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

BETA BLOCKERS IN CRITICALLY ILL PATIENTS WITH TRAUMATIC BRAIN INJURY: RESULTS FROM A MULTI-CENTER, PROSPECTIVE, OBSERVATIONAL AAST STUDY

Eric J. Ley* MD, Samuel D. Leonard BS, Kenji Inaba* MD, Ali Salim* MD, Karen R. O'Bosky MD, Danielle Tatum Ph.D., Hooman Azmi MD, Chad G. Ball* MD, Paul T. Engels* MD, Julie A. Dunn* MD, Matthew M. Carrick* MD, Jonathan P. Meizoso MD, Sarah Lombardo MD, Thomas J. Schroeppel* MD, Sandro Rizoli* MD,Ph.D.,
Cedars-Sinai Medical Center

Invited Discussant: Saman Arbabi, MD, MPH

Introduction: The class of medications that inhibit endogenous catecholamines interaction with beta adrenergic receptors, called beta blockers, is often administered to patients hospitalized after traumatic brain injury (TBI). Small observational trials demonstrate favorable outcomes related to beta blocker use and recent data demonstrates lower mortality when patients routinely receive early propranolol after TBI. We tested the hypothesis that beta blocker use after TBI is associated with lower mortality, and secondarily compared propranolol to other beta blockers, through a prospective, multi-institutional trial.

Methods: The AAST Clinical Trial Group prospectively entered data for TBI patients older than 18 years who required ICU admission into an online database. Patients who received beta blockers were compared to those who did not and a multivariable regression model identified predictors for mortality.

Results: From January 2015 to January 2017 a total of 1835 patients were enrolled from 15 trauma centers in two countries with 46% receiving beta blockers with an institution range between 19% and 79%. The median number of beta blocker doses was 10 and 56% received the first dose by hospital day 1. Those patients that received beta blockers were older (56 vs. 48 years, $p < 0.001$), had higher head AIS score (3.6 vs. 3.4, $p = 0.002$), and required longer hospital length of stay (14.8 vs. 12.3 days, $p < 0.001$). Similarities were noted between cohorts when comparing sex, admission hypotension, Injury Severity Score, Glasgow Coma Scale, and mortality. A multivariable model indicated that beta blocker use was associated with lower mortality (AOR 0.65; $p = 0.012$), and propranolol predicted lower mortality compared to all other beta blockers (AOR 0.53, $p = 0.038$).

Conclusion: When adult TBI patients require ICU admission approximately half will receive beta blockers with the first dose starting early during the hospital stay. Beta blocker use predicts lower mortality and propranolol was favored when compared to other beta blockers. A multi-institutional, randomized controlled trial is necessary to conclusively determine if beta blockers provide neuroprotection.

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

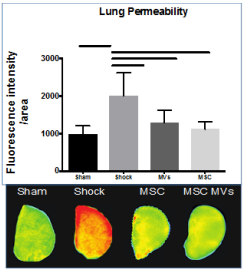
MESENCHYMAL STEM DERIVED MICROVESICLES ATTENUATE VASCULAR PERMEABILITY AND LUNG INJURY INDUCED BY HEMORRHAGIC SHOCK AND TRAUMA

Shibani Pati MD,Ph.D., Daniel Potter Ph.D., Stuart Gibb Ph.D., Martin A. Schreiber* MD, University Of California San Francisco

Invited Discussant: David Livingston, MD

Introduction: ARDS is the clinical disorder responsible for acute respiratory failure in approximately 200,000 patients annually in the United States alone. Aside from supportive care with lung-protective ventilation, there is no pharmacologic intervention or therapeutic modality that reduces mortality from ARDS. Mesenchymal Stem Cell (MSC) therapy is a promising therapeutic modality for the treatment of several disorders characterized by acute inflammation and vascular permeability. MSCs have been shown to mitigate vascular permeability in trauma. Mechanistically, a number of MSC derived paracrine factors have been identified (i.e. TIMP-3) that can recapitulate many of the potent biologic effects of MSCs in severe disease models. More recently it has been shown that MSC derived microvesicles (MVs), containing many of these key soluble factors,have therapeutic potential independent of the MSCs. In this study we sought to determine if MSCs derived MVs could recapitulate the beneficial therapeutic effects of MSCs in an established mouse model of HS induced lung injury.

Methods: Human bone marrow MSCs were expanded in standard MSC media. Microvesicles (MVs) were isolated by ultracentrifugation of conditioned media (CM) from MSCs. MVs are characterized and quantitated by flow cytometry. An established 3-hour coagulopathic mouse model of hemorrhagic shock and laparotomy was utilized. Mice were bled to a mean arterial pressure (MAP) of 35±5 mmHg which was maintained for 90 minutes. At the completion of the shock period, mice were administered IV-1X10 ^{6} MSCs, 30 mg of MSC MVs or no treatment in 200 ml of normal saline. To measure lung vascular permeability, mice received an IR-tagged dye (10kD) 1 hr. prior to sacrifice and lungs were harvested and lung permeability was evaluated on the LICOR Odyssey Scanner. Lung tissue from all groups was analyzed by 2D gel electrophoresis of differentially expressed phospho-proteins and signaling pathways activated between groups.



IV MSCs and MSC MVs inhibit pulmonary vascular permeability induced by HS in a mouse model. Permeability is to10kD Infrared Red tagged dye. Red spectrum indicates increased permeability. Lines indicate p<0.05 by post-hoc Tukey on one way ANOVA.

Results: Lung vascular permeability to 10 kD proteins was significantly decreased by MSC infusion ($p<0.05$) compared to untreated HS mice. Infusion of intravenous MSC-MVs also significantly inhibited lung vascular permeability compared to HS mice and were not significantly different from MSC mice (See Figure). Analysis of lung tissue by 2D gel electrophoresis between HS and HS+MSC and HS+MSC-MV groups reveals that the majority of the proteins and pathways activated by treatment relate to cytoskeletal rearrangement signaling pathways that are known to regulate vascular permeability. Confirmation of these pathways by western blot analysis was conducted and confirmed modulation of the Rho-Rac-CDC42 GTPase pathways by MSCs and MSC-MVs in HS lungs(data not shown).

Conclusion: MSC microvesicles may potentially be used as a novel " stem cell free" therapeutic to treat HS and trauma induced lung injury. MVs would have logistical and practical advantages over MSCs.

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

A MULTICENTER, PROSPECTIVE EVALUATION OF THE OPTIMAL TIMING OF SURGICAL STABILIZATION OF RIB FRACTURES

Fredric M. Pieracci* MD,MPH, Julia Coleman MD, Francis Ali-Osman* MD, Alicia Mangram* MD, Sara Majercik* MBA,MD, Tom White* MD, Elan Jeremitsky MD, Andrew R. Doben* MD, Denver Health Medical Center

Invited Discussant: Martin Zielinski, MD

Introduction: The optimal timing of surgical stabilization of rib fractures (SSRF) remains debated; whereas some authors advocate early repair, others recommend an initial trial of maximal medical management, with rib repair reserved as a "rescue" therapy. The purpose of this study was to 1) identify clinical variables associated with time to surgery and 2), investigate the relationship between time to surgery and outcomes. We hypothesized that shorter time to SSRF improves acute outcomes.

Methods: Following IRB approval, prospectively collected SSRF databases from four high-volume, ACS-verified level I trauma centers were merged and analyzed (2006-2016). The independent variable was days from hospital admission to rib repair, analyzed as both continuous and categorical [divided into early (< 1 day), mid (1-2 days), and late (3-10 days)]. Covariates included patient demographics, associated injuries, and detailed fracture patterns. Outcomes included length of operation, number of ribs repaired, prolonged (> 24 hours) mechanical ventilation, pneumonia, tracheostomy, length of stay, and mortality. Multivariable logistic regression was used to control for significant differences in covariates between groups. Continuous variables were assessed for normality and non-parametric testing was employed as necessary.

Results:A total of 551 patients were analyzed. The median time to SSRF was 1 day (range 0-10); 207 (37.6%) patients were in the early group, 168 (30.5%) in the mid group, and 186 (31.9%) in the late group. There was a significant shift towards earlier SSRF over the study period; 20.4% of patients underwent early repair prior to 2012, whereas 51.5%of patients underwent early repair in 2016 ($p<0.01$). Time to SSRF was significantly associated with study center ($p<0.01$), year of surgery ($p<0.01$), body mass index ($p=0.02$), injury severity score ($p=0.03$), and mechanism of injury ($p<0.01$). Age, gender, comorbidities, fracture number, fracture pattern, degree of pulmonary contusion, and additional injuries were not associated with time to SSRF. Despite repairing the same median number of ribs (4, range 1-13), median length of surgery was 100 minutes longer for the late as compared to the early group (247 vs. 147, respectively, $p<0.01$). Using multivariable regression to control for the aforementioned significant covariates, each additional hospital day prior to SSRF was independently associated with a 18% increased likelihood of pneumonia ($p=0.03$), a 22% increased likelihood of prolonged mechanical ventilation ($p=0.01$), a 15% increased likelihood of tracheostomy ($p<0.01$), and a 6% increased likelihood of mortality ($p=0.07$). Time to surgery was not associated with either hospital ($p=0.77$) or intensive care unit ($p=0.63$) length of stay.

Conclusion: SSRF within 1 day of admission is associated with certain demographic and physiologic variables. After controlling for confounding factors, early SSRF was accomplished using less operative time, and was associated with favorable pulmonary and overall outcomes. These data suggest that, when indicated, SSRF should occur as early as possible.

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

USING HUMAN TRAUMATIC BRAIN INJURY PLASMA TO EXPLORE THE MECHANISMS OF BLOOD BRAIN BARRIER DAMAGE AND MICROVASCULAR HYPERPERMEABILITY

Bobby D. Robinson MD, Binu Tharakan Ph.D., Angela Lomas MD, Katie Wiggins-Dohlvik MD, Chinchusha Anasooya Shaji BS, Justin Regner MD, Stanley J. Kurek* Jr., DO, Claire L. Isbell MD, Scott And White Medical Center

Invited Discussant: Hasan Alam, MD

Introduction: Blood brain barrier (BBB) breakdown and associated vascular hyperpermeability leads to several adverse consequences of traumatic brain injury (TBI), such as tissue edema and elevation of intracranial pressure. Tight junctions (TJs) play an integral role in maintaining BBB integrity; their disruption in TBI suggests that components of the TJ complex or its regulatory factors hold significant promise for the diagnosis and possible treatment of TBI. We sought to measure TJ proteins in human plasma following TBI for use as a biomarker of BBB damage.

Methods: We conducted a prospective pilot study, enrolling 20 subjects with TBI admitted to an ACS verified, state-designated level 1 trauma center. We included patients admitted after trauma mechanism with radiographic evidence of TBI. We excluded conditions known to adversely influence the BBB (burn, intoxication, etc.). Control subjects were individuals presenting to the same center for outpatient care with non-trauma diagnoses. The subjects were matched based on age (+/- 3 years) and gender. Blood was collected from all subjects within 24-48 hours after patient presentation. *In vitro* studies were conducted using human brain microvascular endothelial cells (HBMECs) grown on Transwell inserts as monolayers. Control group was exposed to normal human plasma for 2 hours at 1:2 and 1:3 dilutions, which decreases the chance of confounding factors from other proteins naturally circulating in plasma that could increase permeability. TBI experimental group was exposed to human TBI plasma for 2 hours at 1:2 and 1:3 dilutions. We utilized plasma from each specimen to conduct *in vitro* analysis of TJ breakdown using monolayer permeability studies, measuring a fluorescent dye as it crossed the monolayer of cells. ELISAs were also performed on each TBI and control sample for the following antigens: TJPs and adherens molecules (Claudin-5, Occludin, β-catenin), inflammatory markers (IL-1b, MMP-9, NLRP3), and a known TBI biomarker in S100β.

Results: TBI subjects were mostly female (55%), median age was 63.5 IQR of (49.5, 76) and there was an overall 15% mortality. Most were isolated head injuries (85%). Median ISS was 22.5 with IQR of (14.25, 34.5). Monolayer permeability showed increased hyperpermeability in TBI groups (Figure 1) ELISAs showed that S100β and Occludin were significantly elevated in the TBI plasma (Figure 2). There was an increase in MMP-9 and NLRP3 in TBI subjects but did not reach statistical significance. We found no correlation in S100β or Occludin with ISS.

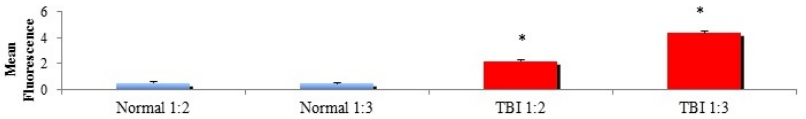


Figure 1: TBI 1:2 and 1:3 plasma increased permeability between normal 1:2 and 1:3 plasma in HBMECs. '*' indicates statistical significance ($p<0.05$). The bars indicate the amount of FITC dextran that passed through the semipermeable membrane lined with endothelial cells. n=12

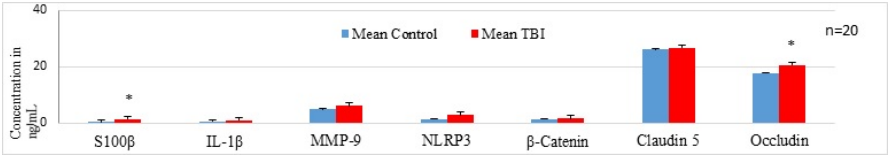


Figure2: TBI Biomarker ELISA results; '*' indicates statistical significance ($p<0.05$).

Conclusion: This pilot study demonstrates plasma alone from TBI patients increases microvascular hyperpermeability (BBB breakdown) *in vitro*. Measurement of these TJ proteins in human plasma provides a framework for elucidating the mechanism of BBB breakdown as it contributes to TBI and a potential biomarker.

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

CONTEMPORARY MANAGEMENT OF HIGH-GRADE RENAL TRAUMA: RESULTS FROM THE AMERICAN ASSOCIATION FOR THE SURGERY OF TRAUMA (AAST) GENITOURINARY TRAUMA STUDY

Sorena Keihani MD, Christopher M. Dodgion* MD, Patrick M. Reilly* MD, Kaushik Mukherjee* MD, Ian Schwartz MD, Sarah Majercik MD, Bradley A. Erickson MD, Benjamin N. Breyer MD, Matthew M. Carrick* MD, Brandi Miller MD, Jurek F. Kocik* MD, Scott Zakaluzny* MD, Reza Askari* MD, Raminder Nirula* MD,MPH, Jeremy B. Myers MD, University of Utah

Invited Discussant: Michael Coburn, MD

Introduction: The rarity of renal trauma limits development of evidence-based guidelines. Although most renal trauma can be managed conservatively, unstable patients with high-grade injuries may need operative intervention, which is mostly nephrectomy. Our aim was to describe contemporary management of high-grade renal trauma in the United States. We hypothesized that certain clinical factors would be associated with need for nephrectomy after high-grade renal trauma.

Methods: From 2014 to 2017, data on high-grade renal trauma (AAST grades III-V) were collected from 14 participating trauma centers. Data were gathered on demographics, injury characteristics, management, and outcomes. Definitions used in our analysis included (1) shock - systolic blood pressure <90 mmHg; (2) massive transfusion - needing >10 packed red blood cells; (3) conservative management - no renal-related interventions (nephrectomy, renorrhaphy, angioembolization, ureteral stenting). Descriptive statistics were used to summarize the cohort. Univariate logistic mixed effect models with clustering by facility were used to look at associations between proposed risk factors and nephrectomy.

Results: A total of 336 adult high-grade renal injuries were recorded. Mean age was 34.1 years (SD: 16.3). 267 (79%) were male. Mechanism of injury was blunt in 239(71%), with motor vehicle accidents the leading etiology. Injuries were graded as III, IV, V in 190 (57%), 100 (30%), and 46 (14%) of the patients. 38 (11%) patients presented in shock. Laparotomy was performed in 133 (40%) patients; 104 were immediate. Overall, 235 (70%) patients were managed conservatively and 101 (30%) patients required 129 renal-related interventions. Nephrectomy was performed in 45 (13%). Penetrating injuries had higher AAST grades, concomitant injuries, blood transfusions, nephrectomies, and renal interventions. In univariate analyses, renal AAST grade, Injury Severity Score, presence of associated injuries, and penetrating injury were significantly associated with the need for nephrectomy. Also, clinical factors at admission such as higher heart rate, shock, higher lactate level, and massive transfusion were associated with higher odds of nephrectomy.

Conclusion: Conservative management is utilized in 70% of high-grade renal injuries. However, there is still a high rate of nephrectomy, mostly during initial management and more commonly with penetrating trauma. Clinical factors like presence of shock, higher heart rate and higher lactate levels were associated with need for nephrectomy for high grade renal injury.

Table-1 Demographics and management of high-grade renal injury (AAST III-V)

	Total N=336	**Blunt N=239**	**Penetrating N=97**	**P-value ***
Age, mean (SD), y	34.1 (16.3)	36.4 (17.9)	28.2 (9.1)	0.001
Male sex, No. (%)	267 (79%)	179 (75%)	88 (91%)	0.001
ISS, mean (SD)	25.7 (12.7)	26.4 (13.0)	23.8 (11.9)	0.1
SBP on admission, mean (SD), mmHg	122.6 (27.7)	122.3 (26.6)	123.3 (30.3)	0.97
Need for PRBC in first 24h, No. (%)	164 (50%)	94 (40%)	70 (74%)	**<0.001**
Associated injuries, No. (%) [1]	247 (74%)	161 (67%)	86 (89%)	**<0.001**
AAST grade, No. (%)				**0.02**
III	190 (57%)	145 (61%)	45 (46%)	
IV	100 (30%)	68 (28%)	32 (33%)	
V	46 (14%)	26 (11%)	20 (21%)	
Conservative management, No. (%)	235 (70%)	192 (80%)	43 (44%)	**<0.001**
Intervention, No. (%)				
Renal Angio-embollization	22 (6%)	18 (7%)	4 (4%)	0.99
Nephrectomy	45(13%)	16 (7%)	29 (30%)	**<0.001**
Other interventions [2]	43 (13%)	18 (8%)	25 (26%)	**<0.001**
Mortality	24 (7%)	15 (6%)	9 (9%)	0.33

AAST, The American Association for the Surgery of Trauma; SD, standard deviation; ISS, injury severity index; SBP, systolic blood pressure; PRBC, packed red blood cells

* Comparisons are made between blunt and penetrating trauma

[1] Defined as presence of any concomitant injury, including: solid organ, gastrointestinal, spinal cord, major vascular, and pelvic fracture.

[2] Other interventions include: partial nephrectomy, renorrhaphy, renal packing, ureteral stent placement, peri-renal drain placement, and percutaneous nephrostomy.

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

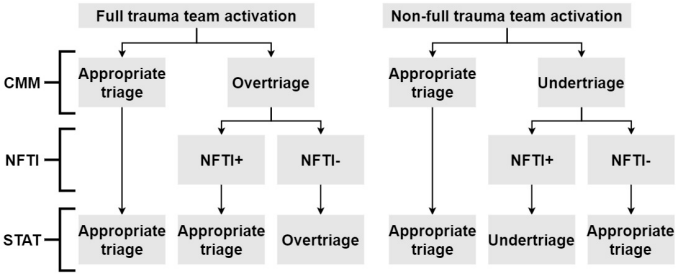
AVOIDING CRIBARI GRIDLOCK: THE SECONDARY TRIAGE ASSESSMENT TOOL (STAT) PROVIDES STANDARDIZED DEFINITIONS OF OVER- AND UNDERTRIAGE THAT ARE MORE ACCURATE THAN THE CRIBARI MATRIX METHOD

Jacob W. Roden-Foreman BA, Nakia R. Rapier RN, Luanna Yelverton RN, Michael L. Foreman* MD, Baylor University Medical Center

Invited Discussant: Chris Cribari, MD

Introduction: The Cribari matrix method (CMM) for calculating over/undertriage is the standard to determine if patients received the proper trauma activation level, but it requires case reviews to correct for the fact that Injury Severity Scores do not account for comorbidities. This study assessed if the Secondary Triage Assessment Tool (STAT)—a combination of the CMM and the Need For Trauma Intervention (NFTI), a novel measure of early resource consumption and mortality based on common registry fields—could more accurately determine over/undertriage in a standardized method.

Methods: The registry of an ACS verified Level I trauma center was queried for all new traumas 1/1/13 - 8/21/16 (n = 9,737). The triage determinations of each metric were tested with binary logistic regressions. Number of risk factors was included to assess if STAT would capture comorbidities. Length of stay (LOS) and number of procedures in the first three days were used as surrogates for overall and early resource consumption, respectively.



Results: When using STAT, overtriages had fewer risk factors, shorter LOSs, fewer procedures, and lower mortality than CMM overtriages. STAT undertriages had slightly more risk factors, marginally longer LOSs, more early procedures, and higher odds of mortality than CMM undertriages. Using STAT resulted a 41.7% overtriage reduction (51.1% to 29.8%) and a 61.5% undertriage reduction (9.1% to 3.5%).

	Cribari Overtriage		STAT Overtriage	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Number of risk factors	1.059 (0.983, 1.140)	0.132	0.843 (0.774, 0.919)	< 0.001
Total LOS	0.933 (0.919, 0.947)	< 0.001	0.888 (0.860, 0.916)	< 0.001
# procedures in 3 days	0.907 (0.888, 0.926)	< 0.001	0.733 (0.705, 0.763)	< 0.001
Overall mortality	0.032 (0.022, 0.045)	< 0.001	0.003 (0.001, 0.012)	< 0.001

	Cribari Undertriage		STAT Undertriage	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Number of risk factors	1.097 (1.044, 1.152)	< 0.001	1.173 (1.083, 1.270)	< 0.001
Total LOS	1.055 (1.044, 1.067)	< 0.001	1.069 (1.055, 1.083)	< 0.001
# procedures in 3 days	1.100 (1.080, 1.120)	< 0.001	1.158 (1.129, 1.187)	< 0.001
Overall mortality	5.172 (3.189, 8.386)	< 0.001	13.521 (7.999, 22.854)	< 0.001

Conclusion: Using CMM with secondary case reviews makes valid multi-institutional triage rate comparisons impossible because of the subjective and unstandardized nature of case reviews. STAT provides a standardized measure of over/undertriage with better discriminant ability than the CMM, and STAT can be readily calculated in trauma registries. By accounting for both anatomic injury severity and resource consumption, STAT may allow trauma centers to better allocate resources and predict patient needs.

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

HOSPITAL VARIATION IN MORTALTY AFTER EMERGENT BOWEL RESECTIONS: THE ROLE OF FAILURE-TO-RESCUE

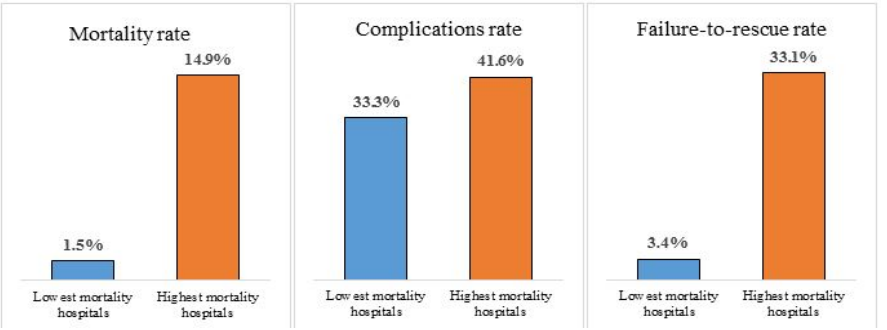
Ambar Mehta BS, David Efron* MD, Mariuxi C. Manukyan MD, Reema Kar MD, Bellal Joseph* MD, Joseph V. Sakran MD,MPH, MPA Johns Hopkins School of Medicine

Invited Discussant: Andrew Peitzman, MD

Introduction: Hospital variation in failure-to-rescue (FTR) rates have partially explained nationwide differences in mortality after elective surgeries. However, few studies have examined FTR and its impact on mortality among patients undergoing emergency general surgery (EGS), which has up to a 50% complication rate. We compared nationwide risk-adjusted mortality, complications, and FTR rates after emergent bowel resections.

Methods: We identified all patients who underwent emergency small or large bowel resections in the 2010-2013 Nationwide Inpatient Sample using the American Association for the Surgery of Trauma criteria. We then calculated risk-adjusted mortality rates for each hospital using multivariable logistic regressions and post-estimation, which adjusted for patient age, gender, race and ethnicity, payer status, and comorbidities. After excluding hospitals with fewer than 20 bowel resections, we ranked the remaining hospitals by their risk-adjusted mortality rates and divided them into five equal groups. We compared both risk-adjusted complication rates and risk-adjusted FTR rates among the top quintile (lowest mortality) and the bottom quintile (highest mortality) of hospitals.

Results: We included 18,407 bowel resections, which represented approximately 90,321 procedures nationwide. Overall, patients were white (78.9%), female (53.9%), and at least 65-years-old (48.8%). These procedures had an unadjusted mortality rate of 7.4%, complication rate of 37.2%, and FTR rate of 16.8%. The bottom quintile of hospitals (Figure) had an overall risk-adjusted mortality rate that was 10.3 times higher than that of the top quintile of hospitals (14.9% vs 1.5%). While risk-adjusted complication rates were similarly high among both the bottom and the top quintiles of hospitals (41.6% vs 33.3%), the risk-adjusted FTR rates were 9.8 times higher in the bottom quintile of hospitals relative to the top quintile of hospitals (33.1% vs 3.4%).



Conclusion: In this nationwide study, we observed widespread hospital variation in risk-adjusted mortality rates after emergent small and large bowel resections. As complication rates were similar across hospitals, the significantly higher FTR rates at higher-mortality hospitals may drive this variation in mortality. System-level initiatives should address postoperative complications to improve and reduce variation in outcomes.

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

RESHAPES: INCREASING AAST ANATOMIC SEVERITY GRADE INFLUENCES BOWEL ANASTOMOSIS TYPE

Matthew C. Hernandez MD, Brandon R. Bruns* MD, Margaret Lauerman* MD, Nadeem N. Haddad MD, Johnathon M. Aho MD, Martin D. Zielinski* MD, David S. Morris* MD, Herb Phelan* MD, Jose J. Diaz* MD, Thomas M. Scalea* Toby Enniss* MD, David Turay* MD,Ph.D., Matthew M. Carrick* MD, John Fam* MD, John S. Oh* MD, University of Maryland Medical Center

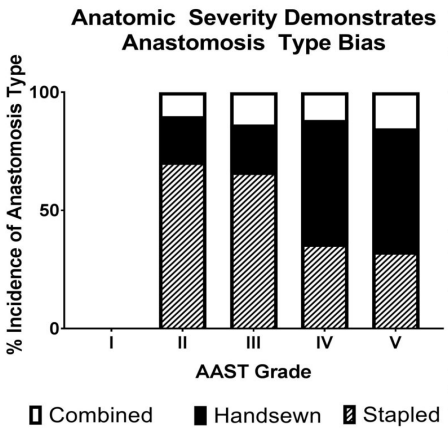
Invited Discussant: Kevin Schuster, MD, MPH

Introduction: Emergency general surgery (EGS) diseases display diverse anatomic severity and the AAST recently developed an anatomic based severity grading system for EGS diseases. Threatened, perforated, or infarcted bowel is conventionally managed with resection and anastomosis (hand sewn (HS) or stapled (ST)). The Stapled versus Handsewn: A Prospective Emergency Surgery Study (SHAPES) analysis demonstrated equivalence between HS and ST techniques, yet surgeons appeared to prefer HS anastomoses for the critically ill. We hypothesized that with increasing AAST grade, surgeons would favor the HS technique and that anastomotic complications would be increased.

Methods: A post hoc analysis of the SHAPES database was performed. Operative reports were submitted by volunteering SHAPES centers. Only patients with EGS diagnoses were included; trauma patients were excluded. Two reviewers assigned AAST grade based on operative report findings. Discrepancies were resolved by a third reviewer. Final AAST grade was compared with various outcomes including: duration of stay, physiologic variables (heart rate, blood pressure, and temperature), laboratory data (leukocytosis, hemoglobin, creatinine, lactate), operative management, anastomosis type, temporary abdominal closure, complication, anastomosis failure (dehiscence, abscess, or fistula), and mortality. Summary, univariate, and multivariable analyses were performed.

