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

MULTICENTER EXTERNAL VALIDATION OF THE GERIATRIC TRAUMA OUTCOME SCORE: THE PROGNOSTIC ASSESSMENT OF LIFE AND LIMITATIONS AFTER TRAUMA IN THE ELDERLY [PALLIATE] STUDY

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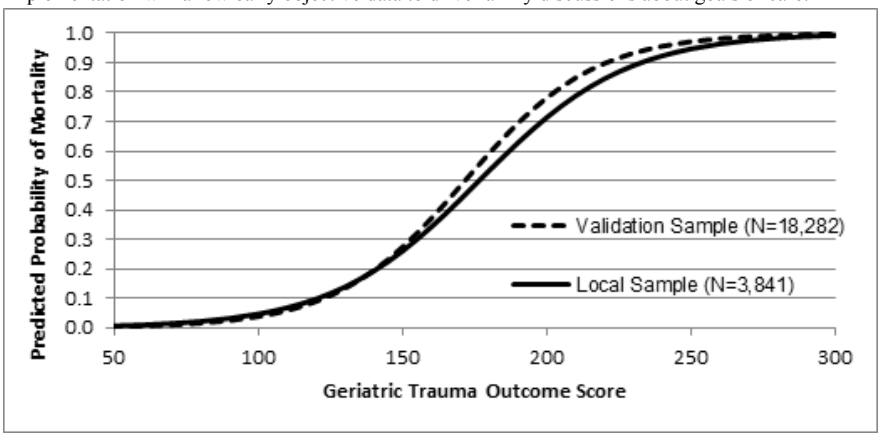
Invited Discussant: Steven Shackford, MD

Introduction: Our core group has previously developed a prognostic tool for geriatric mortality during the index admission after injury. Easily calculated at bedside 24 hrs post-injury, the "Geriatric Trauma Outcome" (GTO) score is GTO=[age] + [ISS x 2.5] + [22 if transfused any PRBCs]. We sought to externally validate the locally-developed model with a large multicenter dataset.
Methods: Four geographically diverse level I trauma centers identified all subjects ≥65 years of age for the time period of the local study (1/1/2000 to 12/31/2013). Age, ISS, PRBCs transfused in the first 24 hours (if any), and mortality were extracted. The GTO model was specified using the formula [GTO= age + (ISS x 2.5) + 22(if given PRBC)] previously developed from the local sample. We then constructed a GTO model that became the sole predictor in a logistic mixed model to estimate the probability of mortality in the validation (test) sample, accounting for site as a random effect as to remove between-site variability. We estimated the misclassification (error) rate, Brier score, Tjur R-square (difference of the predicted probabilities of the two response levels), and AUC in evaluating the predictive performance of the locally-generated GTO model as a predictor of patient mortality in the validation sample in relation to the local sample.
Results: The two independent samples were similar in patient age and clinical characteristics. The local sample consisted of 3,841 subjects, mean age=76.55 yrs (SD±8.06), mean ISS=12.42 (SD±9.87); in-hospital mortality=10.75%; and 11.90% received a PRBC transfusion in the first 24 hrs. The validation (test) sample consisted of 18,282 subjects, mean age=77.01 years (SD±8.14), mean ISS=12.31 (SD±10.64), in-hospital mortality=10.86%, and 14.10% received a PRBC transfusion in the first 24 hrs. Fitting the locally-generated GTO model to the validation sample revealed that the parameter estimates from the validation sample were similar to those of the locally-generated GTO model with highly overlapping 95% confidence limits. Plots of the predicted probability of mortality by GTO score for both samples are shown in the figure. The error rate for the locally-generated GTO logistic model applied to the validation sample was 9.97% and was similar to the error rate of the fitted locally-generated GTO logistic model (9.79%). The Brier score, R-square, and AUC for the locally-generated GTO logistic model applied to the validation sample were 0.0737, 0.2495, and 0.8621, respectively, compared with 0.0775, 0.1998, and 0.8193, respectively, for the fitted locally-generated GTO logistic model from the local sample.

Conclusion:The GTO score accurately predicts probability of dying for injured elderly subjects. Implementation will allow early objective data to drive family discussions about goals of care.



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

INTRAOPERATIVE HYPOTENSIVE RESUSCITATION FOR PATIENTS UNDERGOING LAPAROTOMY OR THORACOTOMY FOR TRAUMA: EARLY TERMINATION OF A RANDOMIZED PROSPECTIVE CLINICAL TRIAL

Matthew M. Carrick* MD, C. A. Morrison MD, James W. Suliburk MD, Michael A. Norman MD, Bradford G. Scott MD, Matthew J. Wall* MD, Kenneth L. Mattox* MD, Baylor College of Medicine

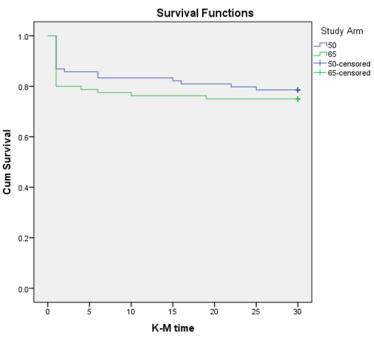
Invited Discussant: Raul Coimbra, MD, PhD

Introduction: Hemorrhagic shock is directly responsible for one-third of trauma related deaths. To date, there have been no studies evaluating intra-operative resuscitation goals for trauma patients in hemorrhagic shock. We hypothesized that intraoperative hypotensive resuscitation would improve survival for patients undergoing operative control of hemorrhage following penetrating trauma.

Methods: Penetrating trauma patients with a systolic blood pressure (SBP) less than or equal to 90 mm Hg were candidates for enrollment. Patients that required laparotomy or thoracotomy for operative control of hemorrhage were randomized to either an experimental group with a target minimum mean arterial pressure of 50 mm Hg (LMAP), or a control group of of 65 mm Hg (HMAP). Patients were followed for 30 days post-operatively for mortality as a primary outcome. Secondary outcomes included stroke, myocardial infarction, acute renal failure, coagulopathy, and infections complications.

Results: A total of 168 patients were enrolled, 86 in the LMAP group and 82 in the HMAP group. Seventy-six percent were the result of gunshot wounds and 24% stab wounds; 76% were male and, the mean age was 31. Baseline base excess (-11.1 mEq/L), hematocrit, systolic blood pressure, ISS, GCS, and AIS were similar between the two groups. MAP measurements intra-operatively were 65.5 $\pm$ 11.6 in the LMAP group and 69.1 $\pm$ 13.8 p=0.06 in the HMAP group. While the LMAP group had a statistically significant lower mortlity for those patients that survived to the ICU (2% for LMAP vs 12% HMAP p=0.013), there was no significant survival advantage at 30 days (Mantel-Cox Survival Chi-Square=0.33, df=1, Sig. 0.564) **(Figure)**. There was no significant difference in secondary outcomes.

The LMAP and HMAP complication rates were acute MI (3% vs 2% p=0.67), stroke (0% vs 3% p=0.15), renal failure (16% vs 13% p=0.67), coagulopathy (31% vs 37% p=0.45), and infections (60% vs 58%, p=0.82). The Data Safety Monitoring Board recommended early termination due to the unlikelihood of reaching a statistically significant difference in 30 day mortality by the end of enrollment.



Conclusion: Based upon these results, hypotensive resuscitation is a safe technique that does not increase end organ damage, infectious complications or coagulopathy. This study however, was unable to demonstrate that hypotensive resuscitation to an LMAP of 55 mmHg could significantly improve the primary outcome of 30 day mortality. While hypotensive resuscitation is potentially ameliorates the effects of life threatening hemorrhage, further study is necessary for the benefits of this strategy to be fully realized.

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

IS THERE AN IMPENDING LOSS OF ACADEMICALLY PRODUCTIVE TRAUMA SURGEONS?

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Indiana University School Of Medicine, Department Of Surgery

Invited Discussant: James Hoth, MD, PhD

Introduction: The objective of this study is to compare the academic impact of trauma surgery faculty relative to faculty in general surgery and other surgery sub-specialties.

Methods: Scholarly metrics were determined for 3,850 faculty at the top 50 NIH-funded university-based and 5 hospital-based surgery departments

Results: **Results:** Overall, 317 trauma surgeons were identified (8.2%). This compared to 703 other general surgeons (18.2%) and 2830 other sub-specialty surgeons (73.5%). The average size of the trauma surgical division was 6 surgeons. Overall, 43% were assistant, 29% associate, 28% full professors, 3.1% had PhD's, 2.5% were MD, PhD's, and, 16.3% were division chiefs/directors. Compared with general surgery, there were no differences regarding faculty academic levels or leadership positions. Other surgical specialties had more full professors (39% vs. 28% $p < 0.05$) and faculty with research degrees (7.7% PhDs and 5.7% MD, PhDs). Median publications/citations were lower especially for junior faculty trauma surgeons (T) compared with general surgery (G) and other (O) surgical specialties- assistant professors (T: 9/76 vs. G: 13/138 and O: 18/241, $p < 0.05$), associate professors (T: 22/351 vs. G: 36/700 and O: 47/846, $p < 0.05$) and professors (T: 88/2234 vs. G: 93/2193, p = N.S [not significant for either publications/citations] and O: 99/2425, p = N.S). Publications/citations for division chiefs/directors were comparable with other specialties- T: 77/1595 vs. G: 103/2081 and O: 74/1738, p = N.S, but were lower for all non-chief faculty, T: 23/368 vs. G: 30/528 and O: 37/658, $p < 0.05$. Trauma surgeons were less likely to have current or former NIH funding than other surgical specialties (17 % vs. 27%, $p < 0.05$) and this included a lower rate of R01/U01/P01 funding (5.5% vs. 10.8%, $p < 0.05$).

Conclusion: Top trauma surgeons are as academically productive as other general surgeons and other surgical specialists. Junior trauma faculty, however, publish at a lower rate than other general surgery or sub-specialty faculty. This suggests an incipient contraction of academic achievement within trauma surgery and its impact across surgery. Drivers responsible for decreased academic productivity and lower NIH funding must be identified, understood and addressed.

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

CURRENT MANAGEMENT OF HEMORRHAGE FROM SEVERE PELVIC FRACTURES: RESULTS OF AN AMERICAN ASSOCIATION FOR THE SURGERY OF TRAUMA MULTI-INSTITUTIONAL TRIAL

Todd W. Costantini MD, Raul Coimbra* MD,Ph.D., John Holcomb* MD, Richard Catalano MD, Thomas M. Scalea* MD, Lashonda Williams MD, Scott Keeney DO, Jason Sperry* MD, Dimitra Skiada MD, Brian H. Williams MD, Alicia Privette MD, Forrest Moore* MD, Pelvic Fracture Study Group, AAST Multi-Institutional Trials Committee

Invited Discussant: Walter Biffl, MD

Introduction: There is no consensus as to the optimal treatment paradigm for patients presenting with hemorrhage from severe pelvic fracture. This study was established to determine the methods of hemorrhage control currently being employed in clinical practice.

Methods: This prospective, observational multi-center study enrolled patients with pelvic fracture from blunt trauma. Demographic data, admission vital signs, presence of shock on admission (SBP < 90mmHg or HR>120 or base deficit < -5), method of hemorrhage control, time to hemorrhage control, transfusion requirements, and outcome were collected.

Results: A total of 1339 patients with pelvic fracture were enrolled from eleven Level 1 trauma centers. 57% were male with a mean age of 47.1 ± 21.6 and ISS of 19.2 ± 12.7. In-hospital mortality was 9%. Angioembolization and external fixator placement were the most common methods of hemorrhage control utilized (see Table). 128 patients (9.6%) underwent diagnostic angiography with contrast extravasation noted in 63 patients. Therapeutic angioembolization was performed on 79 patients (5.9%). There were 178 patients (13.3%) with pelvic fracture admitted in shock with a mean ISS of 28.2 ± 14.1. In the shock group, 44 patients (24.7%) underwent angiography to diagnose a pelvic source of bleeding with contrast extravasation found in 27 patients. 30 patients (16.9%) were treated with therapeutic angioembolization. Aortic balloon occlusion (REBOA) was performed on 5 patients in shock and utilized by only 1 of the participating centers. Patients admitted in shock received an average of 11.8 ± 12.8 units of PRBCs and 10.3 ± 12.5 units of FFP. Mortality was 32% for patients with pelvic fracture admitted in shock.

Table: Pelvic Fracture Hemorrhage Control

	All Patients (n=1339)	Shock (n=178)
Angioembolization Alone	55 (4.1%)	19 (10.7%)
External Fixator Alone	78 (5.8%)	17 (9.6%)
Preperitoneal Pelvic Packing Alone	20 (1.5%)	6 (3.4%)
Embolization + External Fixator	11 (0.8%)	6 (3.4%)
Embolization + Pelvic Packing	6 (0.4%)	2 (1.1%)
External Fixator + Pelvic Packing	3 (0.2%)	1 (0.6%)
Embolization + External Fixator + Pelvic Packing	5 (0.4%)	1 (0.6%)
REBOA +/- any other	5 (0.4%)	5 (2.8%)

Conclusion: Patients with pelvic fracture admitted in shock have high mortality. Several methods were utilized for hemorrhage control with significant variation across institutions. The use of REBOA may prove to be an important adjunct in the treatment of patients with severe pelvic fracture in shock; however, it is in the early stages of evaluation and not currently used widely across trauma centers.

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

TO NEARLY COME FULL CIRCLE: NONOPERATIVE MANAGEMENT OF HIGH GRADE IV-V BLUNT SPLENIC TRAUMA IS SAFE UTILIZING A PROTOCOL WITH ROUTINE ANGIOEMBOLIZATION OF ALL HEMODYNAMICALLY STABLE PATIENTS WITH HIGH GRADE IV-V INJURIES AND ALL PATIENTS WITH CONTRAST BLUSH

Indermeet Bhullar* MD, Daniel Siragusa MD, Todd Loper MD, Andrew Kerwin* MD, Eric Frykberg* MD, Orlando Health

Invited Discussant: Martin Croce, MD

Introduction: Non-operative management of hemodynamically stable high grade (IV-V) blunt splenic trauma injuries remains controversial given the high failure rates that persist despite angioembolization (AE) protocols. Contrast blush (CB) on admission computed tomography (CT) is the primary indicator for active bleeding and AE. However, CT scans can often miss CB; we have recently reported a false negative rate of 85% (17 of 20) for grade IV-V injuries that had no CB on CT but when angiography was performed demonstrated active bleeding. This may explain the high failure rates amongst these patients that are actively bleeding yet fail to get embolized due to a false negative CT. Based on this, the non-operative management (NOM) protocol for hemodynamically stable patients with blunt splenic trauma (BST) was modified in 2011 to include routine AE of high grade (IV-V) injuries along with CB Routine AE for grade III was excluded since our analysis indicated that this would result in a very low number of patients with active bleeding and a significant number of unnecessary angiograms. Patients were then followed prospectively from 2011 to 2014. The failure rates for the new protocol (2011-2014) were compared against the older protocol (2000-2010). The purpose of this study was to determine if the new AE protocol significantly lowered the failure rates for high grade injuries (IV-V) allowing for safe observation without surgery and if the exclusion of grade III injuries allowed for the prevention of unnecessary angiograms without affecting the overall failure rates.

Methods: The records of patients with BST from January 2000 to October 2014 at a Level I trauma center were retrospectively reviewed. Patients were divided into two groups based on the AE protocol utilized and failure rates of non-operative management (FNOM) were compared: Routine AE (RAE) protocol (2011-2014) with AE for all high grade (IV-V) injuries and all injuries with CB (grade I-V) was compared against the Selective AE (SAE) protocol (2000-2010) that only utilized AE for injuries with CB (grade I-V). The overall failure rates for grade (I-V) as well as the failure for low grade (I-III) and high grade (IV-V) injuries were compared for the two groups. Statistical analysis was performed with Fisher's exact test, and $\chi 2$ test.

Results: A total of 712 hemodynamically stable adult patients with BST underwent NOM from 2000 to 2014. Of these 522 (73%) were in the SAE group and 190 (27%) were in the RAE group. Evolving from the SAE to the RAE strategy resulted in a significantly lower overall FNOM rate (grade I-V) (SAE vs. RAE, 4.4% to 1.1%, p=0.037) (Table 1). While there was no significant decrease in FNOM for the low grade (I-III) group (SAE vs. RAE, 2% vs. 0%, p=0.21), there was a significantly lower FNOM rate for the high grade (IV-V) group with the RAE strategy (SAE vs. RAE, 19.2% vs. 2.9%, p=0.008). The FNOM rate for the Grade III injuries was 0% (0/33) supporting their exclusion from the routine AE protocol. This allowed for the prevention of 33 unnecessary angiograms without affecting the overall FNOM rate (1.1%).

