concept.

Session IXA: Papers 18-26
Paper 21: 3:00 PM - 3:20 PM

QUANTIFYING BACTERIAL DNA LEVELS IN ICU PATIENTS SUSPECTED OF BACTERIAL SEPSIS USING WHOLE GENOME SEQUENCING OF PLASMA DNA

Mehreen Kisat MD, MS, Ahuva Odenheimer-Bergman BS, MSc, Havell Markus BS, MPhil, Bellal Joseph* MD, Sridhar N. Srivatsan BS, MS, Tania Contente-Cuomo BS, Zain Khalpey MD,Ph.D., Paul Keim Ph.D., Terence O'Keeffe* MD, MSPH, Reza Askari* MD, Ali Salim* MD, Peter Rhee* MD,MPH, Muhammed Murtaza MD,Ph.D., Brigham and Womens Hospital

Invited Discussant: Jon Simmons, MD

Introduction: Critically ill patients with systemic inflammatory response syndrome (SIRS) are often suspected of bacterial sepsis and treated empirically with broad-spectrum antibiotics. In previous work, we found plasma DNA sequencing can help identify pathogens in patients with positive blood cultures. Here, we hypothesized that quantitative analysis of bacterial DNA (bDNA) levels using whole genome sequencing (WGS) of plasma DNA can enable identification and monitoring in patients with bacterial sepsis across multiple sites of infection.
Methods: We prospectively enrolled 30 consecutive patients suspected of sepsis in the Surgical Trauma ICU. Plasma samples were collected at the time of diagnostic workup for sepsis and at 7 and 14 days during hospital stay. Active bacterial infection was defined based on review of microbiology results and clinical records. We performed WGS of plasma DNA and used bioinformatics classification to calculate the fraction of bDNA reads in each sample. After log transformation, difference in bDNA levels between infection and no infection (unpaired) and longitudinal changes in bDNA levels (paired) were evaluated using t-tests.
Results: We analyzed 72 plasma samples from 30 patients. 27 samples (37.5%) were collected at the time of infection. bDNA levels were 2.0 times higher on average in these samples compared to samples with no infection (Figure 1, p=0.008). Across multiple sources of infection (bronchoalveolar lavage, urine, intraoperative specimens, peritoneal fluid), plasma DNA analysis identified pathogens with high confidence in samples collected at the time of microbial cultures. In 22/30 patients, serial samples were collected during treatment. 17/22 patients had active infection at enrollment and bDNA levels were higher at day 0 compared to the next sample (Figure 2, p<0.001). This trend was not observed in 5/22 patients with no infection at enrollment (Figure 3, p=0.444).
Conclusion: Changes in bacterial DNA levels in plasma can identify and monitor bacterial sepsis across multiple sites of infection. Future work should identify relevant clinical thresholds for bacterial DNA levels in ICU patients with SIRS.

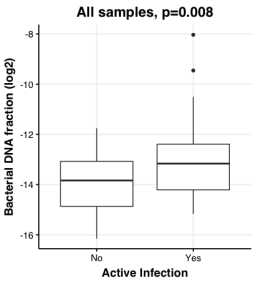


Figure 1

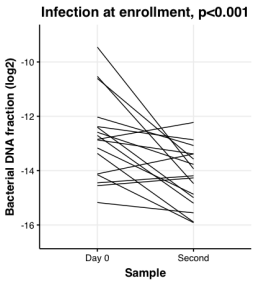


Figure 2

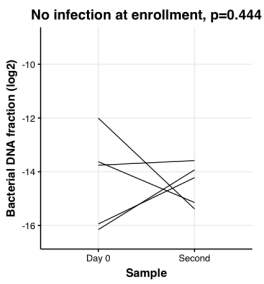


Figure 3

Session IXA: Papers 18-26
Paper 22: 3:20 PM - 3:40 PM

LONG TERM OUTCOMES IN OLDER TRAUMA PATIENTS ADMITTED TO THE ICU: A PROSPECTIVE STUDY

Jessica R. Burgess MD, Katherine Kelley MD, Daisy Proksch BS, Sasha Shaw RN, Jay N. Collins* MD, Eastern Virginia Medical Center

Invited Discussant: Karen Brasel, MD, MPH

Introduction: As age increases, older trauma patients are at increased risk of complications. Prior studies have shown an increase in mortality and length of stay in elderly patients despite similar Injury Severity Scores when compared to their younger cohort. The purpose of this study was to prospectively examine trauma patients over 50 years old that were admitted to the ICU and determine if there were any factors during hospitalization that predicted poor long-term outcomes.

Methods: This was an IRB approved prospective study at a level I trauma center. Trauma patients ≥50 years old were recruited upon admission to the trauma intensive care unit. An initial survey regarding their current health and functional status was performed as well as a prognostic survey completed by the bedside ICU nurse, resident and attending physician. Data regarding initial labs and vitals, procedures, performed, length of stay and discharge disposition were collected during the hospital stay. Patients or their surrogates were interviewed over the phone at 3 and 6 months from discharge to determine their current state of health, functional status and recent admissions to the hospital.

Results:One hundred patients were included in the study over a 6-month time period. The average age was 70.7 years (SD 12.3) and 62% were male. 90% of patients sustained blunt trauma and average ISS was 17.55 (SD 9.2). LOS and ICU LOS were 11.3(SD 12.6) and 6.2 (SD 6.3) days, respectively. There was an 18% inpatient mortality. Of the remaining 82 patients, 39 were discharged home and 43 were discharged to a rehab or skilled nursing facility. At 3 and 6 months, the overall mortality rate was 20% and 24% respectively. At 6 months, 77.8% of surviving patients were living at home or with family members and 42.9% of patients reported requiring more assistance than they did prior to their injury. Only 5 patients remained in a skilled nursing facility at 6 months. When comparing 6-month survivors to nonsurvivors, there was no significant difference in BMI, ICU LOS and total LOS. Nonsurvivors had a significantly higher age (75.4 vs 69.6, p=.028), higher ISS (20.1 vs 16.3, p=.035), higher vent days (4.2 vs 2.1, p=.047), lower admission GCS (11.3 vs 13.3, p<.01) and higher admission lactate (4.5 vs 8.8, p=.013).

Conclusion:Severe trauma in patients ≥50 years of age carries a significant rate of mortality with 24% of patients being deceased at 6 month followup. Nonsurvivors had a higher ISS, age, lower GCS and higher lactate on admission. BMI and length of stay were not associated with increased mortality. Fortunately, nearly half of all patients are able to return to their baseline functional status and are able to live at home either independently or with family within 6 months of discharge.

Session IXA: Papers 18-26
Paper 23: 3:40 PM - 4:00 PM

BETA-BLOCKER THERAPY IN ISOLATED SEVERE TRAUMATIC BRAIN INJURY: A PROSPECTIVE RANDOMIZED CLINICAL TRIAL

Shahin Mohseni MD,Ph.D., Shahram Paydar MD, Amir Niakan MD, Rebecka Ahl MD,Ph.D., Gabriel Sjolin MD, Hossein Abdolrahimzadehfard MD, Zaid Haddadin MD, Bellal Joseph* MD, Hossein Khalili MD, Rajaee Trauma Center, Shiraz Univeristy Hospital

Invited Discussant: Eric Ley, MD

Introduction: Several retrospective and observational prospective studies have detected better outcomes following severe traumatic brain injury (sTBI) in patients exposed to beta-blockers (BB). Prospective randomized trials in such instances are currently lacking. The aim of our study was to evaluate the impact of BB therapy on outcomes in patients with isolated severe TBI.

Methods: We performed a prospective, non-blinded randomized clinical trial, and included all adult (≥18 years) patients with blunt isolated sTBI admitted to our Neuro ICU. We excluded patients who were on preinjury BB therapy or were transferred from a different institution. Patients who were cardiovascularly stable at 24h after admission were randomized to either BB(+) or BB(-). Patients in BB(+) received oral Propanolol 20mg twice daily for 10 days or upto discharge. Outcome measures were in-hospital mortality, functional outcome at discharge and 6 months follow-up measured by the extended Glasgow Coma Scale (E-GOS) score. The association between BB therapy and outcomes of interest was evaluated using Poisson regression model.

Results: A total of 154 patients were included. Forty-four percent of the patients were randomized to BB(+). Overall, mean age was 36 (SD 18) yrs, 86% were male and median GCS was 13 (IQR 7, 15). There was no significant difference between the cohorts regarding the patients' demographics, GCS, Head-AIS, ISS, type of intracranial injury, or requirement of neurosurgical intervention. BB(+) had a lower in-hospital mortality compared to those in the BB(-) group (4.4% vs. 18.6%, p=0.012). On regression analysis, BB(+) was associated with better survival [Adj. RR: 3.1(1.1-8.9), p=0.037]. Further, BB(+) was associated with better functional outcome (E-GOS≥5) at 6 months [Adj. RR: 1.2 (1.02-1.33), p=0.023]. However, there was no statistical difference between the two groups regarding functional outcomes at discharge [Adj. RR: 1.1 (0.94-1.32), p=0.201].

Conclusion: Patients with severe TBI whom received beta-blocker therapy had improved survival and improved long-term functional neurological outcomes. Further studies for establishing specific protocols for BB therapy in the context of sTBI may lead to better outcomes.

Session IXA: Papers 18-26
Paper 24: 4:00 PM - 4:20 PM

DIAPHRAGM PACING IMPROVES RESPIRATORY MECHANICS IN ACUTE CERVICAL SPINAL CORD INJURY

Andrew J. Kerwin* MD, Yohan Diaz Zuniga Brian K. Yorkgitis DO, Jennifer Mull RN, Albert T. Hsu MD, Firas G. Madbak* MD, David J. Ebler* MD, David J. Skarupa* MD, Joseph Shiber MD, Marie L. Crandall* MD, University of Florida, Jacksonville

Invited Discussant: Daniel Grabo, MD

Introduction:Cervical spinal cord injury (CSCI) is devastating with ventilator associated pneumonia being a main driver of morbidity and mortality. Up to 50% of patients with CSCI require mechanical ventilation at hospital discharge. Case reports of diaphragm pacing (DPS) have suggested earlier liberation from mechanical ventilation in acute CSCI patients. We hypothesized DPS implantation would improve respiratory mechanics and facilitate liberation from ventilation.
Methods:We performed a retrospective review of acute CSCI patients managed at a single level 1 trauma center between 1/2005-5/2017. Routine demographics were collected. Patients underwent propensity matching based on age, ISS, ventilator days, hospital length of stay and need for tracheostomy. Patients with complete respiratory mechanics data were analyzed and compared. Those who did not have DPS (NO DPS) had spontaneous Vt recorded at time of ICU admission, at day 7 and day 14 and patients who had laparoscopic DPS implantation (DPS) had spontaneous Vt recorded before and after DPS implantation. Time to ventilator liberation and changes in size of spontaneous tidal volume (Vt) for patients while on the ventilator were analyzed. Bivariate and multivariate logistic and linear regression statistics were performed using STATA v10.
Results:Between 7/2011-5/2017 all acute CSCI patients were evaluated for DPS implantation. 37 patients that had laparoscopic DPS implantation (DPS) were matched to 34 who did not (NO DPS). Following implantation of DPS there was a statistically significant increase in spontaneous Vt compared to NO DPS (+88mL vs. -13 mL; 95% CI 46 – 131 vs. -78 – 51 mL respectively; p=0.004). Median time to liberation after DPS implantation was significantly shorter (10 vs. 29 days; 95% CI 6.5-13.6 vs 23.1-35.3 days; p<0.001). Liberation prior to hospital discharge was not different between the two groups. DPS placement was found to be associated with a statistically significant decrease in days to liberation and an increase in spontaneous Vt in multivariate linear regression models.
Conclusion:DPS implantation in acute CSCI patients produces significant improvements in spontaneous Vt and reduces time to liberation. Comprehensive care of acute CSCI patients should include DPS implantation. Further studies to define the benefits of DPS implantation are needed.

Session IXA: Papers 18-26
Paper 25: 4:20 PM - 4:40 PM

MITIGATING ISCHEMIA REPERFUSION INJURY USING A NEW GENERATION PH

Corina Necsoiu MD, Bryan S. Jordan RN, James Moon MD, Jae Choi Ph.D., Mark Espinoza BS, Andriy Batchinsky MD, Leopoldo Cancio* MD, United States Army Institute for Surgical Research

Invited Discussant: Matthew Martin, MD

Introduction: Non-compressible torso hemorrhage (NCTH) is the leading cause of death on the battlefield. Resuscitative endovascular balloon occlusion of the aorta (REBOA) is a safer alternative treatment to emergency department thoracotomy, which is invasive, with a high risk of death. REBOA, although much less invasive and potentially safer that thoracotomy, is not without risks. These risks include ischemia reperfusion injury below the balloon inflation site that can translate into irreversible damage of the end organs such as intestine or kidney. To mitigate this type of injury, we tested a new generation catheter prototype with a special design that allows partial inflation of the balloon thus permitting some of the blood to flow around the balloon into descending aorta and maintaining a relatively constant range of systolic blood pressure bellow the balloon. In this study, we compared two different systolic blood pressures below the balloon, 45±5 mmHg and 60±5 mmHg respectively and the consequences of this permissive hypotension REBOA (PH-REBOA) on the end organs. We hypothesized that a systolic blood pressure below the balloon of 60 mmHg will be less injurious than 45 mmHg to the end organs.
Methods: Sixteen female swine, weight 45-55 Kg, instrumented and under general anesthesia were bled 50% and then PH-REBOA catheter was placed in zone I for 120 min, followed by transfusion of the shed blood and clinical observation for 24 hours. A third group (n=6) receiving full occlusion for 120 minutes was also included, however all animals in this group died soon after REBOA was deflated.
Results: In group A (PH45) only 1 animal died at the end of transfusion. In group B (PH60) all animals survived 24 hours. Hemodynamically, there were no statistically differences between the groups. In terms of lactate, liver enzymes, cardiac troponin, or myoglobin, there were also no statistically differences at any time. All subjects had significant increase in lactate at the end of 2 hours REBOA time but lactate normalized by 6 hours post-injury. Creatinine increased significantly in group A and remained higher than in group B until the end of the study (see table, $p<0.05$)

	Group	BL	EH	MID REBOA	END REBOA	1 HR	END STUDY
HR	A (n=8)	90±9.3	145±11.9	173±12.1	181±11.4	140±8.7	102±7.1
	B (n=8)	86±4.6	166±10.8	184±16.7	184±18.4	133±9.8	103±7.7
MAP	A	100±4.7	33±3.7	92±8.8	94±10.2	122±5.8	86±6.5
	B	101±5.5	49±4.8	100±8.0	106±7.0	117±3.6	89±9.3
Lactate	A	1.4±0.3	4.1±0.7	9.0±1.1	10.0±1.5	8.5±1.8	1.1±0.3
	B	1.4±0.3	2.3±0.7	6.5±1.2	8.0±1.4	6.0±1.3	0.5±0.1
Creatinine	A	1.5±0.1	1.0±0.1*	2.3±0.1*	2.5±0.1*	2.2±0.1*	2.1±0.3*
	B	1.3±0.1	1.2±0.0	1.7±0.1	1.8±0.1	1.7±0.1	1.4±0.1

Conclusion: Permissive hypotension is a valuable method of extending duration of the REBOA. Although both types of permissive hypotension have similar effects on the end organ, PH45 seems to have more injurious and longer lasting effects on the kidney. More studies are needed to optimize this approach.

Session IXA: Papers 18-26
Paper 26: 4:40 PM - 5:00 PM

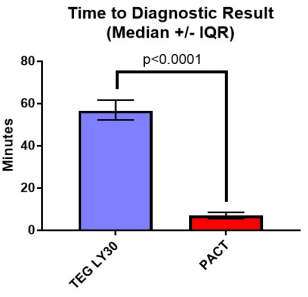
Plasmin-Modified Thromboelastography Rapidly Identifies Patients at Risk of Hyperfibrinolysis, Mortality, and Need for TXA: A Diagnostic Tool to Resolve an International Debate?

Christopher D. Barrett MD, Ernest E. Moore* MD, Hunter B. Moore MD,Ph.D., Sanjeev Dhara BS, James Chandler BA, Michael P. Chapman MD, Angela Sauaia* MD,Ph.D., Michael B. Yaffe MD,Ph.D., Massachusetts Institute Of Technology

Invited Discussant: Bryan Cotton, MD

Introduction: Trauma patients with hyperfibrinolysis measured by thrombelastography (TEG) gain clot strength with TXA, but TXA may harm those without hyperfibrinolysis. TEG fibrinolysis measurements (LY30) can take an hour to obtain results, wasting precious time. Therefore, we set out to develop an assay that could identify hyperfibrinolysis expeditiously to guide TXA administration. The fibrinolytic protease plasmin causes a shortening of clotting time with minimal effects on fibrinolysis in healthy volunteers, unless plasmin inhibitors are depleted. Thus, we hypothesized that trauma patients with clotting time prolongation in the presence of exogenous plasmin (compared to native TEG) are hyperfibrinolytic, have a high rate of massive transfusion (MT) and mortality, and provides an expedited time to diagnosis of hyperfibrinolysis.
Methods: Trauma patients (n=55) at a level 1 trauma center were assessed using TEG assays without exogenous additives (rapid and native), with exogenous plasmin, or with tissue plasminogen activator (t-PA). Rapid TEG was used as the standard to stratify patients into fibrinolytic phenotypes and t-PA sensitivity based off previously published thresholds. Plasmin was used in doses that had no effect on LY30 of healthy volunteer controls but caused shortened R-time (not lengthened) relative to native TEG. In trauma patients, if plasmin TEG R-time was longer than native TEG R-time the patient was considered to have a Plasmin-Associated Increased Clotting Time (PACT). A chi square test was used to determine if PACT was associated with t-PA sensitive hyperfibrinolysis, MT, and mortality.

Results: t-PA sensitive hyperfibrinolytic patients had a median time to TEG results (LY30) of 58 minutes, represented 16% of patients, and compared to the rest of the patients had a high MT rate (78% vs 15%, p<0.001) and mortality rate (78% vs 15%, p<0.001). PACT was also present in 16% of patients and demonstrated virtually identical results for MT and mortality rates as TEG LY30, but had a dramatically faster median time to diagnosis of 6.7 minutes (8.6x faster). PACT and TEG LY30 had diagnostic agreement 67% of the time and predicted MT in 100% of these patients (6/6).



Conclusion: PACT acts as a rapid test result that predicts a high rate of MT and mortality in trauma patients in a median time of 6.7 minutes. PACT has a high probability of identifying trauma patients who are t-PA sensitive, hyperfibrinolytic, and most likely to benefit from TXA in a clinically expeditious time frame.

Session IXB: Papers 27-35
Paper 28: 2:20 PM - 2:40 PM

Does Simulation Work? Monthly Trauma Simulation and Procedural Training is Associated with Decreased Time to Intervention.

Caroline Park MD,MPH, Jennifer Grant MD, Ryan P. Dumas MD, Kareem Abdelfattah MD, FACS, Thomas Shoultz MD, Linda A. Dultz MD,MPH, FACS, Stephen Luk* MBA,MD, FACS, FCCP, Daniel J. Scott MD, Michael Cripps* MD, MSCS, FACS
University of Texas Southwestern Medical Center at Dallas

Invited Discussant: Mark Bowyer, MD

Introduction:
Establishing proficiency in trauma procedures during surgical residency has been limited to annual courses with little data on its effect on the delivery of healthcare and patient outcomes. There is a wide variety of training on content, complexity and frequency with recent studies looking at time to imaging or secondary survey. Given the limitations of an 80-hour work week, patient care and educational priorities, there has been more emphasis on high-yield, reproducible and frequent training for our surgical residents. In this study, we implement monthly case-based simulation after initial training on a variety of bedside trauma procedures. The overall goal is to evaluate the effect of simulation on time to specific procedures and to definitive surgical intervention.