Results: 391 patients were reviewed, with a mean age of (±SD) 61.2±16.8 years, 47% female. Disease severity distribution was as follows: Grade I (n=0,0%), Grade II (n=106, 27%), Grade III (n=113, 29%), Grade IV (n=123, 31%), and Grade V (n=49, 13%). Increasing AAST grade was associated with acidosis and hypothermia (Table). There was an association between higher AAST severity grade and likelihood of HS anastomosis (Graph). There was no difference in surgical site infection (superficial, deep, organ space) by AAST grade ($p>0.05$). Incremental increases in hospital and ICU durations of stay, as well as mortality, were associated with increasing AAST grade (Table). Independent predictors of mortality included (Odds Ratio, 95% CI): any anastomosis complication (4.9, 95% CI 1.96-11.8, $p=0.001$) and AAST grade IV (3.2, 95% CI 1.1-10, $p=0.03$), grade V (6.8, 95% CI 1.8-32.3, $p=0.003$) but not the type of anastomosis performed. There was substantial agreement between reviewers, kappa (95% CI) 0.75 (0.70-0.80, $p<0.0001$).

Conclusion: Higher AAST grades are associated with key clinical outcomes in EGS diseases requiring bowel resection and anastomosis. In the SHAPES trials, surgeons seemed to favor HS anastomosis for higher AAST grade disease severity. Anastomotic-specific complications were not associated with higher AAST grade; however, mortality was influenced by both the presence of any anastomotic complication and increased AAST grade. This is the first study to utilize standardized anatomic injury grades for patients undergoing urgent/emergent bowel resection in EGS. Future EGS studies should routinely include AAST grading as a method for reliable comparison of injury between groups.



	AAST Grade					
Variable	I	II	III	IV	V	P value
Acidosis %	-	3.7	3.5	9.8	16.3	0.01
Hypothermia %	-	1.9	0.8	6.5	16.3	0.001
Duration of Stay*	-	10 [6-16]	9 [6-18]	10 [7-18]	19 [8-29]	0.01
ICU Duration of Stay*	-	0 [0-1]	1 [0-6]	2 [0-8]	4 [1-11]	0.004
Superficial SSI %	-	15.1	14.1	13.8	6.1	0.6
Deep SSI %	-	9.4	7.1	8.1	8.1	0.9
Organ Space SSI %	-	7.5	9.7	10.5	14.3	0.7
Any anastomosis complication %	-	10.4	13.2	11.4	20.4	0.3
Mortality %	-	2.8	5.3	5.7	18.3	0.008

*Median [IQR]

Session: V: Plenary Session Papers 9-13: Canizaro Session
Paper 9: 7:30-7:50 am

THE IMPACT OF ADVANCED AGE ON THE INNATE IMMUNE RESPONSE AND OUTCOMES AFTER SEVERE SEPSIS/SEPTIC SHOCK IN TRAUMA AND SURGICAL INTENSIVE CARE UNIT PATIENTS

Scott Brakenridge* MD, MSCS, Philip Efron* MD, Julie Stortz MD, Tezcan Ozrazgat-Baslanti Ph.D., Zhongkai Wang BS, Gabriela Ghita BS, Alicia Mohr* MD, Lyle L. Moldawer Ph.D., Frederick Moore* MD, University Of Florida

Invited Discussant: Grant O'Keefe, MD, MPH

Introduction: Advanced age is a strong risk factor for adverse outcomes across multiple disease processes, including sepsis. However, surgical and trauma patients are unique from other septic patients in that they incur two or more early inflammatory insults. The effects of advanced age on sepsis pathophysiology, the patient's innate immune response, and clinical outcomes in this population remain unclear.

Methods: We performed a single center, prospective observational cohort study of patients in the Trauma and Surgical Intensive Care Units at an academic Level 1 Trauma Center with severe sepsis/septic shock. Patients were screened, diagnosed and managed with established sepsis protocols supplemented by computerized clinical decision support. All sepsis diagnoses were clinically adjudicated in prospective fashion. Peripheral blood was collected for cytokine and biomarker analysis at 0.5, 1, 4, 7, 14, 21 and 28 days after sepsis protocol initiation. For analysis, cohorts were defined as young (<65 years) and aged (≥65 years). Age-defined cohorts were compared to determine differences in patient characteristics, clinical outcomes and biomarker profiles.

Results: The cohort consisted of 116 patients with severe sepsis (n=56, 48.3%) or septic shock (n=60, 51.7%), with a mean age of 61.5(±14.4) years. Seventy patients (60.3%) presented with sepsis on admission, while the remainder (n=46; 39.7%) subsequently developed 'delayed sepsis' (>2 days after ICU admission). Intra-abdominal sepsis was the leading source (n=50; 43.1%), followed by pneumonia (n=21; 18.1%) and NSTI (n=20, 18.1%). The majority of septic patients (n=70, 60.3%) necessitated a source control procedure. Aged patients had a higher comorbidity burden (Mean Charlson comorbidity index score 5.4 vs 3.3, p<0.001), but were otherwise similar to the young cohort. While exhibiting similar inflammatory (IL-6, IL-8, IL-10) cytokine trajectories, the aged cohort had a higher rate of vasopressor-dependent shock (62% vs 42%, p=0.042), more severe organ dysfunction (Max. SOFA 10 vs. 8, p=0.02), and higher incidence of acute kidney injury (75% vs 57%, p=0.038), chronic critical illness (CCI, 64 vs 46%, p=0.007) and hospital mortality (28 vs 4%, p<0.001). Aged septic patients demonstrate biomarker trajectories suggestive of persistent immunosuppression (Absolute Lymphocyte Count, Neutrophil:Lyphocyte ratio, sPDL-1) and catabolism (IGFBP3).

Conclusion: While mounting a similar initial inflammatory response, aged surgical and trauma patients with sepsis have more profound shock, greater organ dysfunction, and higher mortality. Biomarker profiles suggest a phenotype of persistent immunosuppression and catabolism. Advanced age may necessitate novel approaches to immunotherapy and organ support in order to promote organ recovery and improve survival for critically ill sepsis patients.

Session: V: Plenary Session Papers 9-13: Canizaro Session
Paper 10: 7:50-8:10 am

HOSPITAL VOLUME OF EMERGENCY GENERAL SURGERY IS ASSOCIATED WITH INPATIENT MORTALITY OUTCOMES

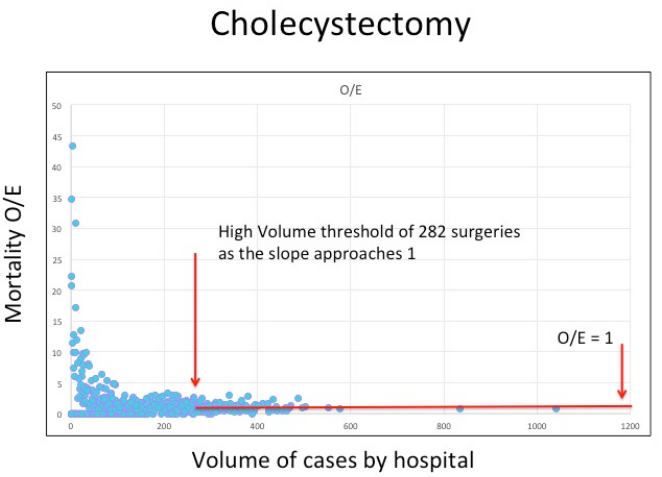
Darwin Ang* MD,MPH,Ph.D., Jason Clark MD, Jason Farrah MD, Alejandro Garcia MD, Joshua Hagan MD, Winston Richards MD, Huazhi Liu MS, Michele Ziglar RN, MSN, James Hurst* MD, University of South Florida College of Medicine

Invited Discussant: Adil Haider, MD, MPH

Introduction: Emergency general surgery (EGS) accounts for up to 50% of inpatient hospital mortality. Recently, it was identified that 7 EGS procedures accounted for 80% of procedures, deaths, costs, and complications of all EGS procedures nationwide. To further refine benchmarks for these key 7 EGS procedures, we examined if there was a threshold for hospital volume associated with mortality.

Methods: This is a population based retrospective cohort study using the Centers of Medicare and Medicaid Services (CMS) database from 2011 to 2013. For each EGS procedure, hospital volume (x-axis) was plotted against risk-adjusted mortality (Y-axis) defined by observed to expected (O/E) ratios. The expected value was calculated by multivariate regression, adjusted for age, gender, race, injury severity, and comorbidities. Because the distribution of the scatter plot is curvilinear, the cut off for defining high volume centers (x-value) was determined by the slope as it approaches the value of 1 (y-value). At this point, the variance between centers is smaller as hospitals increase in volume. High and low volume hospitals were compared to each other to examine outcomes of each of the key EGS procedures.

Results: A total of 983,384 EGS patients were examined who were treated in 1,925 hospitals. Over the three-year period, high volume procedure thresholds were determined for the following procedures: colectomy (271), cholecystectomy (282), peptic and gastric ulcer (198), small bowel resection (38), appendectomy (55), lysis of adhesions (222), and laparotomy (27). All low volume hospitals had O/E ratios greater than 1. With the exception of appendectomy, all high volume hospitals had O/E ratios less than 1.



Conclusion: Volume thresholds are unique by type of EGS procedure. Higher volume hospitals are associated with better mortality outcomes. This volume and mortality outcome relationship may be helpful in defining benchmarks for emergency general surgery.

Session: V: Plenary Session Papers 9-13: Canizaro Session
Paper 11: 8:10-8:30 am

REBOA is Superior to Resuscitative Thoracotomy in Select Patients with Hemorrhagic Shock: Early results from the AAST AORTA Registry

Megan Brenner* MD, Alberto Aiolfi MD, Kenji Inaba* MD, Joseph DuBose* MD, John Holcomb* MD, Laura Moore* MD, Jeremy Cannon* MD, Mark Seamon* MD, David Skarupa* MD, Joseph Ibrahim MD, Chad Ball MD, Andrew Kirkpatrick* MD, Todd E. Rasmussen* MD, Thomas M. Scalea* MD, University Of Maryland / R Adams Cowley Shock Trauma Center

Invited Discussant: Martin Croce, MD

Introduction: Aortic occlusion (AO) is a potentially valuable tool of early resuscitation for patients in or nearing extremis following trauma. While resuscitative thoracotomy (RT) remains an important approach to AO, the emergence of REBOA has introduced another clinical option to achieve this objective – with optimal patient selection remaining a matter of active investigation.

Methods: AAST AORTA registry review identified trauma patients without thoracic penetrating injury undergoing AO at the level of the descending thoracic aorta (RT or Zone 1 REBOA) in the Emergency Department (ED). Survival outcomes relative to the timing of CPR need and admission hemodynamic status were then examined.

Results:Meeting selection criteria were 285 patients who were 81.8% male, injured due to penetrating mechanisms in 41.4%; median age 35.0 [IQR 29], and median ISS of 34.0 (IQR 18). EDT was utilized in 70.9% (202/285), and Zone 1 REBOA in 29.1% (83/285). Overall survival beyond the ED was 49.5% [141/285; RT 44.1% (89/202), REBOA 62.7% (52/83), $p = 0.004$] and survival to discharge was 5.0% [13/285; RT 2.5% (5/202), REBOA 9.6% (8/83), $p = 0.023$]. Discharge GCS was 15 in 84.6% (11/13) of survivors. Pre-hospital CPR was required in 60.4% (172/285) of patients [RT 75.0% (129/172; REBOA 25.0% (43/172)] with a survival beyond the ED of 37.2% [64/172; RT 34.1% (33/129), REBOA 46.5% (20/43), $p = 0.145$], and survival to discharge of 2.9% [5/172; RT 2.3% (3/129), REBOA 4.7% (2/43), $p = 0.60$]. Those requiring CPR after arrival but prior to AO (20.0%; 57/285) had survival beyond the ED of 66.7% (38/57; RT 70.5% (31/44), REBOA 53.8% (7/13), $p = 0.323$] and survival to discharge of 1.8% [1/57; RT 2.3% (1/44), REBOA 0% (0/13), $p = 1.00$). Patients who did not require any CPR prior to AO [56/285, 19.6%; RT 51.8% (29/56), REBOA 48.2% (27/56)], had a survival beyond the ED of 69.6% [39/56; RT 48.3 (14/29), REBOA 92.6% (25/27), $p < 0.001$] and survival to discharge of 12.5% (7/56; RT 3.4% (1/29), REBOA 22.2% (6/27), $p = 0.048$]. If AO patients did not require CPR, but presented with hypotension (SBP < 90 mm HG; 9.1% (26/285); 65.4% EDT; 34.6% REBOA), they achieved survival beyond the ED in 65.4% [17/26, RT 47.1% (8/17), REBOA 100% (9/9), $p = 0.009$] and survival to discharge of 15.4% [4/26; RT 0% (0/17), REBOA 44.4% (4/9), $p = 0.008$].

Conclusion:AO use following CPR for patients without penetrating thoracic injuries is associated with dismal survival rates, regardless of AO type utilized. Among patients not requiring CPR, this early experience suggests REBOA use may have survival benefit over resuscitative thoracotomy for these patients.

Session: V: Plenary Session Papers 9-13: Canizaro Session
Paper 12: 8:30-8:50 am

BANNING OPEN CARRY OF UNLOADED HANDGUNS DECREASES FIREARM-RELATED FATALITIES & HOSPITAL UTILIZATION

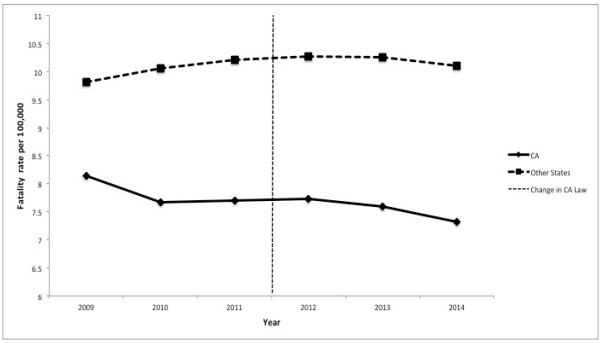
Rachael A. Callcut* MD, MSPH, AnaMaria J. Robles MD, Matthew W. Mell MD, MS
University of California, San Francisco

Invited Discussant: Adrian Maung, MD

Introduction:Since 1967, in California (CA) it has been illegal to openly carry a *loaded* firearm in public except when engaged in hunting or law enforcement. However, beginning Jan 1, 2012, public open carry of *unloaded* handguns also became illegal. Fatal and non-fatal (NF) firearm injuries were examined before and after adoption of the 2012 ban to quantify the effect of the new law on public health.

Methods:State level data was obtained directly from CA and 9 other U.S. State Inpatient & ED discharge databases, vital statistics depts., and the CDC Web Based Injury Statistics Query & Reporting system. Case numbers of firearm fatalities, NF hospitalizations, NF ED visits, and state level population estimates were extracted. Each incident was classified as unintentional, self-inflicted, or assault. Crude incidence rates (per 100,000) were calculated. Strength of overall gun laws was quantified for each state using the Brady grade (A-F), with all grade categories represented by the 9 comparison states. There were no changes to open carry in these 9 states during the study period. Using a difference-in-difference technique (comparing CA to the 9 other states), the rate trends 3 years pre- and post-ban were compared to determine if the 2012 law decreased fatalities and hospital visits.

Results:The 2012 open carry ban resulted in a significantly lower incident rate of both firearm-related fatalities and NF visits ($p<0.001$) [Figure]. The effect of the law remained significant when controlling for overall baseline state gun laws ($p<0.001$). Firearm incident rate drops in CA were significant for male homicide ($p=0.023$), hospitalization for NF assault ($p=0.025$ male; $p=0.023$ female), & ED NF assault visits ($p=0.03$ male; $p=0.08$ female). No significant decreases were observed by gender for suicides or unintentional injury. Changing the law saved an estimated 337 lives (3.8% fewer deaths) & 1285 NF visits (6.6% fewer visits) in CA during the post-ban period.



Conclusion:Open carry ban decreases fatalities and healthcare utilization even in a state with baseline strict gun laws. The most significant impact is from decreasing firearm-related fatal and non-fatal assaults.

Session: V: Plenary Session Papers 9-13: Canizaro Session
Paper 13: 8:50-9:10 am

EARLY PHARMOLOGICAL THROMBOPROPHYLAXIS IN ISOLATED SEVERE PELVIC FRACTURE IS SAFE AND IMPROVES OUTCOMES

Elizabeth Benjamin* MD,Ph.D., Alberto Aiolfi MD, Gustavo Recinos MD, Kenji Inaba* MD, Demetrios Demetriades* MD,Ph.D., LAC+USC Medical Center

Invited Discussant: Michael Cripps, MD

Introduction: The optimal timing of pharmacological thromboprophylaxis (VTEp) in patients with isolated severe pelvic fractures remains unclear. The high risk of venous thromboembolic (VTE) complications after severe pelvic fractures supports early initiation of VTEp however caution regarding the potential hemorrhage associated with these fractures can delay initiation. Pelvic fractures are often associated with additional traumatic injuries that complicate the interpretation of the safety and efficacy of the various VTEp strategies. To minimize this problem this study included only patients with isolated severe pelvic fractures.

Methods: Using the Trauma Quality Improvement Program data, patients with blunt severe pelvic fractures (AIS $\geq$ 3) who received prophylaxis with either unfractionated heparin (UH) or low-molecular-weight heparin (LMWH) were collected. Patients with head, chest, spine, and abdominal injuries AIS $\geq$ 3, or those with angio or operative intervention prior to VTEp were excluded. The study population was stratified according to timing of prophylaxis initiation defined as EARLY ($\leq$48hrs) and LATE (>48hrs). Outcomes included in-hospital mortality, ICU and hospital length of stay (LOS), and VTE.

Results: 2,752 patients were included in the study population. Overall, 2,007 patients (72.9%) received early pharmacological prophylaxis, while 745 (27.1%) received late prophylaxis. LMWH was administered in 2,349 (85.4%) and UH in 403 (14.6%) patients. LATE VTEp was associated with a significantly higher incidence of VTE (4.3% vs. 2.2%, p=0.004). Logistic regression identified LATE VTEp as an independent risk factor for VTE (OR 1.93, p=0.009) and mortality (OR 4.03, p=0.006). LMWH was an independent factor protective for both VTE and mortality (OR 0.373, p<0.001, OR 0.266, p=0.009, respectively).

Conclusion: In isolated severe pelvic fractures, early VTEp is independently associated with improved survival and fewer VTE. LMWH may be preferred over UH for this purpose.

Session: Session VII: Paper 14-17: Emergency General Surgery
Paper 14: 10:00-10:20 am

NONELECTIVE READMISSION AFTER EMERGENCY GENERAL SURGERY

Rishi Rattan MD, Joshua Parreco MD, Nicholas Namias* MBA,MD, University of Miami

Invited Discussant: John Agapian, MD

Introduction: Readmission within 30 days is an important quality benchmark. Prior studies of readmission after emergency general surgery (EGS) are limited to single institutions or states, inability to exclude elective readmission, or inability to track readmissions at a different hospital. There are no national studies on nonelective readmission after EGS. We hypothesized that different-hospital readmission accounted for a significant number of nonelective 30-day readmissions and that predictive factors would be different for same- and different-hospital readmissions.

Methods: The Nationwide Readmissions Database (2013-2014) was queried for all nonelective 30-day admissions with an EGS ICD-9-CM diagnosis code as defined by The American Association for the Surgery of Trauma Committee on Severity Assessment and Patient Outcomes. Univariate and multivariate logistic regression identified risk factors for nonelective 30-day readmission to same and different hospitals. Diagnosis-Related Group on readmission was recorded. Cost was also calculated.

Results: Of the 4,482,143 patients admitted during the study period, 577,783 (12.9%) patients experienced a nonelective 30-day readmission. Of these, 21.4% were admitted to a different hospital. The most common reason for readmission at the same (22.2%) and different (23.5%) hospital was infection. While the next most common same-hospital readmission diagnoses included complaints related to the index admission diagnosis, the next most common diagnoses in different-hospital readmission were heart failure (4.7%) and renal failure (3.7%). The factors most predictive of readmission were: leaving against medical advice (OR 2.42, 95%CI 2.37-2.47), length of stay >7 days (OR 1.96, 95%CI 1.94-1.97), Charlson Comorbidity Index ≥2 (OR 1.69, 95%CI 1.68-1.70), Medicaid (OR 1.45, 95%CI 1.43-1.46), and Medicare (OR 1.45, 95%CI 1.43-1.46). The factors most predictive of readmission to another hospital were: age ≥18 years (18-44 years old, OR 2.95, 95%CI 2.64-3.07; 45-64 years old, OR 2.65, 95%CI 2.45-2.85; ≥65 years old, OR 2.15, 95%CI 1.99-2.32), leaving against medical advice (OR 2.19, 95%CI 2.12-2.27), smaller hospital size (medium, OR 1.71, 95%CI 1.68-1.75; small, OR 1.20, 95%CI 1.18-1.22), and Medicaid (OR 1.25, 95%CI 1.22-1.28). Factors protective against readmission were operative intervention (OR 0.72, 95%CI 0.71-0.72) and index admission to a non-metropolitan hospital (OR 0.88, 95%CI 0.87-0.89). Factors protective against readmission to another hospital were: operative intervention (OR 0.70, 95%CI 0.69-0.72), index admission to a metropolitan teaching hospital (OR 0.83, 95%CI 0.82-0.84), discharge with home health care (OR 0.87, 95%CI 0.85-0.88), and index admission to a not-for-profit hospital (OR 0.88, 95%CI 0.87-0.90). The total initial admission cost was $63.1 billion. The total readmission cost was $17.2 billion. The median index admission cost was $8,233 [$4,989-$14,644]. The median readmission cost was $8,500 [$4,981-$15,682]. Median different-hospital readmission cost was significantly higher than median same-hospital readmission cost ($9,231 [$5,221-$17,779] vs $8,324 [$4,921-$15,168]). All statistical analyses had $p<0.001$.

Conclusions: The previously undescribed national burden of nonelective readmission after EGS, especially to different hospitals, is significant. Common reasons for different-hospital readmission include important quality indicators such as infection and organ failure, which are incompletely captured by prior, limited studies. Predictive factors differ between same- and different-hospital readmission and offer areas for further research, intervention, and quality assessment.

Session: Session VII: Paper 14-17: Emergency General Surgery
Paper 15: 10:20-10:40 am

EGS QUALITY IMPROVEMENT PROGRAM (EQIP) - A PROPOSAL

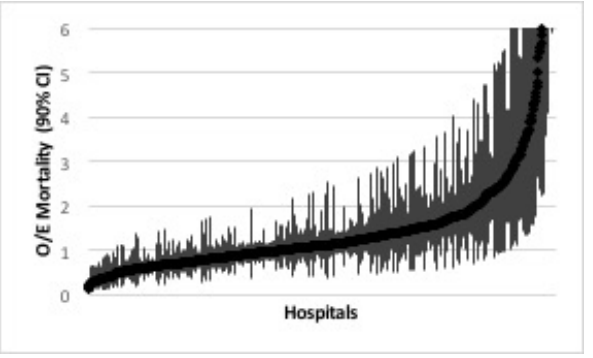
Shahid Shafi* MBA,MD,MPH, Gerald O. Ogola Ph.D., Marie L. Crandall* MD,MPH,
Baylor Scott & White Health

Invited Discussant: John Fildes, MD

Introduction: National Surgical Quality Improvement Program (NSQIP) and Trauma Quality Improvement Program (TQIP) have shown wide variations in risk-adjusted outcomes at participating hospitals. Emergency General Surgery (EGS) is practiced at hundreds of hospitals without such benchmarking. Our study hypothesis was that there are significant variations in risk-adjusted outcomes of EGS patient across these hospitals.

Methods: This is a retrospective analysis of National Inpatient Sample data for 2010 (a nationwide representative sample of inpatients, by the Agency for Healthcare Quality and Research). Patients with EGS diseases were identified using AAST defined ICD-9 codes. Logistic regression analysis was used to determine expected in-hospital mortality rates, adjusted for age, sex, race, ethnicity, insurance type, and comorbidities. Observed-to-expected (O/E) mortality ratios, with 90% confidence intervals, were used to identify hospitals as high performers (O/E ratio significantly lower than 1), low performers (O/E ratio significantly higher than 1), or average performers (O/E ratio overlapping 1).

Results: Nationwide, 2,640,725 patients with EGS diseases were treated at 943 hospitals in 2010. Less than a quarter of the hospitals (139, 15%) were high performers, a quarter were low performers (221, 23%), while the rest performed as well as expected (583, 62%) (see Figure). Mean O/E mortality ratio at high performing hospitals was almost three times lower than that of low performing hospitals (Mean O/E ratio 0.59 vs. 1.73, $p < .001$). The difference between the observed and expected number of deaths at low performing hospitals suggested that there were 4,823 potentially preventable deaths nationally in 2010.



Conclusion: There are significant variations in risk-adjusted outcomes of EGS patients across hospitals, with several hundred potentially preventable deaths. Based upon the success of NSQIP and TQIP, we recommend establishing EGS Quality Improvement Program (EQIP) at the American College of Surgeons. EQIP will provide risk-adjusted benchmarking of hospitals for EGS patients. It will spur performance improvement efforts for EGS care at participating hospitals, similar to the successes of NSQIP and TQIP.

Session: Session VII: Paper 14-17: Emergency General Surgery
Paper 16: 10:40-11:00 am

INTERRUPTED VERSUS CONTINUOUS FASCIAL CLOSURE IN PATIENTS UNDERGOING EMERGENT LAPAROTOMIES: A RANDOMIZED CONTROLLED TRIAL

Marc A. De Moya* MD, Thomas Peponis MD, Jordan Bohnen MBA,MD, Sandra Muse NP, Eva Fuentes MD, Gwendolyn Van Der Wilden MD,Ph.D., Ali Mejaddam MD, Hasan Alam* MD, Peter Fagenholz MD, Haytham Kaafarani MD, Haytham Kaafarani MD, David King* MD, Yuchiao Chang Ph.D., George Velmahos* MD,Ph.D.,
Massachusetts General Hospital

Invited Discussant: Brandon Bruns, MD

Introduction:The optimal method of fascial closure, interrupted versus continuous techniques (IFC and CFC respectively) has been a topic of vigorous debate. The two methods have never been compared in the high risk setting of emergency surgery. We hypothesized that IFC leads to a decrease in postoperative incisional hernia development following emergent laparotomies.

Methods:Between August, 2008 and March, 2014, patients undergoing emergent laparotomies were consented and randomly assigned to either IFC or CFC. Patients were followed postoperatively for at least three months and assessed for the development of hernias, dehiscence, or wound infections. We excluded trauma patients and those who had elective surgery, mesh in place, primary ventral hernia, abdominal surgery within the past 4 weeks, or who were not expected to survive for more than 48 hours. Our primary endpoint was the incidence of postoperative incisional hernias.

Results:136 patients were randomly assigned to IFC (n=67), or CFC (n=69). Baseline characteristics were similar between the two groups. No difference was noted in terms of the length of the abdominal incision, or the peak inspiratory pressure after the closure. The median time needed for closure was significantly longer in the IFC group (22 versus 13 minutes, $p<0.001$). Thirty-seven IFC (55.2%) and 41 CFC (59.4%) patients completed their follow-up visits. There was no statistically significant difference in the baseline and intraoperative characteristics between those who completed follow-ups and those who were lost to follow up. The median time from the day of surgery to the day of the last follow-up was similar between IFC and CFC (233 [112 - 307] versus 216 [131 - 688] days, $p=0.674$), as were the rates of incisional hernia development (13.5% versus 22.0%, $p=0.251$), dehiscence (2.7% versus 2.4%, $p=1.0$), and surgical site infection (16.2%versus 12.2%, $p=0.748$).

Conclusion: There was no statistically detectable difference in postoperative hernia development between those undergoing IFC versus CFC after emergent laparotomies.

Session: Session VII: Paper 14-17: Emergency General Surgery
Paper 17: 11:00-11:20 am

LOWER EMERGENCY GENERAL SURGERY (EGS) MORTALITY AMONG HOSPITALS WITH HIGH QUALITY TRAUMA CARE

John W. Scott MD,MPH, Thomas C. Tsai MD,MPH, Pooja U. Neiman MPA, Gregory J. Jurkovich* MD, Garth H. Utter* MD, MSc, Adil H. Haider* MD,MPH, Ali Salim* MD, Joaquim M. Havens* MD, Brigham and Womens Hospital

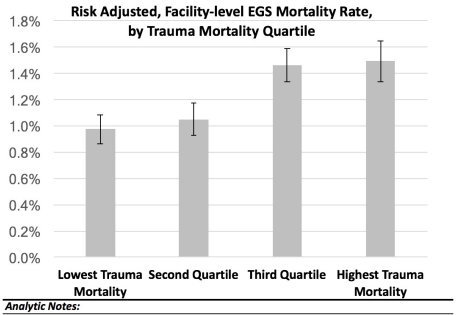
Invited Discussant: Omar Danner, MD

Introduction: Patients undergoing emergency general surgery (EGS) procedures are six times more likely to die than patients undergoing the same procedures electively. This excess mortality is often attributed to patient factors including comorbidities and acute physiologic derangements, leaving few targets for quality improvement. The hospital-level traits contributing to variation in EGS outcomes are not well understood.