Conclusion: Previously prohibitive failure rates limited NOM of high grade IV-V injuries. However, with the new routine AE protocol these failure rates were significant reduced (19% to 2%, p=0.008) to levels that allow for safe observation without surgery. Unnecessary AE (grade I-III without CB) was limited and one of the lowest overall (grade I-V) FNOM rates reported in the literature (1%) was achieved.

Failure Rate of Non-operative Management Based on Angio-embolization Protocol Utilized

GRADE	SAE (2000-2010) % (n)	RAE (2011-2014) % (n)	p
Low (I-III)	2% (8/444)	0% (0/122)	0.21
High (IV-V)	19% (15/78)	3% (2/68)	0.008
Total	4% (23/522)	1% (2/190)	0.04

Table 1. SAE: selective angioembolization protocol; RAE: routine angioembooliza1ton protocol

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

THE HMGB1 SIGNAL PATHWAY IN SEVERE TBI; MECHANISM FOR REDUCED CEREBRAL EDEMA AND IMPROVED OUTCOME AFTER HEPARINOID ADMINISTRATION?

SHENGJIE LI MD, Rachel Eisenstadt BS, Kenichiro Kumasaka MD, Victoria E. Johnson MD, MBChB, Joshua Marks MD, Katsuhiro Nagata MD, Kevin D. Browne BS, Douglas H. Smith MD, Jose L. Pascual* MD,Ph.D., University of Pennsylvania

Invited Discussant: Ronald Maier, MD

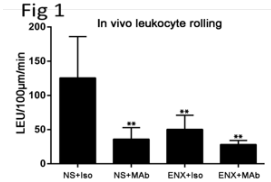
Introduction: Heparins have been shown to reduce cerebral edema and improve neurological recovery in stroke and traumatic brain injury (TBI), in part through blunting of cerebral leukocyte (LEU) recruitment. High mobility group box 1 (HMGB1) protein, an extracellular chemoattractant is known to induce neuroinflammation through blocking of LEU adhesion molecules. We hypothesized that enoxaparin (ENX) after TBI reduces leukocyte mediated edema through the HMGB1 signal pathway.

Methods: 23 CD1 male mice underwent severe TBI by controlled cortical impact (CCI: 1mm depth, 6m/sec) and were randomly assigned to receive either monoclonal antibody against HMGB1 (MAb) or its isotype (Iso) and either ENX (1mg/kg) or 0.9% normal saline (NS). The 4 groups were: NS+Iso (n=5), NS+MAb (n=6), ENX+Iso (n=6), ENX+MAb (n=6). ENX or NS were repeatedly administered at 2, 8, 14, 23 & 32h after TBI and MAb or Iso (25μg) was administered once, 2h after TBI. At 48h, cerebral intravital microscopy was used to visualize LEU interacting with endothelium and microvascular leakage of FITC-albumin. The Neurological Severity Score (NSS) was used to assess post-injury neurological recovery, wet-to-dry ratios determined cerebral and lung edema. ANOVA with Bonferroni correction was used for statistical comparisons.

Results: ENX and MAb similarly reduced in vivo LEU rolling in the injured hemisphere without displaying an additive effect (Fig 1). In vivo albumin leakage was greatest in vehicle-treated animals (35.4±4.3%) and similarly reduced by MAb (23.8±3.6%, $p<0.01$), ENX (23.1±1%, $p<0.01$), or both MAb+ENX (15.3±4.5%, $p<0.01$). CCI-induced ipsilateral cerebral edema (81.7±1.4%) was reduced by MAb (78.2±0.3%, $p<0.01$), ENX (77.9±0.5%, $p<0.01$), and MAb+ENX (77.2±0.3%, $p<0.01$). Post injury lung water (77.2±0.7%), was reduced by ENX (75.2±1.1%, $p=0.04$) and ENX+MAb (75.2%±1.2%, $p=0.03$) but not MAb alone (76.2±1.0%, $p=0.78$). Neurological recovery 24 and 48 hours after injury was lowest in the vehicle-treated group as compared to any of the treated groups without an additive effect between ENX and MAb (Fig 2)

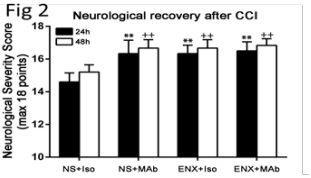
Conclusions: ENX reduces LEU recruitment to injured brain, diminishing cerebrovascular permeability and brain edema. ENX also hastens neurological recovery. Monoclonal antibody blockade against the chemoattractant HMGB1 produces equivalent reductions in LEU recruitment, cerebral edema and neurological activity that is not augmented with addition of ENX. ENX may cause these effects through blocking of the HMGB1 pathway of leukocyte activation.

Fig 1



**p<0.01 vs NS+Iso

Fig 2



24h: **p<0.01 vs NS+Iso; 48h: ++p<0.01 vs NS+Iso;

Session: I: Plenary Papers 1-8
Paper 7: 3:30-3:20

WHEN SPEED IS NOT A VIRTUE: THE IMPACT OF SHORT PRE-HOSPITAL TIMES ON TRAUMA CENTER PERFORMANCE BENCHMARKING

James P. Byrne* MD, N. Clay Mann Ph.D., Christopher J. Hoeft MA, John P. Hunt* MD,MPH, Avery B. Nathens* MD,Ph.D., Sunnybrook Health Science Centre

Invited Discussant: William Cioffi, MD

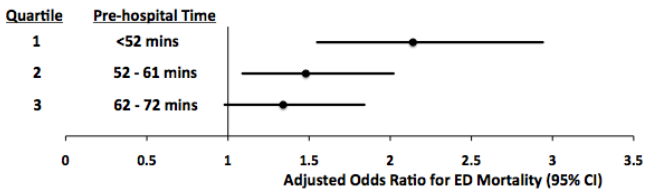
Introduction: External benchmarking of trauma center (TC) performance has become a requirement for verification by the American College of Surgeons (ACS) and is critical to improving quality of care. TCs function within a broader system, yet the impact of system-level factors on TC performance is unknown. Emergency medical service (EMS) performance, an important system factor, might affect the risk profile of patients arriving at TCs, and therefore impact center-level outcomes. Rapid transport by high performing EMS might favorably affect outcomes. Alternatively, rapid transport may result in arrival of more unsalvageable patients to the ED alive, when little can be done to modify their outcomes. To better inform TC performance benchmarking, we set out to explore the impact of EMS pre-hospital time, an important measure of EMS performance, on the rate of ED deaths at TCs across the United States.

Methods: We used a novel ecological study design, linking EMS data from the National EMS Information System (NEMSIS) to TCs participating in the ACS Trauma Quality Improvement Program (TQIP) by destination zip code. This approach provided regional pre-hospital times for populations of injured patients transported to TQIP centers. Total pre-hospital time (PHT), defined as the 90 th percentile EMS time (a standard EMS metric), was assigned to each TC as a new hospital-level variable. TCs were stratified by the overall median PHT into short EMS (SEMS) and long EMS (LEMS) time groups. Analyses were limited to patients aged ≥16 years with blunt or penetrating injury transported directly by land to urban TQIP centers. Hierarchical logistic regression modeling was used to determine the association of PHT with ED death after adjusting for baseline patient characteristics and injury severity.

Results: We identified 87,130 patients meeting inclusion criteria admitted to 100 urban TCs. Across all centers, the median PHT was 61 min and ED mortality was 1.1%. Patients transported to SEMS TCs had similar baseline and injury characteristics to those transported to LEMS TCs. However, centers with SEMS had significantly greater risk-adjusted ED mortality than centers with LEMS [OR 1.5, 95% CI: 1.2–1.9], a finding consistent across blunt [OR 1.6, 95% CI: 1.2–2.1] and penetrating [OR 1.5, 95% CI: 1.0–2.2] trauma. TCs in the quartile of shortest EMS times (<52 mins) had the highest risk adjusted ED mortality [OR 2.1, 95% CI: 1.6–2.9] compared to those within the longest quartile (Figure 1).

Conclusion: Regional EMS pre-hospital times affect the risk profile of patients transported to TCs in ways not captured in conventional risk adjustment. Performance benchmarking programs will need to incorporate measures of EMS performance in future evaluation of risk-adjusted mortality.

FIGURE 1: ADJUSTED ODDS RATIO OF ED DEATH BY PRE-HOSPITAL TIME QUARTILE



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

MULTICENTER VALIDATION OF AAST GRADING SYSTEM FOR ACUTE COLONIC DIVERTICULITS AND PROPOSAL FOR EMERGENCY GENERAL SURGERY QUALITY IMPROVEMENT PROGRAM (EQIP)

Shahid Shafi* MD,MPH, Christopher S. Klekar MBA,MPH, Michel Aboutanos* MD,MPH, Suresh Agarwal* MD, Marie L. Crandall* MD,MPH, Oscar Guillamondegui* MD,MPH, Oliver Gunter* MD, Nathan T. Mowery* MD, Raminder Nirula* MD, Steven E. Ross* MD, Stephanie A. Savage* MD, MS, Kevin M. Schuster* MD, Stefano Siboni MD, Marc D. Trust MD, Garth H. Utter* MD, AAST Patient Assessment Committee

Invited Discussant: Andrew Peitzman, MD

Introduction: AAST has developed a new grading system for uniform description of anatomic severity of Emergency General Surgery (EGS) diseases, ranging from Grade I (mild disease) to Grade V (severe disease). The purpose of this study was to determine the association between AAST grades for Acute Colonic Diverticulitis and patient outcomes. A secondary aim was to assess the feasibility of EGS Quality Improvement Program (EQIP) using risk-adjusted center outcomes, similar to NSQIP and TQIP methodology.

Methods: This is a retrospective study of 1105 patients (one death) from 13 centers. At each center, two reviewers assigned AAST grades, blinded to the other reviewer's assignment. Inter-rater reliability was measured using kappa coefficient. Adverse patient outcome was defined as any of the following: death, complications, intensive care unit use, surgical intervention, or 30-day readmission. Relationship between grade and adverse outcomes was measured using multivariate logistic regression to control for age, comorbidities, and physiologic status at the time of admission. Final model was used to calculate Observed-to-Expected ratios (O-E, 95% confidence intervals) for adverse outcomes for each center.

Results: Median age was 54 years, 52% males, 43% minorities, and 22% required a surgical intervention. Almost two-thirds had Grade I or II disease (Table). There was high level of agreement for grades between reviewers (kappa 0.81). Regression analysis showed that higher disease grades were associated with increasing odds of adverse outcomes, after adjusting for age, comorbidities, and physiology (Table). O-E ratios showed one center with significantly higher than expected adverse outcomes and one center with significantly fewer than expected adverse outcomes.

Grade	N (%)	Adverse Outcomes	Odds Ratio (95% CI)
I	288 (26%)	52 (18%)	Reference Group
II	412 (37%)	122 (30%)	1.8 (1.1 to 2.8)
III	258 (23%)	112 (43%)	4.1 (2.5 to 6.7)
IV	50 (5%)	34 (68%)	13.2 (5.5 to 32.1)
V	97 (9%)	87 (90%)	40.1 (14.5 to 110)

Conclusion: AAST grades for Acute Colonic Diverticulitis are independently associated with patient outcomes. EQIP methodology that incorporates AAST grade, age, comorbidities, and physiologic status may be used for measuring quality of EGS care at centers. This requires wide spread adoption of EGS registries with uniform data elements, including AAST grades.

Session: V: Acute Care Surgery Papers 9-13
Paper 9: 7:30-7:50

DERIVATION AND VALIDATION OF A NOVEL EMERGENCY SURGERY ACUITY SCORE (ESAS)

Naveen F. Sangji MD,MPH, Jordan D. Bohnen MBA,MD, Elie P. Ramly MD, Matthew M. Hutter MD,MPH, Daniel D. Yeh* MD, David R. King* MD, Marc DeMoya* MD, Kathryn Butler MD, Peter J. Fagenholz MD, George C. Velmahos* MD,Ph.D., David C. Chang MBA,MPH,Ph.D., Haytham M. Kaafarani MD,MPH, Massachusetts General Hospital

Invited Discussant: James Davis, MD

Introduction: There currently exists no pre-operative risk stratification system for Emergency Surgery (ES). We sought to develop an Emergency Surgery Acuity Score (ESAS) that predicts perioperative mortality in the ES patient. Such a score could prove useful for: 1) pre-operative patient counseling; 2) identification of patients needing close postoperative monitoring; and 3) risk-adjustment in any efforts at benchmarking the quality of ES.

Methods: Using the 2011 American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database, we identified all surgical procedures that were classified as "emergent". A three step methodology was then performed. First, multiple logistic regression models were created to identify independent predictors (e.g. patient demographics, co-morbidities, and pre-operative laboratory variables) of 30-day mortality in ES. Second, based on the relative impact of each identified predictor (i.e. Odds Ratio), using weighted averages, a novel score was derived. Third, using the 2012 ACS-NSQIP database, the score was validated with evaluation of its c-statistic and ability to predict mortality at 30 days.

Results: From 280,801 NSQIP cases, 18,439 ES cases were analyzed, of which 1,598 (8.7%) resulted in death at 30 days. The multiple logistic regression analyses identified 22 independent predictors of mortality. Based on the relative impact of these predictors, ESAS was derived with a total score range of 0-29. This score has a c-statistic of 0.86 for mortality. The observed probability of 30-day mortality increased from 0% at a score of 0 to 100% at a score of 22 [Figure 1]. In the validation phase, 18,146 patients were included, the mortality rate was 7.2% and the c-statistic of ESAS was unchanged at 0.86.

Conclusion: A novel score was developed and validated that accurately predicts mortality in ES patients, the Emergency Surgery Acuity Score- ESAS.

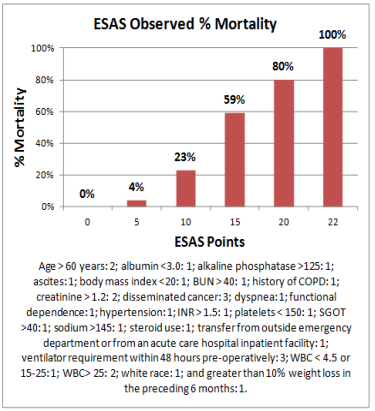


Figure 1: ESAS Variables, Points per Variable, and Observed Percentage Mortality.

Session: V: Acute Care Surgery Papers 9-13
Paper 10: 7:50-8:10

SEVERE COMPLICATED CLOSTRIDIUM DIFFICLE INFECTION: CAN THE UPMC PROPOSED SCORING SYSTEM PREDICT THE NEED FOR SURGERY?

Michelle C. Julien MD, Geisinger Health System

Invited Discussant: Brian Zuckerbraun, MD

Introduction: Clostridium difficile infection (CDI) is one of the most common health care associated infections and it continues to have significant morbidity and mortality. The onset of fulminant colitis often requires total abdominal colectomy (TAC) with ileostomy, which has a mortality rate of 35% to 57%. University of Pittsburgh Medical Center (UPMC) developed a scoring system for severity and recommended surgical consultation for severe complicated disease. The aim of this study is to evaluate if the UPMC proposed scoring system for severe complicated CDI can predict the need for surgical intervention.

Methods: This is a retrospective review of all patients who developed severe complicated CDI at a tertiary care center between January 2007 and December 2012 as defined by the UPMC scoring system. Main outcomes were the need for surgical intervention and 30-day mortality. Criteria for CDI severity was compared between groups using chi-square or Fisher's exact test for categorical data, two sample t-tests for continuous, Wilcoxon rank sum test if continuous data is found to violate normality assumptions. Logistic regression was used to adjust for variables that were found to be significant in bivariate analysis.

Results: Eighty-eight patients had severe complicated CDI. Fifty-nine patients (67%) required surgery and twenty-nine did not. All patients were diagnosed with CDI by positive toxin assays. There was no difference between the groups with respect to age, gender, BMI, or co-morbidities. When comparing the surgical group to the non-surgical cohort, the surgical cohort averaged 20 points on the scoring system compared to 9 in the non-operative cohort. In patients with severe complicated CDI, 14 or more points predicted the need for surgery 75% of the time. Forty-two percent of the surgical cohort had respiratory failure requiring mechanical ventilation compared to 0% in the non-surgical cohort ($p < 0.0001$). Forty-nine percent of the surgical cohort required vasopressors for septic shock prior to surgery compared to 0% in the non-surgical cohort ($p < 0.0001$). Acute kidney injury (AKI) was present in 92% of the surgical cohort versus 72% within the non-surgical cohort ($p = 0.026$). Seventy-six percent of the surgical patients were admitted to the ICU prior to surgery. Within the non-surgical cohort, only 24% of patients required ICU stay during admission. Overall 30 day mortality in the surgical cohort was 30% and there was no mortality in the non-surgical cohort.

Conclusion: The UPMC scoring system for severe complicated CDI can help us predict patients who need a surgical consult and the need for surgical intervention. In patients with severe complicated CDI, evidence of end organ failure predicts surgical intervention.