Methods:
This is a prospective, observational study at a single-institution, level I trauma center with a large surgical residency program between November 2018 and February 2019. A trauma simulation program was implemented in November 2018 to train and evaluate surgical residents from PGY 1 through 5. All rotating residents participated in an initial course led by ATLS-certified instructors on basic trauma procedures such as cordis placement, endotracheal intubation, tube thoracostomy, and resuscitative thoracotomy followed by an end-of-month simulation. All level I (highest level) activations from pre-intervention starting in July 2018 through February 2019 were followed; monitored patient variables included mechanism of injury, blunt or penetrating, gender, and time to intervention in the trauma bay. Pearson's coefficient was used to measure the strength of the relationship between simulation to time to patient intervention.

Results:
Average time to most interventions improved over time but with more consistent improvement after the implementation of formal simulation and procedural training in November 2018. This was most significant in resuscitative thoracotomy and time to CT scan (Table 1).

Conclusion:
High-complexity, routine procedural training and trauma simulation are associated with decreased time to interventions within a short period of time. Routine implementation of a training program emphasizing efficient, effective approaches to bedside procedures is necessary to train our residents in these high-acuity, low frequency situations. Future investigations are warranted in the effect of simulation on short-term and long-term patient outcomes.

Intervention	Average Time to Intervention (pre-simulation)	Average time to Intervention (post-simulation)	r^2
Resuscitative Thoracotomy	13	3.8	0.35
Tube Thoracostomy	12	9.3	0.1
Cordis	13	13	0.02
CT scan	48	39	0.36
OR	23	46	0.21

Table 1. Average time to intervention pre and post-simulation and procedural training (in minutes).

Session IXB: Papers 27-35
Paper 29: 2:40 PM - 3:00 PM

USING ARTIFICIAL INTELLIGENCE TO IMPROVE RELIABILITY OF THE FOCUSED ASSESSMENT WITH SONOGRAPHY FOR TRAUMA (FAST): A PILOT STUDY OF FAST-AI.

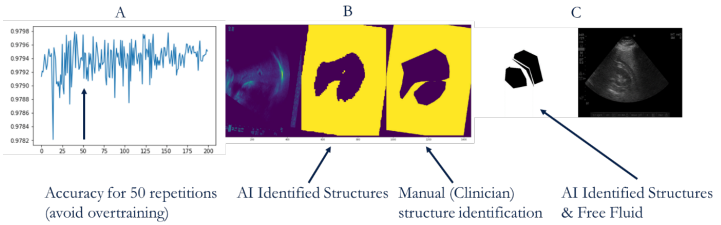
Rachael A. Callcut* MD, MSPH, AnaMaria J. Robles MD, Aaron Kornblith MD, Lucy Z. Kornblith MD, Matt O'Brien MS University of California, San Francisco

Invited Discussant: Matthew Bloom, MD

Introduction: Artificial Intelligence (AI) or deep learning is a powerful tool that can provide approximations of human-domain cognitive processes. The FAST can improve clinically relevant outcomes, but is dependent on the expertise of the examiner and has been limited by inter- and intra-operator variability. We hypothesized that AI could be utilized to enhance imaging recognition and reliability of point of care FAST ultrasound through four algorithmic AI methods: classification, detection, localization, and segmentation.

Methods: 249 highest level trauma activation patients with complete archived FAST video stream images were identified. Two study clinicians with FAST expertise and blinded to the clinical outcomes interpreted the archived FASTs. Views were classified as positive or negative for free fluid and pixel level annotation was also performed by the clinicians to delineate structures of interest (bladder, kidney, liver, spleen, free fluid). Data was split into 80% training and 20% testing. A Residual Neural Network (ResNet) was performed to assess *Classification* (binary outcome of positive or negative hemoperitoneum) and *Detection* (identification of specific anatomic structures). A RetinaNet was utilized to assess *Location* and a VNET algorithm used to assess *Segmentation* (pixel level identification of structures).

Results: The ResNet neural network (n=60 patients, 141 images) *Classification* results were promising with 89.2% accuracy after 125 epochs (repetitions) for determination of the presence or absence of free fluid in the abdomen. In contrast, *Detection* of anatomic structures using ResNet was variable in performance with the best detention of the suprapubic quadrant, but worse performance for the detection of free fluid (40% accuracy). *Localization* performed similarly. Most promisingly, *Segmentation* (n=249 patients, 576 images) was able to identify free fluid and anatomic structures with a DICE evaluation metric (reproducibility validation metric) of 0.98 or 98% accuracy (Figure A – accuracy after 50 epochs; B – identification of structures, C- identification of free fluid).



Conclusions: In this pilot study, deep learning approaches of classification and segmentation demonstrated promise for improving the reliability of the FAST exam at the point of care. Integration into the ultrasound device could extend the utility of FAST to austere environments and for those with less experience to improve the early detection of abdominal bleeding following trauma.

Session IXB: Papers 27-35
Paper 30: 3:00 PM - 3:20 PM

TURNING VALUE INTO ACTION: THE IMPORTANCE OF PUBLIC NARRATIVE AMONG HEALTHCARE PROVIDERS USING DIVERSE MEDIA TO ENACT CHANGE

Marissa A. Boeck MD,MPH, Catherine J. Juillard* MD,MPH, FACS, Rochelle A. Dicker* MD, FACS, Bellal A. Joseph* MD, FACS, Joseph V. Sakran MD,MPH, MPA, FACS Johns Hopkins School of Medicine

Invited Discussant: Nicole Stassen, MD

Introduction: On November 7th, 2018 the National Rifle Association tweeted about an American College of Physicians position paper on firearm injuries and deaths, "Someone should tell self-important anti-gun doctors to stay in their lane." This tweet sparked a global response from healthcare professionals that ranged from everyday stories to graphic photos about caring for firearm-injured patients. The Twitter handle @ThisIsOurLane and hashtags #ThisIsOurLane and #ThisIsMyLane further unified the medical community. This study aimed to evaluate a public narrative advocacy movement though social media, scientific literature, and mass media to assess differences in message volume and time course to enact real-world change.

Methods: Sources were assessed from November 2018 to February 2019 using #ThisIsOurLane and #ThisIsMyLane hashtags and phrases. Social media data were analyzed via Symplur Signals. Scientific literature was reviewed using PubMed, EMBASE, Web of Science, and Google Scholar. Mass media were compiled using Access World News, Newsbank, and Google.

Results: A total of 508,959 tweets were shared using #ThisIsOurLane, #ThisIsMyLane, or both, with a co-occurrence frequency of 21% to 39%. Most participants were from the United States (42-44%) and tweeting in English (95-99%). The most tweets were sent on November 10 (n=34,797 & n=115,432 for #ThisIsOurLane and #ThisIsMyLane, respectively). The Twitter handle @ThisIsOurLane was created on November 10, and rapidly grew to its current 29,017 followers. There were nine scientific articles published between December 7 and February 22. There were n=245 mass media publications from November 9 until February 28: a mix of articles, blogs, TV interviews, petitions, press releases, and podcasts. November 20 had n=23 publications, the most in one day.

Table 1. Hashtag Statistics

Statistic	#ThisIsOurLane (N=181,887) N(%)	#ThisIsMyLane (N=327,072) N(%)
Retweets	166,469 (91)	316,950 (97)
Tweets with media	78,971 (43)	137,196 (42)
Impressions*	577,101,699	704,484,080
Users	90,045	158,961
Users with 1 tweet	63,991 (71)	107,617 (68)
Countries	193	208
U.S. states	50 + Washington DC	
Tweet languages	24	

*Impressions: # of tweets per participant multiplied by # of followers

Conclusions: The rapid, widespread hashtag coverage via different media, participation by healthcare societies and injury prevention groups, and a climate conducive to change were likely important factors leading to House Bill HR8 Bipartisan Background Checks. Social media enables us to quickly move a controversial, multifaceted conversation like firearms from value to action by converting raw data into real people, transcending language and culture. Firearm-related injury and death is a complex issue that requires diverse stakeholder engagement and a multidisciplinary approach, including harnessing the public narrative to shape and deliver the message. Healthcare providers are uniquely suited to do this through sharing the hidden but vivid reality of caring for firearm-injured patients. This intensive approach to policy development and implementation is just as critical as the policy itself, in order to ensure success.

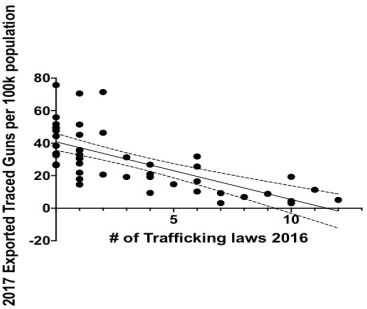
Session IXB: Papers 27-35
Paper 31: 3:20 PM - 3:40 PM

EXPORTED CRIME GUNS, TRAFFICKING, AND STATE ANTI-TRAFFICKING LAWS

Erin G. Andrade MD,MPH, Jennifer M. Leonard MD,Ph.D., Elinore J. Kaufman MD, MSHP, Mark Seamon* MD, Laurie J. Punch MD, Mark Hoofnagle MD,Ph.D., Washington University in St. Louis

Invited Discussant: Deborah Kuhls, MD

Introduction: In states with restrictive gun laws over half of guns used in crimes are trafficked from out of state. We sought to understand the policies, which most influence crime gun trafficking within the continental US. We hypothesized that state laws related to trafficking would significantly impact the number of crime guns traced to a state.
Methods: Gun trace data from 2014-2017 was accessed from the ATF and total crime guns exported to other states for each state were normalized to population using estimates from CDC WISQARS. Firearm laws by state from 2013-2016, 2011-2014, and 2005-2008 were abstracted from the State Firearms Laws Database. The number of anti-trafficking laws were compared to crime gun traces from out of state and normalized to the originating states population. The following law types were included in the model: dealer licensing, record keeping requirements, reporting of sales records to the state, bans on “Saturday Night Specials”, higher than federal minimum age requirement, universal background check, stronger state background check regulation, waiting period for purchase, restrictions on multiple purchases, and state anti-trafficking/straw purchase laws. Linear regression of these variables and figures were plotted using Prism 8.
Results: From 2014-2017 the top five states for total gun exports were Georgia, Texas, Florida, Virginia and Arizona, but states exporting the most crime guns relative to their population were Mississippi, West Virginia, Nevada, Wyoming and South Carolina. Overall increased firearm trafficking laws correlate with decreased gun exports (slope 0.55, R^2 0.47, $p<0.0001$) (2017 data-figure 1). Of the examined types of anti-trafficking laws, the following significantly decreased gun exports at one year: enhanced state recordkeeping requirements(β=-6.902, p=0.0096), permits/de facto gun registration (β=-9.076, p=0.0448), higher age restriction (β=-8.533, p<0.0001), waiting period for purchase (β=-9.263, p=0.0191), and specific anti-trafficking laws (β=-4.727, 0.0244). To account for "time to crime”, which averages nine years, and half of trafficked guns being traced before three years in high trafficking states, we ran the analysis with a three and nine year lag. Only higher age restriction and waiting period for purchase maintain significance throughout the one, three, and nine year models. Overall this model explained 51.88%, 50.85%, 58.03% of the variance in gun exports by state at one, three and nine years respectively.



Conclusion: Increased number of state anti-trafficking laws correlates with decreased gun exports. However, substantial variability in the model remains unexplained by legislative differences alone. Future modeling efforts will incorporate relative distance between states with and without anti-trafficking laws to determine the relationship between proximity, policy, and crime gun exports.

Session IXB: Papers 27-35
Paper 32: 3:40 PM - 4:00 PM

WHERE IS THE EVIDENCE? THE IMPACT OF STATE LAWS ON MOTOR VEHICLE FATALITY RATES, 1999-2015

David M. Notrica* MD, Lois W. Sayrs Ph.D., Nidhi Krishna MSc, Dorothy H. Rowe MD, Dawn E. Jaroszewski MD, Lisa E. McMahon MD, Phoenix Childrens Hospital

Invited Discussant: Heena Santry, MD

Introduction: MVC fatalities have been declining while states passed various legislation targeting driver behavior. This study assesses the impact of state laws on MVC fatality rates to determine which laws were effective.

Methods: Prospective data on MVC fatalities age ≥16 from FARS, state laws, crash characteristics, and verified trauma centers for 50 US states, 1999-2015(n=850) was collected. Generalize Linear Autoregressive Modelling was used to assess the relative contribution of state laws to the crude MVC fatality rate while controlling for other factors.

Results: State laws that lowered minimum allowable blood alcohol (B=-1.7[p<0.001]) were associated with steep declines in MVC death for drivers age 21-55, and effects increased with age. DUI laws enhancing penalties, making revocation automatic, or targeting social hosts had mixed effects by age; increased enforcement, mandatory education, vehicle impoundment and interlock devices had no association with declining mortality. Red light camera laws (B=-0.28[p<0.001]) and seat belt laws (B=-0.24[p<0.05]) were associated with declines in mortality, but speed camera laws had no effect. Graduated Driver License laws were associated with declines for drivers <21 (B=-0.06[p<0.001]); underage alcohol laws showed no association. Laws targeting specific risks (elderly, motorcycles, marijuana) or were enacted recently (cell phones) also showed no effect on declining MVC mortality during the study period.

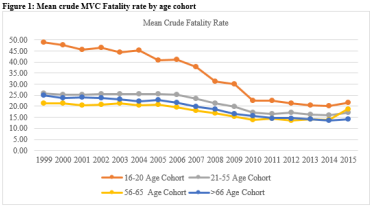
Table 1: Generalized Linear Autoregressive Model estimates for state laws associated with time trends in crude fatality rates by age cohort, 1999-2015.

Law	Age Group Cohorts N=850 Unstandardized Regression Coefficient (p-value)			
	16-20	21-55	56-65	Over 65
GDL	0.06(0.001)**	-0.05(0.25)	-0.03(0.75)	-0.001(0.45)
DUI laws				
Reduced BAC	0.23(0.001)**	1.7(0.001)**	3.2(0.001)**	4.1(0.001)**
Per se BAC	-0.04(0.64)	-0.13(0.001)**	-0.11(0.34)	-0.17(0.05)*
Enhanced DUI Penalties	-0.02(0.52)	-0.002(0.35)	-0.001(0.98)	-0.08(0.89)
Automatic Revocation	-0.009(0.75)	-0.07(0.005)*	-0.09(0.01)*	-0.05(0.05)*
Social Host	-0.21(0.005)*	-0.10(0.001)**	-0.02(0.89)	-0.13(0.07)
Seat Belt	-0.16 (0.04)*	-0.24 (0.05)*	-0.11(0.001)**	-0.02(0.56)
Red Light Camera	-0.13 (0.05)*	-0.07(0.02)*	-0.28(0.001)**	-0.05(0.37)

*Statistically significant at P<0.05; ** Statistically significant at p<0.001

Conclusion: A few key laws, specifically laws lowering allowable BAC, implementing red light cameras, and mandating seatbelt use significantly reduced the MVC mortality rate from 1999-2015. Simply adding more laws or penalties may not equate directly to lives saved. Continued research on state laws will better inform policy makers to meet evolving public health needs in the management of MVC fatalities.

Figure 1: Mean crude MVC Fatality rate by age cohort



Session IXB: Papers 27-35
Paper 33: 4:00 PM - 4:20 PM

ELECTRIC SCOOTERS: IMPACT ON A COMMUNITY

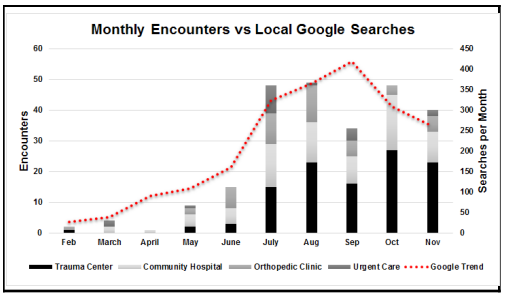
Matthew B. Bloom* MD, Ali Noorzad MD, Carol Lin MD, Milton Little MD, Ernest Lee BS, Sam Torbati MD, Cedars-Sinai Medical Center

Invited Discussant: Nancy Parks, MD

Introduction: Readily accessible electric scooters have demonstrated marked growth and popularity throughout the United States and internationally. This study investigates the impact of electric scooter related injuries within a hospital network.

Methods: The Deep6 artificial intelligence cohort builder was used to retrospectively identify patients involved in electric scooter accidents presenting to an urban hospital network comprised of a Level-1 trauma center, community hospital, stand-alone orthopedic clinic, and a network of urgent care and outpatient clinics, between February 2018 and December 1, 2018. Data included demographic information, mechanism and location of injury, use of protective devices, injury patterns, treatment course, and utilization information. Google Trends data of keyword searches originating from within the local community was used as a surrogate for scooter popularity and cross-referenced against presentation trends. Cost data related to hospital encounters was analyzed.

Results: Data on 248 patients were reviewed. Mean age was 35.8 years, 15(6.0%) were under 16 years old. 109(44.0%) initially presented to the Level 1 trauma center, 76(30.6%) at the affiliated community hospital, 47(19.0%) at the outpatient orthopedic clinic, and 17(6.9%) at urgent care. Only 15(6.0%) were trauma activations, 14(5.6%) others were trauma consults. Overall 37(14.9%) of incidents required a hospital admission, and 5(2.0%) required an ICU admission. Loss of balance was implicated in 121(49%), scooter vs auto 34(13.7%), uneven pavement 25(10%), scooter vs object 6(2.4%), equipment malfunction 7(2.8%), and pedestrian hit by scooter 3(1.2%). Scooter pollution (tripping over a scooter in the street) 14(5.6%) affected the elderly disproportionately, median[IQR] age 67[55-83], $p<0.001$. Eight (3.4%) riders were using helmets, none used wrist guards or other protective gear. 103(41.5%) required a procedure: 33(13.3%) required an operation, 32(12.9%) required orthopedic reductions in the ED, and 40(16.1%) required ED suturing. Injuries to the head and neck were seen in 92 (37.0%) patients, including TBI in 5(2%) and concussion in 19 (7.7%). None of these closed head injury pts. were wearing a helmet. Upper extremity fractures 19 (7.6%), lower extremity fractures 38 (15.3%), pelvic fractures 2(0.8%), spine fractures 3(1.2%). One pt. had grade III liver injury, and another had grade III spleen with multiple left rib fractures and pneumothorax. 6(2.4%) were admitted to the ICU. Complications included 2 pts. with compartment syndromes of extremities. There were no deaths. Facilities costs were greater for patients under the influence of alcohol ($9183 vs $4646, $p=0.047$) and marijuana ($25914 vs $4794, $p=0.002$).



Conclusion: Our study highlights a wide spectrum of electric-scooter related injuries that should be recognized not only by healthcare practitioners, but by policymakers and local government as well. Future studies, city planners, and legislators should focus on maximizing the safety of both riders and pedestrians.

Session IXB: Papers 27-35
Paper 34: 4:20 PM - 4:40 PM

DO ADOLESCENT PATIENTS WITH PENETRATING TRAUMA HAVE BETTER OUTCOMES AT PEDIATRIC TRAUMA CENTERS VERSUS ADULT TRAUMA CENTERS?