Methods: Using the Nationwide Inpatient Sample (2008-2011), we calculated hospital-level risk-adjusted mortality rates for hospitals with $\geq$400 trauma admissions. We then calculated hospital-level risk-adjusted mortality rates for hospitals with $\geq$200 urgent/emergent admissions for seven core EGS procedures (Figure). We used bivariate and multivariate techniques to assess for associations between hospital-level risk-adjusted EGS mortality and hospital characteristics, patient-mix traits, EGS volume, and trauma mortality quartile.

Results: Data from 303 hospitals, representing 153,544 unweighted admissions, revealed a mean hospital-level EGS mortality rate of 1.27% (s.d.=0.65%) for seven core EGS procedures, and 5.50% (s.d.=2.62%) when excluding appendectomy and cholecystectomy. There was a moderate positive correlation between hospital-level trauma mortality and EGS mortality (Pearson's rho=0.399, $p<0.001$). Adjusting for hospital traits, hospital-level EGS mortality was significantly associated with trauma mortality quartile ($p<0.001$, Figure). Risk-adjusted EGS mortality was 0.97% at hospitals in the lowest-quartile for risk-adjusted trauma mortality, and 1.49% at hospitals in the highest-quartile of trauma mortally ($p<0.001$). Sensitivity analyses excluding appendectomy and cholecystectomy found similar significant trends; 4.61% vs 6.73% at lowest vs highest trauma mortality quartile hospitals ($p<0.001$).

Conclusion: Patients at hospitals with lower risk-adjusted trauma mortality have a nearly 50% lower risk of mortality after admission for emergency general surgery procedures. This suggests that the system and process improvement efforts that strive to improve trauma mortality likely also have a positive impact on EGS mortality. EGS-specific systems- and process-measures are needed to better understand drivers of variation in quality of EGS outcomes.



Analytic Notes:

* ***Seven core EGS procedures*** include large bowel resection, small bowel resection, exploratory laparotomy, lysis of adhesions, operation for peptic ulcer disease, appendectomy, cholecystectomy

* ***EGS mortality adjusted for*** year, age, sex, comorbidities, transfers, procedure, diagnosis

* ***Facility-level co-variates*** include bedsize, teaching status, urban/rural location, census region, ownership, racial makeup, payer mix, patient income mix, outpatient surgery rate, EGS volume

Session: IXA: Papers 18-26: Trauma Systems
Paper 18: 2:00-2:20 pm

THE EPIDEMIOLOGY OF FIREARM-RELATED INJURIES IN THE UNITED STATES

Jacob B. Avraham MD, Spiros G. Frangos* MD,MPH, Charles J. DiMaggio MPH,Ph.D.,
New York University Langone Medical Center

Invited Discussant: Thomas Weiser, MD

Introduction: Firearm-related injuries remain an important cause of morbidity and mortality in the United States (US), consuming healthcare resources and fueling political and public health discourse. Most analyses of firearm-related injuries are based on fatality statistics. Treatment and prevention strategies may benefit by a better characterization of the national extent and scope of those firearm-related injuries that survive to hospital care. The objective of this study is to describe the epidemiology of firearm-related injury presenting to the nation's emergency departments (ED) over a recent 4-year period.

Methods: We conducted a secondary retrospective, repeated cross-sectional study of the Healthcare Cost and Utilization Program (HCUP) Nationwide Emergency Department Data Sample (NEDS) from 2009-2012. NEDS is the largest all-payer ED survey in the US, based upon a 20% stratified single-cluster sample of hospital-based EDs across 30 states containing approximately 30 million records. Firearm-related injuries were identified using a variable created by HCUP based on ICD9 E-codes. Results of the analysis are survey-adjusted counts, proportions, means, and rates with associated standard errors (se), and 95% confidence intervals and graphs of age-stratified ED discharge rates for traumatic firearm-related injuries.

Results: There were 71,111 (se=613) ED diagnoses of firearm-related injuries in the US in 2009 (23.2 [se=0.2] per 100,000). This increased 3.9% (se=1.2) to 75,559 (se=610) in 2012 (24.1 [se=0.2] per 100,000). Patients aged 18 to 44 accounted for the largest proportion of overall firearm-related ED diagnoses with 52,187 (se=527) firearm-related ED visits (46.3 [se=0.5] per 100,000) in 2009 and 56,644 (se=528) (49.6 [se=0.6] per 100,000) in 2012—a 7.2% (se=1.6) relative rate increase and an absolute increase of 3.3 (se=0.7) diagnoses per 100,000. Although the absolute numbers were comparatively smaller than adults, the rates of firearm-related injuries increased across all pediatric age groups, most notably among the youngest children (ages 0-4: 17% rate increase, 5-9: 18% increase, 10-14: 6% increase).

Conclusions: Firearm-related injuries treated in US EDs increased during the four-year period studied, driven primarily by an increase in injuries to adults aged 18 to 44, but also with a concerning double-digit relative increase among young children.

Session: IXA: Papers 18-26: Trauma Systems
Paper 19: 2:20-2:40 pm

RE-EXAMINATION OF A BATTLEFIELD TRAUMA GOLDEN HOUR POLICY

Jeffrey T. Howard Ph.D., Russ S. Kotwal MD,MPH, Alexis R. Santos Ph.D., Matthew J. Martin* MD, Zsolt T. Stockinger* MD, US Army Institute of Surgical Research

Invited Discussant: Donald Jenkins, MD

Introduction: Most combat casualties die in the prehospital setting. Efforts directed toward alleviating prehospital combat trauma death, known as killed in action (KIA) mortality, have the greatest opportunity for eliminating preventable death. In 2009, Secretary of Defense Robert M. Gates mandated prehospital transport of casualties to a medical treatment facility within 60 minutes.

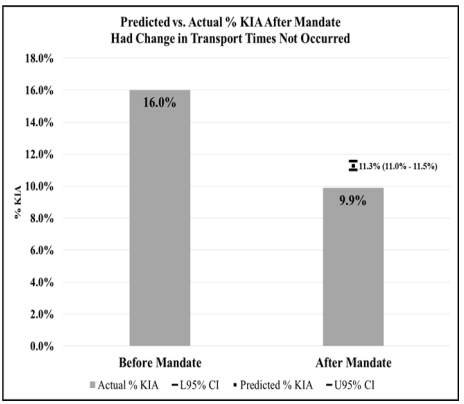
Methods: A retrospective analysis of battlefield data using multivariable tests of competing hypotheses was conducted to evaluate proposed explanations for observed KIA mortality reduction. Observational data obtained on 4,542 battlefield trauma patients during the Afghanistan conflict from September 11, 2001 through March 31, 2014 were analyzed. Inverse probability weighting was used to account for selection bias. Data were analyzed using weighted multivariable logistic regression analysis and bootstrapped simulation analysis to measure and compare alternative hypotheses, including 1) gradual improvement, 2) damage control resuscitation, 3) harm from inadequate resources, 4) change in wound pattern, and 5) reduced transport time, in terms of their relative effects on the outcome of KIA mortality.

Results: The effect of gradual improvement measured through a linear time trend was not significant (AOR=0.99; 95% CI 0.94-1.03; p=0.58). For critically injured casualties with military injury severity score ≥ 25, the odds of KIA mortality were 83% lower for casualties who both needed and received early damage control resuscitation through prehospital blood transfusion (AOR=0.17; 95% CI 0.06-0.51; p=0.002); 33% lower for casualties receiving timely damage control resuscitation and surgery initially at a resource limited forward surgical team (AOR=0.67; 95% CI 0.58-0.78; p<0.001); 70%, 74%, and 87% lower for casualties with dominant injuries to head (AOR=0.30; 95% CI 0.23-0.38; p<0.001), abdomen (AOR=0.26, 95% CI 0.19-0.36; p<0.001) and extremities (AOR=0.13; 95% CI 0.09-0.17; p<0.001); 35% lower for casualties categorized with blunt injuries (AOR=0.65; 95% CI 0.46-0.92; p=0.01); and 39% lower for casualties transported within one hour of injury (AOR=0.61; 95% CI 0.51-0.74; p<0.001).

Results of weighted unadjusted and multivariable adjusted logistic regression models of Killed in Action mortality status (N=4,542)

	Model 1: Unadjusted	Model 2: Covariate Adjusted for Demographics, Transport Time, Injury Severity, Injury Patterns, Initial MTF Type, and Prehospital Blood Transfusion
Variables	OR (95% CI); p value	AOR (95% CI); p value
Transport Time by military Injury Severity Score (mISS)		
≤60 min / mISS≥25	0.48 (0.42-0.56); <0.001	0.61 (0.51-0.74); <0.001
≤60 min / mISS<25	0.01 (0.01-0.02); <0.001	0.01 (0.01-0.02); <0.001
>60 min / mISS<25	0.01 (0.00-0.01); <0.001	0.01 (0.00-0.01); <0.001
>60 min / mISS≥25 (ref)		
Linear Time Trend		0.99 (0.95-1.03); 0.58
Prehospital Blood Transfusion		
Needed / Received		0.17 (0.06-0.51); 0.002
No Need / Received		0.70 (0.31-1.61); 0.40
No Need / Did Not Receive		3.62 (2.91-4.50); <0.001
Needed / Did Not Receive (ref)		
Medical Treatment Facility		
Forward Surgical Team		0.67 (0.58-0.78); <0.001
Combat Support Hospital (ref)		
Mechanism of Injury		
Explosion		1.01 (0.85-1.21); 0.90
Missing		5.93 (3.13-11.21); <0.001
Blunt or other		0.65 (0.46-0.92); 0.01
Gunshot (ref)		
Dominant Body Region		
Head		0.30 (0.23-0.38); <0.001
Neck/Face		0.74 (0.44-1.23); 0.24
Chest		0.77 (0.57-1.04); 0.09
Abdomen		0.26 (0.19-0.36); <0.001
Extremity		0.13 (0.09-0.17); <0.001
External (ref)		
Age		0.97 (0.96-0.98); <0.001
Sex		
Female		0.58 (0.29-1.18); 0.13
Male (ref)		

OR=Odds Ratio; AOR=Adjusted Odds Ratio



Conclusion: Reduction in KIA mortality is associated with early treatment capabilities, blunt mechanism, select body locations of injury, and rapid transport.

Session: IXA: Papers 18-26: Trauma Systems
Paper 20: 2:40-3:00 pm

SPEED ISN'T EVERYTHING: IDENTIFYING PATIENTS WHO MAY BENEFIT FROM HELICOPTER TRANSPORT DESPITE FASTER GROUND TRANSPORT

Joshua B. Brown MD, MSc, Mark L. Gestring* MD, Matthew R. Rosengart* MD,MPH, Timothy R. Billiar* MD, Andrew B. Peitzman* MD, Xilin Chen MPH, Jason L. Sperry* MD,MPH, University of Pittsburgh

Invited Discussant: Robert Mackersie, MD

Introduction: Helicopter emergency medical services (HEMS) have shown survival benefits over ground emergency medical services (GEMS). Most conceptualize the benefit of HEMS as bringing the patient to the trauma center quickly, citing the time and speed advantage over GEMS. However, HEMS may offer benefits in selected patients by bringing the trauma center to the patient. Some severely injured patients may benefit from immediate critical interventions such as advanced airway management or transfusion, as well as more experienced providers regardless of time savings and even when GEMS transport may be faster. Our objective was to determine if any existing triage criteria identify patients at the scene of injury that benefit from HEMS even when prehospital time is shorter for GEMS transport.

Methods: Adults undergoing scene ALS transport by HEMS or GEMS between 2000-2013 in the Pennsylvania State Trauma Registry were included. Propensity score matching was used to match HEMS and GEMS patients for likelihood of HEMS transport based on demographics, prehospital physiology, mechanism, and anatomic injuries. Patients were matched within county to approximate similar distances. Iterative nearest neighbor 1:1 matching was performed, keeping only pairs at each iteration where HEMS patients had longer total prehospital time than the matched GEMS patient. Mixed-effects logistic regression then evaluated the effect of transport mode on survival while controlling for demographics, admission physiology, ISS, transfusions, and procedures, with a random-effect to account for matched pairs. Models were then stratified based on the presence/abscence of triage criteria from national guidelines that had a significant interaction with transport mode to determine which triage criteria when present identify patients with a significant survival benefit when transported by HEMS despite being slower than GEMS.

Results: From 153,729 eligible patients, 8,307 pairs were matched. After matching, all propensity score variables were balanced with no absolute standardized difference between groups >0.1. HEMS total prehospital time was a median of 13minutes (IQR 6, 22) longer than GEMS. Overall, regression revealed HEMS transport was associated with a 22% increase in the odds of survival (OR 1.22; 95%CI 1.03-1.45, p=0.02) among matched pairs. A significant interaction with transport mode was seen for respiratory rate <10 or >29bpm, GCS<14, and hemo/pneumothorax (p<0.05). Patients presenting in the field with one of these criteria had a significant survival advantage when transported by HEMS despite longer prehospital time than GEMS, while there was no association between transport mode and survival in patients without these criteria (TABLE 1).

TABLE 1

	AOR HEMS vs. GEMS	95%CI	p value
Respiratory rate <10 or >29bpm	2.39	1.26—4.55	0.01
Normal respiratory rate	1.16	0.93—1.44	0.20
GCS<14	1.47	1.12—1.92	0.01
GCS≥14	1.07	0.68—1.68	0.76
Hemothorax or pneumothorax	2.25	1.06—4.78	0.03
No hemothorax or pneumothorax	1.16	0.93—1.45	0.19

Conclusion: Patients with abnormal respiratory rate, GCS<14, and hemo/pneumothorax benefit from HEMS transport even when GEMS transport was faster. This suggests these patients benefit primarily from HEMS care, such as airway management, rather than simply faster transport to a trauma center. These criteria may help inform air medical triage protocols, and additional study should further elucidate which patients may benefit from HEMS care even if GEMS transport may be faster.

Session: IXA: Papers 18-26: Trauma Systems
Paper 21: 3:00-3:20 pm

TRAUMA CENTER PROLIFERATION: NEED OR GREED?

Vaidehi Agrawal Ph.D., Priyanka Varma MD, MSc, Dimple Raval Joseph D. Amos* MD, Methodist Hospital of Dallas

Invited Discussant: Kristan Staudenmayer, MD, MSc

Introduction: Traumatic injury is the leading cause of death and disability among the most productive members of society. In recent years, an increase in the number of trauma centers has been noted, galvanized controversially on either a perception or actual need or financial reimbursements. Few studies to date have evaluated the regional need for additional trauma systems. In this study, we employ the newly developed Needs Based Assessment of Trauma Systems (NBATS) Tool, to assess regional need for trauma centers in the state of Texas.

Methods: The American College of Surgeons (ACS) Committee on Trauma (COT) six question NBATS tool was employed to assess regional need for trauma systems within specific Trauma Service Areas (TSA). The first four questions consisted of population density, median transport time, community support, and number of patients with ISS > 15 discharged from non-Level I, II or III trauma centers. A raw score (3 to 23) was calculated and adjusted (by a score of -3 to 2.5) for the number of existing Level I, II and III centers and the volume of severely injured patients seen at those centers. A final score of ≤5 points meant allocation of 1 trauma center; 6-10: 2 centers; 11-15: 3 centers; and 16-20: 4 centers. Multiple date sources were used to collect this data: US Census for population, Department of State Health Services (DSHS) for MTT, Injury Severity Scoring (ISS) > 15 discharges from non-Levels I/II/III and ISS > 15 patients seen in I/II, Regional Advisory Committee (RAC) for Lead agency and ACS and American Trauma Society for existing level I/II/III centers.

Results: After IRB approval, data from 22 TSAs (A-V) in Texas were attained. The maximum point scored on Population was 10 (3 TSAs) and minimum point was 2 (14 TSAs). The maximum point on median transport time was 1 (17 TSAs) and minimum was 0 (5 TSAs). All TSAs had a RAC and hence scored 5 points on community support. All the TSAs noted between 0-200 (ISS>15) patients and received 0 points each. The maximum point scored on existing trauma centers was 0 (8 TSAs) and minimum was -9 (1 TSA). The maximum point scored on actual vs expected number of ISS>15 patients seen in level I/II centers was 2 points (1 TSA) and minimum was -2 (4 TSAs). The raw unadjusted scores for TSA A-V were 7, 8, 7, 8, 16, 7, 10, 8, 10, 7, 8, 8, 8, 8, 14, 16, 16, 12, 8, 7, 8 and 12 respectively. The final scores for TSA A-V were 6, 4, 5, 7, 5, 6, 10, 7, 6, 5, 7, 6, 6, 6, 8, 17, 10, 10, 7, 6, 6 and 10 respectively. Based on above, the number of trauma centers to be allocated was 1 in 4 TSAs, 2 in 17 TSAs, and 4 in 1 TSA. The existing count of Level I/II/III trauma centers was 1 in 6 TSAs, 2 in 5 TSAs, 3 in 3 TSAs, 4 in 3 TSAs, 5 in 2 TSAs, 7 in 1 TSA, and 17 in 2 TSAs. The TSAs which were deficient in number of centers were A, D, H, M, and N. TSAs C, K, S, T, U had the required number of centers, and TSAs B, E, F, G, I, J, L, O, P, Q, and R had higher than required number of centers.

Conclusion: We observed that while cities like Dallas/Fort Worth and Houston had a surplus, Amarillo, Waco, and Brazos Valley were in need for more trauma centers. Although the NBATS tool does give a head start in the assessment of the actual need for trauma centers, one of its limitations is that there is not adequate documentation or uniformity in demonstration of community support by each RAC. Further research is needed to reassess the need of trauma centers in deficient areas and redistribute the funding to regulate the proliferation of trauma centers in saturated areas.

Session: IXA: Papers 18-26: Trauma Systems
Paper 22: 3:20-3:40 pm

DEVELOPMENT OF A TRAUMA SYSTEM AND OPTIMAL PLACEMENT OF TRAUMA CENTERS USING GEOSPATIAL MAPPING

Frederick B. Rogers* MD, MS, FACS, Michael A. Horst Ph.D., Brian W. Gross BS, Eric H. Bradburn DO, MS, FACS, Alan D. Cook* MD, FACS Lancaster General Health/Penn Medicine

Invited Discussant: Ronald Stewart, MD

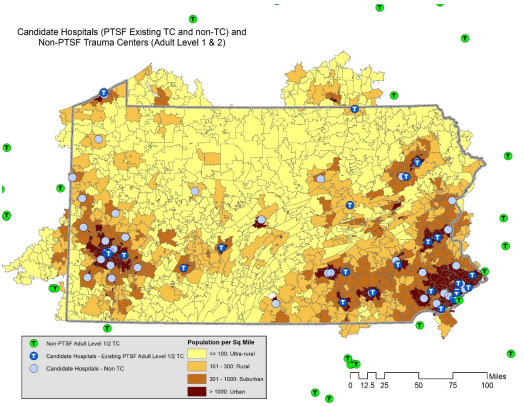
Introduction: The care of patients at individual trauma *centers* (TCs) has been carefully optimized, but not the care provided by trauma *systems*. We sought to objectively determine the optimal placement of trauma centers in a single state (PA) using geospatial mapping.

Methods: We used Pennsylvania Trauma Systems Foundation (PTSF) registry data of adult (age≥15) trauma for calendar years 2003-2015 (n=408,432), hospital demographics, road networks and US Census files. We included TCs and zip codes outside of PA to account for edge effects with trauma cases aggregated to the Zip Code Tabulation Area (ZCTA) centroid of residence. Model assumptions included no prior trauma centers (clean slate), travel time intervals to TC (45, 60, 90 and 120 minutes), TC capacity based on mean ratios of trauma cases per bed size and candidate hospitals ≥ 200 licensed beds (n=64). We used the Network Analyst Location-Allocation function in ArcGIS Desktop to generate models optimally placing 1 to 27 TCs (27 current PA TCs) and assessed model outcomes.

Results: At a travel time of 60 minutes and 27 sites, the optimally placed model was able to reach 96% of trauma cases and 84% of ZCTA compared to the existing trauma network reaching 91% of trauma cases and 70% of ZCTAs. The optimally placed model was equivalent to the current trauma network with only 20 TCs at a 60 minute travel range. Similar results were observed with the other travel times.

Conclusion: Our algorithm selected a set of hospitals for trauma center designation that differed from the current set; we believe that this new set would provide more timely trauma care. Because it considers the complete system, it is likely that our algorithm, or one similar, can better develop trauma systems than the typical, often politically motivated, approach.

Figure 1. Candidate Hospitals for Clean Slate Modeling in the Commonwealth of Pennsylvania



Session: IXA: Papers 18-26: Trauma Systems
Paper 23: 3:40-4:0 0pm

HIGH-NEED HIGH-COST TRAUMA PATIENTS: A NATIONAL ASSESSMENT OF INJURED PATIENTS EXPERIENCING HIGH FINANCIAL BURDEN

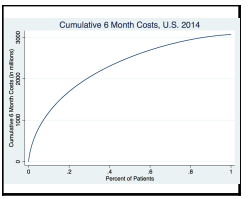
Lisa M. Knowlton* MD,MPH, Charlotte Rajasingh B.A., Lakshika Tennakoon MD, David A. Spain* MD, Kristan L. Staudenmayer* MD, MS Stanford University

Invited Discussant: Michael Rotondo, MD

Introduction: A small proportion of patients account for a majority of healthcare costs. This observation has never been applied to the trauma population. We hypothesized that a small proportion of trauma patients comprised the bulk of national expenses on trauma. We further hypothesized that this heavy financial burden was borne by those least likely to be able to pay.

Methods: We used the 2014 National Readmissions Database (NRD) from the Healthcare Cost and Utilization Project (HCUP). The NRD is a nationally representative database that includes longitudinal data for inpatient hospitalizations. Patients younger than 18 years were excluded, as were patients with missing cost data. We included all admissions with a primary diagnosis of trauma based upon ICD-9 codes. Patients admitted between April-June 2014 were analyzed over a 6-month follow-up period. “High-need, high cost” (HNHC) was defined as patients with 6-month inpatient costs in the top 5%. Patient demographic, injury and hospital characteristics of HNHC patients were evaluated. Univariate and multivariate analyses were performed. Weighted data are presented to provide national estimates.

Results: Of the 35.3 million patients represented in the 2014 NRD database, a total of 299,465 (0.8%) trauma patients met all inclusion and exclusion criteria. The 6-month costs for all trauma patients totaled $3.1 billion. Fewer than 1% of trauma patients (N=1,109) met HNHC criteria. The average 6- month costs were more than 10-fold higher for the HNHC group vs. the non-HNHC trauma group ($287,000 vs. $21,000, p<0.001). HNHC trauma patients vs. non HNHC were predominately male (67.6% vs. 32.4%), younger (51.3 vs. 63.6 years), and had a higher injury severity score (ISS>15: 92.1% vs. 51.8%). They were also more likely to have multiple injuries (62% vs. 29%). HNHC trauma patients had a greater mean number of hospitalizations (2.5 vs. 1.4, p<0.001), and higher 6-month readmission rates (34.2% vs. 23.4%, p<0.001). Factors associated with HNHC status in logistic regression modeling were male gender (odds ratio (OR):1.26, p=0.003), injury severity score of 15 or more (OR 2.1, p<0.001), and Medicaid payer status (2.9, p<0.001). HNHC status patients were also less likely to be hospitalized in private hospitals (vs. government, OR: 0.6, p<0.001).



Conclusion: The US HNHC trauma population consists of only 1% of patients, but cost and resource burden is significant. HNHC characteristics suggest vulnerability surrounding demographic factors including Medicaid status. In addition, HNHC patients are more often associated with care at government hospitals. This suggests that the highest cost burden rests with those least likely to pay. Policy efforts should focus on streamlining services within these centers, and dentifying targeted interventions to improve care and reduce costs.

Session: IXA: Papers 18-26: Trauma Systems
Paper 24: 4:00-4:20 pm

VARABILITY OF INJURED PATIENT CHARACTERISTICS AND CHARGES BY TRAUMA CENTER LEVEL AND OWNERSHIP TYPE

David J. Ciesla* MD, Etienne E. Pracht Ph.D., Steven R. Smith* MD, Joseph J. Tepas* III, MD, Barbara Langland-Orban Ph.D., University of South Florida

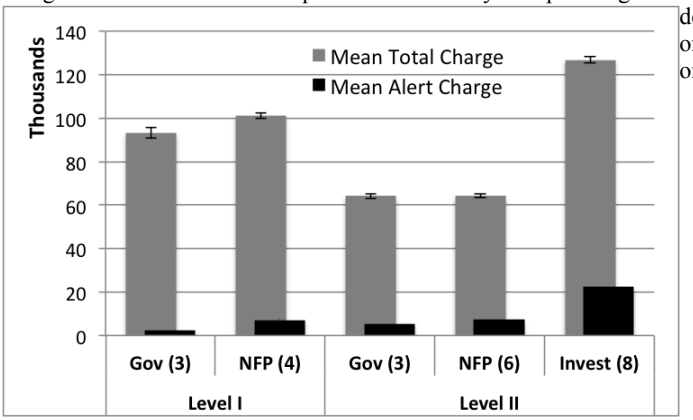
Invited Discussant: Michael Chang, MD

Introduction:The ascension of large healthcare systems coincides with a surge in hospitals seeking trauma center designations, primarily as investor owned Level II centers. In many areas this expansion is disproportionate to changes in population demands suggesting motivations other than public need. The purpose of this study was to compare injured patient charges between trauma centers by level and ownership type.

Methods:Injured patients discharged from the 24 state trauma centers in 2014 were identified using ICD-9 codes in a statewide discharge dataset. An inclusive trauma patient definition was chosen to match that used by the state's department of health in its trauma registry. Elderly isolated hip fractures resulting from falls were excluded. There were 7 Level I (LI) and 17 Level II (LII) trauma centers. Hospital ownership type was defined as government/public (Gov), not for profit (NFP) or investor owned (Invest).

Results:Of 50,473 patients, 36% were discharged from LI and 64% discharged from LII. LII patients were more often older, female and had fall mechanisms and head injuries, but less often multisystem, high mortality risk injury patterns than LI patients. Patients from different hospital types were more similar to one another within trauma center levels than between levels. Payer mix differed between levels and between types within levels with the highest (19%) and lowest (10%) proportion of self-pay observed at LI(Gov) and LII(NFP). The highest (50%) and lowest (37%) proportion of commercial payers were observed at LII(Gov) and LI(Gov) centers. Mean±SEM trauma alert and total hospital charges are shown in the figure. LI(NFP) alert and total charges were higher ($p<0.01$) than LI(Gov). LII(NFP) alert and LII(Invest) alert and total charges were higher ($p<0.01$) than LII(Gov). LII(Invest) treated 52% of LII patients but accounted for 68% of LII charges.

Conclusion:Injured patient charges varied substantially by trauma center level and ownership type. Although higher LI charges may be explained by a higher patient acuity, variability within levels was still observed. The highest charges were observed at LII(Invest) and could not be explained by patient acuity or solely by higher trauma alert charges. This information is important to trauma system planning where value is dependent not only on quality but also on cost.



Session: IXA: Papers 18-26: Trauma Systems
Paper 25: 4:20-4:40 pm

IMPACTING ACUTE STRESS REACTIONS WITH A BRIEF INTERVENTION TO PREVENT POST TRAUMATIC STRESS DISORDER AT A LEVEL 1 TRAUMA CENTER

Stacey S. Manser Ph.D., Thomas B. Coopwood* MD, Katherine Houck MSSW, LCSW
University Of Texas At Austin School Of Social Work

Invited Discussant: Gregory "Jerry" Jurkovich, MD

Introduction: Approximately 20-40% of injured trauma survivors experience posttraumatic stress disorder (PTSD) during the year following injury. The American College of Surgeons Committee on Trauma reports that early screening and referral has the potential to improve symptomatic and functional outcomes and that further study of screening and intervention for PTSD would be beneficial. The purpose of this study was to assess the effect of a brief intervention in reducing or preventing development of PTSD over time in injured patients who screened positive for traumatic stress reactions. We hypothesized that a brief intervention provided at initial hospitalization is associated with a reduced rate of PTSD development.

Methods: In this prospective randomized trial, the 4-item Primary Care-PTSD (PC-PTSD) screen was administered to a convenience sample of injured patients admitted to an academic Level 1 trauma center. After informed consent, patients with identified symptoms of traumatic stress reactions were randomized to an Intervention (I) or a Control (C) group. The 1-hour brief intervention focused on symptom education and normalization, coping strategies, and utilizing supports. The control group received a 3-minute educational brochure review. Both groups completed baseline in-hospital interviews, then 45-day and 90-day telephone interviews. Interviews include the PTSD Checklist-Civilian (PCL-C), measures of social support, treatment seeking, and referral to PTSD treatment for patients with a positive PCL-C.