Session: V: Acute Care Surgery Papers 9-13
Paper 11: 8:10-8:30

RACIAL DISPARITIES IN EMERGENCY GENERAL SURGERY: DO DIFFERENCES IN OUTCOMESPERSIST AMONG UNIVERSALLY-INSURED MILITARY PATIENTS?

Cheryl K. Zogg MSPH, MHS, Wei Jiang MS, Muhammad Ali Chaudhry MD, Adil A. Shah MD, Stuart R. Lipsitz ScD, Joel S. Weissman Ph.D., Zara Cooper* MD, MSc, Ali Salim* MD, Stephanie L. Nitzschke MD, Louis L. Nguyen MBA,MD,MPH, Lorens A. Helmchen Ph.D., Linda Kimsey Ph.D., MSc, Samuel T. Olaiya Ph.D., Peter A. Learn MD, Adil H. Haider* MD,MPH, Center For Surgery And Public Health, Harvard Medical School & Harvard School Of Public Health, Department Of Surgery, Brigham And Women's Hospital

Invited Discussant: Orlando Kirton, MD

Introduction: Racial disparities in outcomes among emergency general surgery (EGS) patients are well described. As many minority patients are also uninsured, increasing access to care is thought to be a viable policy solution to mitigate these inequities. The objective of this study was to determine whether racial disparities in in-hospital, 30- and 90-day outcomes exist within a universally-insured population of military EGS patients.

Methods: Five years (2006-2010) of TRICARE (which provides universal insurance coverage to active/reserve/retired members of the US Armed Services and their dependents) data were queried. Adults (≥18y) with a primary EGS condition (as defined by AAST criteria) were included. Racial differences in demographic and clinical characteristics were compared using descriptive statistics. Risk-adjusted multilevel logistic regression, accounting for clustering of patients within hospitals was used to assess race-associated differences in in-hospital mortality and in mortality, major morbidity (pneumonia, PE, renal failure, UTI, CVA, MI, cardiac arrest, ARDS, sepsis, septic shock) and readmission rates at 30 and 90 days.

Results: Over the 5 years studied, 122,115 EGS patients were identified, of whom, 73.4% were White, 14.4% were Black, and 4.6% were of Asian/Pacific Islander (PI) descent. The largest population subgroups were active-duty (36.4%), males (55.5%), aged 45-64y (36.1%). Overall outcomes by race are presented (Table). Racial differences stratified by EGS diagnostic group, operative vs. non-operative technique, and direct (military hospitals) vs. purchased care (civilian hospitals) revealed similar trends.

Conclusion: Racial differences in surgical outcomes among universally-insured military EGS patients were largely not found; although, some disparities remain. This profound contrast with civilian data, will help to inform policy with the Department of Defense and disparities interventions nationwide, attesting to important differences potentially related to insurance, access to care, and military cultures and values.

Table 1. Risk-adjusted odds ratios (95% CI) for military EGS patients, by race

	Black	Asian/PI	Other
Mortality: In-hospital	1.23 [0.84-1.77]	1.92 [1.15-3.21]*	0.70 [0.37-1.34]
30-day	1.19 [0.96-1.47]	1.28 [0.92-1.78]	1.07 [0.81-1.41]
90-day	1.18 [1.00-1.40]	1.30 [1.01-1.68]*	1.05 [0.82-1.33]
Major Morbidity:			
30-day	1.31 [1.21-1.41]*	0.98 [0.85-1.11]	0.92 [0.82-1.03]
90-day	1.27 [1.17-1.36]*	0.94 [0.83-1.06]	0.88 [0.77-0.98]*
Readmission:			
30-day	0.96 [0.90-1.03]	0.83 [0.75-0.93]*	0.87 [0.80-0.95]*
90-day	0.95 [0.90-1.00]	0.76 [0.69-0.83]*	0.83 [0.78-0.90]*

Reference group = White patients; ***Denotes significance** (two-sided p<0.05)
Outcomes adjusted for: age; sex; active/dependent/retired; service; direct/purchased; Medicare eligibility; rank (a potential proxy of socio-economics); geographic region; Charlson Comorbidity Index (CCI); hospital-level factors

Session: V: Acute Care Surgery Papers 9-13
Paper 12: 8:30-8:50

SURGICAL STRATEGIES AND OUTCOMES IN PATIENTS REQUIRING BOWEL RESECTION IN NON-TRAUMA ABDOMINAL EMERGENCIES

Maria P. Garcia-Garcia MD, Michael W. Parra MD, Juan C. Puyana* MD, Alvaro I. Sanchez MD,Ph.D., Juan C. Saenz MD student, Monica Morales Statistician, Juan P. Herrera-Escobar MD, Alejandro Calle MD, David A. Mejia MD, Paola A. Rodriguez-Ossa MD, Luis F. Pino MD, Carlos A. Ordonez* MD, Fundacion Valle del Lili

Invited Discussant: Jason Smith, MD

Introduction: Selective use of bowel anastomosis in patients undergoing DCL is a recognized strategy for the management of bowel injuries in trauma patients. However, there is insufficient evidence regarding the role and timing of anastomosis in DCL in non-trauma secondary peritonitis (NTSP). We aim to determine outcomes and management options after bowel resection (BR) and DCL in NTSP.

Methods: A retrospective review of patients (≥16 years) with severe NTSP undergoing BR after enteric perforations was performed (2003-2013). All patients without BR were excluded. Patients were divided into two groups: DCL group and definitive surgical procedure (DSP) group. DCL patients underwent segmental BR (ends left in discontinuity), temporary abdominal closure and subsequent delayed anastomosis (DA) or deferred ostomy (DO). DSP included either primary anastomosis (PA) or primary ostomy (PO).

Results: A total of 182 patients were included, mean age was 60.3 years (SD 17.2), 101 (55.5%) were male. Small bowel perforation occurred in 77 (42.3%) patients and colon perforation in 105 (57.7%). Septic shock on admission was present in 68 (37.4%) patients. ARDS developed in 34 (18.7%) cases and MOF in 25 (13.7%). Overall mortality was 39 (21.4%).

	APACHE II Mean (SD)	Total LOS Mean (SD)	ICU LOS Mean (SD)	MVD Mean (SD)	Fistula R Mean (%)	Ostomy C Mean (%)	Mortality Mean (%)
DCL n=72 (39.6%)	**17.5** (7.0)	**36.0** (37.4)	**18.7** (32.8)	**11.0** (9.5)	-	-	12 **(16.7)$**
DA n=60 (83.3%)	17.4 (7.2)	36.7 (40.6)	19.5 (35.8)	11.2 (9.6)	16 **(26.7)****	-	12 **(20.0)**
DO n=12 (16.7%)*	17.6 (6.2)	32.7 (13.5)	14.7 (8.7)	10.4 (9.8)	-	3 **(25.0)**	0 **(0)**
DSP n=110 (60.4%)	**17.1** (5.9)	**27.4** (23.7)	**12.2** (13.0)	**7.2** (10.8)	-	-	27 **(24.5)$**
PA n=51 (46.4%)	17.6 (5.6)	32.0 (29.9)	13.9 (15.1)	7.6 (10.2)	19 **(37.2)****	-	13 **(25.5)**
PO n=59 (53.6%)*	16.6 (6.1)	23.6 (16.1)	10.8 (11.0)	6.9 (11.4)	-	13 **(22.0)**	14 **(23.7)**

LOS=length of stay, MVD=mechanical ventilation days, R=rate, C=complications, *$p<0.01$, **$p=0.32$, $\$p=0.2$

Conclusion: Disease severity was similar among both groups (APACHE II=17), however the incidence of ostomies was significantly lower in patients with DCL as opposed to those that underwent DSP ($p<0.01$). Furthermore, DCL resulted in a decreased fistula and mortality rate when compared to DSP. This data shows that DCL is a safe and reliable surgical strategy in severe NTSP patients requiring bowel resection.

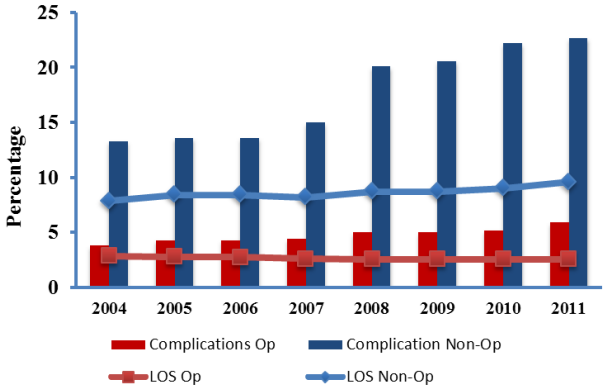
Session: V: Acute Care Surgery Papers 9-13
Paper 13: 8:50-9:10

ANTIBIOTICS FOR APPENDICITIS! NOT SO FAST

Mazhar Khalil MD, Bardiya Zangbar* MD, Peter Rhee* MD, MPH, Ansab A. Haider* MD, Narong Kulvatunyou* MD, Terence O'Keeffe* MD, Andrew Tang* MD, Rifat Latifi* MD, Randall S. Friese* MD, Gary Vercruysse* MD, Bellal Joseph* MD, University of Arizona - Tucson

Invited Discussant: Robert Sawyer, MD

Introduction:Emerging literature in acute appendicitis favors the non-operative management of acute appendicitis. However, the actual use of this practice on a national level is not assessed. The aim of this study was to assess the changing trends in non-operative management of acute appendicitis and its effects on patient outcomes.
Methods:We did an 8 year (2004-2001) retrospective analysis of National Inpatient Sample database. We included all in-patients with the diagnosis of acute appendicitis. Patients diagnosed with appendiceal abscess or patients who underwent surgery for any other pathology were excluded from the analysis. Jonckheere-terpstra trend analysis was performed for operative vs. non-operative management and outcomes.
Results:A total of 436,400 cases of acute appendicitis were identified. Mean age of the population was 33±19 years and 54% were male. There was no significant change in the number of acute appendicitis diagnosed over the study period (p=0.2). During the study period non-operative management of acute appendicitis increased significantly from 4.5% in 2004 to 6% in 2011 (p<0.001). Over the study period, hospital length of stay (5.6±7 to 6±8 days, p<0.001) and the rate of in-hospital complications (13% to 22%, p<0.001) increased significantly in non-operative management of appendicitis. When compared to operatively managed patients, non-operated patients has a higher hospital length of stay (6 ± 8 vs. 3 ± 4, p<0.001), in-hospital complications (18% vs. 5%, p<0.001), and hospital costs (35022 ± 70684 vs. 25968± 31795, p<0.001).
Conclusion:The non-operative management of appendicitis has increased over time; however, outcomes of non-operative management did not improve over the study period. A more in-depth analysis of patient and system demographics may reveal this disparity in trends.



Session: VII: Shock Transfusion Papers 14-17
Paper 14: 10:00-10:20

The AAST Prospective Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery (AORTA) Registry: Data on contemporary utilization and outcomes of aortic occlusion and resuscitative balloon occlusion of the aorta (REBOA)

Joseph J. DuBose* MD, Tom Scalea* MD, Megan Brenner* MD, Dimitra Skiada MD, Kenji Inaba* MD, Jeremy Cannon* MD, Laura Moore* MD, John Holcomb* MD, David Turay MD, Xian Luo-Owen MD,Ph.D., Andrew Kirkpatrick* MD, James Xiao MD, David Skarupa* MD, Nathaniel Poulin* MD, R Adams Cowley Shock Trauma Center / University Of Maryland Medical System

Invited Discussant: Timothy Fabian, MD

Introduction: Resuscitative Aortic occlusion (AO) for resuscitation of patients in traumatic shock remains a controversial issue. Resuscitative Endovascular Balloon Occlusion of the aorta (REBOA) offers an emerging alternative to traditional AO.

Methods:The AAST Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery (AORTA) study group prospectively identified trauma patients requiring aortic occlusion from 8 ACS verified level I centers. Presentation, intervention and outcome variables were collected and analyzed. REBOA and open AO patients were compared.

Results: From Nov 2013-Feb2015, 114 AO patients were captured (46 REBOA; 68 Open); 80.7% male; 62.3% blunt injured. Median ISS was 31.5, arrival SBP < 90 mm Hg in 59.6%; 42.1% requiring pre-hospital CPR. AO occurred in the Emergency Department (ED) (73.7%) or Operating Room (OR) (26.3%). Improvement in hemodynamics with AO was observed in 62.3% [REBOA 29/67.4%; Open 42/61.8%); 36.0% achieving stability (SBP consistently > 90 mm Hg) [REBOA 22/46; 47.8%; Open 19/68; 27.9%, p = 0.014]. Reported access for REBOA was femoral cut-down (50%); US guided (10.9%) and percutaneous without imaging (28.3%). Imaging was used in 65.2% (52.2% plain film, 13.0% fluoroscopy). Deployment was achieved in zones I (78.6%), II (2.4%) and III (19.0%). Balloon migration occurred in 4.4%. A second AO attempt was required in 9.6% [REBOA 2/46, 4.3%; Open 9/68, 13.2%]. REBOA complications were rare (pseudoaneursym 2.1%; embolism 4.3%, 0% limb ischemia). There was no difference in time from AO initiation to successful completion between REBOA and Open patients [REBOA 6.6 ± 5.6 mins; Open 7.2 ± 15.1, p = 0.842]. There was no difference between REBOA or Open AO with regards to overall survival [Overall 21.1% (24/114); REBOA 28.2 (13/46); Open 16.1% (11/68); p = 0.120] or survival after AO initiation in the ED [Overall 9.5% (8/84); REBOA 15.2% (5/28); Open 5.9% (3/49); p = 0.16].

Conclusion: REBOA has emerged as a viable alternative to open AO in centers that have developed this capability. Ongoing maturation of the AAST AORTA database is required to determine the impact of REBOA utilization.

Session: VII: Shock Transfusion Papers 14-17
Paper 15: 10:20-10:40

DAMAGE CONTROL RESUSCITATION AND EMERGENCY LAPAROTOMY: FINDINGS FROM THE PROPPR STUDY

Vicente J. Undurraga Perl MD, Brian Leroux Ph.D., Mackenzie R. Cook MD, Jeffrey D. Kerby* MD,Ph.D., Carolyn Williams RN, BSN, Kenji Inaba* MD, Charles E. Wade* Ph.D., Bryan A. Cotton* MD,MPH, Erin E. Fox Ph.D., Thomas M. Scalea* MD, Barbara C. Tilley Ph.D., John B. Holcomb* MD, Martin A. Schreiber* MD, for the PROPPR Study Group, Oregon Health & Science University

Invited Discussant: Ernest E. Moore, MD

Introduction: The Pragmatic Randomized Optimal Platelet and Plasma Ratios (PROPPR) trial has demonstrated that damage control resuscitation, a massive transfusion strategy targeting a balanced delivery of plasma-platelet-RBC in a ratio of 1:1:1, allows hemostasis to be achieved earlier in a higher percentage of severely injured patients than a 1:1:2 ratio, with a corresponding reduction in deaths due to exsanguination. With improved hemostasis, we hypothesized those patients receiving 1:1:1 ratio would have improved survival after emergency laparotomy.
Methods: Severely injured patients predicted to receive a massive transfusion admitted to 12 level I North American trauma centers were randomized to 1:1:1 versus 1:1:2 as described in the PROPPR trial. From these patients, the subset that underwent an emergency laparotomy, defined previously in the literature as laparotomy within 90 minutes of arrival, were identified. We compared rates and timing of emergency laparotomy as well as post-surgical survival at 24-hours and 30-days.
Results: Of the 680 enrolled patients, 613 underwent a surgical procedure, 359 underwent a laparotomy, and 310 underwent an emergency laparotomy. The proportions of patients undergoing emergency laparotomy were 48% (163/338) and 43% (147/342) for 1:1:1 and 1:1:2, respectively (p=0.20). Median time to laparotomy was 28 minutes in both treatment groups. Among patients undergoing an emergency laparotomy, the proportions of patients surviving to 24 hours and 30 days were similar between treatment arms, 24-hour 88.3% (144/163) for 1:1:1 and 85.0% (125/147) for 1:1:2 (p=0.49), and 30-day 81.6% (132/163) for 1:1:1 and 76.7% (112/147) for 1:1:2 (p=0.51).
Conclusion: We found no evidence that resuscitation strategy affects whether a patient requires an emergency laparotomy, time to laparotomy, or subsequent survival.

Session: VII: Shock Transfusion Papers 14-17
Paper 16: 10:40-11:00

ANGIOGRAPHIC EMBOLIZATION FOR HEMORRHAGE FOLLOWING PELVIC FRACTURE: IS IT "TIME" FOR A PARADIGM SHIFT?