Frederick B. Rogers* MD, MS, FACS, Tawnya M. Vernon BA, Barbara A. Gaines* MD, Scott B. Armen* MD, Brian W. Gross BS, Eric H. Bradburn MD, Penn Medicine Lancaster General Health

Invited Discussant: Kathryn Bass, MD

Introduction: There is little debate that in their totality, pediatric trauma centers (PTC) are uniquely beneficial to the pediatric trauma patient. We sought to determine if this axiom held true, specifically in adolescent patients who were the victims of penetrating trauma. Due to the increased volume of penetrating trauma treated at adult trauma centers (ATC), we hypothesized that ATC would have improved outcome in penetrating trauma for this subset of patients.

Methods: Adolescent patients (age 15-18 years) presenting to Pennsylvania accredited trauma centers between 2003-2017 with a penetrating injury were included. Those who were transferred or dead on arrival were excluded. Patient length of stay, number complications, outcomes and surgical intervention were compared to assess differences between ATC and PTC. Multivariate logistic regression models assessed the adjusted impact of PTC compared to ATC on patient care and outcomes.

Results: A total of 2,594 patients met inclusion criteria. Patients treated at PTC comprised 15% of the study population (n=393). Adolescent presenting with penetrating injury had decreased odds (AOR: 0.538; p=0.05) of surgical intervention at PTC, when compared to those treated at ATC. In adjusted analysis, treatment at a PTC resulted in decreased odds of mortality (AOR: 0.48; p=0.01). Patients had slightly lower odds of complication following care at PTC (AOR: 0.94; p=0.273) and slightly greater odds of an increased length of stay (AOR: 1.48; p=0.538) (Table 1).

Conclusion: Adolescent penetrating trauma patients treated at PTC have overall improved mortality compared to ATC, in conjunction with the fact that significantly more patients are treated non-operatively at PTC. PTC have historically been in the vanguard of non-operative management of solid organ injury—it now appears to be extending to the penetrating trauma domain.

Table 1. Risk-adjusted odds (AOR) of outcomes.

	Mortality		Complications		LOS		Surgery	
Variable	AOR (95% CI)	P	AOR (95% CI)	P	AOR (95% CI)	P	AOR (95% CI)	P
PTC	0.48 [0.27-0.83]	0.010	0.94 [0.85-1.05]	0.273	1.48 [0.43-5.13]	0.538	0.71 [0.55-1.00]	0.05
ISS	1.03 [1.01-1.04]	<0.001	1.00 [1.01-1.01]	<0.001	1.12 [1.09-1.16]	<0.001	1.04 [1.03-1.05]	<0.001
TMPM	239 [117-488]	<0.001	0.98 [0.84-1.15]	0.833	0.01 [0.00-0.04]	<0.001	0.26 [0.17-0.45]	<0.001
Age	1.11 [0.95-1.30]	0.185	1.01 [0.98-1.04]	0.449	1.53 [0.86-2.71]	0.014	1.04 [0.96-1.13]	0.336
	AUROC: 0.911		AUROC: 0.729		AUROC: 0.816		AUROC: 0.671	

PTC= Pediatric Trauma Center; ISS= Injury Severity Score; TMPM= Trauma Mortality Predictor Model; LOS=Length of Stay

Session IXB: Papers 27-35
Paper 35: 4:40 PM - 5:00 PM

OPTIMIZATION BRAIN METABOLISM USING METABOLIC-TARGETED HYPOTHERMIA THERAPY CAN REDUCE MORTALITY OF TRAUMATIC BRAIN INJURY

James M. Prieto MD, Jan-Michael Van Gent DO, Richard Y. Calvo Ph.D., Michael J. Sise* MD, C. Beth Sise MSN, Vishal Bansal MD, Romeo C. Ignacio MD, Scripps Mercy Hospital Trauma Service

Invited Discussant: Ben Zarzaur, Jr, MD, MPH

Introduction Few studies have evaluated characteristics of pediatric patients with extremity vascular trauma. We investigated the epidemiology and management of extremity vascular trauma in pediatric patients and evaluated differences by trauma center status.

Methods: Using the American College of Surgeons (ACS) National Trauma Databank, we identified patients ≤16 years of age with extremity vascular trauma admitted in 2016. Hospitals were categorized as ACS-verified pediatric trauma centers (level I or II),

ACS-verified adult trauma centers (level I or II), or other hospitals (all other trauma centers and non-designated hospitals). Patient data were evaluated by hospital category.

Results: Among 164,882 pediatric admissions, 702 patients were identified for the study. There were 430 (61.3%) patients with lower extremity injuries, 270 (38.5%) with upper extremity injuries, and 2 (0.2%) had both. Mean age was 11.5 years and 51.6% were blunt injured. Overall, 40.2% were admitted to pediatric trauma centers, 28.9% to adult trauma centers, and 30.9% to other hospitals. Hospitals without ACS trauma center verification had a higher amputation rate than any ACS-verified adult or pediatric center (p=0.013). Patients at pediatric trauma centers had the highest rate of discharge home (p<0.001).

Conclusion: The incidence of pediatric extremity vascular injury is low. Centers with ACS verification have greater pediatric limb salvage rates than those without verification. Future study should seek to identify specific regional or resource-related factors attributable to this disparity.

	Pediatric Center		Adult Center			
	Level I (n=207)	Level II (n=75)	Level I (n=114)	Level II (n=89)	Other (n=217)	p-value
Primary mechanism, %						
Blunt	50.2	65.3	43.9	60.9	48.4	0.193
Penetrating	46.4	33.3	53.5	37.9	47.9	
Other	3.4	1.3	2.6	1.2	3.7	
Injury severity score, mean	8.1 (6.1)	9.3 (8.4)	9.4 (8.0)	8.9 (7.1)	9.2 (8.9)	0.727
Surgical technique, %						
Open	49.3	50.7	47.4	44.9	48.8	0.859
Endovascular	3.4	1.3	1.8	2.3	2.8	
Both	5.3	4.0	8.8	5.6	3.2	
Neither	42.0	44.0	42.1	47.2	45.2	
Received as transfer, %	54.1	38.7	42.1	25.8	32.7	< 0.001
Amputation, %	2.9	0.0	0.9	0.0	5.5	0.013
Mortality, %	0.0	0.0	1.8	2.3	0.9	0.234
Discharge home, %	84.1	84.0	80.4	75.9	70.7	< 0.001

Session XI: Papers 36-44
Paper 36: 8:00 AM - 8:20 AM

BARRIERS TO IMPROVING HEALTHCARE VALUE IN EMERGENCY GENERAL SURGERY: A NATIONWIDE ANALYSIS

Kamil Hanna MD, Zaid Haddadin MD, Joseph Sakran* MD,MPH, MPA, Muhammad Zeeshan MD, Lynn Gries MD, Narong Kulvatunyou* MD, Andrew Tang MD, Ashley Northcutt MD, Bellal Joseph* MD, University of Arizona – Tucson

Invited Discussant: Daniel Eiferman, MD

Introduction: There is a growing need to improve the quality of care while decreasing healthcare costs in Emergency General Surgery (EGS). Healthcare value includes costs and quality and is a targeted metric by improvement programs. The aim of our study was to evaluate the trend of healthcare value in EGS over time and to identify barriers to high value surgical care.

Methods: The (2011-2014) National Readmission Database was queried for patients ≥18y who underwent an EGS procedure (according to the AAST definition). Healthcare value (V=quality metrics/cost) was calculated from the rates of freedom from readmission, major complications, reoperation, and FTR indexed over health-care-costs. Outcome measures- were the trends in the quality metrics: 6-months readmission, major complications, reoperation, failure-to-rescue (FTR), healthcare costs, and healthcare value over the study period. Multivariable linear regression was performed to determine the predictors of lower healthcare value.

Results: We identified 863,350 patients who underwent EGS. Mean age was 51±20y and 48% were male. The rates of 6-month readmission, major complications, reoperation, and FTR increased significantly over the study period ($p<0.05$). Figure 1. The median healthcare costs/admission also increased over the study period (2011: $32,000 to 2014: $39,000; $p<0.01$). However, the healthcare value has decreased over the study period (2011: 1.25, 2012: 1.02, 2013: 0.88, 2014: 0.84; $p<0.01$). Predictors of decreased health care value in EGS are illustrated in Table 1.

Conclusion: Health care value in EGS appears to be declining over time. Some of the factors leading to decreased healthcare value in EGS are potentially modifiable. Transforming the quality of surgical care requires reducing fragmentation of care, promoting regionalization, and prioritizing value improvement.



Table 1. Predictors associated with decreased Health Care Value in EGS

Predictor	β	[95% CI]	P-Value
Age ≥65	-0.005	[-0.02-(-0.006)]	<0.01
>3 comorbidities	-0.004	[-0.04-(-0.003)]	<0.01
Readmission to a different hospital	-0.007	[-0.006-(-0.008)]	<0.01
Admission to lower volume centers	-0.003	[-0.003-(-0.002)]	<0.01
Admission on a weekend	-0.004	[-0.005-(-0.003)]	<0.01
Lack of rehabilitation	-0.004	[-0.001-(-0.008)]	<0.01
Private insurance	-0.002	[-0.004-(-0.001)]	<0.01

Session XI: Papers 36-44
Paper 37: 8:20 AM - 8:40 AM

BENCHMARKING THE VALUE OF CARE: VARIABILITY IN HOSPITAL COSTS FOR COMMON OPERATIONS AND ITS ASSOCIATION WITH PROCEDURE VOLUME

Cheryl K. Zogg MSPH, MHS, Andrew C. Bernard* MD, Joseph P. Minei* MBA,MD, Kristan L. Staudenmayer* MD, Kimberly A. Davis* MBA,MD, Yale School of Medicine

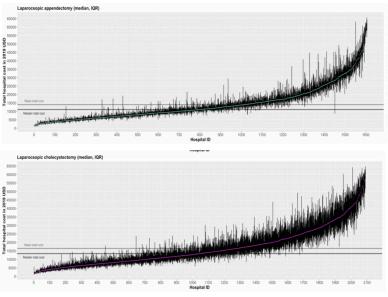
Invited Discussant: Jason Smith, MD

Introduction: Efforts to improve the value of care, defined as changes in quality/cost, have become a priority of health policy and quality improvement initiatives in the US. While many programs, such as the Center for Medicare & Medicaid Services' Hospital Readmissions Reduction Program and American College of Surgeons' Trauma Quality Improvement Program, have sought to increase quality by reducing variability in adverse outcomes, considerably less is known about variability in hospital costs. In conjunction with the mission of the AAST Healthcare Economics Committee, the objective of this study was to examine the extent of variability in total index hospital costs for two common acute care surgery procedures: laparoscopic appendectomy and laparoscopic cholecystectomy. We hypothesized that significant variability in costs exists and that hospitals with higher volumes of each procedure would perform more efficiently and, thereby, at lower cost.

Methods: Nationally-weighted data for adults aged ≥18 years was obtained for patients with primary procedure codes corresponding to each operation in the 2014 (last full year of ICD-9-CM codes: 47.01, 51.23) and 2016 (first full year of ICD-10-CM codes: 0DTJ4ZZ, 0FT44ZZ) National Inpatient Sample. Data from each year were aggregated separately at the hospital-level in order to attain
hospital-specific median index hospital costs in 2019 USD for each operation and corresponding annual procedure volumes. Hospitals were excluded if they performed < 20 weighted operations in order to ensure estimate stability. Variability in median hospital costs and interquartile ranges (IQR) was visualized using caterpillar plots. Differences in (risk-adjusted) median costs based on variations in procedure volume were compared using: (1) ln-transformed linear regression of continuous procedure volume with robust standard errors,(2) categorized procedure volume based on quintile of annual procedures performed, and (3) quantile regression comparing differences in costs based on volume at the 50/60/70/80/90th percentile of volume.

Results: In 2014, based on ICD-9-CM codes, 1,606 hospitals representing 103,520 laparoscopic appendectomies and 2,090 hospitals representing 214,170 laparoscopic cholecystectomies met include criteria. In 2016, based on ICD-10-CM codes, the numbers were similar with 1,563 hospitals representing 86,170 laparoscopic appendectomies and 2,276 hospitals representing 230,120 laparoscopic cholecystectomies. Variability in median hospitals costs (IQR) for each operation in 2014 is presented in Fig1. Compared to a global median of $11,090 (mean: $14,040), median total index hospital costs for laparoscopic appendectomy ranged from $4,530 (10th percentile) to $28,080 (90th percentile). For laparoscopic cholecystectomy, values ranged from $5,460 to $32,570 with an overall global median of $13,390 (mean: $16,460). Cost differences were strongly associated with differences in procedure volume. Regression results for laparoscopic cholecystectomy in 2014 and 2016 are presented in Table1. Compared to the lowest quintile of procedure volume, patients undergoing surgery at the highest volume centers had risk-adjusted median costs that were on average $6,000 (95%CI: $6,728 to$5,272, p<0.001) lower. For laparoscopic appendectomy, the risk-adjusted difference was $3,307 (95%CI: $3,922 to $2,591, p<0.001) lower – a decrease of approximately $150 per 10 additional operations.

Conclusion: Marked variability of median hospital costs for common operations exists. Conservative ranges of the extremes measured from the 10th to 90th percentile suggest differences upwards of $23,000 per patient. Differences remained consistent across consideration of changing coding structures and database years. They were strongly associated with variations in procedure volume, even after controlling for differences in hospital characteristics and severity of patient case-mix. Taken together, the findings suggest room for improvement and a need to address large discrepancies in an often overlooked aspect of the value of care.



Laparoscopic cholecystectomy 2014 (ICD9 procedure code 51.23): Difference in median total hospital cost (2019 USD)

	Unadjusted	95%CI		p-value	Risk-adjusted*	95%CI		p-value
I. Categorical model								
Quintile 1 - lowest volume (reference)	--	--	--	--	--	--	--	--
Quintile 2	-4023	-4565	-3481	<0.001	-3947	-4489	-3406	<0.001
Quintile 3	-5260	-5812	-4708	<0.001	-4862	-5462	-4621	<0.001
Quintile 4	-5971	-6519	-5422	<0.001	-5290	-5945	-4634	<0.001
Quintile 5 - highest volume	-6917	-7464	-6369	<0.001	-6000	-6728	-5272	<0.001
Per 10 additional operations each year…								
II. Ln-transformed model								
Exponentiated mean difference	-224	-247	-201	<0.001	-112	-141	-83	<0.001
III. Quantile regression								
Median (50th percentile)	-136	-157	-114	<0.001	-72	-98	-46	<0.001
60th percentile	-165	-187	-142	<0.001	-77	-107	-46	<0.001
70th percentile	-201	-226	-176	<0.001	-88	-123	-53	<0.001
80th percentile	-242	-280	-205	<0.001	-104	-153	-56	<0.001
90th percentile	-312	-378	-247	<0.001	-137	-214	-59	<0.001

Laparoscopic cholecystectomy 2016 (ICD10 procedure code 0FT44ZZ): Difference in median total hospital cost (2019 USD)

	Unadjusted	95%CI		p-value	Risk-adjusted*	95%CI		p-value
I. Categorical model								
Quintile 1 - lowest volume (reference)	--	--	--	--	--	--	--	--
Quintile 2	-3772	-4328	-3215	<0.001	-3604	-4162	-3046	<0.001
Quintile 3	-4308	-4859	-3757	<0.001	-3834	-4451	-3217	<0.001
Quintile 4	-5175	-5725	-4624	<0.001	-4474	-5152	-3795	<0.001
Quintile 5 - highest volume	-5738	-6290	-5187	<0.001	-4852	-5600	-4097	<0.001
Per 10 additional operations each year…								
II. Ln-transformed model								
Exponentiated mean difference	-197	-221	-173	<0.001	-96	-127	-65	<0.001
III. Quantile regression								
Median (50th percentile)	-136	-157	-114	<0.001	-65	-95	-34	<0.001
60th percentile	-165	-187	-142	<0.001	-75	-108	-42	<0.001
70th percentile	-201	-226	-176	<0.001	-91	-132	-48	<0.001
80th percentile	-242	-280	-205	<0.001	-125	-174	-76	<0.001
90th percentile	-312	-378	-247	<0.001	-165	-252	-78	<0.001

***Models were risk-adjusted for hospital bedsize, hospital teaching status, hospital rurality, hospital geographic region, mean patient age, mean patient AP-DRG risk of mortality, mean patient AP-DRG severity**

Models were run with robust standard errors (aka White-Huber standard errors) to control for heteroskedasticity

Session XI: Papers 36-44
Paper 38: 8:40 AM - 9:00 AM

MANAGEMENT OF CHOLEDOCHOLITHIASIS IN THE ELDERLY: IS ERCP ALONE REALLY A SAFE ALTERNATIVE?

Allison E. Berndtson MD, Sara B. Edwards MD, Alan M. Smith Ph.D., Leslie Kobayashi* MD, Jay J. Doucet* MD, Todd W. Costantini* MD, Laura N. Godat* MD, University of California, San Diego

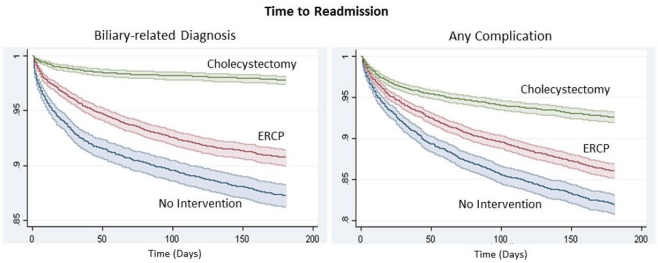
Invited Discussant: Oscar Guillamondegui, MD, MPH

Introduction: Current guidelines recommend that patients presenting with choledocholithiasis (CDL) should undergo cholecystectomy after clearance of the common bile duct via ERCP. Adherence with this guidelines is poor in elderly patients due to perceived risks of operative intervention. We hypothesized that elderly patients treated with ERCP alone would have higher complication and readmission rates than patients treated with cholecystectomy during the index admission.

Methods: The Nationwide Readmissions Database was queried for all patients age 65 or older with an index admission for CDL during the first six months of 2016. Patients were divided into 3 groups based on treatment received: (1) No intervention, (2) ERCP alone, or (3) Cholecystectomy. Analysis included patient demographics, Charlson comorbidity index (CCI), biliary-related readmissions, complications, and mortality. Multivariate regression analyses were performed to identify predictors of procedure done during index admission and of readmissions for patients initially admitted with CDL.

Results: 16,424 patients were admitted with CDL; 38% underwent cholecystectomy, 37% ERCP only and 25% had neither. Increasing age (OR 1.11 to 3.74 by 5-year group, $p < 0.05$) and CCI≥3 (OR 1.63, $p < 0.001$) were associated with non-operative (no cholecystectomy) management during the index admission. Readmission rates for biliary-related complications at 180 days (see Figure) were highest for patients with no intervention, followed by ERCP alone and cholecystectomy (12%, 9% and 2% respectively, $p< 0.001$). Post-operative 180 day readmission for any complication was 7% for patients treated with cholecystectomy. On multivariate analysis, emergent readmission at 180 days was predicted by CCI≥3 (OR 1.74, $p < 0.001$) and need for post-acute care services (OR 1.70, $p < 0.001$). Patients undergoing ERCP or cholecystectomy had a decreased risk of 180-day readmission (OR 0.79, $p < 0.001$ and OR 0.34, $p < 0.001$ respectively). For patients treated with cholecystectomy, predictors of readmission were CCI≥3 (OR 2.10, $p < 0.001$) and discharge to post-acute care services (OR 2.24, all $p<0.001$); increasing age did not predict readmission. Similarly, for those undergoing ERCP only, predictors of 180-day emergent readmission were CCI≥3 (OR 1.79, $p < 0.001$) and discharge to post-acute care services
(OR 1.78, $p < 0.001$).