Results: During the study period, 72 participants completed baseline, 45- and 90-day interviews and were included in this analysis. 87.1% of admissions were due to blunt trauma. Multivariate analysis revealed that all patients who screened positive on the PC-PTSD ($\geq$3) demonstrated statistically significant improvement in PCL-C scores over time ($p=.003$), regardless of the intervention. The intervention group demonstrated more treatment responsiveness, with a 5.54 decrease in 90-day PCL-C scores compared to a 0.85 decrease in the control group. Of those at or above the positive PCL-C cutoff, 25%at the 45-day interview and 43.8% at the 90-day interview had sought PTSD treatment and experienced access barriers. Barriers included no providers in the area, no transportation, no insurance or funds to pay for treatment, and focusing on their ongoing rehabilitation.

Conclusion: Based on initial results, a positive PC-PTSD screen identified patients who later screened positive for PTSD using the PCL-C. The brief intervention provided at initial hospitalization reduced later PTSD development in comparison to the control group. However, due to lack of treatment infrastructure in the community, access to needed PTSD treatment was difficult. It will be important for trauma centers to collaborate with community-based clinics and providers to address the PTSD treatment needs of patients.

Session: IXA: Papers 18-26: Trauma Systems
Paper 26: 4:40-5:00 pm

A STATEWIDE ANALYSIS OF OUTCOMES AFTER EMERGENCY GENERAL SURGERY: DOES SURGEON VOLUME OR HOSPITAL VOLUME MATTER FOR GERIATRIC PATIENTS?

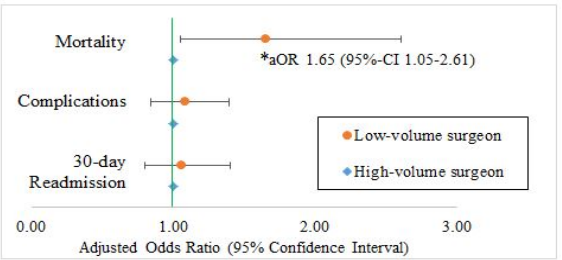
Ambar Mehta BS, Bellal Joseph* MD, Joseph K. Canner MHS, Kent Stevens MD, Christian Jones MD, MS, Elliott Haut* MD,Ph.D., David Efron* MD, Joseph V. Sakran MD,MPH, MPA Johns Hopkins School of Medicine

Invited Discussant: Zara Cooper, MD, MSc

Introduction: Geriatric patients undergoing emergency general surgery (EGS) procedures face significant morbidity and mortality, often due to their age and comorbidities. We sought to assess outcomes after EGS procedures among geriatric patients and their association with both surgeon volumes and hospital volumes.

Methods: We used Maryland's Health Services Cost Review Commission data set to identify patients at least 65-years-old who underwent one of 12 EGS procedures, as defined by the American Association for the Surgery of Trauma, that comprise 90% of the state's EGS burden from 2012–2014. We calculated three outcomes: mortality, the incidence of at least one of eight common EGS complications, and 30-day readmission rates. Median volumes divided both surgeons and hospitals into two groups (low-volume [LV] and high-volume [HV]). Multivariable logistic regressions determined the association between both surgeon volume and hospital volume with the three outcomes. The regressions accounted for hospital-level correlations and adjusted for gender, age, race, ethnicity, payer, comorbidities, region, beds, teaching affiliation, and procedure.

Results: We identified 3,382 patients undergoing an EGS procedure by 302 surgeons at 44 hospitals. LV-surgeons operated on one-sixth (16.5%) of patients. The overall mortality rate was 4.7%, complication rate was 27.0%, and 30-day readmission rate was 11.5%. After adjustment, LV-surgeons relative to HV- surgeons (Figure) were associated with higher mortality (aOR 1.65, 95%-CI 1.04-2.61) but not with complications (aOR 1.08, 95%-CI 0.84-1.39) or 30-day readmissions (aOR 1.06, 95%-CI 0.80-1.40). In contrast, LV-hospitals relative to HV-hospitals were not associated with any outcomes: mortality (aOR 0.91, 95%-CI 0.52-1.58), complications (aOR 0.99, 95%-CI 0.74-1.31), or 30-day readmissions (aOR 0.94, 95%-CI 0.71-1.23). Half (52.0%) of the 227 surgeons working at high-volume hospitals were low-volume surgeons.



Conclusion: Geriatric patients undergoing EGS procedures represent a vulnerable patient population. They experience a high mortality rate, one-in-four suffers a postoperative complication, and one-in-nine are readmitted within 30 days. After adjustment, low-volume surgeons relative to high-volume surgeons had 65% higher odds of mortality, and made up more than half of all surgeons at high-volume centers. As hospital volumes were not associated with outcomes, they should not solely be used for designating verified geriatric center.

Session: IXB: Papers 27-35: Critical Care/Neurotrauma
Paper 27: 2:00-2:20 pm

RESULTS OF A MULTICENTER PROSPECTIVE PIVOTAL TRIAL OF THE FIRST IN LINE CONTINUOUS LACTATE MONITOR IN CRITICALLY ILL PATIENTS

Grant V. Bochicchio* MD,MPH, Stan Nasraway MD, Laura Moore* MD, Eden Nohra MD, Tony Furnary MD, Kelly Bochicchio RN, MS Washington University in St. Louis

Invited Discussant: James Davis, MD

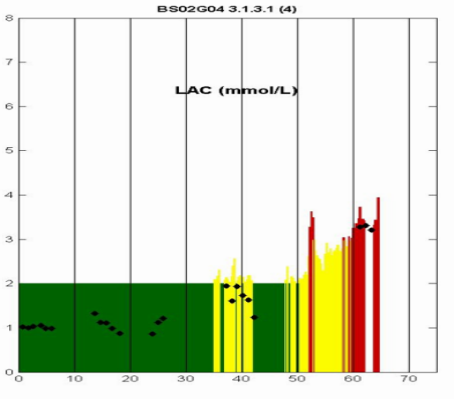
Introduction: Early and aggressive management/clearance of elevated lactate has been clearly demonstrated to improve survival. The Surviving Sepsis Campaign has recently included lactate measurement in their diagnostic and treatment bundles/guidelines. Several studies have demonstrated that a reduction in 2 hour lactate levels guided intervention sooner, with a statistically significant decrease in death and length of stay. It is extremely difficult however, to measure lactate every 2 hours in critically ill patients due to resource constraints and laboratory logistics. Our objective of this pivotal trial was to evaluate the first in human continuous lactate monitor (CLM) in surgical critically ill and trauma patients.

Methods: A multicenter prospective trial was conducted over a 1 year period (2014-2015) at 4 major academic centers. 200 critically ill patients admitted to SICU were enrolled. 3735 lactate measurements were obtained using the CLM and were then compared to the gold standard Yellow Springs Instrument (YSI). The CLM withdrew 0.13 ml of blood every 15 minutes from a central venous line, centrifuged the sample, and used mid-infrared spectroscopy to measure lactate. We plotted a Linear Regression, and analyzed Sensitivity and Specificity at 3 and 4 mmol. CLM and YSI values were "blinded" from clinicians.

Results: There were 2778 CLM to YSI paired measurements between 0-1.9 mmol, within the normal range. There were 957 paired values 2 mmol or greater with a correlation coefficient for linearity of 0.95. Of these, 316 values were 3 mmol or greater with a correlation coefficient of 0.97. Sensitivity and Specificity at 3 mmol (48 patients) was 94% and 96%, improving to 100% and 100% at 4 mmol (24 patients). 37 patients (20%) went from normal to elevated lactate level during the trial demonstrating the ability for early diagnosis of tissue hypoperfusion/sepsis.

Conclusion: This pivotal multicenter trial demonstrates that the first continuous lactate monitor (CLM) is safe and accurate for use in earlier detection of tissue hypoperfusion and/or sepsis in critically ill surgical and trauma patients. Using this technology would decrease the burden on the clinical staff to obtain lactate samples often and allow for a more real-time lab directed resuscitation strategy for lactate clearance.

Figure 1. Graphic Display of Patient Who Became Septic Over 72 Hour Enrollment Period.



Session: IXB: Papers 27-35: Critical Care/Neurotrauma
Paper 28: 2:20-2:40 pm

REINVENTING THE WHEEL: IMPACT OF PROLONGED ANTIBIOTIC EXPOSURE ON MULTI-DRUG RESISTANT VENTILATOR-ASSOCIATED PNEUMONIA IN TRAUMA PATIENTS

Richard H. Lewis Jr., MD, John P. Sharpe MD, Joeseph M. Swanson PharmD, Timothy C. Fabian* MD, Martin A. Croce* MD, Louis J. Magnotti* MD, University of Tennessee Health Science Center - Memphis

Invited Discussant: Lena Napolitano, MD, MPH

Introduction: Ventilator-associated pneumonia (VAP) leads to both increased morbidity (including ventilator days, ICU days and cost) and a two-fold increase in mortality in critically-ill trauma patients. Despite often younger, healthier patients, Gram-negative pneumonias continue to be particularly virulent among the trauma population. More concerning, multi-drug resistant (MDR) strains of both Acinetobacter spp. and Pseudomonas spp. as causative VAP pathogens are becoming increasingly common. Still, the risk factors associated with this increased resistance have yet to be elucidated. The purpose of this study was to examine the changing sensitivity patterns of these pathogens over time and determine which risk factors predict MDR in trauma patients with VAP.

Methods: Patients with either Acinetobacter (AB) or Pseudomonas (PA) VAP ($\geq 10^5$ CFU/mL in BAL effluent) over 10 years were stratified by pathogen sensitivity (sensitive (SEN) and MDR), age, severity of shock and injury severity. Prophylactic and empiric antibiotic days, risk factors for severe VAP (polymicrobial, multiple episodes of inadequate empiric antibiotic therapy (mIEAT) and nosocomial VAP diagnosed within 7 days of admission) and mortality were compared. Multivariable logistic regression (MLR) was performed to determine which risk factors were independent predictors of MDR.

Results: 679 VAP episodes were identified in 406 patients: 309 (76%) men and 97 (24%) women (mean age 44, mean ISS 29, 89% blunt). There were 293 episodes of AB (159 SEN and 134 MDR) and 386 episodes of PA (286 SEN and 100 MDR). The incidence of MDR VAP did not change over the study ($p=0.578$). Groups were clinically similar with the exception of 24-hour transfusions (18 vs 12 units, $p<0.001$) and extremity AIS (1.7 vs 1.4, $p=0.04$), both of which were significantly increased in the MDR group. In addition, antibiotic exposure (prophylactic antibiotic days 7 vs 2, $p<0.001$ and empiric antibiotic days 1.9 vs 1.7, $p<0.001$) as well as mIEAT (57% vs 25%, $p<0.001$) were significantly increased in the MDR group. MLR identified prophylactic antibiotic days (OR 20.3; 95%CI 18.0-21.4) and mIEAT (OR 7.8; 95%CI 6.9-11.3) as independent predictors of MDR in patients with AB and PA VAP after adjusting for severity of shock, injury severity, severity of VAP and antibiotic exposure.

Conclusion: Prolonged exposure to unnecessary antibiotics remains one of the strongest predictors for the development of antibiotic resistance. In fact, MLR identified prophylactic antibiotic days and mIEAT an independent risk factors for MDR VAP. Thus, limiting prophylactic antibiotic days is the only potentially modifiable risk factor for the development of MDR VAP in trauma patients.

Session: IXB: Papers 27-35: Critical Care/Neurotrauma
Paper 29: 2:40-3:00 pm

EARLY DIAGNOSIS USING CANONICAL DISCRIMINANT ANALYSIS OF INNATE IMMUNE RECEPTOR GENE EXPRESSION PROFILE IN INFECTIOUS OR STERILE SYSTEMIC INFLAMMATION

Goro Tajima MD,Ph.D., Ayako Tokunaga BS, Takahiro Umehara Ph.D., Kazuya Ikematsu MD,Ph.D., Osamu Tasaki* MD,Ph.D., Nagasaki University Hospital Emergency Medical Center

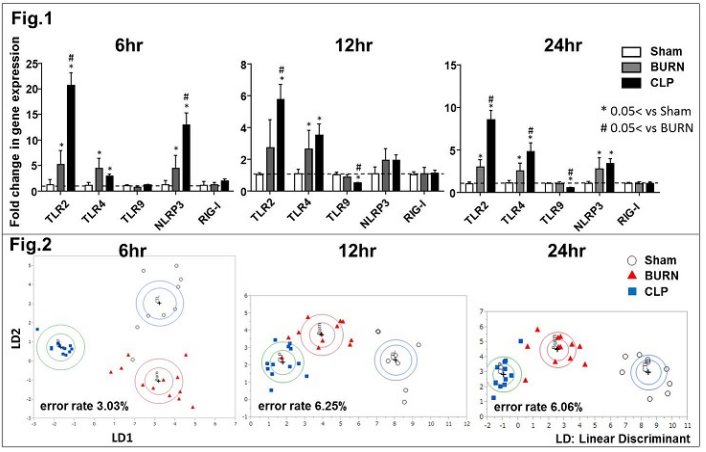
Invited Discussant: Ronald Maier, MD

Introduction: It is difficult to diagnose infection by single biomarker in patients who are under condition of systemic inflammation. We reported that murine sepsis model showed distinctive gene expression patterns of innate immune receptors 24 hours after injury in 75th AAST meeting. We aimed to clarify that time course change of gene expression profile of innate immune receptors in infectious or sterile inflammation, and to establish the early diagnostic method using canonical discriminant analysis of gene expression profile.

Methods: To compare infectious and sterile inflammation, we employed cecal ligation and puncture (CLP) and 20% full thickness burn injury (Burn) model. C57BL/6 mice underwent sham (n=9 x 3groups), CLP (n=12 x 3groups), or Burn (n=12 x 3groups). 6, 12, and 24 hours after injury, mice were sacrificed, and total RNA was extracted from whole blood. Using quantitative real-time PCR, we investigated gene expression of innate immune receptors including TLR2, TLR4, TLR9, NLRP3 and RIG-I. To evaluate all the gene expression together as patterns, each value was standardized, and canonical discriminant analysis was performed at each time point.

Results: Gene expression of TLR2 and TLR4 was significantly increased in both CLP and Burn compared to sham already from 6 hours after injury ($p<0.05$). Gene expression of TLR9 was significantly decreased in CLP compared to both sham and Burn in 12 and 24 hours after injury ($p<0.05$), but not in 6hours. Gene expression of NLRP3 was significantly increased in CLP and Burn compared to sham in 6 and 24 hours after injury ($p<0.05$) (Fig.1). In the canonical discriminant analysis, each group showed distinctive gene expression patterns already from 6 hours after injury. Each group was clearly classified, and the classification error rates were 3.03% (6 hr), 6.25% (12hr) and 6.06% (24hr) respectively (Fig.2).

Conclusion: Canonical discriminant analysis of gene expression profile of innate immune receptors could be convenient and powerful method to distinguish and diagnose infection from sterile systemic inflammation from early stage of the injury.



Session: IXB: Papers 27-35: Critical Care/Neurotrauma
Paper 30: 3:00-3:20 pm

INDICATIONS AND OUTCOMES OF EXTRACORPOREAL LIFE SUPPORT IN TRAUMA PATIENTS

David Zonies* MD,MPH, Peter Rycus MPH, Austin Ward MD, Ravi Thiagarajan MD, Ryan Barbaro MD, Nicholas Cavarocchi MD, Daniel Brodie MD, Roberto Lorusso MD,Ph.D., David McMullan MD, Ali Alt Hssain MD, Pauline Park* MD, Justyna Swol MD, Extracorporeal Life Support Organization

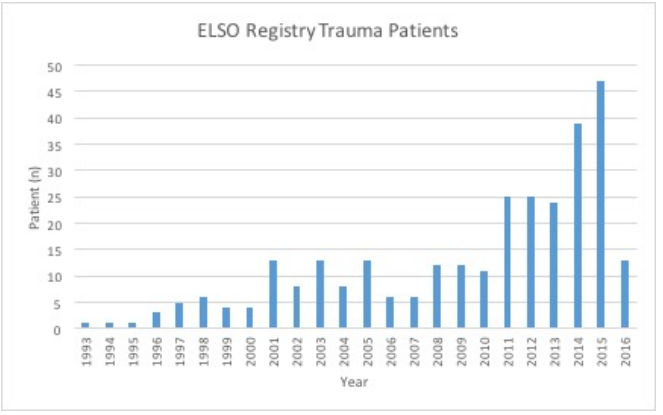
Invited Discussant: Jennifer Smith, MD

Introduction: The use of extracoroporeal life support (ECMO) in the trauma population remains controversial and has been reported in small cohorts with the largest study including 60 patients. High quality evidence to assess realistic survival benefit in this group is required as ECMO remains a resource intensive critical care therapy.

Methods: A retrospective analysis of all adult (>16yo) trauma-related ECMO cases submitted to the ELSO registry (1985-2016) was performed. Baseline characteristics, support indications, therapeutic mode, physiologic characteristics, and survival was assessed.

Results: Among 26,813 adult ECMO patients registered since 1985, 279 trauma patients were identified. One third of cases were performed between 1985-1998 with the first registered case performed in 1993. The majority of cases (70%) were supported over the past 7 years. Patients are predominantly male (78%) with a mean age of 35 ± 15 yrs. The most common ECMO indication was for pulmonary support in ARDS (89%), followed by cardiac support of cardiogenic shock (7%), and E-CPR (4%). The average time on support was 8.8 ± 9.5 days with the longest reported run time of 83 days. ECMO was successfully weaned in 196 patients (70%) with an overall patient survival of 61%. This is favorable when compared to the overal adult registry for pulmonary (57%) and cardiac (40%) survival.

Conclusion: The largest registry to date demonstrates consistently realistic survival among trauma patients placed on ECMO support. With growing experience and an improved safety profile, traumatic injury may not be a contraindication for ECLS, even in cases of cardiac arrest or cases with contraindications for anticoagulation. Extracorporeal life support offers supplemental capacity in the early resuscitation of the trauma patient. Further extended analysis of the registry regarding trauma ECMO management in specific populations may continue to improve patient outcomes.



Session: IXB: Papers 27-35: Critical Care/Neurotrauma
Paper 31: 3:20-3:40 pm

DIRECT PERITONEAL RESUSCITATION REDUCES INTESTINAL PERMEABILITY AFTER BRAIN DEATH

Jessica L. Weaver MD,Ph.D., Paul J. Matheson Ph.D., Amy Matheson BS, Brian G. Harbrecht* MD, Cynthia D. Downard MD, Richard N. Garrison MD, Jason W. Smith* MD,Ph.D., University of Louisville

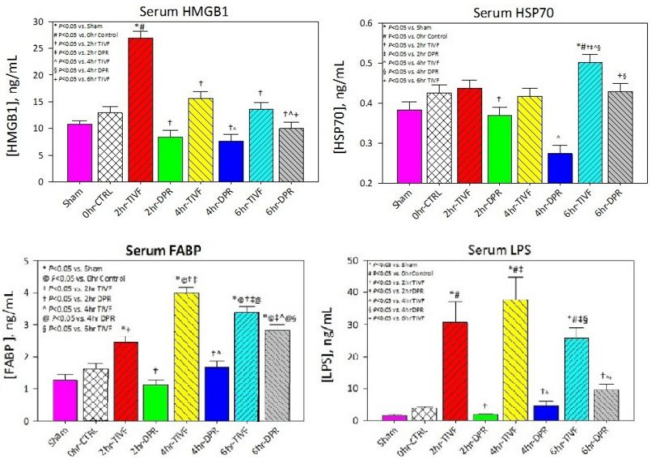
Invited Discussant: Eileen Bulger, MD

Background: Brain death is associated with a profound inflammatory response, but the source of this inflammation is controversial. Intestinal ischemia causes increased inflammatory mediators in other types of shock, but its role in post-brain death inflammation has not been well-studied. Direct peritoneal resuscitation (DPR) improves visceral organ blood flow and has been shown to reduce inflammation after hemorrhagic shock.

Methods: Male Sprague-Dawley rats had a Fogarty catheter inflated in the skull until brain death was achieved. Rats were resuscitated with enough normal saline to maintain a mean arterial pressure of 80 mmHg (targeted intravenous fluid resuscitation, TIVF). Those scheduled for DPR received 30 mL intraperitoneal Delflex solution. Rats were sacrificed at zero, two, four, or six hours after brain death. Protein levels were measured using ELISA. Immunohistochemistry (IHC) was performed using anti-ZO-1 antibodies.

Results: Fatty acid binding protein and lipopolysaccharide, markers of intestinal injury, were increased in serum after brain death and decreased with DPR. Staining for ZO-1 on IHC showed decreased tight junction proteins after brain death, which improved with DPR. Inflammatory cytokines IL-1β and IL-6 were increased at two, four and six hours and decreased at all time points with DPR. Inflammatory markers HMGB-1 and HSP70 increased at two and six hours, respectively, and both were decreased with DPR.

Conclusions: We demonstrated that brain death causes intestinal injury and changes in tight junction integrity, suggesting increased permeability. This correlates directly with increased systemic inflammation. DPR prevents intestinal ischemia and reduces circulating inflammatory markers. This suggests that using this novel therapy as an adjunct to the resuscitation of brain dead donors has the potential to reduce inflammation and potentially improve the quality of transplanted organs.



Session: IXB: Papers 27-35: Critical Care/Neurotrauma
Paper 32: 3:40-4:0 0pm

VALIDITY AND RESOURCE UTILIZATION WITH THE APPLICATION OF THE BRAIN INJURY GUIDELINES: A MULTI-INSTITUTIONAL STUDY

Abid D. Khan MD, Anna J. Elseth BS, Jacqueline A. Brosius MD, Thomas J. Schroeppel* MD, Richard P. Gonzalez* MD, University Of Colorado Health- Memorial Hospital

Invited Discussant: Deborah Stein, MD, MPH

Introduction: The Brain Injury Guidelines provide an algorithm for treating patients with traumatic brain injury (TBI) that does not require repeat head CT (RHCT), neurosurgical consult (NSC), or hospital admission for all patients. Patients categorized as BIG 1 receive no RHCT, no NSC, and are observed in the ED for 6 hours without admission. Patients meeting BIG 2 criteria receive no RHCT, no NSC, and are admitted to the hospital. If BIG 3 criteria are met, a RHCT is performed, the patient is hospitalized, and a NSC is obtained. Heretofore, the algorithm has only been validated at a single institution and the actual decrease in resource utilization has not been measured. The objectives of this study are to provide a multi-institutional assessment of the validity of the Brain Injury Guidelines (BIG) and to quantify the potential reduction in resource utilization that may come from the implementation of these guidelines.

Methods: A multi-institutional retrospective review of all TBI patients over a three year period was conducted at ACS-verified Level 1 and 2 centers. Patients with positive initial head CT findings and a GCS of 13-15 on admission were classified as BIG 1, 2, or 3 based on the guidelines. Patients classified as BIG 3 were excluded from further analysis as the care of these patients under the guidelines does not deviate from the current standard practiced at the participating institutions. Data collected included CT findings, number of hospital days, number of ICU days, number of RHCTs, radiographic and clinical worsening, and neurosurgical interventions performed.

Results: 652 patients met criteria during the study period, 89 were classified as BIG 1, 129 as BIG 2, and 434 as BIG 3. 7.9% of BIG 1 patients and 13.2% of BIG 2 patient had worsening findings on RHCT. One of the BIG 2 patients did require a neurosurgical intervention, however the patient's clinical decompensation would have lead to the application of BIG 3 management guidelines and a RHCT due to a change in neurological exam. BIG 1 and 2 patients had a total of 299 ICU days with an average ICU length of stay (LOS) of 1.37 days. 106 of the 299 (35.5%) ICU days were due to reasons other than TBI. Application of the guidelines would have lead to a dramatic decrease in resource utilization. The BIG 1 and 2 patients would have spent a total of 193 fewer days in the ICU and the average ICU LOS would have dropped from 1.37 days to 0.35 days. 86 of the 89 BIG 1 patients that were admitted would not have required admission for TBI, and 215 NSCs would have been avoided. Additionally, a total of 297 CT scans would not have been obtained, with an average of 1.36 fewer CT scans per patient.

Conclusion: Despite a higher rate of radiographic progression than was observed in the initial study, the application of the BIG algorithm is safe. Overall, the application of BIG criteria would lead a profound decrease in resource utilization by TBI patients due to fewer CT scans, hospital admissions, ICU days, and neurosurgery consults.

Session: IXB: Papers 27-35: Critical Care/Neurotrauma
Paper 33: 4:00-4:20 pm

THE FOURTH EDITION BRAIN TRAUMA FOUNDATION GUIDELINES OFFER NO INDICATIONS FOR INTRACRANIAL PRESSURE MONITORING: CAN PROPENSITY SCORE MATCHED AGE ANALYSIS OF THE NATIONAL TRAUMA DATA BANK GUIDE US?

Anna Liveris MD, Afshin Parsikia MD,MPH, Melvin E. Stone* Jr., MD, Jacobi Medical Center, Albert Einstein College Of Medicine

Invited Discussant: Bellal Joseph, MD

Introduction: The fourth edition Brain Trauma Foundation Guidelines offer no clear indications for intracranial pressure monitoring (ICPM) due to scarce high grade evidence. Evidence supports ICPM for reducing mortality. Other evidence cites decreased survival in elderly patients suggesting age may serve as a clinical indicator ICPM. To reduce selection bias, we used propensity score matching
(PSM) to determine the impact of age on mortality.

Methods: All patients ≥18 years old with isolated traumatic brain injury (TBI), an abbreviated injury scale (AIS) ≥3, and a Glasgow coma scale (GCS) ≤8 between 2008-2014 were included from the National Trauma Data Bank. Exclusion criteria were AIS=6 and death on arrival or within 24 hours. Patients with and without ICPM were compared using Trauma Quality Improvement Program comorbidity and TBI-specific variables, and then were matched via PSM. Logistic regression modeling was used to determine the odds ratio (OR) for death stratified by age.

Results: A total of 23,652 patients were analyzed. Overall, mortality was 29.2% and 15.6% patients underwent ICPM. After PSM, ICPM was associated with death beginning at the age strata, 56-65
(OR 1.5; 95% CI 1.3-1.7; $p<0.001$), with OR increasing for older ranges thereafter. A survival advantage for ICPM began at the age strata, 36-45 (OR 0.8; 95% CI 0.7-0.9; $p=0.001$), with subsequent decreasing OR in younger age ranges.

Table 1. Logistic Regression for Mortality by Age Strata*

Age Strata (years)	*p* value	Odds Ratio	Confidence Interval
18-25	<0.001	0.338	0.284 - 0.403
26-35	<0.001	0.471	0.402 - 0.553
36-45	0.001	0.773	0.664 - 0.901
46-55	0.707	0.976	0.861 - 1.106
56-65	<0.001	1.514	1.334 - 1.719
66-75	<0.001	2.044	1.760 - 2.374
76-85	<0.001	2.740	2.299 - 3.266
86 or greater	<0.001	2.772	1.854 - 4.144

*Matched dataset with a caliper of 0.2 times the standard deviation of the logit of the propensity score

Conclusion: Based on a large propensity-matched sample of TBI patients, ICPM is not associated with survival above 55 years. Until level one data is available, this age threshold should be considered in determining indication for ICPM.

Session: IXB: Papers 27-35: Critical Care/Neurotrauma
Paper 34: 4:20-4:40 pm

ALTERED MONOCYTE AND NK CELL PHENOTYPE CORRELATES WITH POST-TRAUMA INFECTION

Anupamaa Seshadri MD, Gabriel A. Brat MD,MPH, Brian K. Yorkgitis DO, Matthew Giangola MD, Joshua Keegan BS, Jennifer Nguyen BS, Wei Li MD, Yasutaka Nakahori MD, Takeshi Wada MD, Ali Salim* MD, Reza Askari MD, James A. Lederer Ph.D., Brigham and Womens Hospital

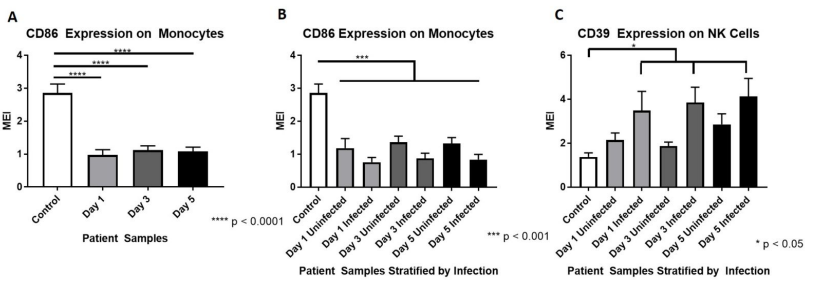
Invited Discussant: Philip Efron, MD

Introduction: Trauma induces a complex immune reaction, requiring a systems biology approach to capture multicellular changes. Using mass cytometry by time-of-flight (CyTOF), we evaluated time series changes in circulating immune cell types in a cohort of trauma patients to identify changes that correlate with predisposition to infection.