Ronald Tesoriero MD, Brandon Bruns MD, Mayur Narayan MD, MPH, MBA, Joseph Dubose* MD, Sundeep Guliani MD, Megan Brenner MD, Deborah Stein* MD, MPH, Thomas Scalea* MD, R Adams Cowley Shock Trauma Center

Invited Discussant: John Holomb, MD

Introduction: Major pelvic disruption with hemorrhage has a high rate of lethality. Angiographic embolization is the mainstay of treatment. Time spent awaiting mobilization of the resources needed to perform angiography allows ongoing hemorrhage. Alternative techniques, such as pre-peritoneal pelvic packing and aortic balloon occlusion (REBOA), now exist. We hypothesized that time to angiography and hemostasis using standard therapy would be vastly longer than anticipated.
Methods: A retrospective review was performed of all patients with pelvic fracture who underwent pelvic angiography at a level one trauma center over a 10 year period. The trauma registry was queried for age, sex, injury severity score (ISS), hemodynamic instability (HI) on presentation (SBP $\leq$ 90, HR $\geq$ 120), and transfusion requirements within 24hrs. Charts were reviewed for indications for, and time to, angiography, time to hemostasis by embolization, and mortality.
Results: 4712 patients were admitted with pelvic fractures during the study period. 344 (0.07%) underwent pelvic angiography. 71% were male. Mean age was 46 years. Mean ISS was 32. Mean 24 hour transfusion requirements were 9.4 units of RBC's and 11 units of FFP. 151 (43.9%) presented with HI and 104 (30%) received massive transfusion (MT). 212 (62%) had embolization. Median time to angiography was 286 min (interquartile range [IQR] 210-378) and time to hemostasis with embolization was 344 min (IQR 262-433). Median procedure time for embolization was 51 minutes (IQR 37-83). Times were significantly shorter when stratified for HI (HI 264 vs stable 309 min; $p=0.03$), and MT (MT 230 vs non-MT 317min; $p < 0.01$). However, time from admission to angiography still took nearly 4 hours. Overall mortality was 18%. Hemorrhage (16%) and sepsis/multiple organ failure (43.5%) accounted for most deaths.
Conclusion: Pelvic fracture hemorrhage remains a management challenge. In our trauma center, with robust resources, the median time to hemostasis was over 5 hours. Nearly 60% of deaths could be directly attributed to, or as a complication of, early uncontrolled hemorrhage. Earlier intervention by Acute Care Surgeons with techniques such as pre-peritoneal pelvic packing, REBOA, and utilization of hybrid operative suites with surgeon performed embolization may improve outcomes.

Session: VII: Shock Transfusion Papers 14-17
Paper 17: 11:00-11:20

COMPUTED TOMOGRAPHY IN HEMODYNAMICALLY UNSTABLE SEVERELY INJURED TRAUMA PATIENTS

Juan P. Herrera-Escobar MD, Carlos A. Ordonez* MD, Juan C. Puyana* MD, Paola A. Rodriguez-Ossa MD, David A. Mejia MD, Alvaro Sanchez MD,Ph.D., Maria P. Garcia-Garcia MD, Monica Morales Statistician, Jhoana C. Rojas-Marquez MD, Amadeus Uribe Jose J. Serna MD, Luis F. Pino MD, Michael W. Parra MD, Universidad Del Valle

Invited Discussant: David Feliciano, MD

Introduction: Dynamic and efficient resuscitation strategies are now being implemented in severely injured hemodinamically unstable patients (HUP) as blood products become readily and more immediately available in the trauma room. Our ability to maintain aggressive resuscitation schemes in HUP allow us to complete diagnostic imaging studies before rushing patients to the operating room. As the criteria for performing CT scans in HUP continue to evolve, we evaluated our current practice in a cross sectional study at a regional level I trauma center over a two-year period (2012-2013).

Methods: Trauma patients (≥ 15 years old) with an injury severity score (ISS) >15 who met criteria of hemodynamic instability (Systolic Blood Pressure (SBP) <100 mmHg and/or Heart Rate >100 bpm and/or ≥4 units of Packed Red Blood Cells transfused in the trauma bay) were included. Isolated head trauma and patients who suffered a pre-hospital cardiac arrest were excluded. The main study outcome was mortality in both groups.

Results: We enrolled 171 patients. CT scans were performed in 80 HUP (47%) immediately upon arrival (CT Group); the remaining 91 patients (53%) went directly to the operating room (63 laparotomies, 20 thoracotomies), and/or 8 (9%) angio-suite (OA Group). Of the CT group, 43 (54%) were managed non-operatively, and 37 (46%) underwent surgery (15 laparotomies, 3 thoracotomies); and 2 (5%) angiography (CT OA Sub-Group). None of the mortalities in the CT group occurred in the CT suite or during their intra-hospital transfers.

Table 1. Hemodynamically Unstable Severely Injured Trauma Patients

Variables	OA Group (n= 91)		CT Group (n= 80)		p-value*
	Total*	Penetrating N=86(95%)	Total*	Penetrating N=37(46%)	
Age, mean (SD)	30.2 (12.1)	29.6 (11)	34.3 (15.5)	32.9 (16.7)	0.13
Male, n (%)	82 (90%)	78 (91%)	71 (89%)	36 (97%)	0.81
ISS, mean (SD)	25.9 (13.9)	25.6 (14)	27.5 (11.1)	26.3 (11.6)	0.02
HR, mean (SD)	113.6 (20)	113.8 (18.3)	111.7 (21.5)	110.8 (23)	0.35
SBP, mean (SD)	85.8 (22.3)	86.6 (22.2)	92.2 (18.6)	91.9 (15.7)	0.06
SBP <90 mmHg, n (%)	51 (56%)	47 (55%)	34 (43%)	15 (41%)	0.09
Patients with RBCT in ER, n (%)	42 (46%)	38 (44%)	19 (24%)	10 (27%)	< 0.01
Time (minutes), median (IR)	34 (20-62)	-	60 (50-75)	-	< 0.01
Mortality, n (%)	16 (18%)	13 (15%)	10 (13%)	2 (5%)	0.29

ISS: Injury Severity Score. Time: Time from admission to operating room HR: Hearth Rate
SBP: Systolic Blood Pressure RBCT: Red Blood Cells Transfusion ER: Emergency Room

Conclusion: There was no difference in mortality between CT and OA groups in HUP. CT scan was attainable in 47% of HUP and avoided surgery in 54% of the cases. Furthermore, CT scan was helpful in deciding definitive/specific surgical management in 46% scanned HUP that necessitated surgery post CT.

Session: XA: Papers 18-26
Paper 18: 2:00-2:20

A PROSPECTIVE, CONTROLLED CLINICAL TRIAL OF SURGICAL STABILIZATION OF SEVERE RIB FRACTURES

Yihan Lin MD, Maridi Rodil BS, Benoit Herbert MD, Robert Stovall* MD, Jeffrey Johnson* MD, Walter Biffl* MD, Ernest Moore* MD, Carlton Barnett* MD, Clay Cothren Burlew* MD, Charles Fox MD, Gregory J. Jurkovich* MD, Fredric Pieracci* MD, Denver Health Medical Center

Invited Discussant: Charles Adams, Jr., MD

Introduction: Previous studies of surgical stabilization of rib fractures (SSRF) have been limited by nonspecific fixation systems, small sample sizes, retrospective methodology, and inclusion of only patients with flail chest. We performed a prospective, controlled evaluation of SSRF as compared to optimal medical management for severe rib fracture patterns among critically ill trauma patients. We hypothesized that SSRF improves acute outcomes.

Methods: We conducted a two-year clinical trial at our level I trauma center. Patients with any of the following rib fracture patterns were included: flail chest; ≥ 3 fractures with bicortical displacement; ≥ 30% hemithorax volume loss; and either severe pain or respiratory failure despite optimal medical management. In the year 2013, all patients were managed non-operatively. In the year 2014, all patients were managed operatively. Standard analgesic, pulmonary toilet, and operative technique protocols were employed for both arms. Pulmonary contusions were quantified using the Blunt Pulmonary Contusion 18 (BPC18) score. Rib fracture pattern severity was quantified using the RibScore. Outcomes included respiratory failure (defined as need for mechanical ventilation), pneumonia, ventilator days, tracheostomy, length of stay, narcotic requirements, daily maximum incentive spirometer volume, and mortality. Univariate and multivariable analyses were performed. Data are expressed as mean (range), number (%), and odds ratio (OR) [95% confidence interval]. Statistical significance is $p<0.05$.

Results: 70 patients were enrolled; 35 in each group. For the operative group, time from injury to surgery was 2 days (0-3), operative time was 140 minutes (68 – 205), and the ratio of ribs fixed to ribs fractured was 0.47 (0.11 -1.00). The operative and non-operative groups were well matched with respect to age, body mass index, and pre-existing pulmonary disease. Injury patterns, including mechanism, injury severity score, and BPC18, were similar between groups. However, the operative group had a significantly higher RibScore (4 vs. 3, respectively, $p<0.01$) and a significantly lower incidence of intracranial hemorrhage (5.7% vs. 28.6%, respectively, $p=0.01$). After controlling for these differences, the operative group had a significantly lower likelihood of both respiratory failure (OR=0.22 [0.06, 0.77], $p=0.02$) and tracheostomy (OR=0.20, [0.05, 0.74], $p=0.02$). The average daily spirometry value was 280 mL higher in the operative group (59-850, $p=0.03$). Furthermore, there were non-significant trends towards a decreased likelihood of pneumonia (20.0% vs. 31.5%, respectively, $p=0.10$), ventilator days (6.4 vs. 10.6, respectively, $p=0.11$), ICU length of stay (8.3 vs. 10.4 days, respectively, $p=0.07$), and hospital length of stay (15.2 vs. 25.3 days, respectively, $p=0.11$) for the operative group as compared to the non-operative group. Narcotic requirements were comparable between groups. There were no mortalities.

Conclusion: In this clinical trial, SSRF as compared to best medical management appeared to improve acute outcomes among a group of critically ill trauma patients with a variety of severe fracture patterns.

Session: XA: Papers 18-26
Paper 19: 2:20-2:40

LOW VOLUME RESUSCITATION FOR HEMORRHAGIC SHOCK: UNDERSTANDING THE MECHANISM OF PEG-20K

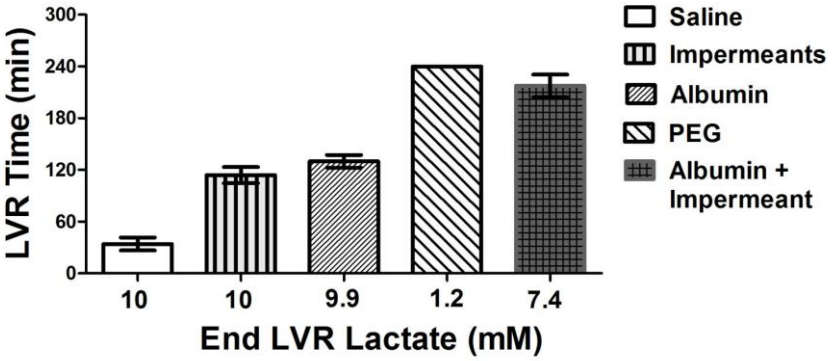
Valerie Plant MD, Dan W. Parrish MD, Susanne Lindell BSN, Ashley Limkemann MD, Heather Reichstetter LVT, Paula Ferrada* MD, Michel Aboutanos* MD, Martin J. Mangino Ph.D., Virginia Commonwealth University

Invited Discussant: Michael Dubick, PhD

Introduction: Hemorrhagic shock reduces oxygen delivery and compromises energy-dependent cell volume control, which leads to lethal cell swelling and no reflow from compressed capillaries. Ischemia-induced cell swelling can be reversed by cell impermeants such as raffinose, trehalose, gluconate, and polyethylene glycol-20k (PEG-20k), which also extend low volume resuscitation time (LVR) after shock. Of these impermeants, PEG-20k is orders of magnitude more effective. We hypothesize that PEG-20k acts as both an oncotic agent and an impermeant, which explains its superior performance by creating two osmotic gradients in the tissue for passive water movement. To support this, we tried to recapitulate the PEG-20k effect by using both a pure impermeant (gluconate) and oncotic (albumin) agent together.

Methods: Rats were hemorrhaged to a mean arterial pressure of 30-35 mmHg until arterial lactate reached 9-10 mM/L. Then, saline-based LVR solutions of 10% PEG-20k or 10% albumin/gluconate were administered at 10% blood volume. Once LVR is begun, the time for lactate to climb back to 9-10 mM/L was determined (LVR Time). A maximum time of 240 minutes was set.

Results: PEG-20k increased the LVR time 7-fold over the saline control and normalized blood pressure during the LVR period, relative to saline. The albumin-impermeant group extended the LVR time 6-fold over the saline control. Albumin alone or impermeants alone increased the LVR time 3-fold over saline, but the combination of both increased the LVR time almost as long as PEG-20k alone. Values are mean +/- SEM. All treatment groups are different from saline ($P<0.05$). Finally, the PEG and albumin-impermeant groups are not different.



Conclusion: These data are consistent with the hypothesis that PEG-20k may act as a hybrid impermeant and oncotic agent in low volume resuscitation following severe hypovolemic shock.

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

A SAFE AND EFFECTIVE MANAGEMENT STRATEGY FOR BLUNT CEREBROVASCUALR INJURY: AVOIDING UNNECESSARY ANTICOAGULATION AND PREVENTING STROKE

Charles P. Shahan MD, Louis J. Magnotti* MD, Shaun M. Stickley MD, Jordan A. Weinberg* MD, Leah E. Hendrick BA, Rebecca A. Uhlmann MS, Thomas J. Schroeppel* MD, Daniel A. Hoit MD, Martin A. Croce* MD, Timothy C. Fabian* MD, University of Tennessee Health Science Center - Memphis

Invited Discussant: Clay Cothren Burlew, MD

Introduction: Few injuries have produced as much debate with respect to management as have blunt cerebrovascular injuries (BCVI). Recent work (AAST 2013) from our institution suggested that 64-channel multi-detector computed tomographic angiography (CTA) could be the primary *screening* tool for BCVI. Consequently, our screening algorithm changed from digital subtraction angiography (DSA) to CTA, with DSA reserved for *definitive diagnosis* of BCVI following CTA positive studies or unexplained neurologic findings. The current study was done to evaluate outcomes, including the potential for missed clinically significant BCVI, since adopting this new management algorithm.

Methods: Patients who underwent DSA (positive CTA or unexplained neurological finding) over an 18-month period subsequent to the previous study (PS) were identified. Screening and confirmatory test results, complications, and BCVI-related strokes were reviewed and compared.

Results: 228 patients underwent DSA: 64% were male with mean age and Injury Severity Score of 43 and 22, respectively. 189 (83%) patients had a positive screening CTA. Of these, DSA confirmed injury in 104 (55%) patients; the remaining 85 (45%) patients (false positives) were found to have no injury on DSA. Five patients (4.8%) suffered BCVI-related strokes, unchanged from the PS (3.9%, p=0.756) – two were symptomatic at trauma center presentation, three occurred while receiving appropriate therapy. No patient with a negative screening CTA suffered a stroke.

Conclusions: This management scheme utilizing 64-channel CTA for screening coupled with DSA for definitive diagnosis was proven to be safe and effective in identifying clinically significant BCVI and maintaining a low stroke rate. Definitive diagnosis by DSA led to avoidance of potentially harmful anticoagulation in 45% of CTA positive patients (false positives). No strokes resulted from injuries missed by CTA.

Session: XA: Papers 18-26
Paper 21: 3:00-3:20

MULTICENTER EVALUATION OF TEMPORARY INTRAVASCULAR SHUNT USAGE IN VASCULAR TRAUMA

Kenji Inaba* MD, Hande Aksoy MD, Juan Duchesne* MD, Rebecca Schroll MD, Jiselle Bock Heaney MD, Mark J. Seamon* MD, Joshua A. Marks MD, John A. Harvin MD, Ryan A. Lawless MD, Demetrios Demetriades* MD,Ph.D., LAC+USC Medical Center

Invited Discussant: Faran Bokhari, MD

Introduction: The indications, technical considerations and outcomes associated with Temporary Intravascular Shunting (TIVS) for vascular trauma in the civilian sector are poorly understood. The objective of this study was to perform a contemporary multicenter review of TIVS usage and outcomes.

Methods: Patients sustaining vascular trauma requiring TIVS insertion from 1/2005-12/2013 were retrospectively identified at four large US Level I trauma centers. Clinical demographics, operative details and outcomes were abstracted.