Conclusion: ERCP alone for CDL in elderly patients has higher biliary-related readmissions and complications than cholecystectomy. Charlson comorbidity index is the strongest predictor of emergent readmission after cholecystectomy or ERCP, while increasing age is not predictive. In patients with CDL, elderly age alone may not justify avoidance of cholecystectomy.



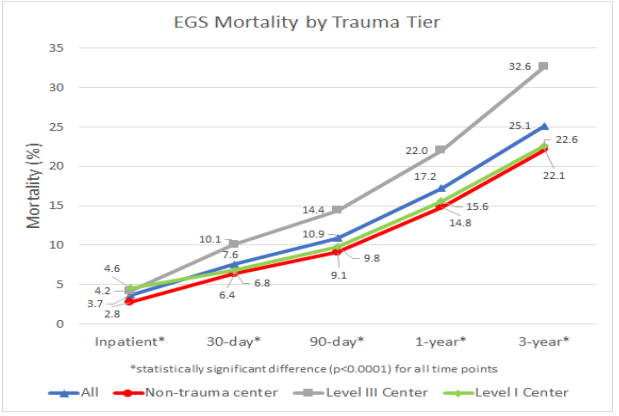
Session XI: Papers 36-44
Paper 39: 9:00 AM - 9:20 AM

ENVISIONING THE PARADIGM: THE BURDEN AND OUTCOMES OF EMERGENCY GENERAL SURGERY (EGS) IN AN INTEGRATED REGIONAL HEALTH SYSTEM

Samuel W. Ross MD,MPH, Caroline E. Reinke MD, MSHP, Bradley W. Thomas MD, Susan L. Evans MD, A. B. Christmas* MD, Ronald F. Sing* DO, Brent D. Matthews MD, Addison K. May* MBA,MD, Carolinas Medical Center

Invited Discussant: Angela Ingraham, MD

Introduction: EGS patient outcomes have been shown to differ significantly on multiple factors including the size and resources of the institution. Our objective was to evaluate our own integrated health care system's experience with EGS. We hypothesized that patients' outcomes would be improved at the larger referral centers.
Methods: Our 2600 bed, thirteen hospital, health system's billing data was queried for AAST defined EGS ICD-9 codes from 2013-2015. Codes were grouped into diagnosis and procedure categories according to prior AAST publications. Outcomes were evaluated by Trauma Center designation as a surrogate for high resource availability and EGS expertise. 30-day mortality was the primary outcome. Standard and multivariate statistics were used to evaluate predictors of mortality.
Results:There were 60,604 non-elective EGS admissions, with 6,724 (11.1%) requiring an operation. Mortality rates for the entire population, and by Trauma Center designation are displayed in Figure 1. Patients at non-trauma centers had fewer comorbidities and predominately had minor procedures if an operation was performed. Risk factors associated with increased 30-day mortality included increased age, hospital length of stay, Charlson Comorbidity Index (CCI), cardiothoracic, bowel obstruction, soft tissue, or resuscitation diagnosis, Level III admission, and requiring a laparotomy; all $p<0.0001$. On multivariate analysis, increased age (OR 1.03, 95%CI 1.028-1.031) and CCI (1.26, 1.24-1.27), decreased BMI (0.98, 0.97-0.99), soft tissue (1.51, 1.40-1.64), bowel obstruction (1.53, 1.36-1.71), and resuscitation diagnoses (9.78, 9.00-10.63), laparotomy (3.94, 2.59-6.00), and Level 3 designation (1.27, 1.16-1.40) were associated with increased independent odds of 30-day mortality.
Conclusion: EGS has a high burden of disease, and outcomes vary widely in the system but were significantly better at the Level I center with a dedicated EGS service. Additionally, we were able to identify certain high-risk features in our population. Early identification of these patients and triage to a higher level of care, through the regionalization of EGS, could help decrease their morbidity and mortality in the future.



Session XI: Papers 36-44
Paper 40: 9:20 AM - 9:40 AM

ACUTE CARE SURGERY MODEL LEADS TO SHORTER LENGTH OF STAY IN MILD GALLSTONE PANCREATITIS

Samuel P. Carmichael MD, Jonathan Krebs BS, Nathan T. Mowery* MD, Wake Forest Baptist Medical Center

Invited Discussant: Kimberly A. Davis, MD, MBA

Introduction: Cholecystectomy within 48h of admission for mild pancreatitis (Ranson <3) can be safely performed leading to decreased length of stay (LOS) and hospital cost. The Acute Care Surgery (ACS) model has been associated with more efficient surgical throughput. We hypothesized that mild pancreatitis patients could safely proceed with surgery the day of consultation without an increase in complications.
Methods: Eligible patients (Ranson <3; 2016-2018) were considered for immediate surgery with goal of cholecystectomy within 12 hours of ACS service consultation (EARLY). This decision was made independent of dietary tolerance or pancreatic enzyme concentration. Patient outcomes were compared to patients in whom cholecystectomy was performed in a more traditional approach (LATE).
Results: A total of 85 patients underwent cholecystectomy. Demographic data and comorbidities between the EARLY (n=34) patients and the LATE (n=51) were similar. Compared to the LATE group, LOS and total costs were significantly decreased in the EARLY group (5.32 vs. 3.65 days [$p<0.05$]; $14,352 vs. $11,144 [$p<0.05$]). Operative duration between the two groups was the same (168.7 vs 167.6 minutes, $p>0.05$). There were three conversions to open surgery and one common bile duct injury, all in the LATE group. Regression analysis controlling for age and admission lipase showed that early intervention was an independent predictor of the LOS (OR 0.037, 95% CI .024-.050, $p<.001$).
Conclusion: Immediate cholecystectomy in mild pancreatitis is safe and cost effective, reducing length of stay by more than 1.5 days. Under the ACS model, patients with mild pancreatitis should be posted for operation the day of consultation rather than awaiting correction of enzymes or diet tolerance.

	Total (n=85)	EARLY (n=34)	LATE (n=51)	
	Mean (SD)	Mean (SD)	Mean (SD)	p-value
Age (years)	59.6 (19.3)	52.3 (17.5)	59.7 (20.0)	p>0.05
% Female	70	70.6	69.6	p>0.05
Lipase (U/L)	4163 (6190)	3237 (3868)	4726 (7224)	p>0.05
Length of Stay (days)	4.69 (2.5)	3.65 (1.9)	5.32 (2.7)	**p<0.05**
Total Cost (USD)	13,140 (5883)	11,144 (5268)	14,352 (5950)	**p<0.05**
EARLY = operation within 12 hours of consultation.				

Session XI: Papers 36-44
Paper 41: 9:40 AM - 10:00 AM

THE EFFECT OF EMS TRANSPORT TIME ON IN-TRANSIT CLINICAL DECLINE IN A RURAL STATE

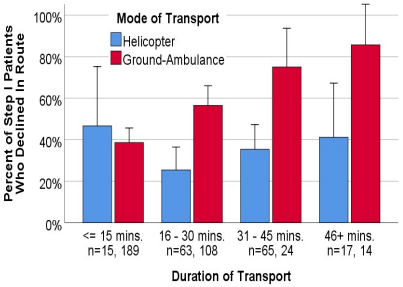
Taylor R. Kai BS, Marlene J. Broady Daniel L. Davenport Ph.D., Andrew C. Bernard* MD, University of Kentucky

Invited Discussant: Jan Jansen, MBBS

Introduction: Rural systems often have longer prehospital transport times compared to urban systems. The duration after which patients experience significant clinical decline remains undefined. Despite EMS protocols directing critically ill patients to higher-level care facilities, geography may compel EMS providers to stop at lower level ones. We aimed to determine the effect of transport time on rate of clinical decline in helicopter (HEMS) and ground (GEMS) transport, as well as the prevalence of patient transport to suboptimal facilities using the EMS Field Triage Decision Scheme (FTDS).

Methods: De-identified data from the 2017 state EMS Information System were analyzed to evaluate the effect of transport time on prehospital clinical decline. Patients were subdivided into those who met or did not meet FTDS Step 1 criteria (RR <10 or >29, SBP <90, or GCS <14) for transport to a Level I, II, or III trauma center; transport via HEMS or GEMS; and whether the appropriate center was reached. Clinical decline was defined in those who met Step 1 criteria as any further deterioration in vital signs from baseline, or as development of FTDS Step 1 criteria *en route.*

Results: Patients who met Step 1 criteria showed a linear increase in decline with increasing ground transport time ($p<0.001$). Helicopter flights >15 minutes showed a similar linear increase in decline with about half the rate as GEMS Step 1 patients ($p=0.001$; fig.). Non-Step 1 patients declined at similar rates (5-7%) regardless of transport time. Of Step 1 patients, 53.9% reached an appropriate center (level I, II, III). The most common reasons for misallocation included "closest facility" (52.1%), followed by "patient's choice" (18.4%).



Conclusion: The FTDS Step 1 criteria accurately predict patients at greatest risk of further clinical decline during prehospital transport, with greatest risk in ground transport compared to helicopter. Rather than decline after the "golden hour", these data suggest that for trauma patients with abnormal physiology, decline is roughly linear throughout transport.

Session XI: Papers 36-44
Paper 42: 10:00 AM - 10:20 AM

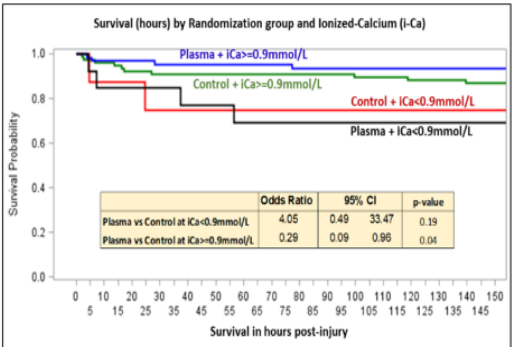
GOT CALCIUM? ADMISSION IONIZED-CALCIUM IN TWO CIVILIAN RANDOMIZED CLINICAL TRIALS OF PRE-HOSPITAL PLASMA

Hunter B. Moore MD,Ph.D., Mattew T. Tessmer BS, Ernest E. Moore* MD, Jason L. Sperry* MD, Mitchell J. Cohen* MD, Michael P. Chapman MD, Anthony E. Pusateri* Ph.D., Francis X. Guyette MD, Joshua B. Brown MD, Matthew D. Neal MD, Brain S. Zuckerbraun* MD, Denver Health Medical Center

Invited Discussant: Jeremy Cannon, MD

Background: Randomized clinical trials(RCTs) support pre-hospital plasma resuscitation in traumatic hemorrhagic shock(THS). However, recent reports of military experience suggest that pre-hospital transfusions predispose patients to hypocalcemia, due to citrate chelation of endogenous calcium. We reviewed admission ionized-calcium (i-Ca) blood levels of two recent pre-hospital plasma RCTs and its impact on coagulation and postinjury survival. We hypothesized that pre-hospital plasma was associated with hypocalcemia and coagulopathy, reducing its survival benefit.

Methods: Patients in two institutions participating in pre-hospital plasma RCTs(Control=normal saline) were included if i-Ca was collected prior to calcium replacement. Adults with THS (SBP≤70mmHg or 71–90mmHg+HR≥108bpm) were eligible. Moderate hypocalcemia was defined as i-Ca<=0.9-1.0mmol/L, severe as i-Ca<0.9mmol/L.



Results: 160 subjects were included (76% men, 71% blunt trauma, median age 40yrs, median injury severity score 22), of whom 48% received pre-hospital plasma. Overall, 44% had hypocalcemia (31% moderate; 13% severe). Pre-hospital plasma (vs controls) was significantly associated with i-CA<1.0mmol/L (OR: 2.00; 95%CI:1.06-3.79). Severe hypocalcemia significantly diminished plasma survival benefit (interaction severe hypocalcemia* randomization group p=0.03; Figure). Hypocalcemia was significantly associated with INR, thrombelastography indicators of clot formation and strength (all p<0.05).

Conclusion: Pre-hospital plasma in the treatment of civilian trauma is associated with hypocalcemia, which diminished its survival benefit. These data underscore the need for calcium replacement guidelines in postinjury resuscitation with blood products.

Session XI: Papers 36-44
Paper 43: 10:20 AM - 10:40 AM

EFFECT OF PLASMA TRANSFUSION RATIO TO RED BLOOD CELLS BETWEEN GERIATRIC AND NON-GERIATRIC MASSIVELY TRANSFUSED TRAUMA PATIENTS: ELDERLY PATIENTS BENEFIT LESS!

Mitsuaki Kojima MD,Ph.D., Akira Endo MD,Ph.D., Xiaofei Zhang MD,Ph.D., Atsushi Shiraishi MD,Ph.D., Megan Brenner* MD, Tomohisa Shoko MD,Ph.D., Yasuhiro Otomo* MD,Ph.D., Raul Coimbra* MD,Ph.D., Tokyo Medical and Dental University

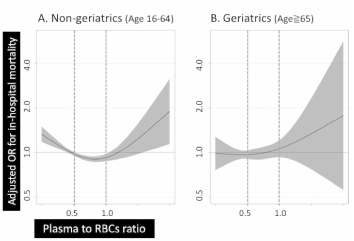
Invited Discussant: Jason Sperry, MD, MPH

Introduction: Massive transfusion protocols (MTP) with well-balanced plasma to red blood cells (RBC) ratio have shown to be associated with improved outcomes in trauma. However, these results were mainly derived from young adults such as military settings. The impact of MTP on elderly trauma patients is still unclear. The aim of the study was to investigate the impact of different plasma transfusion ratios to the outcomes in the non-geriatric and geriatric trauma population.

Methods: A retrospective observational study was performed using the Trauma Quality Improvement Program database from 2013 to 2016. Major trauma patients (Injury Severity Score ≥16) who received massive transfusion (≥4 units of RBC within 4 hours or ≥10 units within 24 hours after hospital arrival) were analyzed. Patients were divided into non-geriatric (16–64 years old) and geriatric (≥ 65 years old) groups. Associations between plasma to RBC ratio and outcomes: in-hospital mortality and incidence of adverse events, were evaluated using a non-linear logistic generalized additive model (GAM). Associations between three categories according to plasma to RBC ratios [low (< 0.5), medium (0.5-1.0), and high (≥ 1.0)] were also assessed using a multivariate regression model.

Results: We identified 11,744 massively transfused trauma patients, including 9,827 (83.7%) non-geriatric and 1,917 (16.3%) geriatric subjects. The GAM plots of the plasma to RBC ratio for in-hospital mortality (adjusted by variables including ISS, Revised Trauma Score, injury mechanisms, injured body region and hospital type) demonstrated a downward convex unimodal curve and the nadir was observed when the ratio was 0.88 in the non-geriatric group (Fig A). The geriatric group showed monotonic increase in the risk of in-hospital mortality with no specific threshold (Fig B). In the categorized multivariate regression analysis, the medium group was significantly associated with reduced in-hospital mortality when compared to low plasma to RBC ratio group in non-geriatric subjects (Table). No association between transfusion ratio and mortality was observed in the geriatric group. An increase in plasma to RBC ratio was significantly associated with a higher incidence of adverse events in both non-geriatric and geriatric groups (Table).

		Non-geriatrics			Geriatrics		
Plasma/RBC ratio		AOR	95% CI	*p* value	AOR	95% CI	*p* value
In-hospital mortality	Low	1.23 *	(1.11-1.37)	<0.01	0.89	(0.71-1.11)	0.30
	Medium	1	[Reference]	-	1	[Reference]	-
	High	1.11	(0.92-1.32)	0.25	1.09	(0.73, 1.65)	0.65
Adverse events	Low	0.73 *	(0.65-0.81)	<0.01	0.66 *	(0.52-0.82)	<0.01
	Medium	1	[Reference]	-	1	[Reference]	-
	High	1.01	(0.85-1.19)	0.89	1.26	(0.84,1.89)	0.24



Association between plasma/RBC ration and in-hospital mortality adjusted by gender, injury mechanisms, RTS, ISS and injured body regions and hospital levels.

Conclusion: Massive transfusion with a plasma to RBC ratio in the range of 0.5 to 1.0 was significantly associated with a reduction of in-hospital mortality among non-geriatric injured adults, but no such association was observed in geriatric patients. Higher incidence of adverse events was observed in both geriatric and non-geriatric trauma patients who received MTP with higher transfusion ratio.

Session XI: Papers 36-44
Paper 44: 10:40 AM - 11:00 AM

LONG-TERM FUNCTIONAL OUTCOMES AFTER TRAUMATIC POPLITEAL ARTERY INJURY: A 20-YEAR EXPERIENCE

Louis J. Magnotti* MD, MS, John P. Sharpe MD, MS, Richard H. Lewis MD, Elizabeth A. Tolley Ph.D., Fridtjof Thomas Ph.D., Dina M. Filiberto MD, Cory R. Evans MD, Leo Kokorev BS, Timothy C. Fabian* MD, Martin A. Croce* MD, University of Tennessee Health Science Center - Memphis

Invited Discussant: Michael Sise, MD

Introduction: Traumatic popliteal artery injury (TPAI) remains a significant cause of limb-loss. For these patients, prolonged ischemia and concomitant injuries contribute to both lower extremity morbidity and poor rates of limb salvage at the time of initial injury. However, little published information regarding long-term functional outcomes exists. This study evaluated the impact of TPAI on long-term functional outcomes in the largest single institutional series reported in the literature.
Methods: Patients with TPAI over 20 years were identified. To better evaluate long-term functional outcomes and limit the impact of time post-injury as a potential bias, only those patients with at least a 2-year follow-up were included. Functional outcomes were measured using the Boston University Activity Measure for Post-Acute Care (AM-PAC) to assess basic mobility (BM) and daily activity (DA). Multiple linear regression, adjusted for age, severity of injury and shock, operative complexity, associated injuries, ischemic time and length of follow-up was used to identify predictors of functional outcome after TPAI.
Results: 214 patients were identified: 123 (57%) penetrating and 91 (43%) blunt. Overall mortality was 1.9% (all in-hospital). Of the 210 survivors, follow-up was obtained in 145 (69%) patients. Mean follow-up was 10.6 years (range 2.4 – 22 years). Mean AM-PAC scores for BM and DA were 78 and 75; both signifying mild impairment (normal > 84). Multiple linear regression failed to identify increasing length of follow-up as a predictor of improved functional outcomes. Only age, lower extremity fracture and ischemic time were identified as predictors of decreased BM and DA.

		All (n=145)		Penetrating (n=84)		Blunt (n=61)	
		BM	DA	BM	DA	BM	DA
Age	β	-0.42	-0.78	-0.82	-1.33	-0.22	-0.50
	p	<0.0001	<0.0001	<0.0001	<0.0001	0.023	0.003
Fracture	β	-6.44	-8.26	-3.32		-9.47	-14.26
	p	0.0002	0.003	0.063		0.002	0.005
Ischemic Time	β	-2.38	-3.60	-1.28	-2.33	-1.98	-2.85
	p	<0.0001	<0.0001	0.048	0.03	0.002	0.007

Conclusion: Increasing age, lower extremity fracture and prolonged ischemic time worsened long-term functional outcomes. Surprisingly, prolonged follow-up (>2 years) did not portend improved functional outcome suggesting that maximal recovery may be achieved within the first 2 years post-injury. Thus, early revascularization emerges as the only potentially*modifiable* risk factor for improving functional outcomes following TPAI.