Methods: Total blood leukocytes were prepared via red blood cell lysis using peripheral blood samples collected at days 1, 3, and 5 after injury from trauma patients aged > 18 with injury severity score > 20 (n=20, mean ISS 37, 60% male), and from age-matched uninjured controls. Cells were stained using a 33-marker broad immune cell phenotyping CyTOF staining panel. Patients were stratified by whether they developed an infection during their hospital course, as defined by both clinical diagnosis and culture-proven infection. Statistics were calculated by one-way ANOVA with multiple comparisons.

Results: CyTOF staining results demonstrated changes in many cell subsets. CD86 mean expression intensity (MEI) on monocytes decreased significantly at all time points after injury (Figure A). When the patients were stratified based on development of infection, there was a trend to decreased CD86 expression on monocytes of those patients that developed subsequent infection as compared to those who did not at each time point (Figure B). On NK cells, we identified significantly increased expression of CD39, which was found by stratification to be significantly increased only in those patients that subsequently developed an infection (Figure C).

Conclusion: This study used an unbiased systems biology approach to identify novel changes in circulating immune cell subsets in trauma patients that correlate with development of post-traumatic infection. Decreased expression of CD86, a costimulatory molecule, on monocytes demonstrates that trauma affects the innate system's ability to control T-cell immunity, and the trend to lower expression on monocytes from patients who develop infection suggests that this breakdown in immune communication may lead to worse outcomes for patients. We also found that CD39 expression on NK cells increased significantly in patients with subsequent infection. CD39 is a protein involved in the generation of adenosine, which has immunosuppressive effects on several immune cell types including NK cells. In summary, our results point to pathways that may be central to second-hit infections, and further study to delineate these pathways could be key to generating clinical biomarkers or targeted immune therapies for trauma patients.



Session: IXB: Papers 27-35: Critical Care/Neurotrauma
Paper 35: 4:40-5:00 pm

VITAMIN D BINDING PROTEIN (DBP DEFICIENCY DECREASES RENAL INFLAMMATORY CYTOKINE LEVELS IN A MURINE MODEL OF RHABDOMYOLYSIS

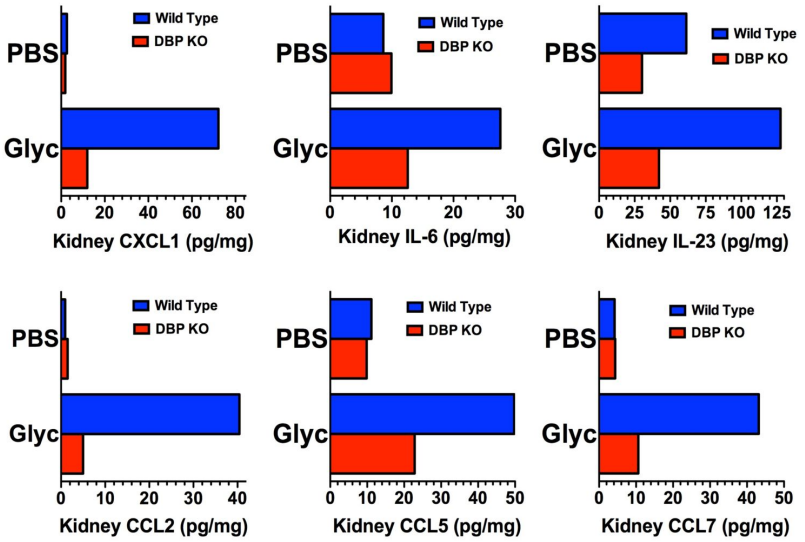
Randeep S. Jawa* MD, Tamineh Tabrizian MD,Ph.D., James Davis MD, James A. Vosswinkel MD, Richard R. Kew Ph.D., Stony Brook University Hospital

Invited Discussant: Joseph Galante, MD

Introduction: Rhabdomyolysis (acute muscle injury) results in a massive release of actin into extracellular fluids where it forms a complex with vitamin D binding protein (DBP). We have previously presented data demonstrating altered levels of select systemic (plasma) cytokines following muscle injury in DBP deficient versus wild-type mice. Herein, we investigate the effects of DBP deficiency on renal cytokine levels.

Methods: With IACUC approval, approximately ten-week old C57BL/6 wild-type (DBP+/+) and DBP deficient (DBP-/-) mice received intramuscular (IM) injections with either 50% glycerol or phosphate-buffered saline (PBS) into the thigh muscles. After 48 hours kidneys were harvested and cytokine levels were measure in pooled tissue lysates (n=8 per group) using a multiplex ELISA.

Results: All animals survived. At 48 hours following IM glycerol injection, DBP-/- mice demonstrated substantially (>50%) reduced renal tissue levels of CCL2, CCL3, CCL4, CCL5, CCL7 (CC chemokines); CXCL1, CXCL10 (CXC chemokines); as well as IL-6 and IL-23 in renal tissue, as compared to wild-type (DBP +/+) mice. Several of these are demonstrated in the figure. As expected, H&E staining did not identify obvious kidney injury in either group of mice.



Conclusion: In the only worldwide DBP knock-out model, we demonstrate that deficiency of DBP, and thus a lack of DBP-actin complexes, in a murine rhabdomyolysis model reduces inflammatory cytokines. As IL-6 levels are correlated with the magnitude of tissue injury, reduced levels would suggest attenuated tissue injury. Reduced CXC cytokine levels would result in less neutrophil recruitment and activation. Reduced CC cytokine levels could indicate a decreased need for monocyte and lymphocyte reparative type functions or may suggest a general inhibition of the leukocyte response. Thus, DBP deficiency may be renal protective. Electron microscopic studies are needed to confirm the reduced renal injury in DBP-/- mice.

Session: XI: Papers 36-44: Outcomes/Guidelines
Paper 36: 8:00-8:20 am

INSURANCE STATUS AND TRAUMATIC INJURY: DO TRAUMA PATIENTS EXPERIENCE INSTABILITY IN COVERAGE AFTER INJURY?

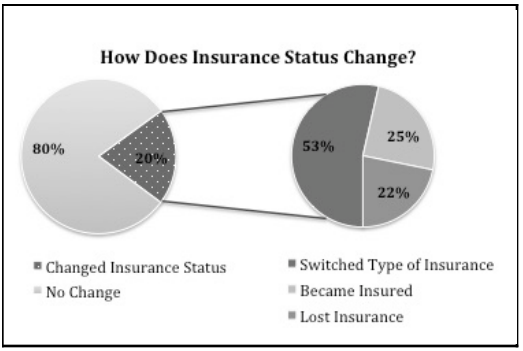
Charlotte M. Rajasingh AB, Thomas G. Weiser* MD, Lakshika Tennakoon MD, MPhil, David A. Spain* MD, Kristan L. Staudenmayer* MD, MS Stanford University

Invited Discussant: David Hoyt, MD

Introduction: Traumatic injuries can change a patient's functional status, which in turn may affect a patient's ability to maintain insurance. This instability could make accessing follow-up care for an injury challenging. The association between a traumatic event and an individual's insurance status over time is not known. We aim to describe the pattern of post-injury insurance status change for patients who require readmission after a traumatic injury. We hypothesize that a large number will experience changes in insurance between hospitalizations.

Methods: We used the Nationwide Readmission Database (2013-2014), from the Healthcare Cost and Utilization Project, which is a nationally representative sample of readmissions in the United States. We included patients ages 26-64 admitted with any diagnosis of trauma who had at least one readmission within 6 months. Patients on Medicare and those with missing payer information were excluded. The primary outcome was a change in insurance status. Weighted numbers are reported.

Results: A total of 48,057 patients met inclusion criteria. The payer mix of this population at the index hospitalization was 44% government (Medicaid or other government program), 42% private insurance, and 14% self-pay. A total of 9,699 (20%) changed their insurance status during the 6 months. Of these, 53% switched types of insurance, 25% went from being uninsured to insured, and 22% lost their insurance entirely (Figure 1). Of those who gained insurance, 50% gained insurance via Medicaid. Of the 9,699 patients who had a change, the government adopted a larger fraction of injured patients (40% to 64%), while private payer coverage decreased (36% to 15%). The proportion of self-pay patients was relatively unchanged (24% to 21%), but underneath this was the flux of patients losing and gaining insurance.



Conclusion: This is the first analysis at the national level to assess individual's insurance coverage after injury. Approximately 1 in 5 patients change their insurance, and there is significant churn between being insured and not being insured. Furthermore, after injury, the government absorbs a larger proportion of patients indicating a growing reliance on government programs like Medicaid. Trauma patients are particularly vulnerable to changes in insurance coverage after injury, and this should be considered in determining future legislative priorities.

Session: XI: Papers 36-44: Outcomes/Guidelines
Paper 37: 8:20-8:40 am

HOW HAS THE AFFORDABLE CARE ACT CHANGED OUTCOMES IN EMERGENCY GENERAL SURGERY?

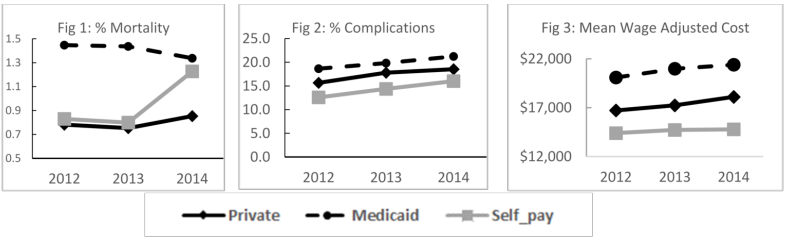
Michelle Hamel MD,Ph.D., Laura N. Godat MD, Raul Coimbra* MD,Ph.D., Jay Doucet* MD, University of California, San Diego

Invited Discussant: John Harvin, MD

Introduction: Lack of insurance coverage increases complications and mortality from surgical procedures. The Affordable Care Act (ACA) has insured more Americans but it is unknown if this improves outcomes from emergency general surgery (EGS) procedures. This study seeks to determine how increasing insurance coverage changes outcomes in EGS.

Methods: This is a retrospective review using the Nationwide Inpatient Sample (NIS) database from 2012-2014. Patients aged 18-64 undergoing EGS procedures were identified by ICD-9 codes. Patient demographics, hospital characteristics and Charlson Comorbidity Scores (CCS) were obtained. Outcomes were measured by mortality, complications and calculated costs. Univariate and multivariate analyses were performed to determine the factors associated with worsened outcomes for EGS procedures.

Results: 303,411 patients were included. Medicaid (MCD) admissions increased 16% from 19,900 to 23,172 ($p<0.001$) and Self-pay (SP) admissions decreased 33% from 16,297 to 10,919 ($p<0.001$). Mortality significantly increased for SP patients in 2014 (Fig. 1, $p<0.001$). Complications increased annually in all payer groups (Fig. 2, $p<0.001$). Wage-index adjusted costs increased annually in all groups (Fig. 3, $p<0.001$) .
After adjusting for age and CCS, SP status in 2014 was associated with increased mortality (OR 2.06, 95% CI 1.67-2.53). There was an increased odds of complications with MCD (OR: 1.39, 95% CI 1.32-1.46) but not Private insurance or SP.
After adjusting for age and CCS, regression analysis indicated MCD status increased costs (+$974.68, 95% CI: 248.50-1700.58).



Conclusions: The ACA has increased the number of insured Americans admitted for EGS procedures with an associated decrease in mortality for those patients who became insured. The decreased mortality may reflect newly covered patients presenting earlier without fear of financial repercussions of an uninsured EGS admission. It is unclear why ACA implementation is associated with higher costs for insured patients and higher rates of complications for MCD patients. Further study is needed to determine why costs and complications are increasing in EGS.

Session: XI: Papers 36-44: Outcomes/Guidelines
Paper 38: 8:40-9:00 am

CONTEMPORARY UTILIZATION OF RESUSCITATIVE THORACOTAMY: RESULTS FROM THE AAST AORTIC OCCLUSION FOR RESUSCITATION IN TRAUMA AND ACUTE CARE SURGERY (AORTA MULTICENTER PROSPECTIVE REGISTRY

Joseph J. DuBose* MD, Laura Moore* John B. Holcomb* MD, Megan Brenner* MD, Thomas M. Scalea* MD, David Skarupa* MD, Tim Fabian* MD, Tiffany Bee* MD, Kenji Inaba* MD, Thomas O'Callaghan* MD, Nathaniel Poulin MD, Todd E. Rasmussen* MD, David Grant Medical Center

Invited Discussant: Mark Seamon, MD

Introduction: Resuscitative thoracotomy (RT) has been a tool of trauma care for over 5 decades. Interval reviews of RT use have been conducted over this time frame, most recently the evidence-based practice management guideline (PMG) of the Eastern Association for the Surgery of Trauma (EAST). The present study was designed to examine contemporary RT utilization and outcomes compared to historical data (n = 10,238) from the EAST PMG review from published series 1974 – 2013.

Methods: The AAST AORTA registry was utilized to identify patients undergoing RT from Feb 2013 to Dec 2016. Demographics, injury data, physiologic presentation and outcomes were reviewed. Contemporary data were compared to those of the EAST PMG review.

Results: Three-hundred and ten RT patients from 18 contributing AORTA participating centers were identified. The majority were injured by penetrating mechanisms (197/310, 64%), most commonly from gunshot (163/197, 83%). Signs of life (SOL) (organized electrical activity, pupillary response, spontaneous movement or appreciable pulse/blood pressure) were present on arrival in only 47% (147/310). When compared to the EAST PMG results, there was no difference in either hospital survival (5% vs 8%) or neurologically intact survival between historical controls or AORTA registry patients in any category combination of mechanism / anatomic location / presenting signs of life. [Table] RT continues to be utilized in 14% (45/310) of blunt injuries W/O SOL on admission, without documented survivors.

Conclusion: Comparison of historical RT controls to more contemporary patients from the AORTA registry suggests that outcomes following RT have not changed. Despite a wealth of accumulated data over several decades, RT continues to be performed for patients after blunt mechanisms of injury who present W/O SOL despite lack of demonstrated hope for survival benefit.

	AORTA REGISTRY (N = 310)	EAST GUIDELINES REVIEW – POOLED (N = 10,238)	*p-value*
Overall Survival	16/310 (5%)	871/10,238 (8%)	*p = 0.51*
Penetrating thoracic with SOL present on admission			
Hospital Survival, n/N (%)	7/47 (14.9%)	182/853 (21.3%)	*p = 0.38*
Neurologically intact survival, n/N (%)	7/47 (14.9%)	53/454 (11.7%)	*P = 0.57*
Penetrating thoracic W/O SOL present on admission			
Hospital Survival, n/N (%)	1/54 (1.9%)	76/920 (8.3%)	*p= 0.11*
Neurologically intact survival, n/N (%)	1/54 (1.9%)	25/641 (3.9%)	*p= 0.46*
Penetrating extra-thoracic with SOL on admission			
Hospital Survival, n/N (%)	4/32 (12.5%)	25/160 (15.6%)	*p = 0.70*
Neurologically intact survival, n/N (%)	4/32 (12.5%)	14/85 (16.5%)	*p = 0.65*
Penetrating extra-thoracic injury W/O SOL on admission			
Hospital Survival, n/N (%)	1/64 (1.6%)	4/139 (2.9%)	*p = 0.58*
Neurologically intact survival, n/N (%)	1/64 (1.6%)	3/60 (5.0%)	*p = 0.29*
Blunt injury with SOL on admission			
Hospital Survival, n/N (%)	3/68 (4.4%)	21/454 (4.6%)	*p = 0.94*
Neurologically intact survival, n/N (%)	1/68 (1.5%)	7/298 (2.4%)	*p = 0.66*
Blunt injury W/O SOL signs of life on admission			
Hospital Survival, n/N (%)	0/45 (0%)	7/995 (0.7%)	*p = 0.57*
Neurologically intact survival, n/N (%)	0/45 (0%)	1/825 (0.1%)	*p = 0.82*

Session: XI: Papers 36-44: Outcomes/Guidelines
Paper 39: 9:00-9:20 am

OUTPATIENT ADHERENCE WITH VENOUS THROMBOEMBOLISM PROPHYLAXIS AFTER ORTHOPAEDIC TRAUMA: A RANDOMIZED CONTROLLED TRIAL OF ASPIRIN VS. LOW MOLECULAR WEIGHT HEPARIN

Bryce E. Haac MD, Richard Van Besien BA, Nathan O'Hara MHA, Gerard Slobogean MD,MPH, Theodore Manson MD, Robert O'Toole MD, Herman Johal MD,MPH, Peter Berger BS, George Reahl BS, Dimitrius Marinos BS, Yasmin Degani BS,MPH, Daniel Mascarenhas BS, Daniel Connelly BS, Thomas Scalea* MD, Deborah Stein* MD,MPH, R Adams Cowley Shock Trauma Center

Invited Discussant: M. Margaret Knudson, MD

Introduction: Orthopaedic trauma patients are often treated with outpatient venous thromboembolism (VTE) chemoprophylaxis with Aspirin (ASA) or low molecular weight heparin (LMWH). Poor adherence is known to be associated with increased VTE rates. While patients may prefer oral prophylaxis compared to injections, rates of outpatient adherence to these two regimens are not known. We hypothesized that adherence would be greater with ASA compared to LMWH. A secondary objective was to identify determinants associated with higher adherence.

Methods: We conducted a prospective randomized controlled trial of adult trauma patients presenting to a level-I trauma center with operative extremity fracture or any pelvic/acetabular fracture requiring VTE prophylaxis. Patients were randomized to receive either LMWH 30mg BID or ASA 81mg BID. Patients prescribed outpatient prophylaxis were contacted 10 to 21 days after discharge to assess adherence measured by the validated Morisky Medication Adherence Scale (MMAS-8) which ranges from 0 (lowest) to 8 (highest) and categorizes into low, medium, and high adherence groups.

Results: 150 patients (64 on LMWH, 86 on ASA) on chemoprophylaxis at time of follow-up completed the questionnaire. There were no differences in demographic variables between groups. Adherence was high overall (mean MMAS 7.2, SD 1.5). 98 patients (65%) had high, 32 (21%) had medium and 20 (13%) had low adherence. Adherence for the two regimens was similar (LMWH: 7.4 vs. ASA: 7.0, p=0.13). However, patients on LMWH were more likely to feel hassled by their regimen (23% vs. 9%, p=0.02). High adherence was associated with older age (OR 1.04, CI 1.01-1.06, p<0.01), longer hospital length of stay (OR 1.12, CI 1.00-1.26, p=0.048), having a nurse administer the prophylaxis (OR 4.56, CI 1.65-12.56, p<0.01), and having health insurance (OR 3.9, CI 1.2-12.3, p=0.02). Injury severity and pattern were not significant determinants of adherence. However, there was a trend towards higher adherence scores in patients with pelvis or lower extremity orthopaedic injuries (OR 8.08, CI 0.88-74.31, p=0.06) and in patients who were non-weight bearing or had stand-pivot restrictions (OR 1.83, 0.89-3.75, p=0.10). There was no significant correlation for sex, race, education, distant history of VTE, daily ASA or Plavix use pre-injury, or inpatient refusal of a dose with outpatient adherence (p>0.05).

Conclusion: Outpatient adherence with VTE prophylaxis is high with no significant difference between ASA and LMWH, but there are some differences in adherence within subpopulations. These must be considered when designing larger trials to explore efficacy.

Session: XI: Papers 36-44: Outcomes/Guidelines
Paper 40: 9:20-9:40 am

OPTIMAL TIMING OF INITIATION OF THROMBOPROPHYLAXIS AFTER NON-OPERATIVE SPINAL TRAUMA: A PROPENSITY MATCHED ANALYSIS

Muhammad Khan MD, Fahad Shabbir MD, Terence O'Keeffe* MB, ChB, MSPH, FACS, Joseph V. Sakran MD,MPH, Michael Truitt MD, Andrew L. Tang* MD, FACS, Lynn M. Gries MD, Arpana Jain MD, Narong Kulvatunyou* MD, FACS, Bellal A. Joseph* MD, FACS University of Arizona - Tucson

Invited Discussant: Todd Costantini, MD

Introduction: Patients with spinal trauma have the highest risk of venous thromboembolism (VTE). Guidelines recommend initiation of anticoagulation; however, timing of its initiation is not well defined. The aim of our study was to assess the impact of early vs late initiation of venous thromboprophylaxis in patients with spinal trauma managed non-operatively.

Methods: We performed 2-year (2013-14) review of all patients with isolated spine trauma (S-AIS$\geq$3 and other body region AIS<3) managed non-operatively and received prophylactic anticoagulation in Trauma Quality Improvement Program (TQIP) database. Patients were divided into two groups based on timing of initiation of thromboprophylaxis; early ($\leq$48 hours), and late (>48 hours) and were matched in a 1:1 ratio using propensity score matching for demographics, admission vitals, injury severity, and type of prophylaxis (Heparins vs Low Molecular weight heparin). Outcome was incidence of deep venous thrombosis (DVT) and pulmonary embolism (PE), red cell transfusions (used as surrogate marker for bleeding events), and mortality after initiation of thromboprophylaxis.

Results: 39,876 patients had isolated spine trauma. 30,291 were managed non-operatively, of which 9080 patients (early: 4540, late: 4540) were matched. Matched groups were similar in age (p=0.50), gender (p=0.40), systolic blood pressure (p=0.75), heart rate (p=0.25), ISS (p=0.70), spine-AIS (p=0.84), and type of prophylaxis (p=0.82). DVT rate was higher in late group without affecting PE or mortality rates. **(Table1.)**

Conclusion: Early VTE prophylaxis is associated with decreased rates of DVT in patients with non-operative spinal trauma without increasing the risk of bleeding and mortality. VTE prophylaxis should be initiated within 48-hours post injury to reduce the risk of DVT in this high-risk patient population.

Table 1. Outcome measures

Variables	Early (n=4540)	Late (n=4540)	*P*
DVT, % (n)	1.7% (78)	7.7% (348)	<0.001
PE, % (n)	0.7% (32)	0.8% (39)	0.92
Red cell transfusions, (mean ± SD)	0.7 ± 0.3	0.9 ± 0.4	0.39
Mortality, % (n)	3% (136)	3.8% (172)	0.29

Session: XI: Papers 36-44: Outcomes/Guidelines
Paper 41: 9:40-10:00 am

COMPLIANCE WITH ACS-COT RECOMENDED CRITERIA FOR FULL TRAUMA TEAM ACTIVATION AND ASSOCIATION WITH UNDERTRIAGE DEATHS

Christopher J. Tignanelli MD, Wayne E. Vander Kolk MD, Judy N. Mikhail Ph.D.,RN, Matthew J. Delano MD,Ph.D., Mark R. Hemmila* MD, University of Michigan

Invited Discussant: Robert Winchell, MD

Introduction: Over-triage of injured patients within a trauma system is associated with improved mortality and optimal resource utilization. The American College of Surgeons Committee on Trauma (ACS-COT) has put forward six minimum criteria for full trauma team activation (ACS-6) in the *Resources for the Optimal Care of the Injured Patient (6th Edition)*. We hypothesized that ACS-COT verified trauma center compliance with these criteria is associated with low under-triage rates and improved overall mortality.

Methods: Data from a state-wide collaborative quality initiative was utilized. We used data collected from 2014 through 2016 at 29 ACS verified Level 1 and 2 trauma centers. Inclusion criteria were: adult patients (≥16 years) and ISS ≥5. Patients directly admitted, missing data, or with no signs of life were excluded. Trauma team activation status was divided into four categories: full, partial, trauma consult, and no activation. Data collected reflects the highest activation status and accounts for activation upgrades. Quantitative data existed to analyze four of the ACS-6 criteria (ED SBP ≤ 90 mmHg, respiratory compromise or emergent intubation, central GSW, and GCS < 9). An intervention was defined as receiving one or more of the following: transfusion of blood within 4 hours of arrival, emergent central line insertion, emergent operation, emergent angiography, emergent intubation, emergent chest tube placement, or placement of cerebral monitor. Patients were considered to be under-triaged if they had major trauma (ISS>15) and did not receive a full trauma team activation.

Results: 43,461 patients were included in the study. Compliance with the individual ACS-6 minimum criteria for full trauma team activation varied from 49% to 81%. The presence of any ACS-6 criteria was associated with a high intervention rate and significant risk of mortality (OR 16.6, 95% CI 15.0-18.4). Of the 853 deaths that were not a full activation, 364 (43%) were classified as under-triaged, and 266 (31%) had at least one ACS-6 criteria present. Under-triaged patients with at least one ACS-6 criteria exhibited increased mortality (OR 1.5, 95% CI 1.3-1.9). GCS less than 9 and need for emergent intubation were the ACS-6 criteria most frequently associated with under-triage mortality.

ACS-6 Activation Criteria	Incidence % (N)	Full Activation % (N)	Intervention % (N)	Under-triage % (N)	Under-triage Mortality % (N)
Any	12 (5,112)	65 (3,328)	79 (4,027)	12 (630)	29 (184)
None	88 (38,349)	5.2 (2,009)	15 (5,821)	12 (4,759)	1.4 (464)
SBP< 90	2.6 (1,121)	49 (546)	63 (710)	12 (129)	16 (20)
Intubation	6.7 (2,923)	74 (2,161)	100 (2,161)	15 (451)	33 (149)
Central GSW	3.7 (1,604)	75 (1,207)	67 (1,072)	2.1 (34)	26 (9)
GCS<9	4.8 (2,080)	81 (1,680)	91 (1,897)	12 (241)	46 (111)

Conclusions: Compliance with the ACS-COT minimum criteria for full trauma team activation remains sub-optimal and is associated with increased mortality. This data suggests that compliance with minimum activation criteria can be used as a potential quality metric. This study suggests that practice pattern modification to more strictly adhere to the minimum ACS-COT criteria for full trauma team activation will save lives.

Session: XI: Papers 36-44: Outcomes/Guidelines
Paper 42: 10:00-10:20 am

REDUCING OPIOID USE IN TRAUMA PATIENTS: A PAIN MANAGEMENT PROTOCOL LEADS TO FEWER OPIOID PRESCRIPTIONS, BETTER PAIN MANAGEMENT, AND GREATER PATIENT SATISFACTION

Jessica L. Gross MD, Anna N. Miller MD, Allyson K. Bryant MD, Margaret R. Rukstalis MD, Christen M. Seguin CNP, Gerald Rebo PharmD, Kristin Rebo PharmD, Paul F. Smith Robert S. Weller MD, Preston R. Miller* MD, Wake Forest University School of Medicine

Invited Discussant: Oscar Guillamondegui, MD, MPH

Introduction: Ninety one Americans die every day from an opioid overdose, and nearly half of these deaths involve a prescription opioid. Sales of prescription opioids have increased four-fold from 1999 through 2014; however, there has not been an overall increase in the amount of pain reported by Americans. Sales of opioids vary state by state and North Carolina is one of 13 states with the highest rate of opioid prescriptions. Due to concern over these issues, our trauma service developed a pain management protocol (PMP) with the goals of adequate pain control while using fewer opioids in the post-discharge setting. The goal of this project is to compare opioid use and patient satisfaction before and after protocol implementation.

Methods: A multidisciplinary team was formed to create a standardized approach to pain control in trauma patients. The team included members from trauma, orthopedic trauma, psychiatry, anesthesia, and pharmacy. Prior to the creation of the PMP, pain control on the trauma service was not standardized and included oxycodone and intravenous opiods as needed. The PMP provided a step wise approach to pain control: Acetominophen or ibuprofen for mild pain, 5 mg oxycodone/ 325 mg Tylenol every six hours as needed for moderate to severe pain (maximum 8 tablets/24 hours) and tramadol (50 mg to 100 mg) every 6 hours as needed for breakthrough pain. The medications were staggered to allow administration of oral pain medications every three hours as needed. If pain was not adequately controlled on these short acting agents, long acting oral opioids such as extended release oxycodone or extended release morphine were added and titrated as necessary. At discharge, the patients were provided with a weaning plan for their pain medication. The PMP was implemented on a day to day basis by our advanced practice providers. We performed a review of patients that were then seen in follow up by these same advanced practice providers. We compared the amount of opioid medication (converted to morphine milligram equivalants-MME) prescribed at discharge and in clinic follow up before and after the institution of the PMP.