Results: A total of 271 vascular injuries (96.5% arterial) requiring TIVS were identified in 264 patients. Mean age 30.1 (range 4-89) years, 89.4% male, GCS 12.5±4.5, ISS 16.6±10.5, 20.8% ISS>25 and 75.6% penetrating. The most common mechanism was GSW (68.1%) followed by AvP (12.6%) and MVC (5.2%). Shunts were placed for Damage Control in 65.9%, staged repair for combined orthopedic and vascular injuries in 33.3% and for insufficient surgeon skillset in 0.7%. The most common vessel shunted was the SFA (26.1%) followed by Popliteal A (18.3%) and Iliac A (14.8%). The most common upper extremity vessel was the Brachial A (12%). The Argyle shunt (85.2%) was the most common conduit followed by chest tubes (9.2%). Average dwell time was 456 minutes (45-5400) with 10.6% placed on systemic heparinization. 74.8% survived to definitive repair, 72.6% survived overall. 97.3% of deaths occurred in those undergoing damage control shunting. Complications included thrombosis (13.4%), compartment syndrome (7%) and amputation (4.2%).

Conclusion: In the largest civilian experience with TIVS insertion to date, both damage control and staged orthopedic vascular injuries were found to be common indications for shunting. With an acceptable survival and complication rate, further prospective evaluation of its role in the management of vascular trauma is warranted.

Session: XA: Papers 18-26
Paper 22: 3:20-3:40

THE PAINFUL TRUTH: THE DOCUMENTATION BURDEN OF A TRAUMA SURGEON

Joseph F. Golob, Jr., MD, John J. Como* MD, MPH, Jeffrey A. Claridge* MD, MS
MetroHealth Medical Center

Invited Discussant: Frederick Luchette, MD, MSc

Introduction: Implementation of the electronic medical record (EMR) has introduced several unintended consequences including introduction of unfavorable workflows and increased documentation demands. We intended to define the attending trauma surgeon's EMR documentation burden and its economic impact at a busy regional Level I trauma center.

Methods: A retrospective descriptive study was performed at an academic Level I trauma center. The EMR was queried to determine the number of documentation entries during 2014 for the eight attending trauma surgeons. These eight surgeons were then surveyed to estimate the duration of time it took to write each note type, and this mean time was used to calculate the total time needed for documentation. The hospital financial database was queried for 2014 hospital charges and work relative value units (WRVUs) for the trauma division and for the orthopaedic surgery and neurosurgery departments to generate a comparison. The charges and WRVUs were broken down into those generated from documentation (evaluation and management codes – E&M) and those generated from procedures (current procedural terminology codes – CPT).

Results: During 2014, there were 5,864 trauma activations with 3,111 patient admissions. The trauma attending surgeons wrote a total of 26,455 documentation entries. Seventy-four percent of these were progress notes, 15% were histories and physicals, 5% were operative notes, 3% were consults, and 3% were procedures. Of these notes, 92% were from inpatients. Documentation time estimates for the trauma service demonstrated that it took 1,760.5 hours or 73.3 24-hour days to complete these 26,455 notes. Financial data revealed that 44% of the trauma surgeon charges were directly related to documentation (Table 1). This compares to 14% for attending orthopaedic surgeons and 7% for attending neurosurgeons. Financial data also demonstrated that 55% of a trauma surgeon's WRVUs were directly related to documentation compared to 28% for orthopaedic surgeons and 19% for neurosurgeons (Table 2).

Table 1 – Total charges by E&M and CPT

	E&M Charges	**CPT Charges**	**Total Charges**
Trauma Surgery	$6,061,586 (44%)	$7,661,641 (56%)	$13,723,227
Orthopaedic Surgery	$4,245,376 (14%)	$25,631,894 (86%)	$29,877,270
Neurosurgery	$1,353,296 (7%)	$18,158,478 (93%)	$19,511,774
Total	$11,660,258 (18%)	$51,452,013 (82%)	$63,112,271

Table 2 – Total WRVUs by E&M and CPT

	E&M WRVUs	**CPT WRVUs**	**Total WRVUs**
Trauma Surgery	40332 (55%)	32371 (45%)	72703
Orthopaedic Surgery	31492 (28%)	80429 (72%)	111921
Neurosurgery	10657 (19%)	45907 (81%)	56564
Total	82481 (34%)	158707 (66%)	241188

Conclusion: Our data show that the EMR has introduced a significant documentation time burden to the busy academic trauma surgeon. The trauma surgeon's documentation burden is critical for defining hospital charges and WRVUs, and it differs from that of orthopaedic surgeons and neurosurgeons. Workflow changes, such as the introduction of scribes, may help the documentation burden and improve hospital charges and WRVUs of the trauma surgeon.

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

USE OF ENDOTRACHEAL TUBES WITH SUBGLOTTIC SECRETION DRAINAGE REDUCES VENTILATOR-ASSOCIATED PNEUMONIA IN TRAUMA PATIENTS

Jennifer L. Hubbard MD, Wade L. Veneman RRT, Rachel C. Dirks Ph.D., James W. Davis* MD, Krista L. Kaups* MD, MSc, UCSF Fresno

Invited Discussant: Andrew Kerwin, MD

Introduction: Patients suffering from traumatic injuries have a higher incidence of ventilator-associated pneumonia (VAP) compared to other critically ill patient populations. Previous studies of patients with predominantly medical diagnoses and use of endotracheal tubes allowing subglottic secretion drainage (ETT-SSD) have shown significant reduction in VAP rates. We hypothesized that use of ETT-SSD would reduce ventilator-associated pneumonia in trauma patients.

Methods: A retrospective review from 2010-2014 of adult trauma patients orotracheally intubated for more than 48 hours was performed at a level 1 trauma center. Patients were compared based on standard endotracheal tube (ETT) versus ETT-SSD. The primary outcome was incidence of VAP per 1000 ventilator days. The diagnosis of VAP was made by quantitative bronchoalveolar lavage (BAL) cultures as defined by Center for Disease Control (CDC) criteria.

Results: Of 1,135 patients included in the study, 667 patients had ETT and 468 had ETT-SSD. Groups did not differ by demographics, injury severity score (ISS), ICU length of stay, or total ventilator days. The VAP rate was lower in the SSD-ETT group and approached significance (SSD-ETT: 5.5 vs ETT: 7.8, p=0.059); however, the number of patients with a severe head or chest injury (AIS $\geq$ 3) differed between the two groups (p<0.001; p=0.031, respectively). Using binary logistic regression to control for these confounding variables, SSD-ETT was highly significant for reduction of VAP incidence (OR=0.6, 95% CI=0.4-0.9, p=0.027).

	ETT (n=667)	ETT-SSD (n=468)	P value
Mean Age (years)	44	45	0.42
ISS (mean)	24	25	0.68
Ventilatory days (mean)	13	13	0.69
ICU LOS	14	13	0.16
Chest AIS $\geq$ 3	311 (47%)	188 (40%)	0.031
Head AIS $\geq$ 3	350 (53%)	316 (68%)	<0.001
VAP rate	7.8	5.5	0.059

Conclusion: After controlling for confounding factors, ETT-SSD decreased overall VAP incidence in trauma patients. We recommend use of ETT-SSD in trauma patients to decrease VAP incidence in this high-risk patient population.

Session: XA: Papers 18-26
Paper 24: 4:00-4:20

THE IMPACT OF PATIENT PROTECTION AND AFFORDABLE CARE ACT ON TRAUMA CARE: A STEP IN THE RIGHT DIRECTION

Bellal Joseph* MD, Ansab A. Haider MD, Bardiya Zangbar MD, Narong Kulvatunyou* MD, Mazhar Khalil MD, Andrew Tang* MD, Terrence O'Keeffe* MD, Rifat Latifi* MD, Donald J. Green* MD, Randall S. Friese* MD, Peter Rhee* MD, MPH, University of Arizona - Tucson

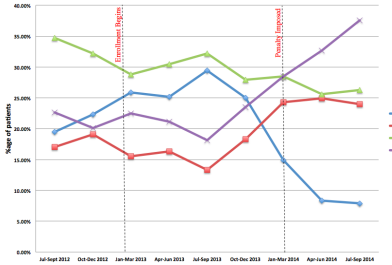
Invited Discussant: L.D. Britt, MD, MPH

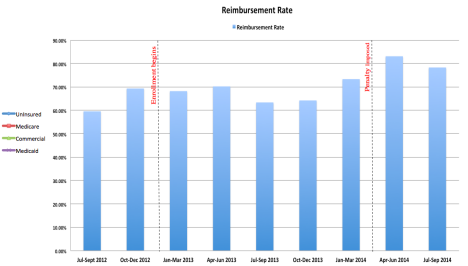
Introduction: The Patient Protection and Affordable Care Act (ACA) was implemented to guarantee health care for all Americans. The implementation of ACA is likely to influence the insurance status of Americans and reimbursement rates of trauma centers. The aim of this study was to assess the impact of ACA on the patient insurance status, hospital reimbursements and clinical outcomes at a Level I trauma center.

Methods: We performed a retrospective analysis of the trauma registry and financial database at our level I trauma center for a 27-month (July 2012- September 2014) period by quarters. Our outcome measures were: change in insurance status, hospital reimbursement rates (Total Payments/Expected Payments), and clinical outcomes pre and post-ACA (March, 2014). Jonckheere–Terpstra trend analysis was performed to assess trends in outcomes over each quarter (3 months).

Results: A total of 9,892 patients were included in the study. There was 15.1% reduction in the proportion of uninsured patients (23.2% vs. 8.1%; $p<0.001$) and a 13.8% increase in reimbursement rate (80.7% vs. 66.9%; $p<0.001$) in the post ACA period compared to the pre-ACA period. There was no difference in the mortality rate ($p=0.18$), complication rate ($p=0.67$), and hospital length of stay ($p=0.06$) between the two groups.

On trend analysis, there was a significant decrease ($p<0.001$) in the proportion of uninsured patients and commercially insured patients. During this same time there was a significant increase in Medicaid and Medicare patients. The hospital reimbursement rates ($p<0.001$) significantly increased over the study period. **(Figures 1 and 2)**





Conclusion: The implementation of ACA has led to a decrease in the number of uninsured and commercially insured trauma patients. There was a significant increase in Medicare and Medicaid trauma patients. This was associated with an increase in hospital reimbursements that substantially improved the financial revenues of trauma centers. There were also trends towards decreased rate of hospital admissions and shorter hospital length of stay.

Session: XA: Papers 18-26
Paper 25: 4:20-4:40

VOLUMETRIC ANALYSIS OF DAY OF INJURY COMPUTED TOMOGRAPHY IS ASSOCIATED WITH REHABILITATION OUTCOMES AFTER TRAUMATIC BRAIN INJURY

Sarah Majercik* MBA,MD, Joseph Bledsoe MD, Joel MacDonald MD, Ryan Barrett MS, Susan Horn Ph.D., Michael Larson Ph.D., Ramona O. Hopkins Ph.D., David Pisani MD, Mark H. Stevens MD, David Ryser MD, Intermountain Medical Center

Invited Discussant: David Livingston, MD

Introduction:Quantitative neuroimaging is a relatively underused modality to classify severity and to predict outcomes of traumatic brain injury (TBI). Specific volumetric analysis of traumatic lesions in the acute setting has rarely been used to predict long-term patient outcomes after TBI. The purpose of this study was to investigate the relationship between acute brain injury lesion volume and eventual rehabilitation outcomes in patients with TBI at a single Level One Trauma Center.

Methods: All patients with a TBI who were admitted to our in-house rehabilitation unit after a stay on the acute care trauma service between February 2009 and July 2011 were prospectively identified and analyzed. Hospital and rehabilitation data points including demographic data and outcome variables such as cognitive and motor FIM scores, length of stay in the rehabilitation unit, and ability to return to home/independent living were abstracted from the medical record and the trauma registry. Cortical structure and injury lesion volumetrics were quantified in cubic centimeters on day-of-injury brain computed tomography (CT) scans using computer software created for this task. A multiple step-wise regression model using 13 independent variables (age, ISS, Head AIS, brain injury volume, Rotterdam score 1 or 2, Rotterdam score 3 or 4, Rotterdam score 5 or 6, anti-platelet agent use at admission, warfarin use at admission, ED GCS, need for neurosurgical procedure, need for endotracheal intubation in the field or in the hospital) was created to identify variables that predict outcomes after rehabilitation. $P<0.05$ was considered significant.

Results: 96 patients over the study period met inclusion criteria and had sufficient data to analyze. Mean age was 43±21 years, admission GCS was 8.4±4.8, ISS was 24.7±9.9, and head AIS 3.73±0.97. Acute hospital length of stay (LOS) was 12.3±8.9 days and rehabilitation LOS was 15.9±9.3 days. Volume of TBI lesions on the day of injury was negatively associated with cognitive FIM at the time of admission ($p=0.004$) and discharge ($p=0.004$) from the rehabilitation unit. Size of TBI lesions was also negatively associated with ability to be discharged to home after the rehabilitation stay ($p=0.006$). Day of injury TBI lesion volume did not show any association with 9-month FIM scores.

Conclusion: In a cohort of patients with moderate to severe TBI requiring a rehabilitation unit stay after the acute care hospital stay, day of injury brain injury lesion volume is associated with cognitive outcomes as measured by FIM at the time of admission and discharge from the rehabilitation unit. Further, injury volume also relates with ability to return to home. Volumetric imaging may have important implications in the future to help surgeons make realistic predictions in the acute phase about ultimate outcomes in TBI patients.

Session: XA: Papers 18-26
Paper 26: 4:40-5:00

DISCOVERING THE TRUTH ABOUT LIFE AFTER DISCHARGE: LONG-TERM TRAUMA RELATED MORTALITY

Rachael A. Callcut MD, MSPH, Glenn Wakam BS, Amanda S. Conroy BA, Lucy Z. Kornblith MD, Benjamin M. Howard MD,MPH, Eric M. Campion MD, Mary F. Nelson RN, MPA, Matthew W. Mell MD, MS, Mitchell J. Cohen* MD, University of California, San Francisco

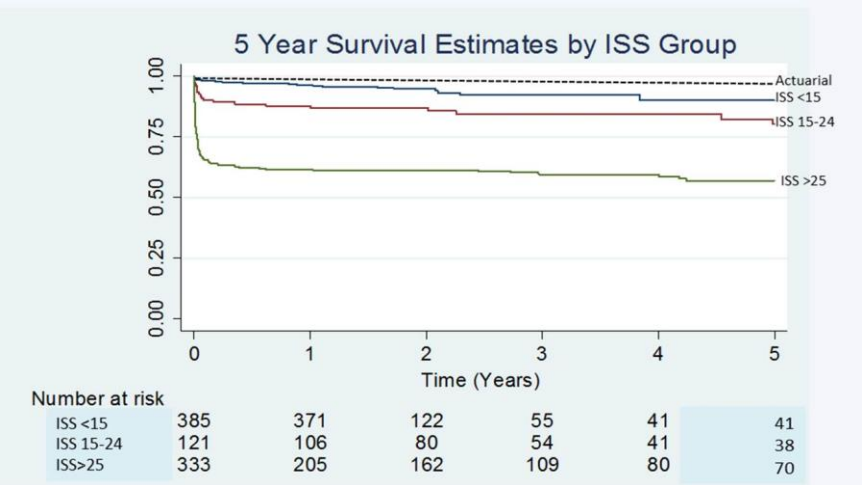
Invited Discussant: Alicia Mangram, MD

Introduction: Outcome after traumatic injury has typically been limited to determination at the time of discharge from the incident hospitalization or brief follow-up. This study is the first to investigate the natural history of long-term survival following traumatic injury.

Methods: All highest level activation patients prospectively enrolled in an on-going cohort study from 2005-2012 were selected. To allow for long-term follow-up, patients had to be enrolled at least 1 year prior to the latest available data from the National Death Index (NDI 2013). Time and cause of mortality was determined based upon institutional medical records or death certificates. Survival status was determined by the latest date of either care in our institution or query from the NDI. Kaplan-Meier curves were created stratified for injury severity (ISS). Survival was compared with estimated actuarial cohort survival based on age, gender, and race.

Results: 908 highest level activation patients with a median ISS of 18 were followed for a median 1.7 years (IQR 1.0 – 2.9 years) with a maximum follow-up of 9.8 years. Survival data was available on 99.8% of patients. Overall survival was 73% (663/908). For those with at least 2 year follow-up, overall survival was only 62% (317/509). Severity of injury predicted long-term survival (p<.0001) with those severely injured having the poorest outcome (57% survival at 5 years). For all ISS groups, survival was worse than predicted actuarial survival [p<0.001, FIGURE]. Excluding early deaths (<=30 days), observed survival was still significantly lower than estimated actuarial survival from day 31 to 5 years across ISS groups [p<0.002]. 18% (45/245 deaths) of all deaths occurred after 30 days and 80% (36/45) of these occurred post-hospital discharge. Amongst late deaths, 53% occurred between 31 days to 1 year post trauma. Trauma related mortality was the leading cause of post-discharge death accounting for 41% of the late deaths.

Conclusion: Post-discharge deaths represent a significant percentage of total trauma related mortality especially for those severely injured. Despite having 'survived' to leave the hospital, long term survival was worse than predicted actuarial survival suggesting that the mortality from injury does not end at 'successful' hospital discharge. Efforts should be undertaken to track deaths beyond hospital discharge to understand the true outcome following trauma.