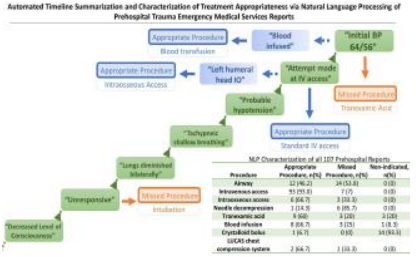
Session XIVA: Papers 45-53
Paper 45: 2:00 PM - 2:20 PM

NATURAL LANGUAGE PROCESSING OF PREHOSPITAL EMS TRAUMA RECORDS ALLOWS FOR AUTOMATED CHARACTERIZATION OF TREATMENT APPROPRIATENESS

Christopher J. Tignanelli MD, Greg M. Silverman BS, Elizabeth A. Lindemann BS, Alexander L. Trembley NRP, BSM, Jon L. Gipson MD, FACS, Gregory Beilman* MD, FACS, Raymond Finzel BS, Reed McEwan MS, Benjamin C. Knoll BS, Serguei Pakhamov Ph.D., Genevieve B. Melton-Meaux MD,Ph.D., FACS University of Minnesota Dept of Surgery

Invited Discussant: Mark Gestring, MD

Introduction: Inappropriate prehospital trauma care is a significant contributor to preventable deaths. Current databases lack timelines of clinical events. Temporal associations and procedural indications are critical to characterize treatment appropriateness. Natural language processing (NLP) methods present a novel approach to bridge this gap. We developed an NLP system to automatically extract procedures and procedural indications from emergency medical services (EMS) motor vehicle crash (MVC) records.
Methods: 107 records were utilized to extract airway procedures, intraosseous/intravenous (IV) access, blood transfusion, crystalloid bolus, LUCAS chest compressions, tranexamic acid bolus, and needle decompression. Reports were processed using four clinical NLP systems and augmented via a word2phrase method with a large integrated health system data repository to identify terms semantically similar with 11 procedural indications. Airway procedure was indicated in patients that were non-responsive, had respiratory distress, or a Glasgow Coma Scale < 9. Intravenous access should be attempted for all patients. Intraosseous access was indicated if failed IV attempt or hypotensive (systolic blood pressure < 90 mmHg) patients requiring rapid or multiple access. Needle decompression was indicated in hypotensive patients with absent breath sounds. Tranexamic acid was indicated in all hypotensive patients (per local protocol). Blood infusion was indicated in all hypotensive patients. Crystalloid bolus was indicated for hypotensive patients when blood is not available or for continued hypotension after EMS 2 units of packed red blood cells have been transfused. LUCAS was indicated for all patients receiving cardiopulmonary resuscitation. Extracted elements were temporally related to reconstruct timelines. Indications were matched with procedures and categorized as appropriate, missed (indicated but not performed), or non-indicated. The accuracy of automated characterizations was then evaluated via manual review of 50 notes.
Results: NLP identified 150 procedures with 100% recall and 93% precision. Automated timeline summarization was completed for all patients (figure). This facilitated automated retrospective evaluation of adherence with 8 locoregional EMS practices. For each procedure, 20-86% of patients had documentation of procedural indications but the system did not identify an associated procedure performed. Commonly missed procedures included airway control (53.8%) and needle decompression (85.7%). Additional measures evaluated IV guage appropriateness, only 79% of patients received a 14-18 gauge IV. 93.3% of patients received non-indicated crystalloid boluses.
Conclusion: NLP methodologies allow for extraction of procedural indication data and automated timeline summarization. Future directions should focus on optimizing and expanding NLP methods and linking NLP data with current databases to facilitate locoregional performance monitoring and improvement efforts.



Session XIVA: Papers 45-53
Paper 46: 2:20 PM - 2:40 PM

HOSPITAL RESOURCES DO NOT PREDICT ACCURACY OF SECONDARY TRAUMA TRIAGE: A POPULATION-BASED ANALYSIS

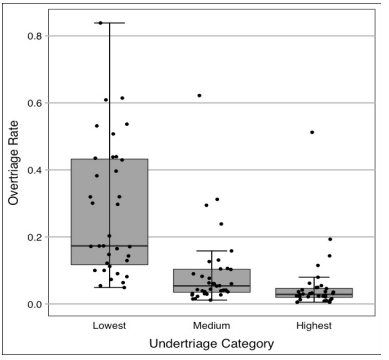
Bourke W. Tillmann MD, Avery B. Nathens* MD,Ph.D., Matthew P. Guttman MD, Priscila Pequeno MSc, Damon C. Scales MD,Ph.D., Petros Pechlivanoglou Ph.D., Barbara Haas MD,Ph.D., Sunnybrook Health Science Centre

Invited Discussant: Brian Eastridge, MD

Introduction: Identifying severely injured patients who require transfer to a trauma center poses a significant challenge. The structures and processes of care at non-trauma centers (NTCs) that lead to accurate secondary triage are poorly understood. The objective of this study was to evaluate the relationship between under- and overtriage, and to identify center-level factors associated with accurate secondary trauma triage.

Methods: We performed a population-based, retrospective cohort study of all injured patients transported to a NTC in a regional trauma system between fiscal years 2009 and 2016. Patients discharged from the emergency department of a NTC were excluded. NTCs were categorized based on the availability of human resources (board-certified emergency physicians, orthopedics, general surgery) and physical resources (CT imaging, ICU). Rates of under- and overtriage were calculated for the trauma system and each NTC. NTCs were stratified into tertiles based on their undertriage rates, and overtriage rates were compared. The association between under- and overtriage rates, adjusted for NTC resources and case-mix, was modelled using negative binomial regression. We then used bivariate mixed effect models, adjusted for patient case-mix, to evaluate the relationship between NTC resource strata and the accuracy of secondary triage.

Results: Inclusion criteria identified 118,973 patients at 182 NTCs. Overall 16,481 (13.9%) patients were transferred to a trauma center. Among those with severe injuries (n=37,528), 77% were never transferred (undertriaged), while among patients without severe injuries (n=81,445), 11% were transferred to a trauma center (overtriaged). After adjusting for case-mix, a lower undertriage rate was associated with an increased rate of overtriage (RR 1.92, 95% CI 1.37 – 2.69 and 3.74, 95% CI 2.52 – 5.54, for medium and low undertriage rate NTCs respectively vs high undertriage rate NTCs). However, in each undertriage tertile NTCs demonstrated a wide range of overtriage (Figure). There was no relationship between hospital resources and overtriage rates. Furthermore, the availability of hospital resources was unrelated to the overall accuracy of triage (p=0.13).



Conclusions: We observed significant variation in the rates of under- and overtriage, and the accuracy of secondary triage across NTCs. While NTCs with lower undertriage rates tended to have higher overtriage rates, we identified NTCs that had low rates of both under- and overtriage. Additionally, secondary triage accuracy was not dependent on a NTC's available resources. Our findings suggest that low rates of undertriage can be achieved while maintaing acceptable rates of overtriage, and that factors other than resource availability play a key role in triage accuracy. Evaluation of processes of care at highly accurate NTCs may lead to the creation of strategies to improve triage accuracy across the trauma system.

Session XIVA: Papers 45-53
Paper 47: 2:40 PM - 3:00 PM

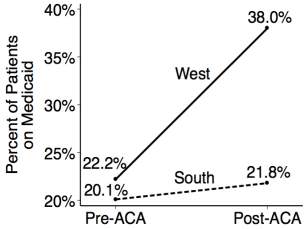
THE IMPACT OF MEDICAID EXPANSION ON TRAUMA-RELATED EMERGENCY DEPARTMENT UTILIZATION: A NATIONAL EVALUATION OF POLICY IMPLICATIONS

Lisa M. Knowlton MD,MPH, FRCSC, Melody S. Dehghan BA, Amber W. Trickey Ph.D., MS, CPH, Lakshika Tennakoon MD, MPhil, Arden M. Morris MD,MPH, FACS, David A. Spain* MD, FACS Stanford University Medical Center

Invited Discussant: Joseph Minei, MD, MBA

Introduction: The impact of Medicaid expansion, under the Affordable Care Act (ACA) of 2014, upon national trauma-related emergency department (ED) utilization is unknown. We aimed to assess whether the ACA was associated with changes in trauma patient ED use and payer mix. We hypothesized that post-ACA ED visits would decline and that Medicaid coverage would increase disproportionately in regions of widespread policy adoption.

Methods: We queried the National Emergency Department Sample (NEDS) for those with a primary trauma diagnosis (ICD-9CM codes), aged 18 to 64. As most states implemented Medicaid expansion in January 2014, we compared hospitalizations pre-ACA (2012) to post-ACA (10/2014 to 09/2015 to maintain consistency with ICD-9CM codes). Primary outcomes were change in ED visits and payer status; secondary outcomes were change in costs, discharge disposition and inpatient length of stay. Univariate and multivariate analyses were performed, including difference-in-differences analyses. We compared changes in ED trauma visits by payer (Medicaid, uninsured, private) in the West (91% living in a Medicaid expansion state) versus the South (12% in a Medicaid expansion state).



Results: Among 21.2 million trauma-related ED visits analyzed, there was a 13.3% decrease in ED visits post-ACA. Overall, there was a 7.2% decrease in uninsured ED visits (pre- vs. post-ACA: 25.5% vs. 18.3%, p<0.001), a 6.6% increase in Medicaid coverage (17.6% vs. 24.2%, p<0.001) and a 1.3% increase in private payer-covered visits (37.6% vs. 38.9%, p<0.001). Among those admitted to hospital (n=604,126; 2.9%), mean LOS was longer (pre- vs. post-ACA: 3.8 vs. 4.1 days, p<0.001) and the percent discharged to rehabilitation increased (15.5% vs. 19.1%, p<0.001). In difference-in-differences regional comparisons, trauma patients had 40% increased odds of having Medicaid coverage post-ACA compared to pre-ACA (aOR 1.40, p<0.001). Patients in the West had 31% greater odds of having Medicaid than in the South (aOR 1.31, p<0.001). The post-ACA increase in Medicaid coverage was significantly greater in the West than in the South (aOR 1.60, p<0.001). Post-ACA, there was a 25% increase in inpatient discharge to rehabilitation (aOR 1.24, p<0.001). Trauma inpatients were also more likely to have Medicaid coverage than those discharged from the ED (aOR 1.20, p<0.001).

Conclusion: Medicaid expansion was associated with a significant increase in insurance coverage for trauma patients and a decrease in injury-related ED visits, which may result from access to other outpatient services. Overall, increases in inpatient Medicaid coverage improved discharge to post-acute services for trauma patients. Efforts to ensure sustainability of expanded coverage will benefit injured patients and trauma systems.

Session XIVA: Papers 45-53
Paper 48: 3:00 PM - 3:20 PM

LIFTING THE BURDEN: STATE MEDICAID EXPANSION REDUCES FINANCIAL RISK FOR THE INJURED

John W. Scott MD,MPH, Mark G. Shrime MD,MPH,Ph.D., Barclay T. Stewart MD, MscPH, Saman Arbabi* MD,MPH, Eileen M. Bulger* MD, Joseph Cuschieri* MD, Ronald V. Maier* MD, Bryce R. Robinson* MD, MS Harborview Medical Center

Invited Discussant: Jay Doucet, MD, MSc

Introduction: Injuries disproportionately affect the poor and can be expensive to treat. Uninsured patients are at greatest risk for financial strain due to high out-of-pocket healthcare costs relative to their income. As a part of national health reform, our state expanded eligibility for Medicaid coverage in 2014, which resulted in over 600,000 non-elderly adults gaining coverage. We hypothesized that state Medicaid expansion (ME) was associated with a reduction in financial risk among injured patients.

Methods: We analyzed all patients aged 18-64 years admitted for Level 1 trauma center care in our state from 2012-2017. We defined 2012-2013 as the pre-policy period and 2014-2017 as the post-policy period. To adjust for year-to-year variation in patient demographics, injury characteristics, and facility traits, we used multivariable linear regression models to evaluate for pre-/post-policy changes in length of stay, complications, mortality, failure to rescue, and discharge disposition among the policy-eligible sample. We used state and US census data to estimate post-subsistence income and out-of-pocket expenses for admitted patients. We then applied these two estimates to determine catastrophic healthcare expenditure (CHE) risk as defined by the WHO (out-of-pocket health expenses $\geq$40% of estimated post-subsistence income).

Results: We identified 16,801 patients admitted over the 6 year study period. After ME, the Medicaid coverage rate increased from 20.4% to 41.0% and the uninsured rate decreased from 19.3% to 3.7% ($p<0.001$ for both). There was no significant change in private insurance coverage. ME was not associated with significant changes in length of stay, complications, mortality, failure to rescue, or discharge to rehab. After ME, CHE risk for the policy-eligible sample fell from 36.3% to 17.7% ($p<0.01$). The annual number of uninsured patients at risk for CHE fell 80% after ME, ranging from 404-437 patients in the pre-policy period to 77-90 patients in the post-policy period (Figure, $p<0.01$). For privately insured patients, 298-350 were at risk for CHE annually. At the facility level, the proportion of all charges paid for by charity care fell from 12.4% to 1.5% ($p<0.01$).

Conclusion: State Medicaid expansion led to an 80% reduction in the uninsured rate among non-elderly adults admitted for injury. The number of uninsured patients at risk of CHE and the proportion of charges paid for by charity care fell precipitously in the post-policy period. ME appears to have shifted much of the financial risk from injured patients and hospitals to the state. However, nearly one-third of privately insured patients may be *under*insured as private insurance was not fully protective from CHE.

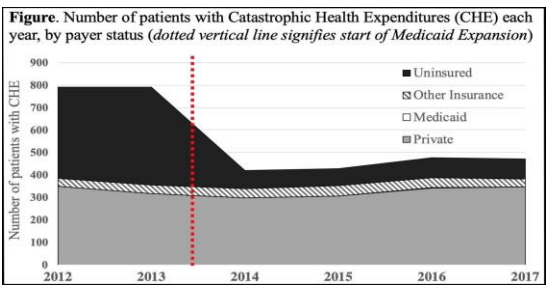


Figure. Number of patients with Catastrophic Health Expenditures (CHE) each year, by payer status (*dotted vertical line signifies start of Medicaid Expansion*)

Session XIVA: Papers 45-53
Paper 49: 3:20 PM - 3:40 PM

READMISSION AFTER NON-OPERATIVE TRAUMA: INCREASED MORTALITY AND COSTS WITH DELAYED INTERVENTION

Marta McCrum MD,MPH, Chong Zhang MS, Angela Presson Ph.D., Raminder Nirula* MD,MPH, University of Utah

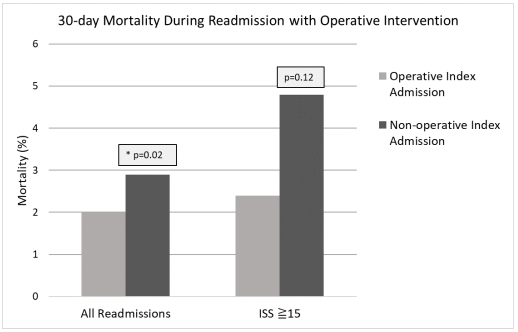
Invited Discussant: David Spain, MD

Introduction: Nearly half of patients hospitalized after traumatic injury are managed non-operatively. These patients may have unique health needs that contribute to readmission. We sought to examine patterns of readmission after non-operative trauma, including rates of delayed operative intervention, associated mortality and cost.

Methods: The Nationwide Readmissions Database (2013-2014) was queried for all index adult trauma admissions and 30-day non-elective re-admissions. Index admissions were classified as operative (OI) or non-operative (NOI), and readmissions examined for presence of operative intervention (OR). Outcomes of interest included mortality and cost during readmission. Multivariable cox regression identified risk factors for readmission requiring OR after NOI.

Results: Of 2,244,570 eligible admissions, there were 58,495 non-elective readmissions (2.6%): 38,235 (65.4%) after NOI, and 20,260 (34.6%) after OI. Overall rate of readmission was 2-fold higher after NOI compared to OI (3.6% vs 1.8% $p<0.001$). Readmitted NOI patients were older (median 71y vs OI 69y) with higher proportions of severe injury (ISS ≥15) (23.4% vs 17.7%), public insurance (74.4% vs 66.5%) and initial discharge home (42.7% vs 28.6%), and were readmitted earlier (NOI median 8 days vs OI 9 days) ($p<0.001$ for all). Operative intervention during NOI readmission was common:31.2% overall and 36.5% of severe injury. Among severely injured NOI patients requiring OR, 62% carried a primary diagnosis of intracranial injury, and 55.1% required non-spine neurological procedures. Mortality was higher for redamitted NOI patients requiring OR compared to OI patients (2.9% vs 2%, $p=0.02$). Operative readmission after NOI cost a median of $17,364 [IQR $11,481, $27,816] per admission, and carried a total annual cost of $147M (95% CI $141M-$154M). Intracranial hemorrhage was an independent risk factor for failed non-operative management in both the overall (HR 1.11, 95% CI 1.01-1.22) and severely injured (HR 1.46, 95% CI 1.24-1.71) populations.

Conclusions: Nearly one-third of patients readmitted after initial non-operative management of traumatic injuries require operative intervention. NOI patients requiring OR on readmission experience increased mortality and accrue nearly $150M in potentially preventable annual costs. Patients with head injury appear to be particularly vulnerable. Further research should focus on identifying patients and specific injury patterns at risk for failure of non-operative management prior to initial hospital discharge.



Session XIVA: Papers 45-53
Paper 50: 3:40 PM - 4:00 PM

ATTRIBUTABLE RISK OF READMISSION AFTER TRAUMA

Erin Hall MD,MPH, Brendan Carr MD, Alexis Zebrowski MPH,Ph.D., MedStar Washington Hospital Center

Invited Discussant: Saman Arbabi, MD, MPH

Introduction:Increased risk of hospital readmission after trauma is poorly characterized and difficult to benchmark because of widely varying baseline risk of hospitalization among trauma patients. Our objective was to accurately quantify the trauma attributable risk of hospital readmission and identify those populations most at risk for readmission after trauma discharge.

Methods: Patients with trauma admissions were identified in the 2013 Nationwide Readmissions Database (NRD) using ICD-9 and E-codes. Conditional Poisson regression was combined with a case-crossover design to estimate risk ratios comparing the risk of hospitalization for up to 90 days prior to the index trauma with the risk for readmission up to 90 days later. Every patient served as his or her own control allowing for an estimation of the increased risk of readmission attributable to the trauma. Results were further stratified by age, injury severity, and mechanism of injury.

Results: 811,763 trauma patients were included. Of these, the majority (n=472,574, 58.2%) were minor injuries (ISS <9) and 55% (n=379,150) were falls. Older age (≥ 60 years old) was associated with increased risk of readmission (IRR 1.95, 95% CI 1.94-1.97 vs. IRR 1.83, 95% CI 1.81-1.86) despite more minor injuries. Injury severity resulted in a dose response effect with a 68% increased readmission risk (IRR 1.68, 95% CI 1.66-1.69) for minor injuries, a 2.4-fold increased risk (IRR 2.4 95% CI 2.39-2.47) for moderate injuries, and a 3-fold increased risk (IRR 3.01, 95% CI 2.92-3.10 for severe injuries. Attributable risk differed by mechanism with falls associated with a 2-fold increase (IRR 2.02, 95% CI 1.98-2.03), MVC associated with 4-fold increase (IRR 4.32 95% CI 4.13-4.54) and GSW associated with 8-fold increased risk (IRR 8.23, 95% CI 6.94-9.76).