Results: From 1/1/2015 - 12/31/2016, 2006 patients were managed by our advanced practice providers. 905 patients were cared for prior to PMP initiation on 12/14/15 and 1101 were cared for after initiation. Prior to the protocol, the average MME per prescription was 1402 (2233 MME/person) as compared to 728 MME per prescription (2093 MME/person) after PMP implememtation. ($p=<0.0001$) Additionally, the trauma unit in which these patients were housed was recognized for the most improved patient satisfaction and the most improved pain control after initiation of the PMP on the trauma servce.

Conclusion: A PMP for the trauma service created by a multidisciplinary team was associated with better pain control for our patients with increased patient satisfaction. This standardized PMP including a set weaning plan also let to decreased MME prescription after patient discharge.

Session: XI: Papers 36-44: Outcomes/Guidelines
Paper 43: 10:20-10:40 am

TRAUMA TRANSITIONAL CARE COORDINATION: A MATURE SYSTEM AT WORK

Erin C. Hall MD,MPH, Rebecca Tyrrell RN, Thomas Scalea* MD, Deborah Stein* MD,MPH, R Adams Cowley Shock Trauma Center

Invited Discussant: Karen Brasel, MD, MPH

Introduction: We have previously demonstrated effectiveness of a Trauma Transitional Care Coordination Program (TTCC) in reducing 30 day readmission rates for trauma patients most at risk. With program maturation, we achieved improved readmission rates for specific patient populations.

Methods: TTCC is a nursing driven program that supports patients at high risk for 30 day readmission. TTCC interventions include calls to patients (or caregivers) within 72 hours of discharge to identify barriers of care, complete medication reconciliation, coordinate medical appointments or home visits, and offer individualized problem solving. Account IDs were used to link TTCC patients with the Health Services Cost Review Commission (HSCRC) database to collect data on statewide unplanned 30 day readmissions.

Results: 430 patients were enrolled in the TTCC program from January 2014 to December 2016. The majority were men (73% n=315) with a mean age of 43 years (range 17-92 years). Only 11% (n=50) of TTCC enrollees were privately insured, 60% had Medicaid (n=259), and 14.6% had Medicare (n=63). 73% had HSCRC severity of injury (SOI) ratings of 3 or 4 (maximum SOI = 4). The most common All Patient Refined Diagnosis Related Groups (APR-DRG) for participants were: lower extremity procedures (n=63, 14%); extensive abdominal/thoracic procedures (n=35, 8%); musculoskeletal procedures (n=33, 7.7%); complicated tracheostomy and upper extremity procedures (n=24 each, 5.6%); infectious disease complications (n=14, 3%); major chest and respiratory trauma, major small and large bowel procedures and vascular procedures (n=12 each, 2.8%). TTCC was particularly helpful in patients with complicated tracheostomy and lower extremity injury. TTCC participants with complicated tracheostomy had a 9% reduction (15% vs 24%) in 30 day readmission rates compared to those without TTCC and those with lower extremity injury had a 6% (10% vs 16%) reduction in 30 day readmission rates when compared to those without TTCC.

Conclusion: Targeted outpatient support for high risk patients can decrease 30 day readmission rates. As our TTCC program matured, we reduced 30 day readmission in patients with complicated tracheostomy and lower extremity injury. This represents over one million dollars savings for the hospital per year through quality based reimbursement.

Session: XI: Papers 36-44: Outcomes/Guidelines
Paper 44: 10:40-11:00 am

IMPLEMENTATION OF A CT SCAN PRACTICE GUIDELINE FOR PEDIATRIC TRAUMA PATIENTS REDUCES UNNECESSARY SCANS WITHOUT IMPACTING OUTCOMES

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Invited Discussant: Richard Falcone, Jr., MD

Introduction: Computed Tomography (CT) scans are commonly used to evaluate trauma patients. Despite proven efficacy in diagnosing many injuries, they are costly and pose risks from ionizing radiation in children. Recent literature has demonstrated the utility of CT scan algorithms in the management of pediatric trauma.

Methods: Our Pediatric Level 2 Trauma Center (TC) implemented a CT scan practice guideline for pediatric trauma patients in March 2014. The guideline recommended for or against CT of the head and abdomen/pelvis from clinical findings, and was based on publications from the Pediatric Emergency Care and Research Network (PECARN). There was no chest CT guideline. We reviewed all pediatric trauma patients for CT scans obtained during their initial evaluation before and after guideline implementation. The Trauma Registry Database was queried to include all pediatric (age<13) trauma patients seen in our TC from 2010-2016. Penetrating mechanism and deaths in the TC were excluded. CT scans of the head, chest, and abdomen/pelvis obtained in the TC were collected; inpatient scans were not included. Scans were considered positive if any organ injury was detected. Primary outcome was the number of patients undergoing CT and number of positive CT. Secondary outcomes were hospital length of stay (LOS), readmissions, and mortality. Statistical tests used were Chi-square and Wilcoxon rank-sum tests for categorical and continuous variables, respectively. $P<0.05$ was considered significant.

Results: In the study period,1934 patients were identified, 1106 pre- and 828 post-guideline. Patient volume increased during the study period. There was no difference in injury mechanisms, although Injury Severity Scale was higher in the post-guideline group (5 vs. 4, p=0.03). Absolute reductions in head, chest, and abdomen/ pelvis CT scans were 17.7%, 11.5%, and 18.8% respectively ($p<0.01$). Percent positive head CTs were equivalent, but percent positive chest and abdomen CT increased after guideline implementation. Mortality, LOS, and readmissions were unchanged.

	Pre-Guideline N = 1106	Post-Guideline N = 828	P-value
Age, median (IQR)	7.4 (3.1-12.3)	7.3 (3.0-12.1)	0.73
Injury Severity Scale, median (IQR)	4 (4-10)	5 (4-10)	0.03
Head CT – All (%)	639 (57.8)	332 (40.1)	<0.01
Head CT – Positive (%)	159 (24.9)	95 (28.6)	0.21
Chest CT – All (%)	216 (19.5)	66 (8.0)	<0.01
Chest CT – Positive (%)	47 (21.8)	24 (36.4)	0.02
Abdomen CT – All (%)	465 (42.0)	192 (23.2)	<0.01
Abdomen CT – Positive (%)	75 (16.1)	49 (25.5)	0.01
Hospital LOS, median (IQR)	1 (1-3)	1 (1-2)	0.48
Readmissions (%)	2 (0.2)	5 (0.6)	0.13
Mortality (%)	27 (2.3)	18 (2.0)	0.66

Conclusions: Implementation of a pediatric CT guideline significantly decreases quantity of all CTs, reducing the radiation exposure without a difference in outcome. Trauma centers treating pediatric patients should adopt similar guidelines to decrease unnecessary CT scans in children.

Session: XIIIA: Papers 45-54: Preclincial/Translational Science
Paper 45: 1:30-1:50 pm

GUT EPITHELIAL CELL-DERIVED EXOSOMES TRIGGER POST-TRAUMA IMMUNE DYSFUNCTION

Mitsuaki Kojima MD, Todd W. Costantini* MD, Theresa W. Chan MD, Andrew Baird Ph.D., Brian P. Eliceiri Ph.D., Raul Coimbra* MD,Ph.D., University of California, San Diego

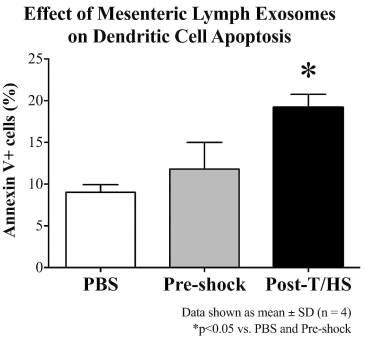
Invited Discussant: Rosemary Kozar, MD, PhD

Introduction: Exosomes are nano-sized extracellular vesicles that act as endogenous mediators that modulate the immune response. We have previously shown that exosomes released into mesenteric lymph (ML) following trauma/hemorrhagic shock (T/HS) induce pro-inflammatory cytokine production in macrophages and are involved in the pathogenesis of post-shock acute lung injury. However, the cellular origin of ML exosomes and their role in the post-trauma immune response remains unclear. We hypothesized that exosomes released from damaged intestinal epithelial cells (IECs) contribute to post-trauma immune dysfunction by altering the function of dendritic cells (DCs), key regulators of the adaptive immunity.

Methods: Male rats underwent cannulation of the femoral artery, jugular vein and ML duct prior to hemorrhagic shock. T/HS was induced by laparotomy and 60 minutes of HS (mean arterial pressure, 35 mmHg) followed by resuscitation with shed blood and two times normal saline. The ML was collected before hemorrhagic shock (pre-shock) and after T/HS (post-T/HS) for isolation of exosomes by differential centrifugation. Surface markers of exosomes harvested from pre-shock and post-T/HS ML were assessed by flow cytometry to determine their cellular origin and phenotypic changes. DCs were generated from bone marrow cells with GM-CSF to study the effects of exosomes on DC maturation by measuring CD80 and CD86 by flow cytometry. Exosome-mediated DC apoptosis was studied using Annexin V.

Results: Exosomes isolated from ML highly expressed CD63 (exosome marker) and EpCAM (epithelial cell-specific marker) but were negative for CD4 (T cell) and CD11b/c (macrophage and DC), suggesting their derivation from IECs. The expression of immunomodulatory molecules such as MHC class II and Fas ligand on ML exosomes were significantly increased after T/HS ($p<0.05$ vs. pre-shock). Co-incubation of DCs with post-T/HS ML exosomes, but not pre-shock ML exosomes, markedly suppressed the expression of CD80 and CD86 on DCs by 20% and 30%, respectively ($p<0.05$ vs. pre-shock). Furthermore, post-T/HS ML exosomes induced DC apoptosis as demonstrated by increased Annexin V+ cells compared to DCs exposed to pre-shock ML exosomes (see figure).

Conclusion: Gut epithelial cells release "killer" exosomes carrying death signals into the ML after injury. ML exosomes may be critical mediators of post-traumatic immunosuppression causing dysfunction and depletion of DCs.



Session: XIIIA: Papers 45-54: Preclincial/Translational Science
Paper 46: 1:50-2:10 pm

CHANGES IN EXHALED $^{13}CO_2/^{12}CO_2$ BREATH DELTA VALUE AS A NEW EARLY PREDICTOR OF INFECTION IN ICU PATIENTS

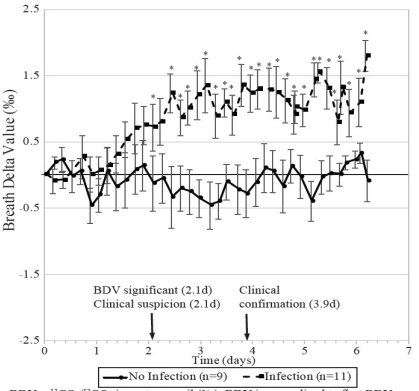
Ann P. O'Rourke MD,MPH, Sara A. Buckman MD, PharmD, David C. Evans* MD, Andrew J. Kerwin* MD, Emily A. Breunig BS, Daniel E. Butz Ph.D., University Of Wisconsin

Invited Discussant: Jon Simmons, MD

Introduction: We have developed a new, non-invasive predictive marker for onset of infection in surgical ICU patients. The exhaled $^{13}CO_2/^{12}CO_2$ ratio, or breath delta value (BDV), has been shown to be an early marker for infection in a proof of concept human study and in animal models of bacterial peritonitis. In these studies, the BDV changes during onset and progression of infection, and these changes precede physiological changes associated with infection. Earlier diagnosis and treatment will significantly reduce morbidity, mortality, hospitalization costs, and length of stay. The objective of this prospective, observational, multi-center study was to determine the predictive value of the BDV as an early diagnostic marker of infection.

Methods: Critically ill adults after trauma or acute care surgery with an expected length of stay of >5 days were enrolled. The BDV was obtained every 4 hours for 7 days and correlated to clinical infection diagnosis, serum C-reactive protein and procalcitonin levels. Clinical infection diagnosis was made by an independent endpoint committee.

Results: Groups were demographically similar (n=20). Clinical infection diagnosis was confirmed on day 3.9 ± 0.6. Clinical suspicion of infection (defined by SIRS criteria and/or new antibiotic therapy), was on day 2.1 ± 0.5 in all infected patients. However, 5 of 9 (56%) non-infected subjects also met clinical suspicion criteria. The BDV significantly increased by 1-1.7‰ on day 2.1 after enrollment ($p<0.05$) in subjects who developed infections, while it remained at baseline (+/- 0.5‰) for subjects without infections.



BDV = $^{13}CO_2/^{12}CO_2$ in parts per mil (‰). BDV is normalized to first BDV. Clinical suspicion based on change in a SIRS criterion or change in antibitoic treatment. Data marked with an astarisk (*) are significant with $p<0.05$.

Conclusion: A BDV >1‰ accurately differentiates subjects who develop infections from those who do not and predicts the presence of infection up to 48 hours before clinical confirmation. The BDV may predict the onset of infection and aid in distinguishing SIRS from infection, which could prompt earlier diagnosis, earlier appropriate treatment, and improve outcomes.

Session: XIIIA: Papers 45-54: Preclincial/Translational Science
Paper 47: 2:10-2:30 pm

EARLY CYTOKINE CHANGES PREDICT TRAUMA-INDUCED COAGULOPATHY IN MULTIPLY INJURED PATIENTS

Stephanie Savage* MD, MS, Greg E. Gaski MD, Ben L. Zarzaur* MD, Tyler McCarroll BS, Jennifer L. Hartwell MD, Todd O. McKinley MD, Indiana University School Of Medicine

Invited Discussant: Yashuhiro Otomo, MD

In**Introduction**: Injury and the complex immunologic response to injury can result in trauma-induced coagulopathy (TIC). The MAR ratio, calculated from admission thromboelastography (TEG) , offers a novel surrogate of underlying coagulation dysregulation and it predicts death. We have postulated that, in part, exhaustion of substrate from unregulated thrombin burst results in inability to manufacture normal clot. This results in weak clot (low MA) and longer onset to clot formation (R-time). Activation of the inflammatory cascade, a hallmark of severe injury, is associated with TIC. In this study, we hypothesized that trauma-associated changes in admission cytokines would correspond to predictable changes in TEG values in TIC.

Methods: Injured patients admitted to the TICU at a Level 1 trauma center were included in this IRB approved study. Basic demographic, injury and laboratory data, including admission TEG, were collected on all patients. Serial blood samples were collected, centrifuged within 2 hours and plasma was stored for su bsequent analysis of inflammatory mediators. Correlation analysis was used to determine the relationship between the admission R-time and MA and the inflammatory mediators IL-1b, IL-6, IL-8 and MCP-1.

Table 1. Correlation between Cytokine Levels and TEG values

R-Time (seconds)	Correlation Coefficient	p-value
IL-1b	-0.00406	0.9738
IL-6	0.44576	0.0001
IL-8	0.49033	<0.0001
MCP-1	0.26087	0.0330

MA (mm)	Correlation Coefficient	p-value
IL-1b	0.11238	0.3615
IL-6	-0.41399	0.0004
IL-8	-0.36317	0.0023
MCP-1	-0.30330	-0.0126

Results: 93 patients were included in this study. 80% were male, mean age was 37 years (SD 12), 98% suffered blunt trauma and mean ISS was 29.4 (SD 12.5). The mean base excess on admission was -5.3 mEq/L (SD 4.3), mean R-time was 3.75s (SD 0.96) and the median MA was 61.4mm (IQR 55.4, 64.3). Median values for cytokines included : IL-1b 1.09 ng/L (IQR 0, 3.06), IL-6 118.96 ng/L (IQR 43.67, 428.88), IL-8 29.91 (IQR 14.53, 100.52), MCP-1 757.24 ng/L (445.91, 2318). Correlation analysis was performed between these cytokines and the admission R-time and MA (Table 1). IL-6 and IL-8 levels were positively correlated with the R-time while IL-6, IL-8 and MCP-1 were negatively correlated with MA.

Conclusion: Interaction between the innate inflammatory response and the coagulation cascade occurs following severe trauma. Dysregulation may lead to extreme conditions including trauma-induced coagulopathy. In this study, we demonstrated a relationship between increased levels of IL-6 and IL-8 and increasing R-time. Though increased activation of coagulation by these cytokines would theoretically result in more rapid onset of clot formation (lower R-time), we found the reverse. We hypothesize based on previous research with the MAR ratio that this is due to rapid consumption of clot substrate immediately following injury, with inadequate levels remaining for clot formation by the time of TEG at admission. This is reflected by the inverse ratio of rising IL-6, IL-8 and MCP-1 with lower MA – a weaker clot.

Session: XIIIA: Papers 45-54: Preclincial/Translational Science
Paper 48: 2:30-2:50 pm

MICROFLUIDICS: A HIGH THROUGHPUT SYSTEM FOR THE ASSESSMENT OF THE ENDOTHELIOPATHY OF TRAUMA AND THE EFFECT OF TIMING OF PLASMA ADMINISTRATION ON AMELIORATING SHOCK ASSOCIATED ENDOTHELIAL DYSFUNCTION

Lawrence N. Diebel* MD, Jonathan V. Martin MD, David M. Liberati MS Wayne State University

Invited Discussant: Martin Schreiber, MD

Introduction: Early resuscitation after trauma-hemorrhagic shock (HS) with plasma rather than crystalloid may ameliorate systemic endothelial cell
(EC) injury and dysfunction (endotheliopathy of trauma [EOT]). Animal studies have shown that the protective effects of plasma after HS may in part be due to the preservation of the syndecan-1 component of the endothelial glycocalyx (EG) and resultant EG restoration. Early endothelial cell activation or injury is associated with increased release of tPA and thrombomodulin. *In vitro* modeling suggests that plasma also may attenuate increased susceptibility to tPA mediated fibrinolysis in part by preservation of plasma proteins. Microfluidics is a high throughput technology that has been used to study bleeding and thrombotic disorders *in vitro*. We postulated that endothelial lined microfluidic networks would be a useful platform to study the endothelial cell activation/injury under flow conditions to mimic HS. We also hypothesized this would allow characterization of the potential protective effects and optimal timing of plasma administration on the development of "EOT" in our model.

Methods: Confluent human umbilical vein endothelial cells (HUVEC) were added to microfluidic flow channels of a BioFlux 48 well plate that has been primed and coated with fibronectin. Monolayers are formed within the microfluidic channels after overnight perfusion of the cells with complete media at a shear force of 1 dyne/cm ^{2}. The microfluidic plate was subsequently treated with epinephrine (epi) and exposed to hypoxia reoxygenation (HR) for 60 minutes. 5% human plasma in culture media or media alone (control) was perfused either immediately following treatment (early plasma) or after a 3 hr. delay (late plasma). The perfusate was collected 60 and 120 minutes after treatment and glycocalyx injury indexed by syndecan-1, and endothelial cell activation/injury determined by soluble thrombomodulin (TM) and tissue plasminogen activator (tPA) concentrations (all by ELISA). Injury to the glycocalyx was also assessed by staining cells with FITC-wheat germ agglutinin (FITC-WGA) antibody and visualizing the glycocalyx with a fluorescent microscope and performing image analysis.

Results:

Mean ± S.D.; N = 5 for each HUVEC (EC) group after 1 hour perfusion

	tPA (pg/ml)	PAI-1 (pg/mL)	TM (pg/ml)	Syndecan-1 (ng/mL)	EG fluorescent intensity
EC control	1685 ± 150.5	5977 ± 232.9	25.9 ±2.9	25.7 ± 3.5	17.1 ± 1.8
EC+HR+Epi	3621 ± 385.5*	4996 ± 193.2	100.5 ± 8.7*	92.2 ± 8.2*	5.8 ± 0.7*
EC+HR+Epi+ "early" plasma	1735 ± 140.2	5962 ± 243.8	28.0 ± 2.9	24.9 ± 4.3	13.1 ± 1.2*#
EC+HR+Epi+ "late" plasma	3674 ± 394.1*	5164 ± 358.2	84.7 ± 7.9*	86.1 ± 5.5*	7.2 ± 1.6*

* $p < 0.05$ vs HUVEC control; # $p < 0.05$ vs HUVEC + HR + epi ± late plasma.
No significant changes occurred with prolonged (2-hr) perfusion

Conclusion: Our study demonstrates that microfluidic technology may be useful to recreate endothelial biology associated with EOT. "Early" plasma administration protects against EG degradation and EC activation/injury and resultant hypocoagulable state. Microfluidics may provide a useful platform for the identification of endothelial dysfunction associated with HS and to monitor the efficacy of endothelium targeted therapies.

Session: XIIIA: Papers 45-54: Preclincial/Translational Science
Paper 49: 2:50-3:10 pm

ATTENUATION OF ENDOTHELIAL PHOSPHATIDYLSERINE EXPOSURE DECREASES ISCHEMIA-REPERFUSION INDUCED CHANGES IN MICROVASCULAR PERMEABILITY

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Invited Discussant: William Cioffi, MD

Introduction: Translocation of phosphatidylserine (PS) from the inner leaflet to the outer leaflet of the endothelial membrane via scramblase has been implicated as the apoptotic signal responsible for loss of endothelial barrier integrity after ischemia-reperfusion injury (IRI). We hypothesized that inhibition of PS expression on endothelial cells attenuates increases in PS expression in vitro and microvascular permeability (L_p) observed during IRI in vivo.

Methods: In vitro, using Annexin-V labeled bovine pulmonary artery endothelial cells (BPAECs) we measured intracellular and extracellular production of PS during anoxia/reoxygenation (A/R). We then measured mesenteric microvascular permeability (L_p) in rat post-capillary mesenteric venules subjected to IRI via SMA occlusion (45 minutes) and release (300 minutes) with known scramblase inhibitors. Rats underwent extracellular inhibition (DTE, n=3), inhibition of trafficking to the endothelial membrane (2-bromopalmitate, n=3), intracellular downregulation of activity (DIDS, n=3), and targeted RNA interference of scramblase production (siRNA scramblase, n=3). Rats also underwent pre (n=3) and post (n=3) SMA occlusion diannexin administration (400µg/kg 15-minute continuous femoral vein infusion). Diannexin is a highly specific PS antagonist that prevents PS dependent signaling pathways.

Results: In vitro, A/R increased intracellular PS production by 83% compared to controls (ratio signal PS/Beta actin control vs. A/R = 2.4±0.1 vs. 4.4±0.3 optical intensity units, OIU, $p<0.01$). Extracellular PS exposure increased 2-fold compared to controls (control = 2374±82.6 vs. A/R = 5430±165 OIU, $p < 0.01$). IRI increased L_p 6-fold in 1st phase (105 minutes) and 8-fold in 2nd phase (255 minutes). When compared to controls, DTE attenuated microvascular permeability by 35% 1st phase and 46% 2nd phase (L_p DTE vs. IRI 1st phase = 4.3±0.24 vs. 6.0±0.47, L_p DTE vs. IRI 2nd phase = 5.1±0.22 vs. 8.1±0.45, $p<0.01$ for both). 2-BP attenuated microvascular permeability by 45% 1st phase and 64% 2nd phase (L_p 2-BP vs. IRI 1st phase = 3.6±0.18 vs. 6.0±0.47, L_p 2-BP vs. IRI 2nd phase = 2.9±0.58 vs. 8.1±0.45, $p<0.01$ for both). DIDS attenuated microvascular permeability by 50% 1st phase and 23% 2nd phase (L_p DIDS vs. IRI 1st phase = 3.3±0.29 vs. 6.0±0.47, L_p DIDS vs. IRI 2nd phase = 7.2±0.30 vs. 8.1±0.45, $p<0.01$ for both). Targeted inhibition by RNA interference attenuated microvascular permeability 67% 1st phase and 74% 2nd phase (L_p combined vs. IRI 1st phase = 2.2±0.34 vs. 6.0±0.47, L_p combined vs. IRI 2nd phase = 2.5±0.17 vs. 8.1±0.45, $p<0.01$ for both). When administered after SMA occlusion, diannexin diminished L_p 98% (pre) and 92% (post) overall compared to IRI (L_p diannexin vs. IRI 1st phase = 1.9±0.13 vs. 6.0±0.47, L_p diannexin vs. IRI 2nd phase = 1.4±0.06 vs. 8.1±0.45, $p<0.01$ for both).

Conclusion: PS exposure is a key event in the pathogenesis of microvascular dysfunction during IRI. Antagonism of PS by intracellular and extracellular mechanisms after anoxic insult in vitro or ischemic insult in vivo protects endothelial cells against injury. Clinically, surgeons may potentially use PS antagonism as a strategy to mitigate the effects of IRI.

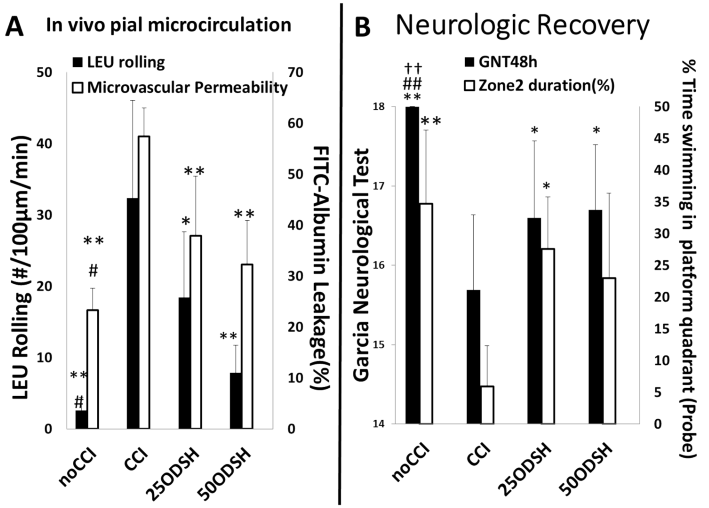
Session: XIIIA: Papers 45-54: Preclincial/Translational Science
Paper 50: 3:10-3:30 pm

NON-ANTICOAGULANT DESULFATED HEPARIN ACUTELY REDUCES LEUKOCYTE MOBILIZATION AND BRAIN EDEMA AND IMPROVES WATERMAZE LEARNING ABILITY WEEKS AFTER TRAUMATIC BRAIN INJURY

Katsuhiro Nagata MD, Yujin Suto MD,Ph.D., John Cognetti MSE, Kevin D. Browne BA, Kenichiro Kumasaka MD,Ph.D., Victoria E. Johnson Ph.D., MBChB, Lewis Kaplan* MD, Joshua Marks MD, Douglas H. Smith MD, Jose L. Pascual* MD,Ph.D., University Of Pennsylvania, Perelman School Of Medicine

Invited Discussant: Vishal Bansal, MD

Introduction: Unfractionated heparin (UFH) after TBI reduces leukocyte (LEU) accumulation, and enhances early cognitive recovery but may increase bleeding from trauma. It is unknown if non-anticoagulant 2,3-O desulfated heparin (ODSH) may similarly reduce post-TBI cerebral inflammation. We hypothesized that ODSH after TBI reduces LEU-mediated brain inflammation and improves neurological recovery. **Methods**: CD1 male mice (n=66) underwent either TBI (controlled cortical impact; CCI) or sham craniotomy. ODSH [25mg/kg (25ODSH) or 50mg/kg (50ODSH)] or saline was administered (~Q8H) for 48h after TBI. At 48h, intravital microscopy (n=46) visualized rolling LEUs and fluorescent albumin leakage, the Garcia Neurological Test (GNT) assessed neurologic function and brain wet/dry ratios evaluated post-mortem cerebral edema. In separate animals (n=20), learning/memory ability (% time swimming in Probe platform quadrant) was assessed by the Morris Water Maze (MWM) 17days after TBI. ANOVA with Bonferroni correction determined significance ($p<0.05$). **Results**: Compared to CCI, both ODSH doses reduced post-TBI pial LEU rolling and cerebrovascular albumin leakage (FigA). 50ODSH reduced injured cerebral hemisphere edema (77.7±0.4%) vs. CCI (78.7±0.4%, $p<0.01$). Compared to CCI, both ODSH doses improved GNT at 48hrs (FigB). Learning/memory ability which was lowest in CCI (5.9±6.4%) improved in 25ODSH (27.5±8.2% $p=0.02$). **Conclusion**: ODSH after TBI reduces LEU recruitment, microvascular permeability and cerebral edema. Lower dose ODSH also improves acute neurological recovery leading to improved learning/memory ability weeks after injury.