Session: XB: Papers: 27-35
Paper 27: 2:00-2:20

TRAUMA SYSTEM REGIONALIZATION IMPROVES MORTALITY IN PATIENTS REQUIRING TRAUMA LAPAROTOMY

David W. Schechtman BS, Jack C. He MD, Debra Allen RN, BSN, Jeffrey A. Claridge* MD, MetroHealth Medical Center

Invited Discussant: Patrick Reilly, MD

Introduction: A regional trauma network (RTN) consisting of multiple hospital systems and collaboration with local EMS was established in 2010 to improve trauma outcomes. This study evaluates the impact of the trauma network on patient survival, ICU length of stay, and hospital length of stay in patients who required trauma laparotomy.
Methods: Patients who arrived via EMS and required trauma laparotomy from January 2008 to December 2013 were analyzed. Patients admitted during 2008-2009 and 2011-2013 were designated as pre-RTN and RTN groups respectively. 2010 was excluded as a transitional year. The primary outcome of the study was mortality. The two groups were also compared for age, gender, mechanism of injury, injury severity score (ISS), admission to procedure start time, length of stay, number of ICU days, and level of admitting trauma center.
Results: 569 patients were analyzed, 231 patients were pre-RTN and 338 were in the RTN group. Overall, mean age was 35.7 ± 17.1 and median ISS was 16 (25-75th percentile: 9-26). The two groups were compared in Table 1. Overall there was a 33% relative reduction in mortality from the pre-RTN to RTN group (p=0.035), and 29.7% more patients were triaged to a level I trauma center in the RTN group (p<0.001). Logistic regression showed that being in the RTN group was an independent predictor for survival (p=0.026) with odds ratio of 0.53 (95% CI 0.30-0.93). Patients with penetrating trauma had a non-significant decrease in mortality and a reduction of one day of ICU stay (p=0.001). Patients with blunt trauma had a significant reduction in mortality from 38.3% in the pre-RTN group to 22.6% in the RTN group (p=0.017).

All Patients	*Pre-RTN (n=231)*	*RTN (n=338)*	*p - value*
Age (mean ± SD)	36.3 ± 18.0	35.4 ± 16.4	ns
ISS (median, IQR)	16 (9-26)	16 (9-25)	ns
Male	85.7%	82.0%	ns
Blunt Trauma	35.1%	34.0%	ns
Triaged to a Level 1 Trauma Center	66.7%	96.4%	**<0.001**
ICU Days (median, IQR)	2 (0-6)	1.5 (0-6)	**0.047**
Hospital Mortality	19.9%	13.3%	**0.035**

Table 1 (SD, Standard deviation; IQR, interquartile range)

Conclusion: This study focused on the unique patient population that required trauma laparotomies. It showed trauma system regionalization led to a significant increase in the number of patients triaged to a level I trauma center, and reduction of ICU length of stay. More importantly, it demonstrated the benefit of regionalization by showing a significant reduction of hospital mortality in this critically injured patient population.

Session: XB: Papers: 27-35
Paper 28: 2:20-2:40

TRAUMA CENTER CARE IS ASSOCIATED WITH REDUCED READMISSIONS AFTER INJURY

Kristan L. Staudenmayer* MD, MS, Thomas G. Weiser MD,MPH, Paul Maggio* MBA,MD, David Spain* MD, Renee Hsia MD, MSc Stanford University

Invited Discussant: Adil Haider, MD

Introduction: Trauma center care has been associated with improved mortality. It has not been shown if trauma center care is associated with readmissions at a population level. We hypothesized being treated in a trauma center would be associated with reduced readmission rates due to improved care.

Methods: We conducted a retrospective analysis of all hospital visits in California for patients with trauma using the Office of Statewide Health Planning and Development Database from 2007-2008. All hospital admissions and emergency department visits associated with injury were longitudinally linked. Counties were organized into those with and without trauma centers. Regression models were developed to predict readmissions controlling for patient variables, length of stay for initial hospitalization, living in a region with trauma center access, and triage patterns.

Results: A total of 211,404 patients were included in the analysis. Of these, 5,094 (2%) died during the index hospitalization. Of those who survived their initial hospitalization, 79,123 (38%) experienced one or more readmissions within one year. The majority of these were single admissions (n=42,043; 60%), but 40% (n=28,280) experienced multiple readmissions. Over 67% of readmissions were unplanned, and 8% of readmissions were associated with a primary diagnosis of trauma. After controlling for patient variables known to be associated with readmissions, triage to a Level I or II trauma center reduced the odds of readmission compared to not receiving care at a Level I or II trauma center (OR 0.89, $p<0.001$). The association between trauma center care and a reduction in readmissions at one year was also significant, but the magnitude of the effect was less (OR 0.96, $p<0.001$). Other factors associated with readmissions at both 30 days and one year included age, number of comorbidities, injury severity, and length of stay.

Conclusion: Readmissions after injury are common and are often unscheduled. While patient factors play a role in this, care at a trauma center is associated with decreased odds for re-admission, even when controlling for severity of injury. This suggests the benefits of trauma center care extend beyond improvements in mortality to improved long-term outcomes and ultimately reduced resource utilization.

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

RURAL TRAUMA TEAM DEVELOPMENT COURSE DECREASES TIME TO TRANSFER FOR TRAUMA PATIENTS

Bradley M. Dennis MD, Oliver L. Gunter* MD,MPH, Melissa D. Smith RN, MSN, Catherine S. Wilson RN, MSN, ACNP-BC, Michael A. Vella MD, Mayur B. Patel MD,MPH, Timothy C. Nunez* MD, Oscar D. Guillamondegui* MD,MPH, Vanderbilt University Medical Center

Invited Discussant: Eric Kuncir, MD, MS

Introduction: The Rural Trauma Team Development Course (RTTDC) teaches initial management of the trauma patient to critical access hospitals with limited resources. The course emphasizes early stabilization and rapid transfer to definitive care with limited use of radiologic adjuncts. We hypothesize that the RTTDC will reduce the time from arrival to transfer.

Methods: We conducted a pre/post analysis of trauma patients who were transferred from critical access outside hospitals from 2012-2014. Data collected included demographics; ISS; CT imaging; method of transfer; times of arrival, call for transfer and discharge from outside hospital; and mortality. Using a difference-in-differences model, we compared transfer times of patients from critical access hospitals that participated in an RTTDC course to a control group of patients from similar centers that did not take part in the course. The model was adjusted for demographics, injury mechanism and ISS. Primary outcome was time to outside hospital transfer. Secondary outcomes were CT imaging rates and mortality.

Results:253 patients were available for study. Demographics, CT imaging and mortality rates were similar between the two groups. ISS was higher in the control group overall (17 vs 13, p=0.02), but remained consistent for each group across both time periods. The RTTDC group showed a 58-minute decrease (Figure) in time from arrival to call for transfer (p=0.01) and a 73-minute reduction in time to transfer (p=0.002). Compared to the control group, the RTTDC group had significantly greater reduction in time from arrival to transfer (-62 minutes, p=0.02).

Conclusion:RTTDC training significantly improved times to contact and transfer of rural patients to a trauma center without increasing mortality rate. There was no difference in the prevalence of CT imaging in either group. RTTDC is an effective trauma outreach program to improve the timeliness of patient transfers from critical access hospitals to regional trauma centers.

Pre/post comparison, individualized by exposure groups.

Variable	Pre	Post	
Arrival to call (min)	**RTTDC pre**	**RTTDC post**	***p-value***
	134 (71-176)	76 (54-131)	0.01*
	Control pre	**Control post**	
	100 (65-144)	121.5 (73.5-165)	0.28
OSH transfer time (min)	**RTTDC pre**	**RTTDC post**	***p-value***
	195 (120-251)	122 (91-176)	0.002*
	Control pre	**Control post**	
	153 (105-205)	184.5 (110-237.5)	0.31

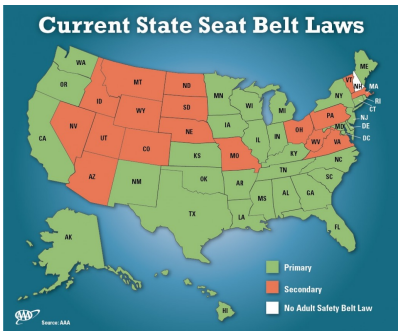
Session: XB: Papers: 27-35
Paper 30: 3:00-3:20

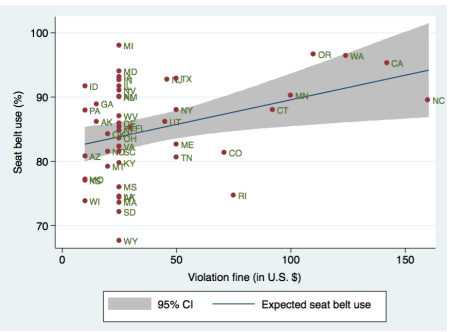
PRIMARY SAFETY BELT LEGISLATION AND HIGHER VIOLATION FINES SAVE LIVES

George Kasotakis MD,MPH, Pieter Smit MD, Alyssa VonPuttkammer BS, Lisa Allee MSW LICSW, Bedabrata Sarkar MD,Ph.D., Kofi Abbensetts MD, Robert Schulze* MD, Peter Burke* MD, Boston University Medical Center

Invited Discussant: Rochelle Dicker, MD

Introduction: Motor vehicle collisions (MVC) remain the primary cause of mortality among people aged 5-35 in the US, and a major source of morbidity in all age groups. While MVC-related morbidity and mortality has multiple contributing factors, the primary common end pathway is rapid deceleration. Although seat belts are widely known to mitigate this - reducing fatalities by 45-60% and preventing 50-65% of moderate to severe injuries – their use remains suboptimal. Several factors affect safety belt utilization, including age, socioeconomic status, public safety education programs, and state legislation (primary vs. secondary laws, and fine level associated with infractions). While the former factors are problematic or costly to intervene on, state legislation may be easier to target.
Methods: Data were obtained from the National Highway Traffic Safety Administration (NHTSA) and the Centers for Disease Control (CDC) regarding each of the 50 states' type of legislation and safety belt violation fines. Pertinent literature was also reviewed. A goal of increasing seat-belt use from the current rate of 85% to 90% was identified as appropriate at this stage. Data were reviewed to identify a relationship between legislation type and seat belt use, and regression models were fitted to measure the association between seat belt use and type of state legislation / levels of violation fines.
Results: Only 31 states currently have primary seat belt legislation. Enactment of, or upgrade to primary laws led to an increase in seat belt use by 33% (IQR 20-44%) and 14% (IQR 9-23%) respectively, while fatalities due to MVC decreased by 8% (IQR 3-14%). The average nationwide fine was also deemed to be 'affordable' at $39.50 (IQR $25-48) and fine level was found to be a strong predictor of seat belt use (effect estimate 0.08, 95% C.I. 0.02-0.13, p=0.01). By upgrading to primary safety belt legislation and increasing the fine to ≥$100, it is estimated that a 5.6-6.9% increase in seat belt use can be anticipated. This usage increase is estimated to help prevent 20,625 serious injuries, and save 1,417 lives and $4.5B in healthcare, property, and lost productivity annually.
Conclusion: All states should upgrade safety belt legislation to primary and increase fine levels to ≥$100. This would lead to significant reduction in MVC-associated morbidity and deaths.





Session: XB: Papers: 27-35
Paper 31: 3:20-3:40

GEOGRAPHIC DISTRIBUTION OF TRAUMA CENTERS AND INJURY RELATED MORTALITY IN THE UNITED STATES

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

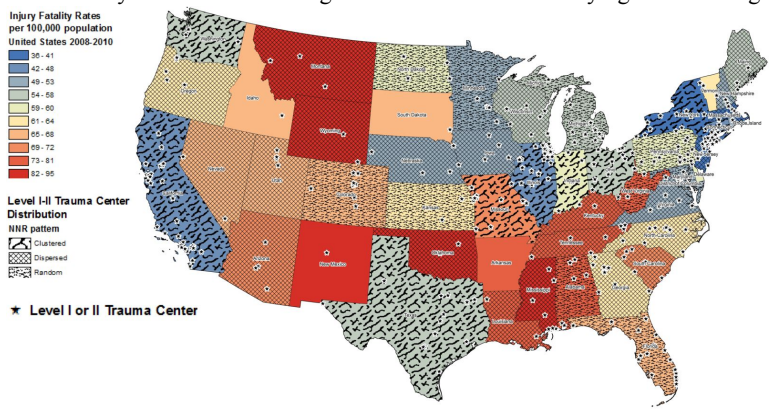
Invited Discussant: James Haan, MD

Introduction: Regionalized trauma care improves outcomes; however access to care is not uniform across the US. The objective was to evaluate whether geographic distribution of trauma centers is correlated with injury mortality across state trauma systems.

Methods: Level I and II trauma centers in the contiguous US in 2010 were mapped. State-level age-adjusted injury fatality rates per 100,000 people from 2008-10 were obtained. Fatality rates were evaluated for spatial autocorrelation using Moran's I. Nearest neighbor ratio (NNR) was obtained for each state. A NNR<1 indicates clustering while a NNR>1 indicates dispersion of state trauma centers. NNR were tested for significant difference from a random geographic distribution. Spearman correlation was performed between NNR and fatality rates. Mean fatality rate was compared between states with trauma center clustering vs dispersion. OLS and spatial-lag regression determined the association between fatality rate and NNR, controlling for state characteristics including ISS, air medical bases, income, education, and ratio of level I:II centers. Subgroup analyses were performed for firearm, violent, MVC, and TBI mortality.

Results: Injury fatality rates were spatially autocorrelated (Moran's I=0.35, p=0.001). Nine states had a clustered pattern (median NNR 0.55, IQR 0.48-0.60), 22 had a dispersed pattern (median NNR 2.00, IQR 1.68-3.99), and 10 had a random pattern (median NNR 0.90, IQR 0.85-1.00) of trauma center geographic distribution (7 states had ≤1 centers). Figure 1 illustrates fatality rates and geographic distribution pattern by state. Fatality rate and NNR had a small but significant correlation (r_S=0.34, p=0.03). Clustered states had a significantly lower fatality rate compared to dispersed states (53.5±9.9 vs 64.8±14.2, p=0.04). Spatial-lag regression outperformed standard OLS regression (LRT p=0.01) and demonstrated fatality rates increased 0.02 per 100,000 people for every 1 unit increase in NNR (p<0.01). Clustered states had lower fatality rates for MVC and TBI fatality rates, but not for firearm and violent fatality rates.

Conclusion: Geographic distribution of trauma centers appears to influence injury mortality with a more clustered pattern of state trauma centers associated with lower injury fatality rates. These results may have implications for trauma system planning and further study is needed to investigate the mechanisms underlying these findings.



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

IMPACT OF A STANDARDIZED PRE-HOSPITAL TRAUMA TRIAGE PROTOCOL IN A RURAL STATE

Alison Wilson* MD, Nicole Cornell MS, Sherry Rockwell RN, David Kappel MD, West Virginia University

Invited Discussant: Robert Winchell, MD

Introduction: Rural trauma systems are challenged by EMS variation. A standardized, statewide, pre-hospital triage protocol was adopted. This study was to evaluate the impact of implementation of the protocol.

Methods: Retrospective analysis of state trauma registry evaluating 2 years before (PRE) and after (POST) implementation of standardized statewide triage protocol.

Results: There were 11,182 patients in the PRE group and 11,419 in the POST group. There was ↑ of trauma activations based on physiology (9.8% vs 14.5%, p<.0001) and ↓ based on mechanism (p<.0003) or anatomy (p<.0010). Full trauma team activations (FTTa) after patient arrival were ↓ by 20% (p<.0039) with ↑ of FTTa before arrival (p<.04). There was no difference in partial team activations. FTTa prior to arrival who had an ISS<9 decreased (p<.0014). ED LOS for ventilated patients ↓ by 30 min (p<.0001). The # of pts transported from scene to Level 1,2 ↑ while those transported to Level 3,4 ↓ (p<.0061). Transfers ↓ by 3% (p<.038). In Level 3,4 hospitals, pts requiring mechanical ventilation (MV) ↓ 50% (p<.0001). Of MV patients, ED LOS ↓ 63 min (p<.0001). LOS for non-ventilated patients did not ↓. Pts. in Level 3,4 with an ISS>24 decreased by 1/3 (p<.0008) but no ↓ in mortality. Statewide mortality decreased by 6% (p<.03)

	PRE	POST	p value
Scene to Level 1,2	31.5%	33.0%	0.006
Transferred	5.25%	4.94%	0.038
FTTa after Arrival	4.1%	2.7%	0.0013
ED LOS (mean in min)	151	120	<0.0001
Statewide Mortality	1.9%	1.68%	0.038

Level 3,4	PRE	POST	p value
Scene to Level 3,4	18.0%	17.5%	0.006
ISS > 24	1.43%	.95%	0.0008
Mech. Vent (MV)	9.71%	4.3%	<0.0001
MV ED LOS (mean min)	199	136	<0.0001

Conclusions: A standardized, statewide EMS triage protocol was successfully implemented and resulted in improvement in FTTa prior to patient arrival and improved field triage to a higher level of care as seen by ↑ field transports to Levels 1,2 with ↓ in 3,4 and ↓ transfer rates. The # of severely injured patients at Level 3,4 ↓ with decreased ED LOS for MV pts. The reduction in statewide mortality equates to ≈ 25 lives per year.