Conclusion: Using a novel case-crossover design, we describe significantly increased risk of subsequent hospitalization attributable to injury. This approach allows for vulnerable patients at risk for ongoing adverse health outcomes to be identified, for health systems' performance on long term outcomes to be benchmarked, and for tailored interventions to be developed and tested.

Session XIVA: Papers 45-53
Paper 51: 4:00 PM - 4:20 PM

Implementation of a Hospitalist CoManagement Program may help improve outcomes but not necessarily costs.

Patricia Ayoung-Chee MD,MPH, Erwin Wang MD, MHA, Prashant Sinha MD, Charles Okamura MD, Frank Volpicelli MD, NYU Langone Health

Invited Discussant: Zara Cooper, MD, MSc

Introduction: Comanagement is the shared responsibility, authority and accountability for patient care and outcomes. With the aging of the population, surgical patients are being admitted with more complex comorbidities, requiring highly integrated treatment strategies and coordination of care. The goal of this study was to evaluate the effectiveness of implementing a hospital comanagement program for admitted surgical patients.

Methods: This was a retrospective chart review of patients admitted to surgical services (including trauma and emergency general surgery) who met criteria for comanagement from April, 2017 to August, 2018. Patients were flagged in the electronic medical records system as having met criteria if age < 65 years with two or more comorbidities or if age ≥ 65 years with one comorbidity. Comorbidities included, but were not limited to coronary artery disease, diabetes, hypertension, obesity and hyperlipidemia. Outcomes such as length of stay (LOS) and mortality as well as variable direct cost (VDC) were evaluated.

Results: Over 17 months, there were 462 surgical patients included in the co-management program. The baseline population included surgical patients admitted from September, 2016 to December, 2016, prior to implementation in April, 2017. We observed a nearly 50% reduction in actual LOS and a reduction in LOS adjusted for admission comorbidities (O:E LOS). There was also a substantial reduction in observed to expected mortality ratios. Variable direct cost per case decreased by 43.3% but when adjusted for CMI, there was an increase of 11.3%.

	Non-CoManagement Patients (N=50)	CoManagement Patients (N=462)
Actual LOS (mean)	13.68	7.82
Expected LOS (mean) - adjusted for comorbidities	10.61	8.15
Case Mix Index (CMI)	4.97	2.53
O:E LOS	1.29	0.96
O:E Mortality	1.6	0.52

Conclusion: The introduction of a hospitalist comanagement program at our hospital was beneficial with respect to length of stay and mortality, when adjusted for case mix index. There was also an associated cost benefit per patient stay. Further investigation is needed to evaluate the program's effects on additional outcomes such as complications, discharge disposition and overall transitions of care.

Session XIVA: Papers 45-53
Paper 52: 4:20 PM - 4:40 PM

MORE CALL DOES NOT MEAN MORE BURNOUT: A MULTICENTER ANALYSIS OF TRAUMA SURGEON ACTIVITY WITH FATIGUE AND BURNOUT RISK

Timothy W. Wolff DO, Brittany L. Lisjak PA-C, Urmil B. Pandya MD, FACS, Michael Goodman* MD, Timothy Pritts* MD,Ph.D., FACS, Linda A. Dultz MD,MPH, FACS, Samir R. Pandya MD, FACS, Rajan K. Thakkar MD, Aditi M. Kapil MD, Allison E. Berndtson MD, FACS, Laura N. Godat* MD, FACS, M C. Spalding* DO,Ph.D., OhioHealth Grant Medical Center

Invited Discussant: Jamie Coleman, MD

Introduction: Long, highly stressful stretches of continuous work are thought to be significant contributing factors to the increasing rate of surgeon burnout. Modifying work hours or changing work type to improve burnout rates is a commonly assumed solution, but this remains unproven. We aimed to correlate work-related activity with measured fatigue and burnout risk among trauma and acute care surgeons. We hypothesized that fatigue levels would increase in direct response to length of call-shift, and that this would lead to higher risk of burnout.

Methods: We performed a 30 day, prospective, multicenter study involving trauma, acute care, and pediatric surgeons. Call shift schedules and duration varied among the 6 different Level I trauma centers. Fatigue was quantified for all subjects from actigraphy monitors utilizing a validated alertness model. Fatigue levels <70 predicts the likelihood of causing an error equivalent to a blood alcohol level of 0.08%. Subjects self-reported their daily work activities as “academic” (A), “on-call” (OC), “clinical non-call” (CNC) or “not working” (NW) as well as the respective times associated with each. At the end of the trial period, each surgeon completed a Maslach Burnout Inventory (MBI) to quantify burnout risk. Fatigue levels were correlated with time of day, reported work hours, reported work type, and MBI scores. Variables were compared between call shifts scheduled for 12 and 24 hours.

Results: Mean OC fatigue levels were significantly worse among 24-hour than 12-hour call shifts (83.6 vs. 87.3, $p<0.05$) as were minimum OC fatigue levels (67.0 vs. 76.2, $p<0.01$). 24-hour call shifts were also significantly more likely to include fatigue levels <70 (61.2% vs. 28.6%, $p=0.03$). Additionally, the proportion of total time spent with a fatigue level <70 while OC was higher for 24-hour call shifts (10.3% vs. 5.8%, $p<0.01$). Mean 30-day and OC fatigue levels all correlated weakly with MBI ($R= -0.36$, $R= -0.19$, respectively). Total A, CNC, and NW durations, OC shifts, and OC hours also correlated weakly with MBI ($R=0.10$, $R=0.39$, $R= -0.32$, $R= -0.04$, $R<0.01$, respectively). Both mean and minimum 24-hour pre-call fatigue levels had strong correlations with OC fatigue levels ($R=0.72$, $R=0.63$, respectively), however pre-call NW duration did not.

Conclusion: Trauma surgeon OC fatigue level is directly related to call length and correlates strongly with pre-call fatigue level. Additionally, 24-hour call shifts correlate with increased surgeon fatigue to potentially dangerous levels for longer periods. However, fatigue, call frequency, or call duration did not predict higher risk of burnout. This indicates that surgeon burnout is not a simple function of work hours or work type, and further studies should be performed to identify other modifiable factors to solve this complex problem.

Session XIVA: Papers 45-53
Paper 53: 4:40 PM - 5:00 PM

COMPARISON OF AAST GRADING SCALE TO MODIFIED HINCHEY CLASSIFICATION IN ACUTE COLONIC DIVERTICULITIS: A PILOT STUDY

Joseph Ebersole BS, Andrew Medvecz MD, Cara Connolly MD, Katherine Sborov BS, Lauren Matevish BS, Geoffrey Wile MD, Stephen Gondek MD,MPH, Oliver Gunter* MD, Oscar Guillamondegui* MD,MPH, Brad Dennis* MD, Vanderbilt University Medical Center

Invited Discussant: Marie Crandall, MD, MPH

Introduction: The AAST developed an anatomic grading scale of disease severity including imaging criteria in common surgical conditions, such as diverticulitis. The Hinchey classification requires operative intervention to accurately grade and is incomplete in non-operative cases yet remains the established system for acute diverticulitis. The purpose of this pilot study is to compare the AAST grading scale for acute colonic diverticulitis to the more traditional Hinchey classification system. We hypothesize that the AAST clinical classification scale is equivalent to the Hinchey in predicting outcomes.
Methods: This is a retrospective cohort study in a large academic medical center. A consecutive sample of patients admitted from 2014-2016 with acute diverticulitis and computed tomography (CT) imaging was reviewed. Chart review identified demographic and physiologic data as well as interventional and clinical outcomes. Each patient's initial CT scan was assigned AAST and modified Hinchey classification scores by a trained radiologist. Multivariate regression and receiver-operative curve (ROC) analysis compared the scoring systems for 6 outcomes: need for procedure, complication, ICU admission, hospital length of stay, 30-day readmission and mortality.
Results: 129 patients met study criteria. 42.6% required procedural intervention, 21.7% required ICU admission, 18.6% were readmitted, and 6.2% died. Both AAST and Hinchey classifications predicted the need for operation (AAST odds ratios (OR) 1.55, 12.7, 18.09, 77.24 for stage 2-5, respectively, relative to stage 1; Hinchey OR 8.85, 11.49, 22.9 for stage 1b-3, respectively, relative to stage 1a, stage 4 predicted outcome perfectly). For the need for operation, the c-statistics (AUC) for the ROC analysis for AAST and Hinchey were 0.80 and 0.83 for Hinchey and AAST, respectively (p=0.35). The c-statistics curve for complication for AAST and Hinchey were 0.83 and 0.80, respectively (p=0.33). AAST and Hinchey scores were less predictive and did not differ with respect to ICU admission, readmission, and mortality with c-statistics less than 0.80.
Conclusion: AAST grading of acute diverticulitis is equivalent to the modified Hinchey classification system in predicting the need for procedural intervention and complications in acute diverticulitis. The AAST system may be preferable to Hinchey as it can be reliably applied preoperatively and can be applied based upon imaging findings alone. Although this pilot study demonstrated that the AAST score predicts surgical need, a larger, multi-institutional study is required to establish the predictive value of the AAST score for ICU admission, readmission, hospital LOS, and mortality.

EARLY TREATMENT WITH MESENCHYMAL STEM CELL-DERIVED EXOSOMES PROVIDES NEUROPROTECTION AND IMPROVES BLOOD-BRAIN BARRIER INTEGRITY IN A SWINE MODEL OF TRAUMATIC BRAIN INJURY AND HEMORRHAGIC SHOCK

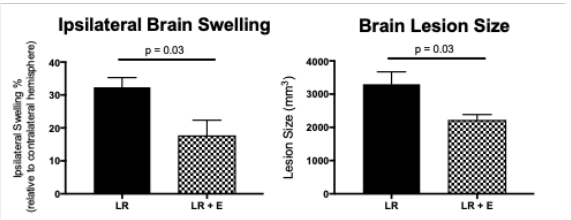
Aaron M. Williams* MD, Jordana F. Brown BS, Umar F. Bhatti MD, Ben E. Biesterveld MD, Vahagn C. Nikolian MD, Nathan J. Graham BS, Kiril Chtraklin DVM, Ali Z. Siddiqui BS, Simone E. Dekker MD,Ph.D., Yuzi Tian MD, Anuska Andjelkovic-Zochowska MD,Ph.D., Ben Buller Ph.D., Hasan B. Alam* MD, University Of Michigan

Invited Discussant: Carrie Sims, MD

Objectives: Administration of human mesenchymal stem cell (MSC)-derived exosomes during the recovery period can enhance neurorestoration in models of traumatic brain injury (TBI) and hemorrhagic shock (HS). Whether early exosome treatment could attenuate the initial brain lesion remains unknown. This study was designed to investigate the impact of early exosome treatment on the severity of brain injury.

Methods: Yorkshire swine were subjected to a severe TBI (12-mm cortical impact) and HS (40% estimated total blood volume). One hour into shock, animals were randomized (n=5/cohort) to receive either lactated Ringer's (LR; 5mL) or LR + exosomes (LR+E: 1×10^{12} exosome particles in 5 mL LR). Animals then underwent additional shock (1 hr) followed by normal saline resuscitation (3x hemorrhage volume). After 6 hours of observation, brain swelling (% increase compared to the uninjured side) and lesion size (mm^3) were assessed. Cerebral hemodynamics and circulating biomarkers of brain injury were compared. Immunofluorescence was used to assess the integrity of the peri-lesional blood-brain barrier (albumin extravasation, tight junction preservation, and laminin expression).

Results: Exosome-treated animals had significantly less ($p < 0.05$) brain swelling (LR: 32.3 ± 2.9%; LR+E: 17.7 ± 4.6%) and smaller lesion size (LR: 3298 ± 374 mm^3; LR+E: 2225 ± 160 mm^3) (Figure). They also had significantly ($p < 0.05$) decreased intracranial pressures and increased cerebral perfusion pressures. In addition, they displayed significantly decreased ($p < 0.05$) albumin extravasation (LR: 45.2 ± 13.8 AUI; LR+E: 17.8 ± 11 AUI) and significantly higher ($p < 0.05$) zona occludens-1 (LR: 19.5 ± 8.4 AUI; LR+E: 28.5 ± 8.5 AUI) and laminin (LR: 21.8 ± 5.3 AUI; LR+E: 28.8 ± 3.1 AUI) expression. Serum glial fibrillary acidic protein levels were also significantly ($p<0.05$) lower in the LR+E group at the end of the experiment.



Conclusions: In a large animal model of TBI and HS, early treatment with MSC-derived exosomes significantly attenuates brain swelling and lesion size, decreases biomarkers of brain injury, and improves blood-brain barrier integrity.

Session XIVB: Papers 54-63
Paper 55: 2:20 PM - 2:40 PM

THE GUT MICROBIOME (GM) IS PREDICTIVE OF CLINICAL OUTCOMES FOLLOWING TRAUMATIC INJURY

Susannah E. Nicholson MD, MS, David M. Burmeister Ph.D., Taylor R. Johnson BS, Zhao Lai Ph.D., Shannon Scroggins MS, Mark DeRosa CRT, Rachelle B. Jonas RN, Ronald M. Stewart* MD, Martin G. Schwacha Ph.D., Donald H. Jenkins* MD, Brian J. Eastridge* MD, University of Texas Health Science Center at San Antonio

Invited Discussant: Jeffrey Claridge, MD, MSc

Introduction: Traumatic injury can lead to a compromised intestinal epithelial barrier, decreased gut perfusion, inflammation and immune derangements. While recent studies indicate that the GM is altered early following traumatic injury, the impact of GM changes on clinical outcomes remains unknown. Our objective of this follow-up study was to determine if the GM is predictive of clinical outcomes in critically injured patients.

Methods: We conducted a prospective, observational study in adult patients (n=67) sustaining severe injury admitted to a Level I Trauma Center. Fecal specimens were collected on admission to the Emergency Department (ED). Microbial DNA was isolated from all fecal samples for 16s rRNA sequencing. GM analysis and taxonomic classification were performed using the QIIME Greengenes 16S rRNA gene database (OTUs; 97% similarity). Alpha and β-diversity were estimated using the observed species metrics. The following clinical outcomes were recorded: mortality, hospital length of stay (LOS), intensive care unit (ICU) LOS, number of days on mechanical ventilation, presence of documented infection (pneumonia, urinary tract infection, bacteremia, wound infection, etc. as documented by positive cultures), and acute respiratory distress syndrome (ARDS; as documented and confirmed by P:F ratio ≤ 300). Statistical analysis of these measures were performed with a permutational analysis of variance (PERMANOVA) for overall significance, with post-hoc pairwise PERMANOVAs to assess differences across groups.

Results: Characteristics of our study population are shown in Table 1. Sex, body mass index (BMI), and injury severity score (ISS) all influence the β-diversity, whereas blunt vs. penetrating trauma does not (Table 2). Beta-diversity on admission differs in patients that died compared to patients that lived regardless of time of death (Table 2; Fig 1; mean time to death = 7.6 days). Significant differences in admission β-diversity were also noted by hospital LOS, ICU LOS and number of days on the ventilator (Table 2). Additionally, differences in admission β-diversity were associated with presence of infection and ARDS during the hospitalization (Table 2). A number of species were enriched in the GM of injured patients that died, which surprisingly included some traditionally probiotic species (Akkermansia muciniphilia, Oxalobacter formigenes, and eubacterium biforme; $p<0.05$).

Conclusion: GM diversity on admission in severely injured patients is predictive of mortality, hospital and ICU LOS, days on mechanical ventilation, and presence of infection and ARDS during the hospitalization. While our study does not address causality, the GM of trauma patients may provide valuable diagnostic and therapeutic targets for the care of injured patients.

	Control	Total
# of subjects	13	72
Age	43	44
# of Females	6 (46%)	23 (31.9%)
# of Blunt		57 (79%)
# of Penetrating		15 (21%)
Mean ISS		21
Mean Shock Index (HR/SBP)		0.96

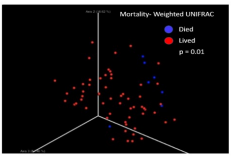


Table 1. Characteristics of our study population reported as means. Shock Index refers to heart rate divided by systolic blood pressure.
Figure 1.A. Principle components analysis (PCA; Weighted UniFrac) on admission in injured patients who died (n=8; blue) compared to injured patients who lived (n=59; red). p= 0.01

β- diversity Measure	Sex	Body Mass Index (BMI)	ISS	Blunt vs. Penetrating	Mortality	Hospital LOS	ICU LOS	Ventilator Days	Presence of Infection	Presence of ARDS
Bray-Curtis	p=0.005*	p=0.025*	p=0.05	p=0.247	p=0.026*	p=0.074	p=0.019*	p=0.033*	p=0.123	p=0.030*
Jaccard	p=0.001*	p=0.207	p=0.088	p=0.123	p=0.016*	p=0.089	p=0.002*	p=0.006*	p=0.089	p=0.029*
Unweighted UNIFRAC	p=0.027*	p=0.605	p=0.273	p=0.368	p=0.053	p=0.11	p=0.022*	p=0.505	p=0.039*	p=0.360
Weighted UNIFRAC	p=0.119	p=0.583	p=0.015*	p=0.219	p=0.010*	p=0.007*	p=0.009*	p=0.101	p=0.205	p=0.074

Table 2. p-values for each of the measured β-diversity indices for sex, BMI, ISS, blunt vs penetrating trauma, mortality, hospital and ICU LOS, ventilator days, and presence of infection and ARDS

Session XIVB: Papers 54-63
Paper 56: 2:40 PM - 3:00 PM

P-SELECTIN ANTIBODY TREATMENT AFTER BLUNT THORACIC TRAUMA PREVENTS PULMONARY ARTERIAL THROMBOSIS WITHOUT SYSTEMIC COAGULATION CONSEQUENCES

Linda M. Schutzman MD, Robert R. Rigor Ph.D., Joseph M. Galante* MD, Ian E. Brown MD,Ph.D., University of California, Davis

Invited Discussant: Amy Makley, MD

Introduction: Thromboembolic events within the pulmonary vasculature remain a major cause of potentially preventable morbidity and mortality after traumatic injury. Currently, the management of this complication is suboptimal as both its prevention and treatment require pharmacologic anticoagulation. Assessment of the risks and benefits of systemic anticoagulation in trauma patients is frequently complicated by the risk of recurrent bleeding from coexisting injuries such as solid organ lacerations or traumatic brain injuries. Previously, in a murine model of blunt thoracic trauma we provided evidence of de novo pulmonary thrombosis associated with an increase in the expression of the cell adhesion molecule, P-selectin. Additionally, we exhibited that systemic administration of a P-Selectin blocking antibody prevented early pulmonary thrombus formation. In this study we perform viscoelastic testing to investigate if P-selectin inhibition has a detrimental impact on normal hemostasis. We hypothesize that P-Selectin blocking antibody will not adversely affect systemic anticoagulation.