*P<0.05 vs. CCI, **P<0.01 vs. CCI, #P<0.05 vs. 25ODSH, ##P<0.01 vs. 25ODSH, ††P<0.01 vs. 50ODSH

Session: XIIIA: Papers 45-54: Preclincial/Translational Science
Paper 51: 3:30-3:50 pm

PREVENTING UNNECESSARY PLATELET TRANSFUSIONS IN TRAUMA RESUSCITATION: PAR-1 PATHWAY INHIBITION IS MORE SPECIFIC THAN ADP INHIBITION FOR PREDICTING COAGULOPATHIC HEMORRHAGE IN THE SETTING OF PLATELET DYSFUNCTION

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Invited Discussant: Forest Sheppard, MD

Introduction: Early platelet dysfunction has been identified as a sensitive biomarker for trauma induced coagulopathy (TIC) and has been specifically implicated in TIC associated with traumatic brain injury. Platelet function in trauma is typically evaluated using agonists of the P2Y12 receptor (ADP) or the thromboxane A2 receptor (arachadonic acid/AA). We have noted that ADP platelet dysfunction may be seen with relatively modest injuries without significant associated bleeding or other evidence of TIC. Literature from the medical and cardiac critical care communities have also indicated that ADP inhibition is an overly sensitive marker of platelet dysfunction and its use as a guide for goal directed transfusion may produce false positives and result in unnecessary platelet transfusions. We hypothesized that measurement of platelet function by stimulation of a more robust platelet activation pathway, such as the thrombin (PAR) receptors, would yield a more specific and clinically reliable metric of platelet dysfunction in TIC.

Methods: Platelet function was assessed in 436 consecutive trauma activation patients using two assays: ROTEM Platelet Aggregometry using ADP and TRAP-6 (a PAR-1 stimulatory peptide) as agonists. Receiver operating characteristic (ROC) curves for prediction of (1) severe clinical coagulopathy requiring blood component administration (as scored by the attending trauma surgeon, who is blinded to the platelet function test results) and (2) massive transfusion (defined as ≥10 units of PRBCs in 6 hours). The optimum sensitivity and specificity for each ROC curve was defined as the point closest to the error-free point (0,1) on the plot.

Results: TRAP-6 aggregometry yielded an ROC curve with an area-under-curve (AUC) of 0.81 (95% CI: 0.71 to 0.91) for prediction of severe clinical coagulopathy, compared to 0.77 for ADP (95% CI 0.64 to 0.90). For prediction of massive transfusion, TRAP-6 yielded an AUC of 0.74 (95% CI: 0.63 to 0.88) compared to 0.69 for ADP (95% CI 0.54 to 0.84). Notably, the improved AUC for TRAP-6 over ADP was the result of a leftward shift of the optimized point, such that for the optimum specificity for prediction of severe clinical coagulopathy for TRAP-6 was 77%, compared to 64% for ADP, at corresponding sensitivities of 82% and 83% respectively. Similarly, optimum specificity for prediction of massive transfusion was 76% for TRAP-6, compared to 62% for ADP, at corresponding sensitivities of 78% and 80%, respectively.

Conclusion: TRAP-6 aggregometry, which is a metric of platelet function via the thrombin receptor (PAR-1) pathway, is a more specific predictor of both clinical coagulopathy and massive transfusion requirement than platelet function testing using an ADP agonist. This superiority in specificity of the TRAP-6 agonist over ADP would result in a roughly 17% reduction in unnecessary platelet transfusion, if the test were applied clinically to goal-directed hemostatic resuscitation with blood components.

Session: XIIIA: Papers 45-54: Preclincial/Translational Science
Paper 52: 3:50-4:10 pm

LATE TXA UTILIZATION IS ASSOCIATED WITH INCREASED BLOOD PRODUCT ADMINISTRATION IN PATIENTS PREDICTED TO RECEIVE MASSIVE TRANSFUSION: A SECONDARY ANALYSIS OF THE PRAGMATIC RANDOMIZED OPTIMAL PLATELET AND PLASMA RATIOS (PROPPR) STUDY

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Invited Discussant: Jeremy Cannon, MD

Introduction: Exsanguination is the leading cause of preventable death after trauma. In addition to a balanced ratio blood component strategy, tranexamic acid (TXA) is used as an adjunct in hemorrhaging patients. This secondary analysis was performed to determine the incidence of TXA utilization and outcome in patients predicted to receive a massive transfusion (MT) in level 1 trauma centers.

Methods: Trauma patients who were predicted to require a MT and admitted to 12 level I North American trauma centers were studied. Patients were divided into those who received TXA and those who did not. We examined 3 hour, 24 hour, and 30 day mortality. We also examined incidence of thromboembolic events, blood product administration within the first 24 hours, length of stay (hospital free days), ICU free days, as well as development of complications including acute respiratory distress syndrome (ARDS), acute kidney injury (AKI), sepsis, and multisystem organ failure (MOF). In our multivariate analysis, we controlled for Injury Severity Score (ISS), Glasgow Coma Scale (GCS), treatment group, mechanism of injury, hypotension and/or tachycardia on admission, geriatric patient (age > 65), and site as independent variables.

Results: 137 out of 680 (20.1%) patients in the PROPPR study received TXA with 130 patients receiving TXA within the first 3 hours after admission. Other adjunctive therapies administered included cryoprecipitate (25.4%), and others (6.6%). The incidence of TXA administration did not differ between the ratio groups (50.3% vs 47.4%, p=0.55), but patients receiving TXA were more severely injured with a median(interquartile range (IQR)) ISS of 34(21) vs 26(20), p<0.01 and a lower median(IQR) GCS of 9(12) vs 14(12), p<0.01. Multivariate linear regression analysis revealed no association between TXA administration and blood transfusion requirements (Table 1). Further analysis revealed that patients who received late (from >1 hour to ≤3 hours after arrival) TXA (41 patients) experienced increased blood requirements in the first 24 hours (Table 1) compared to those remaining 543 patients that did not receive TXA. There was no difference in blood product requirement in those patients who received TXA early (≤1 hour) (89 patients) versus those that did not receive TXA. In patients that received TXA, there was an increased incidence of ARDS (OR (95% CI) 1.99 (1.06,3.73), p=0.03), AKI (1.90 (1.13,3.20), p=0.01), and MOF (4.18 (1.52,11.48), p<0.01) even when controlling for the factors mentioned above. There was also a difference in adjusted 3 hour mortality (OR (95% CI) 0.22 (0.07,0.73), p=0.01) but not 24 hour (0.61 (0.30,1.24), p=0.18) or 30 day mortality (1.42 (0.78,2.59), p=0.25) for any TXA administration. There was no difference in adjusted thromboembolic events or adjusted length of stay. Subgroup analysis with additional variables that were found to have a difference between groups with a p<0.20 were added to the regression model including hematocrit, platelet count, international normalized ratio, creatinine, lactate, and R value on thrombelastography. This analysis showed an increase in PRBC transfusion with late TXA administration (16 out of 232 patients, 7.51 (0.46,14.56), p=0.04), but showed no difference in FFP or platelet administration.

Conclusion: Early TXA use was not associated with improved outcomes. Late TXA use was associated with increased blood product resuscitation. TXA administration in general was associated with improved 3 hour mortality. This did not translate to an improvement in mortality at 24 hours or 30 days. There was a significant increase in the incidence of ARDS, AKI, and MOF in patients who received TXA but this analysis is limited by the differences in the 2 populations despite attempts to control for them.

	Any TXA β (95% CI)	*p**	Late TXA β (95% CI)	*p**
ICU free days	-0.49 (-1.82,0.84)	0.47	-1.37 (-3.55,0.82)	0.22
Hospital free days	-0.50 (-2.06,1.06)	0.53	-1.27 (-3.80,1.27)	0.33
PRBC	1.39 (-1.14,3.91)	0.28	7.09 (2.99,11.19)	<0.01
FFP	1.25 (-0.71,3.22)	0.21	5.47 (2.25,8.68)	<0.01
Platelet	2.02 (-0.19,4.23)	0.07	6.67 (3.08,10.25)	<0.01
Crystalloid	1.09 (0.23,1.95)	0.01	6.74 (3.86,9.61)	<0.01

*β calculated using linear regression, CI: confidence interval

Table 1. Patients receiving TXA and those receiving late (from >1 hour to ≤3 hours after arrival) TXA.

Session: XIIIA: Papers 45-54: Preclincial/Translational Science
Paper 53: 4:10-4:30 pm

ADMINISTRATION OF TRANEXAMIC ACID IS ASSOCIATED WITH DEVELOPMENT OF FIBRINOLYSIS SHUTDOWN AMONG CRITICALLY INJURED TRAUMA PATIENTS

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Invited Discussant: Ernest Moore, MD

Introduction: Trauma patients present with physiologic fibrinolysis, fibrinolysis shutdown, or hyperfibrinolysis. Shutdown is the most common phenotype and is associated with significant mortality. The association between tranexamic acid (TXA), an antifibrinolytic agent routinely given to trauma patients, and development of shutdown is unknown. We hypothesize that TXA is associated with the development of fibrinolysis shutdown in critically ill trauma patients.

Methods: Prospective observational study of 218 critically ill adults admitted to the intensive care unit (ICU) at an urban level 1 trauma center from 08/2011-01/2015 who had thromboelastography performed upon ICU admission. Groups were stratified based on fibrinolysis shutdown, which was defined as LY30≤0.8%. Continuous variables were expressed as mean±standard deviation or median(IQR). Logistic regression was used to determine predictors of shutdown. Adjusted odds ratios and 95% confidence intervals are reported; significance set at $p \leq 0.05$.

Results: Patients were age 46y, 81% male, 75% blunt trauma, 83% had ISS>15, 17% received TXA, 64% developed shutdown, and mortality was 15%. Overall, they received median of 4(2-10) units PRBC, 2(0-6) units FFP, & 0(0-1) units platelets in the first 24 hours. Those with shutdown had worse hemodynamics and BE (-5±6 vs -3±5 mEq/L, p=0.013); received more PRBC [6(3-11) vs 3(2-6) units, p<0.0001], FFP [3(0-8) vs. 2(0-4) units, p=0.001], and platelets [0(0-1) vs 0(0-0), p=0.011]; and more often received TXA (25% vs 4%, p <0.0001). After controlling for these confounders, TXA [aOR 3.69 (95% CI 1.01-13.41), p=0.048] and PRBC transfusions [aOR 1.12 (95% CI 1.04-1.22), p=0.005] were independent predictors of fibrinolysis shutdown (c-statistic 0.71, 95% CI 0.64 – 0.78, p<0.0001).

Conclusion: In a large cohort of severely injured trauma patients with thromboelastography performed on ICU admission, TXA is associated with fibrinolysis shutdown. Those with shutdown were almost 4 times as likely to have received TXA as those who did not. Judicious use of TXA is warranted given the known association between fibrinolysis shutdown and mortality after trauma.

Session: XIIIA: Papers 45-54: Preclincial/Translational Science
Paper 54: 4:30-4:50 pm

PREDICTING THE NEED FOR MASSIVE TRANSFUSION PROTOCOL ACTIVATION: PROSPECTIVE VALIDATION OF A SMARTPHONE-BASED CLINICAL DECISION MAKING APPLICATION

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Invited Discussant: Ben Zarzaur, Jr., MD

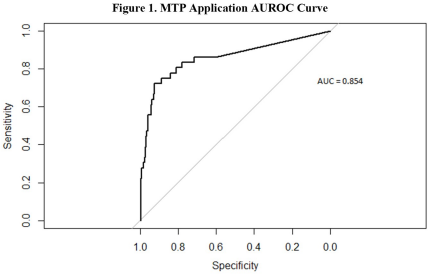
Introduction: Although several analog prediction models exist, accurate prediction of MTP activation remains a challenge. This study prospectively assesses the accuracy of a previously published MTP prediction tool that embeds a complex predictive algorithm within convenient smartphone application for bedside use.

Methods: Prospective patient recruitment was performed at an urban, Level I trauma center from September 2014 to November 2016. For level I activations, the app recorded the surgeon's initial opinion for massive transfusion [MT (≥10 U PRBCs/24 hours)] protocol (MTP) activation, then prompted inputs for the predictive model (gender, admission heart rate and systolic pressure, FAST, base deficit, mechanism). The app provided a probability (Very Low, Low, Moderate/Equivocal, High) that the patient would require MTP & recorded the surgeon's final decision on MTP activation.

Results: Over the study period, 321 trauma activations were enrolled with 36 (11%) requiring and 285 (89%) not requiring MT, and 40 (11%) app predictions were discordant with initial 24 hour transfusions when MTP was activated. Of 285 not requiring MTP, the app correctly predicted 255 (89%), and falsely predicted "High" (6/24, 25%) or "Moderate" (18/24 75%) risk. In 6 cases, surgeon's initial decision to activate MTP was correctly altered because of the "Very Low" predicted risk with none of these patients requiring MTP. Of 36 patients who required MTP, the app correctly predicted that 23 (64%) were at "High" risk of requiring MTP and 7 at "moderate" risk. In 8/18 (44%) of these cases, use of the app caused the surgeon to activate MTP after an initial decision to not activate. For for 7/18 (39%) of those requiring MTP, while the app predicted that MTP would be required, the surgeon's decision, both before and after using the app, was to not activate – the MTP was started & patients received MT without formal MTP activation. In evaluating the predictive power of the mobile app, excluding the moderate/ equivocal predictions, the app achieved a sensitivity =86%, specificity = 97%, respectively, PPV = 0.75 and NPV = 0.99. When moderate/equivocal risk was included as a positive for MTP activation, sensitivity = 67%, Specificity = 90%, NPV = 0.96, & PPV= 0.43. Figure demonstrates AUROC for predictive model.

Conclusion: Smartphone based clinical decision tools can aid surgeons in prediction of MTP activation & may alter practice in real time. Further study is needed to further calibrate models to clinical practice.

Figure 1. MTP Application AUROC Curve



Session: IIIB: Papers 55-64: Outcomes/Guidelines
Paper 55: 1:30-1:50 pm

TO SHUNT OR NOT TO SHUNT IN COMBINED ORTHOPEDIC AND VASCULAR EXTREMITY TRAUMA

Jordan R. Wlodarczyk MD, MS, Alexander S. Thomas MD, Rebecca Schroll MD, FACS, Eric M. Campion MD, Caroline Croyle MPH, CPH, Jay Menaker* MD, Matthew Bradley MD, John A. Harvin* MD, FACS, Morgan L. Collum MD, Jayun Cho MD, Mark J. Seamon* MD, Jennifer Leonard MD, Michael Tiller MD, Kenji Inaba* MD,
LSU Department of Surgery

Invited Discussant: David Feliciano, MD

Intro: There exists a long established but not validated practice of placing temporary vascular shunts in cases of combined vascular and orthopedic extremity trauma. Though logical to prioritize blood flow, large-scale data to support this practice is lacking. We hypothesize that shunting yields no difference in outcomes compared to initial definitive vascular repair. Our study offers a larger scale analysis than previously available in the literature.

Methods: A retrospective chart review was conducted at 6 Level 1 trauma centers from 2004 – 2015 in patients presenting with combined orthopedic and vascular extremity trauma. Patients under 18 or who died in the initial operation were excluded. Patients who received a temporary intravascular shunt in their initial surgery were compared with those who did not. Patients who did not receive a temporary shunt were further subdivided into initial definitive vascular repair vs. initial orthopedic fixation groups. Age, Sex, ISS, Shock Index, AIS, MESS, and mechanism of injury (MOI) were used to control for sampling bias while revision rate, amputation, HLOS, thrombosis, development of compartment syndrome or rhabdomyolysis were used to assess outcomes. Fisher exact tests, Chi Square and Wilcoxon's nonparametric tests were used to assess for statistical significance.

Results: In the study period 291 patients presented with the above inclusion criteria. Seventy-two had temporary shunt placement, 97 had initial definitive vascular repair, and 122 had initial orthopedic fixation. There was no difference between shunted vs. non-shunted patients regarding Age, Sex, ISS, Shock Index and MOI. The shunted group had a higher AIS (3.0 vs. 2.8 $p=0.04$) and MESS (6.1 vs. 5.7 $p=0.006$) than the non-shunted groups. Shunted patients had a significantly lower rate of compartment syndrome (15% vs. 34%, $p=0.002$). Among those patients who developed compartment syndrome, those who were shunted tended to be younger (23 vs 35 yrs, $p=0.03$) and were more likely to sustain a penetrating injury (p=0.007). There was no difference in gender, MESS, AIS, Shock index, or ISS to account for the development of compartment syndrome. When initial definitive vascular repair vs. initial orthopedic fixation were compared, those receiving initial orthopedic fixation had an increased AIS (82% vs 68%, p=0.04) and more commonly sustained blunt trauma (80% vs 65%, p=0.02). Initial orthopedic fixation had a longer HLOS (61% vs 38% with HLOS >15 days, $p=0$.049) and a higher rate of amputation (20% vs 7%, $p=0.006$).

Conclusion: There was a significant increase in the development of compartment syndrome associated with lack of a temporary shunt during the initial operation. Though it seems to have become common practice to proceed directly to definitive vascular repair during the initial surgery, the morbidity is improved with the placement of a temporary shunt. Patients also have better outcomes when having their orthopedic injury addressed after the vascular injury. Until prospective studies can further elucidate the protective effect of shunt placement on compartment syndrome, we advocate that the practice of placing temporary shunts continue, especially in the young, penetrating trauma patient.

Session: IIIB: Papers 55-64: Outcomes/Guidelines
Paper 56: 1:50-2:10 pm

TIME COURSE AND OUTCOMES ASSOCIATED WITH TRANSIENT VERSUS PERSISTENT FIBRINOLYTIC PHENOTYPES AFTER INJURY: A NESTED, PROSPECTIVE, MULTICENTER COHORT STUDY

Derek J. Roberts MD,Ph.D., Kyle J. Kalkwarf MD, Hunter B. Moore MD, Mitchell J. Cohen* MD, Erin E. Fox Ph.D., Charles E. Wade Ph.D., Bryan A. Cotton* MD, University of Calgary

Invited Discussant: Karim Brohi, MD

Introduction: The extremes of fibrinolysis (hyperfibrinolysis, HF, and shutdown, SD) acutely after injury are associated with increased mortality. However, the temporal changes in fibrinolytic activity and impact on mortality remain poorly defined. Recently, two independent single center studies suggested that persistent SD after injury is associated with increased mortality and morbidity. We conducted a nested, prospective cohort study to determine the incidence of different fibrinolytic phenotypes and the trajectories and associated outcomes of these phenotypes over time.
Methods: The study was set at three American College of Surgeons-verified, level-1 trauma centers over a 14-month period. Injured adult patients meeting the highest level of trauma team activation that arrived within six hours of injury were included in the analysis. Serial rapid thrombelastography (rTEG) measures, including clot lysis at 30-minutes (LY30), were obtained at presentation and 3-, 6-, 12-, 24-, 48-, 72-, 96-, and 120-hours. We used LY30 values and previously published definitions to divide patients into the following fibrinolysis phenotypes: SD (LY30 ≤0.8%), physiologic fibrinolysis, PHYS, (LY30 >0.8% to <3%), and HF (LY30 ≥3%). Multivariable logistic and mixed-effects regression models were used to estimate odds ratios (OR) [and surrounding 95% confidence interval (CI)] for mortality and predictors of persistent SD, respectively.
Results: In total, 1242 patients were enrolled, of which 795 had serial rTEG data. The median age was 38 years and most patients were injured by blunt mechanisms (73%), resulting in a median Injury Severity Scale (ISS) score of 21. In total, 44% presented with SD, 36% with PHYS, and 20 with HF. The overall mortality was highest among those who presented with HF (18%), followed by SD (9%), and PHYS (6%) (p=0.001). While mortality within the first 24-hours was highest with admission HF (14% vs. 5% SD vs. 4% PHYS; p=0.001), both admission HF (7%) and SD (6%) had higher mortality after 24-hours compared to PHYS (3%) (p=0.04). Admission HF was independently associated with an increased 30-day mortality (OR, 4.19; 95% CI, 1.03-16.98; p=0.04). With respect to trajectory, all patients who presented with HF switched into another phenotype or died within 24-hours of admission. The majority of patients that presented in SD remained in the SD phenotype: 75% through 96 hours and 68% at 120-hours. Further, persistent SD at 24 hours was associated with increased mortality after 24 hours (OR 3.20, 95% CI, 1.51-6.67).
Conclusion: Our findings suggest that almost 70% of major trauma patients who present with SD remain in the SD phenotype up to 120-hours post-injury. Patients presenting with HF, on the other hand, transition to SD/PHYS phenotypes or die within 24 hours. While early mortality remains greatest with the HF phenotype, persistent SD at 24-hours predicted late mortality.

Session: IIIB: Papers 55-64: Outcomes/Guidelines
Paper 57: 2:10-2:30 pm

THE ROLE OF DIVERSION IN EMERGENT COLECTOMY FOR HEMORRHAGE

Jeremy L. Holzmacher MD, Sara L. Zettervall MD,MPH, Lisbi Rivas Ramirez MD, Gregor Werba MD, Ashtin Jeney BS, Elizabeth Schroeder* MD, Khashayar Vaziri MD, Babak Sarani* MD, Stephen Gondek* MD,MPH, George Washington University Hospital

Invited Discussant: Patrick Bosarge, MD

Introduction: Patients undergoing emergency colectomy for hemorrhage represent a unique challenge in intraoperative decision making as most receive blood transfusions prior to surgery. Data mandating diversion with significant blood product usage are largely extrapolated from the trauma population and are not directly relevant to the lower GI bleed patient. Therefore, we evaluated the decision to proceed without diversion on 30-day outcomes in emergency surgery patients undergoing partial colectomy for hemorrhage. We hypothesize that primary anastomosis in patients that received a blood transfusion preoperatively is at least as safe as diversion.

Methods: A retrospective analysis was performed utilizing the targeted colectomy module of the National Surgical Quality Improvement Program (NSQIP) for patients undergoing emergency partial colectomy from 2012-2014. Demographic characteristics and 30-day outcomes were compared amongst patients by type of surgery performed at the index operation: primary anastomosis (PA), primary diversion (PD), and anastomosis with proximal protective ostomy (PPO). Multivariable analysis was performed to identify predictors of 30-day outcomes.

Results: 342 emergency colectomy patients were included with 233 PA patients, 87 PD patients, and 22 PPO patients. Of those, 60 PD, 159 PA, and 12 PPO patients received a preoperative blood transfusion. In all comers, demographic characteristics were similar except for the ACS calculated risk of morbidity (PD 46.33±13.06, PA 36.14±11.9, PPO 36.77±10.20, $p<0.001$) and mortality (PD 20.27±19.87, PA 10.71±13.26, PPO 13.25±11.87, $p<0.001$). Overall infectious complications, organ space infections, and need for intervention for anastomotic leak were similar between groups. For patients that received a transfusion prior to surgery, there was no significant difference in postoperative overall infectious complications (PD 26.7%, PA 23.9%, PPO 33.3%, $p=0.729$), rates of anastomotic leak requiring intervention (PD 1.7%, PA 8.2%, PPO 8.3%, $p=0.211$), or mortality (PD 16.7%, PA 11.9, PPO 8.3%, $p=0.577$). After controlling for NSQIP calculated risk of morbidity and mortality in both all comers and transfused patients, type of operation was not a significant predictor of mortality ($p=0.063$ and 0.238, respectively) or infectious complication ($p=0.444$ and 0.532, respectively); however, preoperative risk of morbidity and mortality were significant predictors of worse outcomes. There were no observed anastomotic leaks in patients that had an ACS risk calculated morbidity less than 25%.

Conclusions: Preoperative blood product usage does not mandate diversion in patients undergoing emergency partial colectomy for hemorrhage and the decision to divert patients should not be based on blood use alone. Preoperative risk stratification of postoperative morbidity should guide intraoperative decision making, and high risk patients likely benefit from diversion.

Session: IIIB: Papers 55-64: Outcomes/Guidelines
Paper 58: 2:30-2:50 pm

DON'T MISS AN OPPORTUNITY: ROUTINE HIV AND HCV SCREENING AMONG TRAUMA PATIENTS

Gina M. Simoncini MD,MPH, Josue Oyola-Jimenez BA, Davone Singleton, Jill Volgraf RN, BA, Leonard Mason* MD, Amy Goldberg* MD, Temple University Hospital

Invited Discussant: Tanya Zakrison, MD, MPH

Introduction: Many patients who seek care for trauma-related encounters have limited access to healthcare, yet remain at high-risk for certain conditions. Our penetrating trauma population was previously studied and has a 1.2% prevalence of human immunodeficiency virus (HIV) and 7.6% prevalence of hepatitis C antibody (HCV Ab). In this study, we sought to routinely screen all trauma patients for HIV and HCV.

Methods: In the last 6 months, all patients evaluated at an urban Level I trauma center were prospectively screened for HCV Ab and offered HIV testing, after verbal consent was obtained. Demographics were collected on gender, ethnicity, age, and history of intravenous drug use (IVDU). Data was collected on the number of tests ordered by the trauma service and resulted for HCV and HIV. We determined the prevalence of HIV and HCV Ab. All inpatients who tested positive for HCV Ab underwent confirmatory viral load testing. If patients were discharged prior to confirmatory testing, a navigator contacted them to return for confirmatory testing. If results were available after a patient was discharged, a navigator contacted them to discuss results. If patients were diagnosed with chronic HCV or HIV, the navigator worked with the patient to link them to care or re-engage them in care.

Results: During the last 6 months, 799 patients were screened for HCV with prevalence of 14% (109). Forty-five patients (41%) had history of IVDU. Forty-three percent (47) patients were baby boomers and 55% (60) were not. Sixty-three patients (58%) underwent HCV confirmatory testing, with 46 patients diagnosed with chronic HCV and 17 patients who spontaneously cleared HCV. Four patients were newly diagnosed with chronic HCV. Twenty-one patients (45%) were previously aware of their chronic HCV diagnosis, but not following with a physician. HIV prevalence was 2.8% (3) of the 107 patients screened for HIV, but there were a total of 12 patients already living with HIV among the patients screened for HCV. There were two patients newly diagnosed with HIV. Of the patients previously aware of their HIV diagnosis, 33% were not on antiretroviral therapy. With the help of our navigator, 22 of the 47 chronic HCV patients (47%) have attended at least one visit with a HCV specialist.

HCV Ab + Demographics

		Hx of IVDU	no Hx of IVDU	Total
Gender				
	Male	33	46	79
	Female	12	18	30
Race/Ethnicity				
	White, Non-Hispanic	15	28	43
	African American, Non-Hispanic	11	22	33
	Hispanic/Latino/mixed	17	11	28
	Unknown	2	3	5
Age				
	Baby Boomer Birth Cohort	15	32	47
	Non-Birth Cohort	30	30	60
	No data		2	2
HCV Viral Load				
	Positive	23	23	46
	Negative	6	11	17
	Not performed	16	30	46
Total		45	64	109

Conclusion: Our trauma service cares for over 2000 patients per year, but many of these patients do not have regular access to care. By routinely screening patients for HIV and HCV at the point of care, in an emergency setting, we are able to diagnose high-risk patients. With the use of a navigator, we are able to re-engage these patients back into care. Trauma service HIV and HCV screening is an opportunity to diagnose and re-engage a vulnerable population, which cannot be missed.

Session: IIIB: Papers 55-64: Outcomes/Guidelines
Paper 59: 2:50-3:10 pm

EXAMINING RACIAL DISPARITIES IN LATE WITHDRAWAL OF CARE AMONG SEVERELY INJURED PATIENTS

Melissa A. Hornor MD, Avery B. Nathens* MD, James P. Byrne* MD, AMERICAN COLLEGE OF SURGEONS

Invited Discussant: Selwyn Rogers, Jr., MD

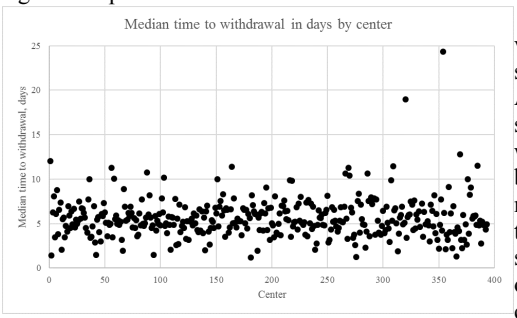
Introduction: Racial disparities in medical treatment for seriously injured patients across the spectrum of care are well established, but racial disparities in end of life decision making practices have not been well scrutinized. As time from admission to time of withdrawal of care increases, so does the potential for ineffective care, healthcare resource loss, and patient and family suffering. We sought to determine the existence and extent of racial disparities in time to withdrawal of care after severe injury.

Methods: A cohort of severely injured patients (ISS> 15, age > 16) with a withdrawal of care order > 24 hours after admission were derived from ACSTQIP (2013 – 2017). We identified patients with late withdrawal of care, defined as those whose care was withdrawn at a time interval beyond the 75 th percentile for the entire cohort. Univariate and multivariate analyses were performed utilizing descriptive statistics, and t-tests and chi-squared tests where appropriate. Multivariable regression analysis was performed with random effects to account for hospital-level clustering using late withdrawal as the primary outcome, and race as the primary predictor of interest.