Session: XB: Papers: 27-35
Paper 33: 4:00-4:20

PEDIATRIC GUNSHOT WOUND RECIDIVISM: IDENTIFICATION OF HIGH-RISK YOUTH

Peter Gibson MD, Adam D. Fox* DO, DPM, Irfan Ahmed MD, Rutgers-NJMS University Hospital

Invited Discussant: Jeffrey Upperman, MD

Introduction: Until recently, studies analyzing demographics and mechanisms of injury have not addressed the pediatric population. Although penetrating injury is the most common reason for pediatric trauma recidivism, there is a paucity of literature specifically looking at this population. With more than 11% of pediatric patients shown to not survive penetrating injuries, gunshot wounds (GSW) present a significant concern for children and their communities. The objective of this study was to identify those in the pediatric community at the highest levels of risk for suffering GSW on multiple occasions. Compiling patient demographic information, a population can be identified for implementation of appropriate interventions.

Methods: A retrospective review querying our urban level 1 trauma database was performed. Patients aged 0-18 sustaining GSW from 2000 to 2011 were selected. This was further refined to include those who returned to the hospital for another injury by firearm. Demographic data, including age of initial and subsequent presentation, gender, race, zip code, home address, and disposition of hospital stay were compiled. Local city data was compiled by zip codes as well as high schools within these areas. Demographics were analyzed for each patient domicile, proximity to local high schools, and the proximity to our level 1 trauma center.

Results: Over the 12 year study period 896 pediatric patients were discharged from the hospital after initial firearm injury with subsequent 8.8 % recidivism rate. All recidivists were male with the majority being African American (94.9 %). 14% of the time recidivists were between ages 13-15 and 86% were 16-18 at the time of first injury [Figure 1]. Recidivists overall mortality rate was 11.4 %. The subsequent incident occurs within the first year, two years, or three years 32%, 53% and 69% of the time respectively. Nine individuals in our study group suffered GSW on three separate occasions with a mortality rate of 22%. Regarding the domicile, 53 % of the patients were located in one of four zip codes which border one another and contain four public high schools. The remaining recidivists were dispersed throughout an area of 25 miles covering multiple school districts [Figure 2].

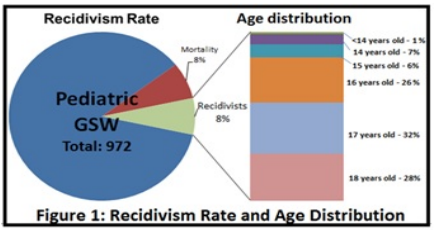


Figure 1: Recidivism Rate and Age Distribution

Conclusion: Recent data has shown that the trend of firearm violence is once again rising. This is a societal problem which cannot be ignored, and only through identifying those most at risk, can interventions be effective. Utilizing demographic data we have been able to identify an at-risk population where there is a greater than a one in twelve chance of getting shot multiple times. Also, we demonstrated a time frame in which the level of risk remains elevated. This study plays an important role in identifying an understudied at-risk population. Utilization of this type of demographic data can help target those at highest risk by allocating resources that can have the greatest impact on this societal burden.

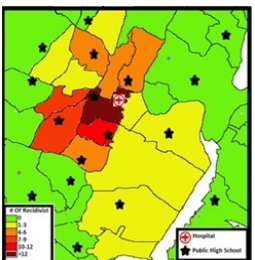


FIGURE 2: Geographic Distribution of Recidivists

Session: XB: Papers: 27-35
Paper 34: 4:20-4:40

TRENDS OF HOSPITALIZATIONS, DEATHS, AND COSTS FROM TRAUMA PATIENTS IN THE UNITED STATES, 2005-2010

ALVARO I. SANCHEZ ORTIZ MD, MS, ROBERT T. KRAFTY Ph.D., MAURICIO A. RAMIREZ MD, MATHEW ROSENGART* MD,MPH, ANDREW B. PEITZMAN* MD, JUAN CARLOS PUYANA* MD, University of Pittsburgh

Invited Discussant: Nicole Stassen, MD

Introduction: There have been studies reporting declines in injury specific trends over time in the United States (US); nonetheless, injuries remain an important public health problem for this country. To properly allocate resources, trauma related trends require updating and characterization across the US. We aimed to evaluate trends of yearly estimates of hospitalizations, deaths, and costs (adjusted for inflation over time) associated with hospitalized injury patients.
Methods: From six years (2005-2010) of the Nationwide Impatient Sample (NIS) database, patients with discharge diagnoses of trauma were analyzed. Patients with severe (injury severity score>16) and with penetrating trauma were also analyzed separately. Yearly odds of hospitalizations and deaths and yearly averages of log-transformed costs were assessed using multilevel regressions controlled for demographics, comorbidity measures, and hospital characteristics. Analyses were repeated by US regions.
Results: There were 2,752,514 hospital discharges of trauma patients, accounting for 5.7% of total NIS discharges during 2005-2010. Fall-related injury accounted for 45.2% of trauma patients. Hospitalizations increased significantly from 5.5% to 6.3% during 2005-2010 (OR 1.025, 95%CI 1.014-1.036, $p<0.001$). In penetrating trauma, hospitalizations increased significantly over time only in the South region (OR 1.026, 95%CI 1.017-1.036, $p<0.001$). Overall mortality was 2.5%; it decreased significantly over time (OR 0.976, 95%CI 0.970-0.983, $p<0.001$). For penetrating trauma, mortality increased significantly (OR 1.044, 95%CI 1.011-1.078, $p=0.008$) during 2005-2010. Median costs decreased from $10,236 in 2005 to $9,299 in 2010 ($\beta$ -0.025, 95%CI -0.025 -0.024, $p<0.001$), a trend that was consistent among all US regions.
Conclusion: Trends for trauma showed increased trends in hospitalizations but substantial reductions in mortality and costs, perhaps related to continuous improvements in trauma care across the US. However, there were some demographic and regional variations. Trauma patients are becoming more comorbid and uninsured. In addition, falls became the leading mechanism of injury. Finally, mortality for penetrating trauma is increasing significantly over time. More effective fall prevention programs may reduce the burden of trauma-related hospitalizations. Violence and injury prevention efforts and trauma resources will need to be directed to accommodate the increasing trends of penetrating trauma.

Session: XB: Papers: 27-35
Paper 35: 4:40-5:00

IMAGING PRIOR TO TRANSFER TO DESIGNATED PEDIATRIC TRAUMA CENTERS (PTCs) EXPOSES CHILDREN TO UNNECESSARY RADIATION

Yana Puckett MD, Matthew Caley MD, Shannon W. Farmakis MD, Louis W. Bonacorsi MD, Colleen M. Fitzpatrick MD, Kaveer W. Chatoorgoon MD, Jose Greenspon MD, Dennis W. Vane* MBA,MD, Cardinal Glennon Children's Medical Center
Invited Discussant: Stephen Kaminski, MD

Introduction:Pediatric trauma patients transferred to PTCs often have imaging at the originating hospital (OH) which is unnecessary based on Advanced Trauma Life Support (ATLS) guidelines or needs to be repeated because of technical issues. Additionally, the use of computed tomography (CT) has raised concerns about cancer risk from ionizing radiation leading many PTCs to adopt radiation dose reduction strategies. We hypothesized that pediatric trauma patients are exposed to unnecessary radiation from imaging prior to transfer.

Methods:A retrospective review was performed on all trauma patients who underwent CT imaging prior to transfer to our Level 1 PTC between 2010 and 2014. Data was collected on demographics, mechanism of injury, Glasgow Coma Scale (GCS), type of imaging, necessity for repeat imaging, appropriateness of imaging, and radiation dose delivered. Comparative radiation dosing was calculated using the dose length product (DLP [expressed in mcGy-cm]). In total, 1383 scans were performed prior to transfer. DLP data was not universally available from OH and for this reason we excluded all CT scans except CT of the Abdomen and Pelvis (CTAP) and CT of the Head (CTH). Scans were deemed clinically appropriate if they met ATLS guidelines (ATLS+) and not indicated if they did not meet ATLS indications (ATLS-). Some scans were repeated (ReCT) due to technical issues including lack of contrast when indicated, incomplete anatomical scan, poor quality. Median Δ DLP represents the difference in dosages patients received at OH vs. PTC. In instances where the study was not repeated, the comparison was made to standard calculated dosages for the same scan. Statistical Package for the Social Sciences (SPSS) software version 20 (SPSS, Chicago, IL) was used to perform statistical analysis.

Results:673 patients were analyzed. Average age was 11 years, and 65.4% were male.

	Total Overall	Median DLP PTC (Range)	Median DLP OH (Range)	Median Excess DLP	P-Value
Total Patients	673	217.6 (61.1-1139.8)	487.2 (134.3-2621.9)	269.6	<0.0001
Total CTAP	194	144.64 (61.12-1139.8)	407.68 (134.3-919.2)	376.69	0.004
Total CTH	528	228.11 (121.9-600.8)	797.50 (160-2289.5)	526.00	<0.001
CTAP ATLS+	152	146.0 (61.12-1139.8)	399.1 (134.3-2621.9)	253.1	0.005
CTAP ATLS+ ReCT	7	0.00 (0.0-0.0)	399.9 (149.1-399.9)	399.9	N/A
CTAP ATLS-	42	0.00 (0.0-0.0)	420.2 (256.7-546.5)	420.2	N/A
CTH ATLS+	514	224.8 (121.9-600.8)	726.4 (160.9-2289.5)	501.0	<0.0001
CTH ATLS+ ReCT	10	0.00 (0.0-0.0)	1072.1 (386.4-2289.5)	1072.1	N/A
CTH ATLS-	14	0.00 (0.0-0.0)	1053.9 (846.5-1261.2)	1053.9	N/A

Median DLP at PTC was 56.2% lower for all analyzed scans compared to OH ($p<0.0001$). Moreover, looking at relative decrease inradiation, DLP at PTC was 64.5% lower for CTAP and 71.4% lower for CTH. Children were exposed to a median radiation dose of 578.62 mcGy-cm for scans at OH that were completely unnecessary. Even when indicated (ATLS+) and technically correct, children received on average an additional 444.42 mcGy-cm of radiation at OH than they would have received had the scans been performed at PTCs using pediatric radiation reduction strategies.

Conclusion:Pediatric trauma imaging performed at transferring institutions often does not adhere to ATLS guidelines and exceeds required ionizing radiation dosages. These data indicate CT scanning of patients at OHs ultimately transferred to PTCs utilizing dose reduction strategies represents an area where pediatric radiation exposure is unnecessarily excessive. These data further confirm ATLS guidelines supporting prompt patient transfer without delay for imaging.

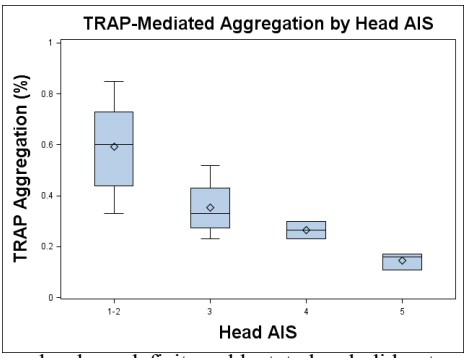
DEGREE OF PLATELET DYSFUNCTION CORRELATES WITH SEVERITY OF TRAUMATIC BRAIN INJURY: A PROSPECTIVE STUDY OF TRAUMA PATIENTS

Matthew T. Ramsey BS, Timothy C. Fabian* MD, Charles P. Shahan MD, John P. Sharpe MD, MS, Scott E. Mabry BS, Jordan A. Weinberg* MD, Martin A. Croce* MD, Lisa K. Jennings Ph.D., University of Tennessee Health Science Center - Memphis

Invited Discussant: Mitchell Cohen, MD

Introduction: Exsanguination associated with acute traumatic coagulopathy (ATC) is a leading cause of death following severe injury. While platelets occupy a pivotal role in clot formation, scant clinical research has been performed due to complexities resulting from the need for rapid handling and complex testing of platelet functions. While the thrombin pathway has been proposed as a mediator of platelet dysfunction in trauma, it has not been systematically investigated. The purpose of this study was to evaluate the thrombin pathway.

Methods: 40 trauma patients and 20 non-injured controls were enrolled in the study at a level one trauma center. Platelet aggregation was tested by light transmission aggregometry (LTA) with two agonists, adenosine diphosphate (ADP) and thrombin receptor agonist peptide (TRAP). Mean fluorescence intensity (MFI) and percent positivity of CD62 on ADP-activated platelets were evaluated using flow cytometry.



Results: Compared to healthy controls, trauma patients had significantly decreased ADP-(74% vs. 64%, p=.0003) and TRAP-mediated (72% vs. 47%, p<.0001) platelet aggregation, and ADP-mediated CD62 expression (65% vs. 43%, p=.0176). Platelet count was not significantly different. In trauma patients, TRAP-mediated aggregation was inversely proportional to Head AIS (figure, p=.0062).GCS was likewise inversely proportional to TRAP-and ADP-mediated aggregation. Measures of shock, including admission blood pressure, pulse, base deficit, and lactate level, did not correlate with any of the measures of platelet dysfunction.

Conclusions: Trauma patients have significantly lower levels of platelet activation and aggregation compared to healthy controls. Severity of head injury was significantly correlated with platelet dysfunction in a step-wise fashion. Our data suggest that the thrombin receptor pathway plays an important role in platelet dysfunction in trauma.

HISTONE DEACETYLASE GENE EXPRESSION PROFILES ARE ASSOCIATED WITH OUTCOMES IN BLUNT TRAUMA PATIENTS

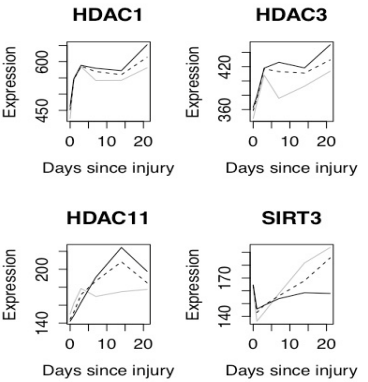
Martin Sillesen MD,Ph.D., Theodore Bambakidis BS, Simone Dekker BS, Rasmus Fabricius MD, Peter Svenningsen MD, Peter J. Bruhn BS, Lars B. Svendsen MD, Jens Hillingsø MD,Ph.D., Hasan Alam* MD, University of Michigan

Invited Discussant: Philip Efron, MD

Introduction: Treatment with histone deacetylase inhibitors (HDACI), such as valproic acid VPA, increases survival in animal models of trauma and sepsis. VPA is a pan-inhibitor that blocks most of the known HDAC isoforms. Targeting individual HDAC isoforms may increase survival and reduce complications, but little is known about the natural history of HDAC gene expression following trauma. We hypothesized that distinct HDAC isoform gene expression patterns would be associated with outcomes following trauma.

Methods: 28 day longitudinal HDAC leucocyte gene expression profiles in 172 blunt trauma patients were extracted from the Inflammation and Host Response to Injury (Glue Grant) dataset. Outcome was classified as complicated (death or no recovery by day 28, n=51) or uncomplicated (n=121). Mixed modeling was used to compare the HDAC expression trajectories between the groups, corrected for age, sex and Injury Severity Score. Weighted gene correlation network analysis (WGCNA) was employed to identify modules of genes with significant co-expression, and HDAC genes were mapped to these modules. Biological function of the modules that contained HDAC's was investigated using the Gene Ontology database.

Results: Elevated longitudinal HDAC expression trajectories were associated with complicated outcomes for HDAC1 ($p=0.02$), HDAC3 ($p<0.01$) and HDAC11 ($p=0.04$). In contrast, suppressed expression of SIRT3 was associated with adverse outcome ($p<0.01$) (figure). WGCNA analysis identified significant co-expression of HDAC and SIRT genes with other genes involved in ribosomal function and downregulation of protein translation in response to stress (HDAC1), T-cell signaling and T-cell selection (HDAC3) as well as coagulation and hemostasis (SIRT3). No co-expression of HDAC11 was identified.



28 day gene HDAC expression profiles of patients with complicated outcomes (solid black) or uncomplicated outcomes (solid grey). Dashed lines represent mean expression values.