Methods: A murine model of medium velocity lateral thoracic trauma was used. Wild type mice were divided into sham control and experimental injury groups. Thirty minutes after trauma, mice were treated with one of the following: P-Selectin blocking antibody, isotype control antibody, low dose heparin, high dose heparin or normal saline. At 90 minutes, whole blood was collected via the inferior vena cava for characterization of coagulation by Viscoelastic Coagulation Monitor (VCM VetTM; Entegrion, Durham, NC), a variation of standard thromboelastography. Mean clotting time, clot formation time, clot kinetics (alpha-angle) and maximum clot firmness were compared between each treatment group.

Results: In both sham and trauma groups, compared to vehicle (normal saline) alone, no statistical difference was noted in any coagulation parameters after injection with P-selectin antibody, isotype control, or low dose heparin. In contrast, mice that received high dose heparin had significantly longer clotting times ($p<0.001$), clot formation times ($p<0.001$), lower alpha angles ($P<0.001$) and lower clot firmness ($P<0.001$). Notably, in mice subject to trauma we found that P-selectin antibody treated group had a significantly higher alpha-angle ($P<0.05$) compared to either the low dose or high dose heparin treatment groups ($p<0.05$; T-test).

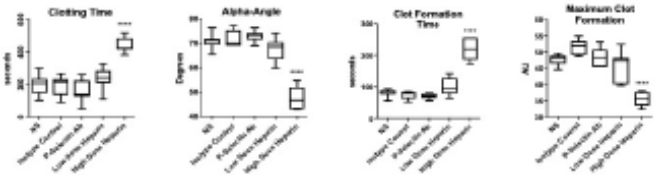


Figure 1 : Viscoelastic testing results 90 minutes after trauma (n=7-8 in each group).

Conclusion: Administration of P-Selectin blocking antibody did not adversely affect systemic anticoagulation as measured by viscoelastic testing. Additionally, when compared to both prophylactic and treatment doses of heparin, P-selectin inhibition had less anticoagulant effect on clotting kinetics as demonstrated by a higher alpha-angle. This data further endorses P-selectin inhibition as a potentially effective and targeted therapy that may circumvent the complications associated with pharmacologic anticoagulation.

A GENOMICS JOURNEY TO IMPROVED UNDERSTANDING OF POST-INJURY PLATELET BIOLOGY: PLATELET RNA SIGNATURES IN TRAUMATIC BRAIN INJURY

Lucy Z. Kornblith MD, Alexander T. Fields Ph.D., Rachael A. Callcut* MD, Mitchell J. Cohen* MD, Cedric M. Bainton Roland J. Bainton MD,Ph.D., University of California, San Francisco

Invited Discussant: Martin Schreiber, MD

Introduction: Nearly half of injured patients show evidence of impaired platelet aggregation *in vitro*, most common in those who have severe injury, brain injury, and in those who do not survive. The underlying mechanism of this impairment is not well understood, and is not explained simply by loss of circulating platelets. Platelets are endowed by their megakaryocyte mothers with immature messenger RNAs (mRNAs) as well as RNA editing and protein synthesis machinery, allowing platelets to alter their functions based on physiologic signals. Thus, platelet genomics may provide an upstream understanding of the pathways involved in downstream impairments in platelet function brought about by the physiologic insult of trauma. As proof of concept, we sought to investigate platelet RNA signature discoverability in cell free plasma (CFP). We hypothesized that there are alterations in platelet specific RNA signatures in patients with severe isolated traumatic brain injury (TBI) vs. healthy controls. **Methods**: High throughput RNA sequencing with unsupervised clustering and high read depth (~20 million reads per sample) were applied to CFP samples that were prospectively collected from 10 patients with isolated severe TBI (AIS head score ≥3, AIS all other categories <3) at a single Level 1 Trauma Center from 2005-2011. Publicly available data from the CFP of 23 healthy control patients was used to statistically center and filter the trauma patient data. Classification and organospecific transcriptome enrichment comparisons were used to provide statistical power for identifying platelet specific RNA signatures in TBI vs. healthy controls. **Results**: A total of 40 differential platelet RNA signatures were discovered in patients with isolated severe TBI vs. healthy controls. The top ten upregulated and downregulated candidate platelet gene signatures discovered in TBI patients vs. healthy controls are listed in the **Table**. TBI patients had both upregulated and downregulated platelet specific gene products with up to a 36-fold increase and a 296-fold decrease in frequency per thousand mapped reads in the top candidate platelet specific genes (**Table)**. **Conclusion**: Using high throughput RNA sequencing, we have discovered a list of 40 candidate platelet RNA signatures in cell free plasma from TBI patients that are upregulated or downregulated compared to healthy controls.This proof-of-concept novel finding may indicate that during injury-stimulated platelet activation, a pool of resident pre-mRNAs may undergo modifications including splicing events for modulation of protein expression involved in platelet function. This supports our future focus on injury induced modulated platelet transcripts in both cell free plasma and isolated platelets to identify candidate genes that map to alterations in post-injury platelet function and may be used as a 'liquid biopsy' for refining targeted treatments in post-injury hemorrhage.

Table. Top Differentially Discovered Platelet Genes in Cell-Free Plasma (CFP) from TBI vs. Control Patients.

Geneid	Gene Product	Function	CFP Rank	Plt Rank	FC vs Control
HIST1H2AG	Histone H2A type 1	Chromatin organization	8468	1129	35.666
RPS16	40S Ribosomal Protein S16	Translation	259	3207	9.140
PF4	Platelet Factor 4	Chemokine	2694	13	8.840
PPBP	Platelet Basic Protein	Chemokine	139	1	5.746
RPS25	40S Ribosomal Protein S25	Translation	91	3390	3.288
SKA2	Spindle and Kinetochore Associated Protein 2	Microtubule binding, mitosis	1134	11179	-31.184
SRSF6	Ser/Arg-rich Splicing Factor 6	Alternative splicing	1080	1107	-31.590
GPCPD1	Glycerophosphocholine phosphodiesterase	Metabolism, muscle development	3673	4802	-40.018
BAG6	Large Proline Rich Protein	Apoptosis, NK cell activation	2447	4560	-238.697
SLAMF7	SLAM Family Member 7	Immunity	1995	4471	-296.421

CFP rank was determined by comparing frequency per thousand mapped reads (FPKM) in CFP to that found in brain. Platelet (Plt) rank was determined by comparing FPKM from isolated Plt to that found in brain tissue. Fold change (FC) vs control was determined by the ratio of a gene's FPKM in TBI CFP to its FPKM in control CFP. The negative reciprocal of ratios less than one (i.e., FPKM in control higher than TBI) was used to convert those values to fold change.

Session XIVB: Papers 54-63
Paper 58: 3:20 PM - 3:40 PM

THE AAST PROSPECTIVE, OBSERVATIONAL, MULTICENTER STUDY INVESTIGATING THE INITIAL EXPERIENCE WITH REVERSAL OF NOVEL ORAL ANTICOAGULANTS IN TRAUMA PATIENTS

Brent Emigh MD, Leslie Kobayashi* MD, Miroslav Kopp MD, Mitch Daley PharmD, James Haan* MD, Clay Cothren Burlew* MD, Raminder Nirula* MD, Forrest Moore* MD, Sigrid Burruss MD, Stephen Kaminski* MD, Julie Dunn* MD, Matthew Carrick* MD, Thomas Schroeppel* MD, Carlos V. Brown* MD, AAST Multicenter Novel Oral Anticoagulants Group Dell Medical School, The University Of Texas At Austin

Invited Discussant: Sandro Rizoli, MD

Introduction: Novel oral anticoagulants (NOACs) such as direct thrombin inhibitors (Dabigatran) and Factor Xa inhibitors (Apixaban, Rivaroxaban, Edoxaban) have essentially replaced warfarin as the drug of choice in patients requiring anticoagulation. This has led to an explosion of injured patients presenting to trauma centers while taking NOACs. In 2013, 4-factor concentrates were approved for NOAC reversal, in 2015 Idarucizumab was approved for Dabigatran reversal, and in 2018 Andexanet Alfa was approved for Factor Xa inhibitor reversal. We hypothesized that recent approval of these reversal agents would lead to increased utilization as well as improved outcomes for trauma patients taking NOACs.

Methods: This was a multicenter, prospective (2015-2018), observational study of all adult trauma patients taking NOACs who were admitted to one of fifteen participating Level 1 trauma centers. Variables included demographics, admission physiology, injury pattern (AIS) and severity (ISS), type of NOAC, and treatment with reversal agent. The primary outcome was mortality.

Results: 606 patients taking NOACs were included, with an average age of 75 years old. The most injured body regions were the head (AIS=1.5), extremities (AIS=1.2), and chest (AIS=0.66). Distribution of NOACs were Apixaban (47%), Rivaroxaban (45%), Dabigatran (8%), and Edoxaban (0.3%). Only 13% of patients taking NOACs received a reversal agent. The most common reversal agents were factor concentrates (87%), Idarucizumab (12%), and Andexanet Alpha (1%). Those who received a reversal agent were older (78 vs. 74, $p=0.007$), more severely injured (ISS: 16 vs. 7, $p<0.0001$), and had more severe head injuries (Head AIS: 2.9 vs. 1.3, $p<0.0001$). Patients who were reversed had a higher mortality (12% vs. 3%, $p=0.0009$) but after logistic regression reversal was not independently associated with mortality ($p=0.42$). When comparing patients who received factor concentrates to those who received drug-specific reversal agents, there was no difference in demographics, admission physiology, injury pattern or severity, but those who received drug-specific agents had a higher mortality (30% vs. 8%, $p=0.04$). After logistic regression, receiving a drug-specific reversal agent was independently associated with mortality (OR 14.8, 95%CI 1.4-155.6, $p=0.02$).

Conclusion: The vast majority of trauma patients taking NOACs do not receive a reversal agent. Those who do have their NOAC reversed usually receive a factor concentrate and only 13% receive one of the currently available drug-specific reversal medications. Patients who received reversal were more severely injured, sustained more severe head injuries, and had a four-fold higher mortality. The subgroup of patients who received a drug-specific reversal agent had a higher mortality and receiving a drug-specific reversal agent was independently associated with mortality.

Session XIVB: Papers 54-63
Paper 59: 3:40 PM - 4:00 PM

GERIATRIC TBI: WHAT WE KNOW NOW

Mira H. Ghneim MD, Deborah M. Stein* MD,MPH, Jennifer Albrecht Ph.D., Desmond Khor MD, Jill B. Watras* MD, James M. Haan* MD, Robert D. Winfield* MD, Sasha D. Adams* MD, Scott B. Armen* MD, Fady S. Nasrallah* MD, Julie Dunn* MD, MS, Thomas J. Schroeppel* MD, MS, Zara Cooper* MD, MSc, Karen Brasel* MD, AAST
MITC Geri-TBI Study Group* R Adams Cowley Shock Trauma Center

Invited Discussant: Mayur Patel, MD, MPH

Introduction: Traumatic brain injury (TBI)-related hospitalizations and fatalities in elderly patients will continue to increase as the world's population ages. Although guidelines for the treatment of TBI have been established, they do not address the special challenges of managing TBI in older patients. The aim of the study was to describe the epidemiology and current management of a large population of geriatric patients with isolated TBI treated in trauma centers and make comparisons across age groups.

Methods: This is a prospective multi-center observational study of patients across 43 trauma centers. Inclusion criteria were age ≥40 years, and computed tomography (CT)-verified TBI. Patients with any other body region injury abbreviated injury scale score (AIS) >2 and presentation at enrolling center >24 hours after injury were excluded. Demographic, clinical, injury, and outcome information was collected. Age was categorized by distribution into three categories representing the bottom quartile (group 1, 40-59 years, n=776), the middle two quartiles (group 2, 60-81 years, n=1,454) and the top quartile (group 3, >81 years, n=849). Differences in distributions of variables between age categories were tested using Chi-square Goodness of Fit, and Anova or the Kruskal-Wallis test for continuous variables. We conducted additional similar analyses, restricting to patients with moderate and severe TBI, defined as Glasgow Coma Scale Score (GCS) <13.

Results: A total of 3,081 patients were enrolled over a 14-month period. Mean age was 70 (±14.1) years, 55% were males, 73% white non-Hispanic, and 79% of the patients presented with an AIS-head score of ≥ 3. **(Table 1)** Upon stratification into age groups, the 3 groups were similar with respect to head AIS, but the older age groups had a shorter ICU length of stay (LOS), fewer days of mechanical ventilation and more palliative care interventions. Older patients were less likely to undergo intracranial pressure monitoring and neurosurgical interventions. There was a trend toward increased in-hospital mortality and older patients were less likely to be discharged home or return to preinjury level with limited restrictions on outpatient follow-up. **(Table 2)** When the analysis was restricted to the subgroup with moderate to severe injury (n=711), the same results were found. Mortality rates increased by age cohort and older patients were less likely to be discharged home. **(Table 3)**

Table 1. Injury and Outcomes Adults age>40 with TBI	
Falls	79%
Subdural Hematoma	64%
GCS *	14 (13,14)
ICP Monitoring	135(4%)
Neurosurgical Intervention	307 (10%)
Hospital LOS	6.3 ±7.7 days
ICU LOS	4.5 ±7 .8 days
Mortality	306 (10%)
Discharge home	1522 (49%)

Table2. Outcomes per Age Group	40-59 (n=776)	60-80 (n=1,454)	>81 (n=849)
ICU LOS*	5.5±7	4.6 ±6.5	3.4±3.5
Ventilator days*	6.9±9.1	6.9±7.5	4.5±3.5
ICP monitoring*	9%	4%	1%
Neurosurgical Intervention	13%	10%	8%
Palliative Interventions*	6%	11%	22%
Mortality	8%	10%	12%
Discharge home*	64%	53%	35%
Pre-injury functional level*	64%	54%	44%

* p<0.001

Table 3. Outcomes in moderate to severe cohort (GCS<13)	40-59 (n=250)	60-80 (n=302)	>81 (n=159)
ICP Monitoring*	24%	16%	6%
Neurosurgical Intervention*	28%	27%	12%
Hospital LOS*	12.5± 12.1	11.0±11.2	6.3± 6.9
Palliative Intervention*	17%	35%	57%
Mortality#	24%	37%	40%

* p<0.001, # p=0.001

Conclusion: Despite the public health burden, studies of elderly patients with TBI are uncommon. This large observational study is the first to describe a modern population of older patients with isolated TBI and their management. Comparisons by age reveal expected findings of overall worse outcomes in older patients. The differences observed by age provide the basis and background needed to design management strategies and interventions that can be targeted to older patients with TBI.

Session XIVB: Papers 54-63
Paper 60: 4:00 PM - 4:20 PM

THE AMERICAN ASSOCIATION FOR THE SURGERY OF TRAUMA (AAST) RENAL INJURY GRADING SCALE: IMPLICATIONS OF THE 2018 REVISIONS FOR INJURY RECLASSIFICATION AND PREDICTING BLEEDING INTERVENTIONS

Sorena Keihani MD, Bryn E. Putbrese MD, Douglas M. Rogers MD, Kaushik Mukherjee* MD, Sarah Majercik MD, Christopher M. Dodgion* MD, Scott A. Zakaluzny* MD, Brian P. Smith* MD, Jurek F. Kocik* MD, Matthew M. Carrick* MD, Reza Askari* MD, Raminder Nirula* MD, Jeremy B. Myers MD, AAST Multi-Institutional Trials Committee

Invited Discussant: Fernando Kim, MD

Introduction: In 2018, the original 1989 AAST Renal Injury Scaling was revised to better characterize high-grade renal trauma (HGRT) and reflect the increased reliance on CT scans and non-operative management of renal injuries. However, it is unknown how the 2018 revisions (2018-AAST) will change the grading of HGRT and if this revised grading outperforms the original 1989 grading (1989-AAST) in predicting the bleeding interventions. We aimed to contrast injury grades between the two grading systems and to compare each scale's ability to predict the need for bleeding interventions.

Methods: Data on high-grade renal trauma (AAST grades III-V) were collected from 14 Level-1 trauma centers from 2014-2017. Patients with initial CT scans were included. Two radiologists, blinded to the grades submitted by each center and outcomes, reviewed the scans to re-grade the injuries according to the 1989 and 2018 AAST grading. Descriptive statistics were used to assess the reclassifications. Mixed-effect logistic regression with clustering by facility was used to measure the predictive power of each classification in a multivariable model adjusted for age, sex, and injury severity score. The areas under the curves (AUCs) were compared.

Results: 322 patients were included. Overall, 46 patients underwent bleeding interventions including 19 renal angioembolization, 15 nephrectomies, and 12 other open procedures. Using the 2018-AAST, 87 (27.0%) of injuries were upgraded, 11 (3.4%) were downgraded, and 224 (69.5%) were unchanged. Of the injuries graded as III using the 1989-AAST, 33.5% were upgraded to grade IV using the 2018-AAST grading, mostly because of segmental renal artery or vein injury. Of the injuries graded as IV using the 1989-AAST the majority (96.3%) remained the same. Of grade V injuries, 58.8% were downgraded using the 2018-AAST due to changes in the definition of shattered kidney and also the requirement for active bleeding in a devascularized kidney to be considered grade V. When compared to grade III, both grade IV and V injuries had higher odds of undergoing intervention in the 2018-AAST grading. For the 1989-AAST grading, only grade V had significantly higher odds for intervention. The odds ratios from multivariable models are presented in Table-1. There was no difference in the AUC between the 2018-AAST and 1989-AAST grading (0.72, 95% CI: 0.64-0.79 vs. 0.68, 95% CI: 0.59-0.76) [Figure-1].

Conclusion: The 2018-AAST grading provides more precise definitions for HGRT and also includes radiographic findings such as active bleeding. These changes result in a better classification of grade IV and V injuries by focusing on bleeding risk. However, these revisions increase the heterogeneity for grade IV injuries mostly by including segmental vascular injuries without active bleeding. Compared to the 1989-AAST grading, the 2018-AAST did not significantly improve the overall prediction for bleeding interventions. The 2018-AAST grading eliminates ambiguity in many cases of renal trauma and should serve as an anatomic description rather than a prognostic tool.

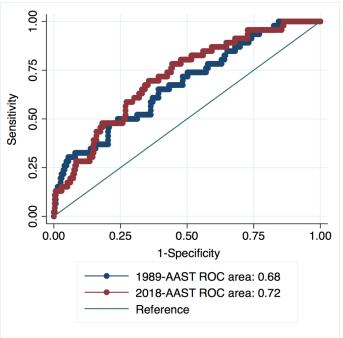


Table-1: Multivariable models comparing the 1989 and 2018 AAST renal injury grading for prediction of bleeding interventions after HGRT.