Results: 13,067 patients with withdrawal of care orders were included in the analysis from 393 centers. Median time to withdrawal was 5.6 days (IQR 2.6-10.3). African American patients were over-represented among patients whose care was withdrawn late (10.16% vs 7.08%, p<0.01). After adjustment for patient and injury characteristics, African American race (OR 1.41, 95% CI 1.20-1.64) was a significant predictor of late withdrawal of care.

Predictors of late time to withdrawal[a]	Odds Ratio, (95% CI)
African American race	1.41, (1.21-1.65)
White race	1 [Reference]
Age, years	0.99 (0.98-0.99)
Female sex	0.78 (0.62-0.97)
Comorbidities	
0	1 [Reference]
1	1.17, (1.04-1.31)
2	1.21, (1.05-1.41)
3+	1.35, (1.18-1.54)
Mechanism of injury	
Fall	1 [Reference]
MVC	1.43, (1.27-1.63)
Motorcycle	1.50, (1.23-1.83)
Other blunt	1.27, (1.04-1.55)
Pedestrian	1.50, (1.28-1.76)
Severe injury AIS ≥ 3 by body region	
Head	0.85, (0.74-0.98)
Chest	1.30, (1.16-1.46)
Abdomen	1.41, (1.21-1.64)
Lower extremity	1.10, (1.16-1.22)
GCS motor score ≤ 3	1.19, (1.16-1.22)
Shock[b]	0.94, (0.82-1.08)

[a]Other non-significant covariates included in the model: other race, insurance status, stab mechanism of injury, severe spine injury
[b]SBP ≤ 90mmHg
AIS, Abbreviated Injury Scale; SBP, systolic blood pressure; GCS, Glasgow Coma Scale



Conclusion: There is substantial variability in time to withdrawal in seriously injured patients, and African American race is a significant predictor of late withdrawal. These findings might be due to patient preference or medical decision making, but speak to the value in assuring a high standard related to identifying goals of care and improving end of life care.

Session: IIIB: Papers 55-64: Outcomes/Guidelines
Paper 60: 3:10-3:30 pm

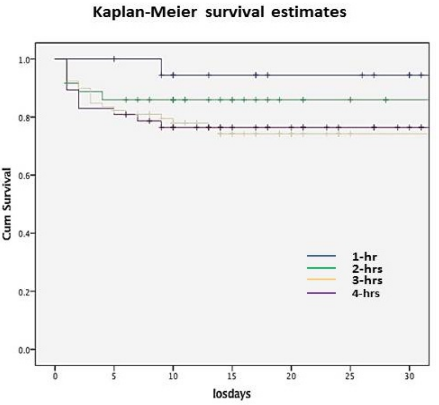
EFFECT OF DOOR-TO-ANGIOEMBOLIZATION TIME ON MORTALITY IN PELVIC FRACTURE: EVERY HOUR OF DELAY COUNTS

Kazuhide Matsushima MD, Alice Piccinini MD, Morgan Schellenberg MD,MPH, Vincent Cheng BA, Aaron Strumwasser MD, Elizabeth Benjamin* MD,Ph.D., Kenji Inaba* MD, Demetrios Demetriades* MD,Ph.D., LAC+USC Medical Center

Invited Discussant: Bruce Crookes, MD

Introduction: Angioembolization (AE) is widely used for hemorrhagic control in patients with pelvic fractures. The latest version of the *Resources for Optimal Care of the Injured Patient* issued by the American College of Sugeons Committee on Trauma requires interventional radiologists to be available within 30 minutes to perform an emergent AE . However, the impact of time-to-AE on patient outcomes remains unknown. We hypothesized that a longer time-to-AE would be significantly associated with increased mortality in patients with pelvic fractures.

Methods: This is a 2-year retrospective cohort study using the American College of Surgeons Trauma Quality Improvement Program (ACS-TQIP) database from January 2013 to December 2014. Adult patients (age ≥18 years) with blunt pelvic fractures who underwent AE of the pelvis <4 hours after hospital admission were included. Patients who required hermorrhagic control surgery <4 hours for any associated injuries in other body regions were excluded. Multivariable logistic regression analysis was performed to evaluate the impact of time-to-AE on patient in-hospital mortality.



Results: There were 51,545 patients with pelvic fracture during the study period. A total of 181 patients (0.4%) met our inclusion criteria and were included for analysis. The median age was 54 (IQR: 38-68) and 69.6% were male patients. The median ISS was 34 (IQR: 27-43). Overall in-hospital mortality rate was 21.0% (5.3%, 16.7%, 25.3%, and 23.4% for time-to-AE of 1 hour, 2 hours, 3 hours, and 4 hours, respectively; p for trend=0.09). The median volume of packed red blood cell transfusion <4 and 24 hours after admission was 4 and 7 units, respectively. After adjusting for other covariates in the multivariable logistic regression analysis, longer time-to-AE was significantly associated with increased in-hospital mortality (AOR: 1.71 for each hour delay, 95%CI: 1.07-2.71, p=0.024).

Conclusion: Prolonged time-to-AE for hemorrhagic control after pelvic fracture is associated with an increased risk of mortality. Every trauma center should have resources allocated to preventing significant delay in performing AE. Further studies are warranted to determine the role of other adjunctive tehniques (e.g. REBOA) to temporize pelvic hemorrhage while waiting for AE.

Session: IIIB: Papers 55-64: Outcomes/Guidelines
Paper 61: 3:30-3:50 pm

USE OF OPEN AND ENDOVASCULAR SURGICAL TECHNIQUES TO MANAGE VASCULAR INJURIES IN THE TRAUMA SETTING: A REVIEW OF THE AAST PROOVIT REGISTRY

Edwin R. Faulconer MBBS, Bernardino C. Branco MD, Melissa Loja MD, Kevin Grayson Ph.D., James Sampson MD, Timothy C. Fabian* MD, Tiffany Bee* MD, John Holcomb* MD, Megan Brenner* MD, Thomas M. Scalea* MD, David Skarupa* MD, Kenji Inaba* MD, Nathaniel Poulin* MD, Todd E. Rasmussin* MD, Joseph J. Dubose* MD, David Grant USAF Medical Center

Invited Discussant: J. David Richardson, MD

Introduction: Vascular trauma data have been submitted to the American Association for the Surgery of Trauma PROspective Observational Vascular Injury Trial (PROOVIT) database since 2013 from multiple level I and II trauma centers throughout the United States. To date over 2,500 records have been submitted. We present preliminary data from the registry to describe the current use of endovascular surgery in vascular trauma.

Methods: We reviewed registry data from March 2013 to December 2016 with permission from the PROOVIT review panel. All patients who had an injury to a named artery, excepting forearm and lower leg, were included. Arteries were grouped into anatomical regions (neck, thoracic outlet, thorax, upper limb, major abdominal, abdominal branches and lower limb) and regions (compressible and non-compressible) for analysis. This review was limited to patients with non-compressible transection, partial transection, or flow limiting defect injuries. In addition to descriptive statistics, we developed multivariate linear models to assess the relationships between study variables.

Results: 1143 patients from 22 institutions had 1 or more arterial injuries in the regions defined. Median age was 32 years (interquartile range [IQR] 23-48) and 76% were male. Mechanisms of injury were 49% blunt, 41% penetrating, and 1.8% of mixed aetiology. Gunshot wounds accounted for 73% of all penetrating injuries. Endovascular techniques were used least often in limb trauma (upper limb 3% (n=7/203), lower limb 5% (n=18/381)) and most commonly in patients with blunt injuries to more than one region (50%, n=116/231). Penetrating wounds to any region were preferentially treated with open surgery (74%, n=341/459) with endovascular and combined approaches only accounting for 34 cases (7%). The most common indication for endovascular treatment was blunt non-compressible truncal injuries (NCTI). Patients with transection, partial transection or flow limiting NCTI treated with endovascular surgery had higher overall injury burden as reflected by injury severity scores and longer associated hospital stays, but required less packed red blood cells (PRC), and had lower in hospital mortality than those treated with open surgery on univariate analysis. On multivariate analysis of this NCTI group, low hemoglobin and abdominal injury were independent predictors of mortality, and amongst survivors, type of injury, hemoglobin, lactate, and vasopressor use were predictors of PRC use in the first 24 hours.

Conclusion: Our review of the PROOVIT registry demonstrates that both endovascular and open surgery is being performed for vascular injuries in all regions of the body. These findings support the use of endovascular treatment of vascular injuries in the severely injured, but additional investigation is needed to define indications and optimal utilization of endovascular technologies in the setting of vascular trauma.

Session: IIIB: Papers 55-64: Outcomes/Guidelines
Paper 62: 3:50-4:10 pm

CIVILIAN PRE-HOSPITAL TOURNIQUET USE IS ASSOCIATED WITH IMPROVED SURVIVAL IN PATIENTS WITH PERIPHERAL VASCULAR INJURIES

Pedro G. Teixeira MD, Carlos V. Brown* MD, Brent Emigh MD, Michael Long MD, Michael Foreman* MD, Brian Eastridge* MD, Stephen Gale* MD, Michael S. Truitt* MD, Sharmila Dissanaike* MD, Therese Duane* MD, John Holcomb* MD, Alex Eastman* MD,MPH, Justin Regner* MD, University Of Texas At Austin, Dell Medical School

Invited Discussant: Jay Doucet, MD, MSc

Introduction: Tourniquets have proven effective in achieving temporary hemostasis and reducing mortality from extremity wounds incurred on the battlefield. Although the use of tourniquets was empirically transitioned from the military to the civilian pre-hospital environment, there has been a paucity of civilian data to substantiate an attributable survival benefit. We hypothesized that civilian prehospital tourniquet use is associated with reduced mortality in patients with peripheral vascular injuries.

Methods: Multicenter retrospective review was conducted of all patients sustaining peripheral vascular injuries admitted to 11 Level 1 trauma centers from January 2011 to December 2016. The study population was divided into two groups based on prehospital tourniquet use. Demographics and injury characteristic were compared and factors associated with mortality were identified. Logistic regression analysis, adjusting for demographics as well as physiologic and injury-related parameters was used to evaluate the association between pre-hospital tourniquet use and mortality. The secondary outcome of delayed amputation was also assessed.

Results: Over the 6-year study period, 1,026 patients with peripheral vascular injuries were admitted to participating centers. Pre-hospital tourniquet was used in 181 (17.6%) patients. Tourniquets remained in place for 77.3±63.3min (Interquartile Range: 39.0-92.3 min). Traumatic amputations occurred in 98 patients; 35.7% of those utilized a tourniquet. Mortality was 3.9% in the Tourniquet group compared to 5.2% in the No-Tourniquet group [OR (95% CI): 0.73 (0.33-1.65), p=0.452]. After multivariable analysis adjusting for age, gender, mechanism of injury, hypotension on admission, GCS, ISS, presence of associated severe head or torso injury, presence of major vascular injury, and traumatic amputation, the use of tourniquets was found to be independently associated with survival [Adjusted OR (95% CI): 5.86 (1.41-24.47), Adjusted p=0.015]. Delayed amputation rates were not significantly different between the two groups [1.4% vs. 1.2%, OR (95% CI): 1.19 (0.26-5.57), p=0.687].

Conclusion: Although still underutilized, civilian prehospital tourniquet application was independently associated with a six-fold mortality reduction in patients with peripheral vascular injuries. Our data support a more aggressive pre-hospital approach to the application of extremity tourniquets in civilian trauma patients with extremity hemorrhage and traumatic amputation.

Session: IIIB: Papers 55-64: Outcomes/Guidelines
Paper 63: 4:10-4:30 pm

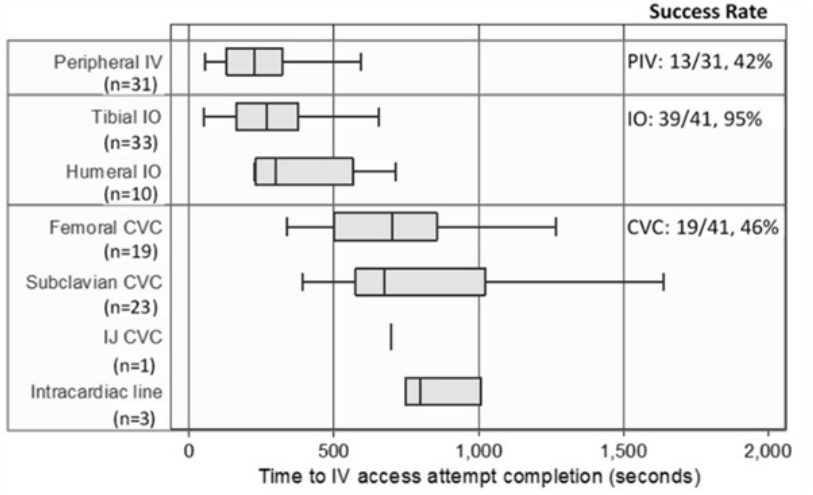
THE IOs HAVE IT: A PROSPECTIVE OBSERVATIONAL STUDY OF VASCULAR ACCESS SUCCESS RATES IN TRAUMA PATIENTS IN EXTREMIS USING VIDEO REVIEW

Kristen M. Chreiman MSN, Ryan P. Dumas MD, Mark J. Seamon* MD, Patrick K. Kim* MD, Patrick M. Reilly* MD, Lewis J. Kaplan* MD, Jason D. Christie MD, MSCE, Daniel N. Holena* MD, MSCE University of Pennsylvania

Invited Discussant: Peter Rhee, MD, MPH

Introduction: Quick and successful vascular access in injured patients arriving in extremis is crucial to enable early resuscitation and rapid OR transport for definitive repair. We hypothesized that intraosseous (IO) access would be faster and have higher success rates than peripheral IVs (PIVs) or central venous catheters (CVCs).

Methods: High-definition video recordings of resuscitations for all patients undergoing Emergency Department Thoracotomy (EDT) from 4/2016-2/2017 were reviewed as part of a quality improvement initiative. Demographic information and mechanism of injury were recorded as were access type, access location, start and stop time, and success of each vascular access attempt. Times to completion for access types (PIV, IO, CVC) were compared using Kruskal-Wallis test adjusted for multiple comparisons while success rates by access type were compared using chi-squared test.



Results: Study patients had a median age of 31 (IQR 29-49), were 93% male, 96% African American, and 93% sustained penetrating trauma. A total of 120 access attempts in 31 patients occurred (median 4 (IQR3-5) attempts per patient). PIVs and IOs attempts took similar amounts of time ($p>0.05$), but both were faster than CVC attempts (PIV 226(IQR128-322); IO 283 (IQR174-446); CVC 682 (IQR529-890) seconds; $p<0.001$ for both PIV and IO vs. CVC). Intraosseous lines had higher success rates than PIVs or CVCs (95% vs. 42% vs. 46%, $p<0.001$). Times and success rates for specific access attempts by site and type can be seen in Figure 1.

Conclusions: Access attempts using IO are as fast as PIV attempts but are more than twice as likely to be successful. Attempts at CVC access in patients in extremis have high rates of failure and take a median of over 10 minutes. While IO access may not completely supplant PIVs and CVCs, IO access should be considered as a first line therapy for trauma patients in extremis.

Session: IIIB: Papers 55-64: Outcomes/Guidelines
Paper 64: 4:30-4:50 pm

SIX-MONTH FOLLOW-UP OF THE INJURED TRAUMA SURVIVOR SCREEN: CLINICAL IMPLICATIONS AND FUTURE DIRECTIONS

Joshua C. Hunt Ph.D., Karen J. Brasel* MD, Terri A. DeRoon-Cassini Ph.D., Medical College of Wisconsin

Invited Discussant: Kamela Scott, MD, PhD

Introduction: A significant minority of admitted trauma patients will develop posttraumatic stress disorder (PTSD) or depression. The Injured Trauma Survivor Screen (ITSS) has been shown to predict PTSD and depression risk at 1 month after traumatic injury. We hypothesized that the ITSS would retain accuracy at 6 months post-injury. The added effect of a measure of acute stress at the time of injury was also examined.

Methods: Patients were enrolled following admission to a Level I trauma center. All participants were administered the ITSS and the PTSD Checklist for DSM-5 during initial hospitalization an average of 3 days after injury (SD = 2.4). The Clinician Administered PTSD Scale for DSM-5 (CAPS-5), and the Center for Epidemiological Studies Depression Scale Revised (CESD-R) were administered by graduate and postdoctoral level mental health professionals an average of 6.5 months after injury (SD = 36.44 days) . Data from two studies were pooled yielding a 6-month follow-up sample of 202 participants. Receiver Operating Characteristic (ROC) curve analyses were run controlling for participants that had mental health intervention and were not symptomatic for PTSD (n = 33) or depression (n = 24) since their injury, and for those who had experienced additional potentially psychologically traumatic events (PTSDn = 23).

Results: The ROC curve analysis for the ITSS PTSD scale (n = 146) was conducted with 32.88% (n = 48) of the sample testing positive for PTSD at 6 months. PTSD specific prediction indices are listed in the table below:

Predictive utility of the ITSS PTSD scale, PCL-5, and combined risk positive groups for PTSD

Screening tools (cutoffs for positive risk)	Indices	CAPS 6 Month
ITSS PTSD	ROC curve (95% CI)	.764 (0.687, 0.830)
(≥2)	Sensitivity	85.42% (n = 41/48)
	Specificity	67.35% (n = 66/98)
	PPV	51.4%
	NPV	91.9%
PCL – 5	ROC curve (95% CI)	.802 (0.728, 0.863)
(≥16)	Sensitivity	77.08% (n = 37/48)
	Specificity	77.05% (n = 74/98)
	PPV	58.1%
	NPV	89.3%
Combined Risk Group	ROC curve (95% CI)	.773 (0.696, 0.838)
(Both ITSS and PCL-5 risk positive)	Sensitivity	72.92% (n = 35/48)
	Specificity	81.63% (n = 80/98)
	PPV	61.6%
	NPV	88.2%

With regard to depression, 22% percent (n = 40/178) of the sample was positive for depression and the ITSS depression scale yielded a sensitivity of 72.50%, specificity 70.29%, NPV 91.1% and PPV 37.9% (AUC = .714, 95% CI = 0.642, 0.779). Of those with PTSD (n = 59) in the full sample 55% (n = 33) had comorbid depression.

Conclusion: The 9-item ITSS, which takes approximately 5 minutes to administer, is a stable screening tool for predicting those most at risk for PTSD and/or depression. The combined risk group data provide evidence that symptom evaluation by a psychologist would improve specificity in identifying those likely to develop posttraumatic psychological distress. These results help to further inform the recommendation of the American College of Surgeons Committee on Trauma regarding PTSD and depression screening in trauma centers.

Session: XIV: Papers 65-67: Sunrise Session
Paper 65: 8:00-9:20 am

VARIABILITY IN MANAGEMENT OF BLUNT LIVER TRAUMA AND CONTRIBUTION OF LEVEL OF ACS-COT VERIFICATION STATUS ON MORTALITY

Christopher J. Tignanelli MD, Bellal Joseph* MD, Jill L. Jakubus PA-C, MHSA, MS, Gaby A. Iskander* MD, MS, Brian C. George MD, MAEd, Mark R. Hemmila* MD, University of Michigan

Invited Discussant: Rajesh Gandhi, MD, PhD

Introduction: Patients who sustain blunt liver trauma and are treated at an ACS-COT verified Level 1 trauma center have an overall lower risk of mortality compared with patients admitted to a Level 2 trauma center. However, studies comparing outcomes for Level 1 and 2 trauma centers have failed to identify specific elements contributing to these differences. We hypothesize that clinical practice variation exists between Level 1 and 2 trauma centers in management of blunt liver injury. Our objective in this study is to identify practice variations and their effect on clinical outcomes.

Methods: Data from a state-wide collaborative quality initiative for trauma was utilized. The dataset contains information from 29 ACS-COT verified Level 1 and 2 trauma centers from 2011 to 2016. Inclusion criteria were: adult patients (≥16 years), ISS ≥ 5, blunt mechanism of injury, and evidence of AIS grade 3 or higher liver injury. Patients directly admitted, transferred out for definitive care, missing data, or with no signs of life were excluded. Propensity score matching was used to create cohorts of patients treated at Level 1 or 2 trauma centers. The 1:1 matched cohorts were used to compare in-hospital mortality, management strategy, complications, ICU and hospital LOS, failure to rescue, and differences in admitting patterns.

Results: 454 patients were included in the analysis (227 Level 1 cohort and 227 Level 2 cohort). After propensity matching, no significant baseline characteristic differences were noted between groups Patients treated at Level 2 trauma centers had higher in-hospital mortality than those treated at Level 1 trauma centers. Level 2 trauma centers utilized angiography for patients with grade 3 liver injuries less compared with Level 1 centers and admitted significantly fewer patients with a grade 3 or above liver injury to the ICU. ICU admission status was associated with reduced mortality. Despite a lower rate of overall complications, Level 2 trauma centers were more likely to fail to rescue their patients. Patients treated at Level 1 trauma centers were more likely to develop pneumonia and ARDS. No significant differences were noted in other complications or hospital length of stay.

Outcome	Level 1 Trauma Center	Level 2 Trauma Center	p-value
Mortality, % (n)	8.8 (20)	15.4 (35)	0.03
Complication, % (n)	22 (51)	15 (35)	0.055
Failure to rescue, % (n)	16 (8)	34 (12)	0.045
ARDS, % (n)	2 (4)	0 (0)	0.045
Pneumonia, % (n)	11 (25)	4 (9)	0.004
Process	**Level 1 Trauma Center**	**Level 2 Trauma Center**	**p-value**
First Treatment, % (n)			
Non-operative	77 (174)	79 (179)	0.007
Angiography	12 (28)	5 (11)	
Operative	11 (25)	16 (37)	
ICU admission, % (n)	77 (175)	64 (145)	0.002
ICU LOS, mean ± SD	7.2 ± 9.5	5.2 ± 7.8	0.03
Hospital LOS, mean ± SD	9.2 ± 10.1	8.3 ± 9.2	0.3

Conclusions: Admission with an AIS grade 3 or higher liver injury to a Level 2 trauma center is associated with increased in-hospital mortality. Level 2 trauma centers were less likely to utilize angiography or admit high grade liver injuries to the ICU. This variation in practice may lead to the inability to rescue critically ill patients when a complication develops. Future research should investigate contributors to underutilization of resources for patients with high grade liver injuries.

Session: XIV: Papers 65-67: Sunrise Session
Paper 66: 8:20-8:40 am

DECREASED MORTALITY, LAPAROTOMY AND EMBOLIZATION RATES FOR LIVER INJURIES, WITH 70% NOM OF GRADE 4&5 INJURIES

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Invited Discussant: Mayur Narayan, MD, MPH, MBA

Introduction: Although the management of liver injuries is based on physiology with NOM as the treatment of choice in hemodynamically normal patients, the optimal management of OIS grade 4&5 injuries is still being discussed. From 2002, we formalized a treatment protocol including mandatory angiography for OIS grades 3-5. Based on published results from this period, angiography has been performed only when signs of bleeding since 2009. Simultaneously, our resuscitation strategy was updated. We hypothesized that these changes would result in a further decreased laparotomy rate and need for AE, as well as increased survival.

Methods: All adult patients with liver injuries admitted during 2002-2014 were analyzed retrospectively based on data from the institutional Trauma Registry and patient charts. The cohort was divided in two consecutive periods 2002-2008 (P1) and 2009-2014 (P2). The total study population, and subgroups of transfused patients and patients with OIS grade 4&5 liver injuries, underwent analyses for trends and differences between P1 and P2.

Results: 583 patients were included (P1:237, P2:346), median ISS 29. The groups were comparable for age, gender, MOI, injury severity and physiology, both the total population and subgroups. The overall laparotomy, angiography and AE rates decreased from P1 to P2; 35% to 24%; $p<0.01$, 31% to 9 %; $p<0.01$, and 11% to 5%; $p<0.01$, respectively. The NOM failure rate was 1% in both periods. Simultaneously, a reduction in 30-day crude mortality was observed (14% to 7%; $p=0.02$), with a concomitant decrease in hemorrhage related deaths (8% to 3%; $p<0.01$). A multivariate logistic regression model identified age, BD, ISS and laparotomy as independent predictors of mortality with an OR of 3.8 (CI 1.84-8.00) for dying if laparotomy was required, and a 64% reduced adjusted risk of death in P2 ($p<0.01$). In the subgroup with OIS grade 4&5 injuries [n=149 (26%), median ISS 34], a similar reduction in angiography and AE rate was seen (68% to 22%; $p<0.01$ and 30% to 12%; $p<0.01$). In both periods 70% of grades 4&5 injuries underwent NOM, with overall 98% success rate and 2% mortality. The 30% requiring surgery were critically ill (median BD 15, ISS 43), and the mortality remained high (P1 52%; P2 40%). Analysis of the subgroup transfused ≥5 RBCs confirmed a more balanced transfusion strategy and fewer hemorrhagic deaths in P2 (29% to 13%, $p=0.04$).

Conclusion: Changes in resuscitation and treatment protocols were associated with decreased laparotomy, angiography and AE rates, as well as overall and hemorrhage related mortality. NOM is safe in 70% of patients with grade 4&5 injuries, with low failure rates and mortality, in contrast to the critically ill 30% requiring surgery who still have poor outcome.

Session: XIV: Papers 65-67: Sunrise Session
Paper 67: 8:40-9:00 am

CONTEMPORARY MANAGEMENT OF RECTAL INJURIES AT LEVEL I TRAUMA CENTERS: THE RESULTS OF A AAST MULTI-INSTITUTIONAL STUDY

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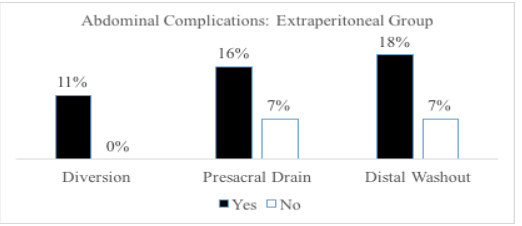
Invited Discussant: Timothy Fabian, MD

Introduction: Traumatic injuries to the rectum are uncommon. Limited published data exist to drive decision-making while caring for patients with these complex injuries. Rectal injuries have been historically treated with a combination of modalities including direct repair, resection, proximal diversion, presacral drainage, and distal rectal washout. We hypothesized that rectal injuries may be selectively managed without diversion and the addition of distal rectal washout and pre-sacral drainage are not beneficial.

Methods: AAST multi-institutional retrospective study from 2004-2015 of all patients who sustained a traumatic rectal injury and were admitted to one of the 22 participating centers. Demographics, mechanism, location and grade of injury, and management of rectal injury were collected. The primary outcome was abdominal complications
(abdominal abscess, pelvic abscess, and fascial dehiscence).

	Direct Repair/Resection	Diversion	Drain	Distal Washout
Entire population	61%	72%	16%	14%
Intraperitoneal	83%	71%	7%	9%
Extraperitoneal	44%	76%	22%	17%

Results: There were 812 patients in the cohort, mean age was 33 years old, 86% were male, and 72% sustained penetrating trauma. Rectal injury was intraperitoneal in 41%, extraperitoneal in 58%, and ~~not documented~~ in 1%. Rectal injury severity included the following grades I: 28%, II: 41%, III: 13%, IV: 12%, and V: 5%. In order to eliminate confounding variables contributing to early mortality, we examined the 785 patients who survived > 48 hours with univariate and multivariate analysis. Patients with intraperitoneal injury managed with a proximal diversion developed more abdominal complications (23% vs. 9%, p=0.003), but independent risk factors [adjusted odds ratio (95% confidence interval), p-value] for abdominal complications included high grade injury [2.6 (1.2-5.1), p=0.006] and penetrating mechanism [2.7 (1.1-6.7), p=0.04]. Among patients with extraperitoneal injuries there were more abdominal complications in patients who received proximal diversion (p=0.0002), presacral drain (p=0.004), or distal rectal washout (p=0.002). After multivariate analysis, distal rectal washout [3.4 (1.4-8.5), p=0.008] and presacral drain [2.6 (1.1-6.1), p=0.02] were independent risk factors to develop abdominal complications.



Conclusion: Traumatic rectal injury is uncommon and usually occurs after penetrating trauma. Most injuries are extraperitoneal and lower grade. The majority of patients undergo direct repair/resection as well as diversion, though diversion is not associated with improved outcomes. While some patients still receive a presacral drain and/or distal rectal washout, these additional maneuvers are independently associated with an increase in abdominal complications and should not be routinely included in the treatment of rectal injuries.