	Original AAST (1989)		Revised AAST (2018)	
Predictors	OR (95% CI)	P-value	OR (95% CI)	P-value
Renal injury grade				
Grade III	1.00 (Reference)	---	1.00 (Reference)	---
Grade IV	1.81 (0.78 – 4.22)	0.17	3.04 (1.43 – 6.45)	0.004
Grade V	9.00 (2.78 – 29.20)	<0.001	12.03 (2.52 – 57.53)	0.002
Age	1.01 (0.99 – 1.03)	0.40	1.01 (0.98 – 1.02)	0.78
Male Sex	3.76 (1.30 – 10.88)	0.01	3.21 (1.14 – 9.06)	0.03
Injury Severity Index	1.02 (0.99 – 1.05)	0.09	1.03 (1.00 – 1.06)	0.03

Session XIVB: Papers 54-63
Paper 61: 4:20 PM - 4:40 PM

EXTRA-PERITONEAL PACKING IN UNSTABLE BLUNT PELVIC TRAUMA, A PROPENSITY SCORE ANALYSIS

Simone Frassini Shailvi Gupta MD,MPH, Stefania Cimbanassi MD, Stefano Granieri Fabrizio Sammartano MD, Thomas M. Scalea* MD, Osvaldo Chiara MD, Universita' Degli Studi Di Milano - ASST Niguarda Hospital

Invited Discussant: Joergen Joakim Joergensen, MD

Introduction:

Hemodynamically unstable pelvic fractures often require a multi-modal approach including both operative and endovascular management. While an important adjunct in hemorrhage control, time to angioembolization (AE) even at the most advanced trauma centers may take hours. Extra-peritoneal packing (EPP) is a fast and effective procedure that can immediately address pelvic hemorrhage from the retroperitoneal space in severe pelvic injuries. The aim of this study is to evaluate the efficacy of early EPP in mortality and hemodynamic stability in unstable blunt pelvic trauma.

Methods:

All trauma patients admitted to an urban Level I trauma center were evaluated from 2002 – 2018. Inclusion criteria were patients >= 14 years old who sustained blunt trauma with pelvic fractures and hemodynamic instability (systolic blood pressure < 90 mmHg). Exclusion criteria were a concomitant head injury (AIS >3) and patients with extra-pelvic injury who underwent resuscitative thoracotomy. The patient population was divided into two groups: an EPP group and a no-EPP group. Our institution's practice it to perform extra-peritoneal packing in the trauma bay if necessary. Propensity score analysis (PSA) using quasi-randomization was used to adjust for differences in baseline characteristics in the two groups. A one-to-one matched analysis using nearest-neighbor matching was performed based on the estimated propensity score of each patient. A match occurred when one patient in the EPP group had an estimated score within 0.1 standard deviation (SD) of another in the no-EPP group.

Results:

Eight hundred and sixty-six of 8374 major trauma patients presented with a pelvic fracture (10.3%). Two-hundred forty four patients presented with a hemodynamically unstable pelvic fracture (180 no EPP, 64 EPP). With propensity score matching, thirty-seven patients in each group were analyzed. Survival within the first 24 hours was significantly improved in the EPP group (81.1% vs. 59.5%, p=0.046). Overall survival was significantly improved in the EPP group (78.4% vs. 56.8%, p=0.05). Those patients who underwent early EPP (n=64) had a significant improvement in hemodynamic stability, with a pre-EPP mean arterial pressure (MAP) of 49.1 mmHg and post-EPP MAP of 68.8 mmHg ($p < 0.01$).

Conclusion:

EPP is an effective procedure that can be performed immediately to improve hemodynamic stability and overall survival in patients who sustain severe blunt pelvic trauma. The early use of EPP can be life saving in those facilities without immediate access to endovascular options.

Session XIVB: Papers 54-63
Paper 62: 4:40 PM - 5:00 PM

IMPLEMENTATION OF A MULTIDISCIPLINARY PERINATAL EMERGENCY RESPONSE TEAM (PERT) IMPROVES TIME TO DEFINITIVE OBSTETRICAL EVALUATION AND FETAL ASSESSMENT IN PREGNANT TRAUMA PATIENTS

Amanda B. Sosulski MD, Jennifer Smith MD, Ramy Eskander MD, Ashkan Moazzez MD,MPH, Neil Patel MD, Brant A. Putnam* MD, Dennis Y. Kim* MD, Harbor-UCLA Medical Center

Invited Discussant: Tanya Zakrison, MD, MPH

Introduction: Trauma is the leading cause of non-obstetric death during pregnancy and is associated with an increased risk of maternal mortality. Fetal demise may be as high as 60% following major trauma and 80% in the presence of maternal shock. In an effort to improve the coordination and delivery of timely, efficient, and organized care for pregnant trauma patients, we developed an institutional multidisciplinary quality initiative designed to improve response times of non-trauma specialists and ensure immediate availability of resources. We hypothesized that implementation of PERT would improve time to patient evaluation by the obstetrics (OB) team and maternal/fetal outcomes.

Methods: We performed a 6-year (2012-2018) retrospective cohort analysis of consecutive pregnant trauma patients presenting to our university-affiliated, county Level 1 trauma center. Patients in the pre-PERT cohort (prior to April 2015) were compared to a post-PERT cohort. Variables analyzed included patient demographics, mechanism of injury, injury severity score (ISS), trimester of pregnancy, and level of trauma activation. The main outcome measure was time to OB evaluation. Secondary outcomes included time to fetal heart rate (FHR) monitoring, time to admission, length of stay (LOS), complications, and mortality.

Results: Of 92 pregnant trauma patients, there were 50 patients (54.3%) in the pre-PERT cohort and 42 (45.7%) in the post-PERT group. There were no significant differences between groups regarding demographics including, age, race, ISS, and mechanism of injury. Blunt injuries predominated (98.9%), with the most common mechanism being motor vehicle collisions (76.1%), followed by assaults (13%), and falls (6.5%). There was a significant decrease in Level 1 (highest tier) activations pre- and post-PERT (46% vs. 21%, p=0.01), which was accompanied by a concomitant increase in the use of lower tier trauma consultation criteria to activate the trauma team (38% vs. 69%, p= 0.002).The mean time to OB evaluation was 44 minutes in the pre-PERT cohort compared to 14 minutes in the post-PERT cohort (p = 0.001) Time to FHR monitoring was also significantly decreased post-PERT implementation (72 vs. 37 minutes, p=0.002) There were no significant differences between groups regarding time to admission (135 vs. 170 minutes, p=0.15), complications, or LOS. There were no reported mortalities.

Conclusion: Implementation of a multidisciplinary perinatal early response team improves time to evaluation by the obstetrics team and time to fetal heart monitoring which has the potential to translate into improved care for both mother and fetus post-injury. Further research is required to determine if the costs and resources associated with PERT activation are offset by a decrease in overtriage rates and higher-tier trauma activations.

Session XIVB: Papers 54-63
Paper 63: 5:00 PM - 5:20 PM

OPIOID RISK TOOL CAN IDENTIFY PATIENTS WITH INCREASED INPATIENT OPIOID USE AFTER A TRAUMATIC INJURY

Husayn A. Ladhani MD, Kristen J. Conrad-Schnetz DO, Brian T. Young MD, Sarah E. Posillico MD, Esther S. Tseng MD, Vanessa P. Ho MD,MPH, Jeffrey A. Claridge* MD, MS MetroHealth Medical Center

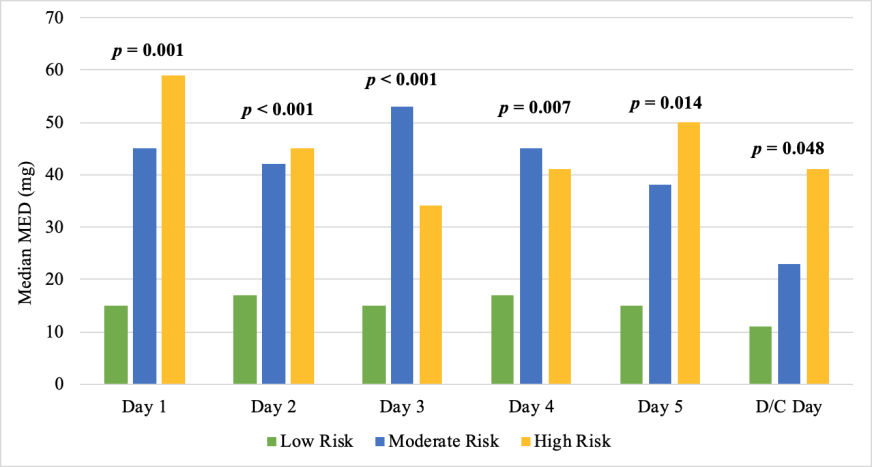
Invited Discussant: Andrew Bernard, MD

Introduction: The Opioid Risk Tool (ORT) is a screening test used for identifying patients with chronic pain at risk for opioid abuse. Its utility in predicting inpatient opioid use for acute pain is unknown. We hypothesized trauma patients deemed high risk by the ORT would require more inpatient opioid pain medication (OPM).

Methods: Trauma floor patients were prospectively evaluated from 11/2017 to 2/2018. Patient and injury characteristics, injury severity score (ISS), length of stay (LOS), and discharge data were obtained. ORT was completed within 24 hrs of floor admission, which classified patients into low, moderate, or high risk groups. Daily OPMs in morphine equivalent doses (MEDs) and non-opioid pain medications (NOPM) were recorded for floor days 1 to 5, and day of discharge. Groups were compared to identify differences in injury characteristics, OPM and NOPM use as inpatient and prescribed at discharge. Kruskal-Wallis and Chi-square tests were used.

Results: 350 consecutive patients were included: median age 59 yrs (IQR 33-76), male 62%, and median ISS 12 (IQR 9-17); 85% had a blunt mechanism. ORT was completed for 262 (75%) patients; 139 low, 73 moderate, and 50 high-risk. The three groups significantly differed in age, gender, and mechanism of injury (all $p<0.001$), without a difference in ISS, LOS, or discharge disposition. Median MED ranged between 11-59mg and differed significantly between the three groups for all inpatient days (see Figure). Groups had similar inpatient NOPM use (94% vs. 93% vs. 92%, $p=0.935$), discharge MEDs (113mg vs. 180mg vs. 210mg, $p=0.174$), and discharge NOPMs (70% vs. 74% vs. 76%, $p=0.733$).

Conclusion: The ORT is associated with increased inpatient OPM use after a traumatic injury. Efforts targeted towards early identification and interventions for patients at risk may help prevent future opioid abuse.



Session XV: Papers 64-66
Paper 64: 8:00 AM - 8:20 AM

EFFECT OF ORAL ANTICOAGULANTS ON OUTCOMES FOLLOWING SEVERE TRAUMATIC BRAIN INJURY IN THE ELDERLY

Jason P. Hecht PharmD, Zachary LaDuke PharmD, Anne H. Cain-Nielsen MS, Mark R. Hemmila* MD, Wendy L. Wahl* MD, St. Joseph Mercy Hospital, Ann Arbor

Invited Discussant: Rosemary Kozar, MD, PhD

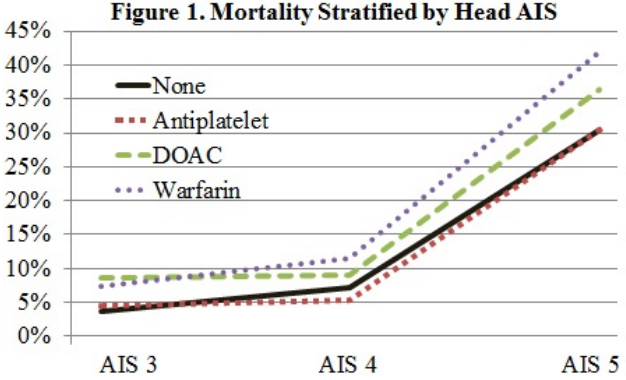
Introduction: Anticoagulant agents are prescribed for atrial fibrillation and venous thromboembolism with increasing use in the elderly population. Vitamin K antagonists like warfarin have been the historical oral anticoagulants of choice, however, upwards of 50% of all new oral anticoagulant prescriptions are for direct oral anticoagulants (DOAC). Despite this change in prescribing practices, outcome data remains scarce following a severe traumatic brain injury (TBI) on these new agents.This study sought to evaluate in-hospital outcomes of elderly patients with severe traumatic brain injuries and the effect of pre-injury anticoagulants.

Methods: Patient records were obtained from 29 level 1 and 2 trauma centers in the Michigan Trauma Quality Improvement Program (MTQIP) from 2012 to 2018. Overall, 8312 patients were included who were ≥ 65 years old, suffered a fall, and had an abbreviated injury score - head (AIS-head) of ≥ 3. Pre-injury anticoagulant and antiplatelet agents were identified. Outcomes included hospital mortality or hospice, length of stay (LOS) and serious in-hospital complications.

Results: Of the 8312 patients 3293 were on antiplatelet agents (AP), 1083 on warfarin (VKA), 304 on DOAC, and 3632 on no agents (none). The mean AIS-head of all patients was 3.78. There were 298 (27.5%) patients in the VKA group who died or were hospice as compared to 65 (21.4%) in the DOAC group (p=0.03).

Mortality was then stratified by pre-injury agent and AIS-head score (**Figure 1**). After adjusting for patient factors there was an increased risk of mortality or hospice in the VKA group as compared to the none group (OR 1.61; 95% CI 1.29 – 2.00) that was not seen in the AP (OR 1.13; 95% CI 0.94 – 1.36) or DOAC group (OR 1.35; 95% CI 0.92 – 1.97). The risk of serious complications was increased for the VKA (OR 1.39; 95% CI 1.08 – 1.79) and AP groups (OR 1.30; 95% CI 1.06 – 1.58) but not observed in the DOAC group (OR 1.41; 95% CI 0.89 – 2.22). Hospital LOS was a mean of 6.7 days in the warfarin group, 5.7 days for DOAC, and 5.6 days for both the AP and none groups (p<0.001).

Figure 1. Mortality Stratified by Head AIS



Conclusion: In elderly severe TBI patients pre-injury DOAC patients had statistically lower mortality or hospice and hospital LOS than warfarin despite the lack of a dedicated reversal agent. After adjusting for patient factors both agents had similar increases in mortality and serious complications. Results of this study should help alleviate concerns amongst providers when prescribing DOAC agents to elderly patients.

Session XV: Papers 64-66
Paper 65: 8:20 AM - 8:40 AM

TIMING AND TYPE OF VTE CHEMOPROPHYLAXIS IS ASSOCIATED WITH ACUTE TRAUMATIC BRAIN INJURY OUTCOMES

Darwin Ang* MD,MPH,Ph.D., Mark McKenney* MD, Matthew Carrick* MD, Stephen Flaherty* MD, Patrick Offner* MD, Ernest Gonzalez* MD, Roger Nagy* MD, John Armstrong* MD, David Plurad* MD, David Acuna* MD, Mathis Adams MD, Nicole Tapia MD, Ocala Regional Medical Center

Invited Discussant: Elliott Haut, MD, PhD

Introduction:Patients with traumatic brain injury (TBI) pose a unique challenge as it is unclear when the optimal timing is to start chemoprophylaxis for venous-thromboembolic events (VTE). The purpose of this study was to determine the optimal timing and type of chemoprophylaxis for TBI patients.

Methods:This is a retrospective cohort study (2013-2018) from 87 trauma centers across the United States. The patient population consisted of those with TBIs. Patients were excluded if they were on outpatient anticoagulation. The primary outcomes were in-hospital mortality and VTE events. The exposure groups were low molecular weight heparin (LMWH) and unfractionated heparin (UFH). Data was then further stratified by timing of initiation of the VTE prophylaxis. The outcomes were risk adjusted using multivariable regression for age, gender, injury status (penetrating vs. blunt), injury severity, and patient comorbidities.

Results:A total of 61,783 patients with TBI were included in the study. The majority of patients did not receive chemoprophylaxis 52,751 (85.4%), while 7,116 (11.5%) were treated with UFH, and 1,711 (2.8%) were treated with LMWH. Compared to TBI patients without VTE prophylaxis, patients on LMWH had lower mortality, aOR 0.23 (95% CI 0.15, 0.35) and had higher VTE, aOR 2.01 (95% CI 1.31, 3.08). Patients on UFH did not have significant decrease in mortality aOR 0.96 (95% CI 0.87, 1.07) and had higher VTE aOR 13.58 (95% CI 8.56, 21.56). When stratified by timing of administration, mortality benefit was seen if LMWH was given within 6 hours of admission, aOR 0.25 (95% CI 0.09, 0.66). This benefit persisted past 6 hours and continued past 72 hours. VTE was also lower if LMWH was given within 24-48 hours (0% VTE, n = 266 patients). VTE remained significantly higher in the UFH cohort regardless of timing of administration.

Conclusion:Mortality and VTE events among TBI patients may be associated with both type and timing of VTE prophylaxis. The use of LMWH has a beneficial association with both outcomes. Optimal timing of administration appears to be between 24 and 48 hours of hospital admission.

Session XV: Papers 64-66
Paper 66: 8:40 AM - 9:00 AM

REPEAT CT HEAD SCAN IS NOT INDICATED IN TRAUMA PATIENTS TAKING NOVEL ANTICOAGULATION: A MULTI-INSTITUTIONAL STUDY

Caitlin Cohan MD, Genna Beattie MD, Jessica Cox MD, Joseph Galante MD, Amy M. Kwok MD,MPH, Rachel C. Dirks Ph.D., Gregory Victorino* MD, University of California San Francisco - East Bay

Invited Discussant: Bellal Joseph, MD

Introduction: Guidelines for imaging anticoagulated patients following traumatic injury are unclear. An interval CT head (CTH) is commonly performed after an initial negative CTH to assess for delayed intracranial hemorrhage (ICH-d). The rate of ICH-d is low in those taking warfarin and largely unknown in those taking novel anticoagulants (NOACs). Specifically, the clinical outcomes for patients taking NOACs who develop ICH-d remain unknown. NOACs have less interactions with other medications and in the non-traumatic setting, appear to have a better safety profile than warfarin. We hypothesized that patients taking NOACs would have a lower rate of ICH-d than those on warfarin and more favorable clinical outcomes when ICH-d occurred.

Methods: Anticoagulated patients presenting with blunt trauma to multiple level I trauma centers between 2016 and 2018 were evaluated. Patients with intracranial hemorrhage on initial CTH and those taking non-oral anticoagulation or antiplatelet agents alone (without warfarin or NOAC) were excluded. Outcomes included: ICH-d, administration of reversal agents, neurosurgical intervention, readmission, and death. Multivariable regression was performed to evaluate for patient factors associated with development of ICH-d.

Results: A total of 739 patients met inclusion criteria. Patients were divided into a warfarin only group (n=409) and NOAC only group (n=330). The average age was 76 years old with 49% males. Repeat CTH was performed in 52% of cases. The incidence of ICH-d identified by repeat CTH in the NOAC group was 2.5% (4/159) vs. 4% (9/224) in the warfarin group, p=0.42. ICH-d did not result in neurosurgical intervention or death for those taking NOACs. When evaluating the entire NOAC group, including those without a repeat CTH, there were no neurosurgical interventions or deaths related to head injury. In the entire warfarin group, there was one neurosurgical intervention and 2 deaths due to head injury. Reversal agents were administered in 1.8% (6/330) of patients in the NOAC group versus 13.7% (56/409) in the warfarin group, p<0.01. On multivariate regression analysis of both groups, male sex (OR 18.6, p=0.03) and AIS head ≥2 (OR 25.4, p=0.04) were strongly associated with development of ICH-d.

	NOAC	Warfarin	p
Repeat CTH (%)	48	55	0.07
ICH-d (%)	2.5	4	0.42
Reversal Agent Administered (%)	1.8	13.7	<0.01
Neurosurgical Intervention (n)	0	1	N/A
Readmission (%)	4.2	1	0.06
Deaths from Head Injury (n)	0	2	N/A

Conclusion: To our knowledge, this is the largest study of patients on NOACs assessing clinical outcomes following ICH-d. In the NOAC group, ICH-d occurred only 2.5% of the time when CTH was routinely repeated. Regardless of routine repeat CTH, none of the patients taking NOACs required neuro-intervention or died as a result of their head injury. Our findings suggest NOACs may have a better safety profile following trauma compared to warfarin and repeat CTH is not indicated for those on NOACs.