Conclusion: This is the first study to describe longitudinal changes in HDAC expression in trauma patients. Expression trajectories of HDAC1, 3, 11 and SIRT3 correlate strongly with outcomes following trauma, and can thus serve as circulating biomarkers. They may also be promising targets for pharmacological intervention. The effects of HDAC and SIRT gene expression in trauma may be mediated through pathways involved in ribosomal and T-cell function as well as coagulation and hemostasis.

CHARACTERIZING THE GUT MICROBIOME IN TRAUMA: SIGNIFICANT CHANGES IN MICROBIAL DIVERSITY OCCUR EARLY AFTER SEVERE INJURY

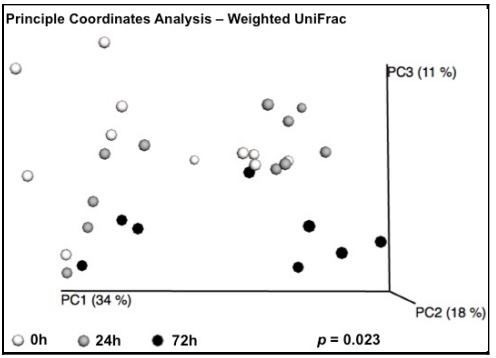
Benjamin M. Howard MD,MPH, Lucy Z. Kornblith MD, Amanda S. Conroy BA, Mary F. Nelson RN, MPA, Eric M. Campion MD, Rachael A. Callcut* MD, MSPH, Carolyn S. Calfee MD, MAS, Brandon J. Lamere MPH, Douglas W. Fadrosh MS, Susan V. Lynch Ph.D., Mitchell J. Cohen* MD, University of California, San Francisco

Invited Discussant: Lawrence Diebel, MD

Introduction: Multiple recent studies have demonstrated the vital influence of commensal microbial communities on human health and disease. The central role of the gut in the response to injury is well-described; however, no prior studies have used culture-independent profiling techniques to characterize the gut microbiome after severe trauma. We hypothesized that in critically injured patients, the gut microbiome would undergo significant compositional changes in the first 72 hours following injury.

Methods: Following IRB approval, trauma patient stool samples were prospectively collected via digital rectal exam at the time of presentation (0h). For injured patients who required admission to the ICU (n=12), additional stool samples were collected at 24h and/or 72h. Patients found to be uninjured served as controls (n=10). DNA was extracted from stool samples and PCR amplification targeting the16S rRNA gene was performed; amplicons were sequenced and binned into operational taxonomic units (OTUs; 97% sequence similarity). Beta-diversity was calculated and analyzed using Principle Coordinates Analyses, and negative binomial regression was used to determine significantly enriched OTUs.

Results: Critically-injured patients had a median Injury Severity Score of 27 and suffered polytrauma. At baseline (0h), there were no detectable differences in gut microbial community diversity between injured and uninjured patients. Injured patients developed changes in gut microbiome composition within 72h, characterized by significant alterations in phylogenetic composition and taxon relative abundance (Weighted UniFrac p=0.023, Figure).



Differences in enriched taxa at 0h vs. 72h showed that the distribution of OTUs changed significantly over time. Members of the bacterial orders Bacteroidales, Fusobacteriales, and Verrucomicrobiales were depleted over 72h, whereas Clostridiales and Enterococcus members enriched significantly.

Conclusion: In this first study of the gut microbiome after trauma, we demonstrate that significant changes in phylogenetic composition and relative abundance occur in the first 72h after injury. This rapid change in intestinal microbiota represents a critical and previously unrecognized phenomenon that may influence clinical course and outcomes following severe trauma. The gut bacterial community is known to modulate inflammation and is related to a range of clinical outcomes. A better understanding of the nature of these post-injury changes may lead to the ability to intervene in otherwise pathological clinical trajectories.

Session: XIIIA: Critical Care/Shock Papers 36-45
Paper 39: 2:30-2:50

AN EARLY DECISION MODEL PREDICTS THE NEED FOR UNCROSSED MATCHED BLOOD (UnXRBC) AND MASSIVE TRANSFUSION (MT) FOLLOING TRAUMA

Deborah M. Stein* MD,MPH, Peter F. Hu Ph.D., Colin Mackenzie MD, Shiming Yang Ph.D., Stephen T. Bartlett MD, Thomas M. Scalea* MD, R Adams Cowley Shock Trauma Center
Invited Discussant: Bryan Cotton, MD

Introduction: Hemorrhage is the leading cause of potentially preventable death following injury. Continuous automated vital signs (VS) have been shown to predict outcome and need for intervention better then manually recorded VS. Early blood use is associated with improved outcomes, but recognizing the need for uncrossmatched blood (UnXRBC) or predicting need for massive transfusion (MT) in patients with hemorrhagic shock can be challenging. Manually recorded field or admission VS often underestimate shock. A validated predictive model could accelerate decisions and save lives. We compared mathematical models using field and admission ED VS versus continuously recorded VS collected in the first minutes after admission.
Methods: We modeled data collected on adult trauma patients admitted to a level one trauma centerover a three-year period for 3 outcomes: need for UnXRBC, need for >4 units of blood within 4 hours (MT1) and need for >=10 units within 24 hours (MT2). In addition to field and admission VS (systolic blood pressure SBP and heart rate HR), continuous VS were collected and shock index (SI) were calculated every 2 seconds post admission. VS features including mean, max, min, dose of SBP<90, HR>120 and SI>1 were calculated for 5, 10 and 15 minutes after admission. Five models were then constructed. All models used age, and gender. Model 1 used field VS to predict need for UnXRBC, MT1 and MT2. Model 2 used admission VS. Models 3, 4 and 5 used continuous VS features over 5, 10 and 15 minutes, respectively. Area under receiver operating characteristic curves (AUROC) were used to evaluate predictive power.
Results: 10,636 patients with over 5 million continuous VS data points within 15 minutes of trauma admission were analyzed. Patients were predominantly male (68%) with mean age of 42.9 ±19 years and 23% had Injury Severity Score >=15. Among all patients 4.1%, 2.2% and 1.3% received UnXRBC, MT1 and MT2 respectively. There was no difference in Model 1 or 2's ability to predict UnXRBC (AUROC=0.77, 0.80), MT1 (0.81, 0.82) or MT2 (0.82, 0.83). Predictive ability was significantly improved as duration of VS monitoring increased and was significantly better with continuous VS Model 3 (0.83, 0.85, 0.86), Model 4 (0.86, 0.87, 0.88) and Model 5 (0.87, 0.89, 0.91) to predict UnXRBC, MT1 and MT2, respectively, compared to Models 1 and 2.

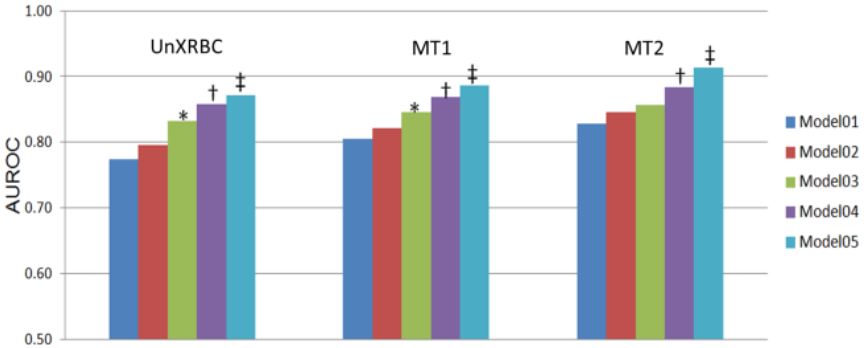


Figure-Continuous VS versus field and ED VS. * Model 3 significantly better than Models 1 and 2.† Model 4 significantly better than Models 1 through 3. ‡ Model 5 significantly better than Models 1 through 4

Conclusion: Models using continuous VS improve prediction for the need for UnXRBC or MT in patients with hemorrhagic shock. Computer generated decision trees generated from automated continuous VS can identify the need for emergency blood use and direct earlier blood product administration, potentially saving lives.

Session: XIIIA: Critical Care/Shock Papers 36-45
Paper 40: 2:50-3:10

BMI STRONGLY IMPACTS THE DIAGNOSIS AND INCIDENCE OF HIT IN THE ICU

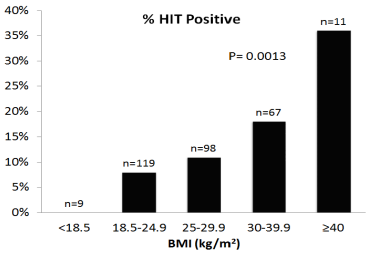
Matthew B. Bloom* MD, Andrea A. Zaw MD, David M. Hoang MD, Tong Li BS, Bansuri Patel BS, Eric J. Ley* MD, Daniel R. Margulies* MD, Cedars-Sinai Medical Center

Invited Discussant: Adrian Maung, MD

Introduction: Obesity has been linked to various immune-mediated conditions, including rheumatoid arthritis, systemic lupus erythematosus, and inflammatory bowel disease. Our objective was to examine the association of body mass index (BMI) with diagnosis of heparin-induced thrombocytopenia (HIT).

Methods: Prospectively collected data on patients in the surgical and cardiac ICU between January 2007 and August 2014 presumed to have HIT by clinical suspicion were reviewed. Patients were categorized into 5 BMI groups as underweight (<18.5), normal (18.5-24.9), overweight (25-29.9), obese (30-39.9), morbidly obese (≥40). Demographic and clinical data including Warkentin 4T scores, anti-platelet factor 4 (PF4 OD), Serotonin Release Assay (SRA), and thromboembolic diseases were recorded. HIT positive patients were defined as having SRA>20%. 2-sided Cochran-Armitage Trend Test was used evaluate an ordered association between BMI and HIT.

Results: A total of 304 patients met inclusion criteria. Mean age was 62.1 ± 16.5 years, 59% were male, and mean BMI was 27 ± 6 kg/m^2. 36 (12%) were positive for HIT. Incidence of HIT increased progressively with BMI [0%, 8%, 11%, 18%, 36%; P = 0.0013] (Figure 1). Compared to patients with normal BMI, patients with BMI 30-39.9 had a 170% increase in the odds for HIT [OR = 2.67, 95% CI = 1.06-6.71, P = 0.037], while patients with BMI ≥40 had a 600% increase [OR = 6.98, 95% CI = 1.72-28.43, P = 0.0067]. Using a logistic regression model, each 1 unit increase in BMI was associated with a 7.7% increase in the odds of HIT (P=0.0034). PF4≥2.0 also increased with BMI (P=0.0003), while PF4≥0.4 and PF4≥0.8 did not reach significance. In-hospital mortality increased significantly with BMI above normal (P = 0.026). Warkentin 4T scores, DVT, PE, and stroke did not correlate with changes in BMI. Male/female ratios were similar across the groups.



Conclusion: Not previously described, increasing BMI appears to be strongly associated with increased rates of HIT in ICU patients. Obesity is an important new clinical variable for estimating the pre-test probability of HIT, and patient "Thickness" may be a 5th "T". Additional biochemical work is indicated to decipher the role of obesity in this immune-mediated condition.

	BMI kg/m^2					
	<18.5 (n=9)	18.5-24.9 (n=119)	25-29.9 (n=98)	30-39.9 (n=67)	≥40 (n=11)	P
PF4>0.4	89%	61%	62%	76%	91%	0.063
PF4>0.8	33%	28%	32%	34%	55%	0.135
PF4>2.0	0	4%	12%	21%	18%	0.0003 *
DVT	22%	40%	38%	36%	36%	0.898
PE	11%	18%	13%	7%	9%	0.062
Stroke	0	3%	1%	0	0	0.196
Mortality	33%	25%	26%	39%	55%	0.026 *

LOW INTENSITY EXERCISE IN ACUTE PHASE IMPROVES LIPID METABOLISM AND SURVIVAL OF LPS-INDUCED SEPTIC MICE VIA ACTIVATION OF PGC-1 ALPHA EXPRESSION

Takayuki Irahara MD, Norio Sato* MD,Ph.D., Kosuke Otake MD, Kazuo Inoue Ph.D., Kaoru Koike* MD,Ph.D., Tohru Fushiki Ph.D., Hiroyuki Yokota* MD,Ph.D., Graduate School Of Emergency And Critical Care Medicine, Nippon Medical School

Invited Discussant: Paul Bankey, MD, PhD

Introduction:

Regarding the effect of exercise during critical illness such as sepsis, it is reported to be beneficial to exercise prior to the onset or in late phase for reducing inflammatory response or for rehabilitation. However, the effect of exercise for the pathophysiology of sepsis in acute phase after the onset is unclear. We investigated the alteration of energy substrate metabolism and survival proportions when LPS-induced septic mice were exercised with low intensity in acute phase, and also examined PGC-1 alpha, the important factor of lipid metabolism.

Methods:

C57BL/6 mice were divided into 4 groups. Control (C) group given normal saline, low dose (L) group given LPS 1mg/kgBW, medium dose (M) group given LPS 5mg/kgBW and high dose (H) group given LPS 10mg/kgBW intraperitoneally (n=15-16 per group). Furthermore, each group was divided into sedentary (SED) or exercise (EX) group (n=7-8 per group), and EX groups were exercised on the treadmill (12m/min, 0°, 30min) three times in the first day and twice in the second and third day after LPS administration. Survival proportions and other vital reactions were measured and indirect calorimetry by respiratory gas analysis was performed until 72 hours. Organ weight and lipid levels in plasma and liver were also measured. We further evaluated mRNA and protein expression of PGC-1 alpha by quantitative PCR and western blotting.

Results:

Survival proportions of H-EX were significantly improved compared with H-SED (100% vs 50%, $p<0.05$). Fatty acid oxidation (FAO) was significantly decreased at 16hrs after LPS administration in M, H-SED, and tend to increase in all EX groups. FAO of H-SED survived mice (n=4) and H-EX survived mice (n=8) at 16hrs after LPS administration were almost equal (15.1±2.7mg/kg/min and 15.2±1.5) and they were significantly higher than FAO of H-SED non-survived mice (n=4) (vs 9.0±0.4, $p<0.01$), suggesting FAO is related to survival. Epididymal fat weight was markedly decreased in all EX groups compared with SED, on the other hand, lipid levels in plasma and liver were elevated in all EX groups. These results suggest exercise induces lipid to be carried from endogenous fat into blood and liver as the energy source. The mRNA and protein expression of PGC-1 alpha were decreased in L, M, H-SED compared with C-SED, and significantly increased in all EX groups.

Conclusion:

Our study suggests the mechanism that low intensity exercise in acute phase improves lipid metabolism and survival of LPS-induced septic mice via activation of PGC-1 alpha expression. It's a revolutionary finding that exercise in acute phase after the onset might have the therapeutic effect for the pathophysiology of sepsis.

Session: XIIIA: Critical Care/Shock Papers 36-45
Paper 42: 3:30-3:50

EARLY INITIATION OF EXTRACORPOREAL MEMBRANE OXYGENATION IMPROVES SURVIVAL IN ADULT TRAUMA PATIENTS WITH SEVERE ACUTE RESPIRATORY DISTRESS SYNDROME

Patrick L. Bosarge MD, Lauren A. Raff MD, Gerald McGwin Jr., Ph.D., Shannon L. Carroll MD, Enrique Diaz-Guzman MD, Jeffrey D. Kerby* MD,Ph.D., University of Alabama Birmingham

Invited Discussant: Robert Maxwell, MD

Introduction: The use of extracorporeal membrane oxygenation (ECMO) in the trauma population has been reported to have a mortality benefit in patients with severe refractory hypoxic respiratory failure. This study compares the early initiation of ECMO for management of severe Acute Respiratory Distress Syndrome (ARDS) versus a historical control immediately preceding the use of ECMO for trauma patients.

Methods: A retrospective study was conducted at a single high volume American College of Surgeons verified Level I trauma center with a dedicated 28 bed trauma burn intensive care unit. The study population was limited to trauma patients diagnosed with severe ARDS using the Berlin definition (PaO2/FiO2 [P/F] ratio <100). Within this population, two groups of patients were selected: patients managed with either ECMO or conventional ventilation (CONV). The criteria for patients being placed on ECMO were severe ARDS with refractory hypoxia despite maximal mechanical ventilation (limited by ARDSnet standards). The primary outcome of interest was mortality; secondary outcomes included hospital LOS, ICU free days, and ventilator free days.

Results: Fifteen ECMO patients managed from March 2013 to November 2014 were identified as were fourteen CONV patients managed from March 2012 to February 2013 who met the Berlin definition of severe ARDS. Age (ECMO mean [SD], 39.2 [16.9] years; CONV 36.6 [13.7] years; $p = 0.65$) and Injury Severity Scores (ECMO 28.6 [18.2]; CONV 28.4 [9.7]; $p = 0.97$) were similar between the groups. Length of stay (ECMO 61.9 [48.1] days; CONV 40.1 [37.1] days; $p = 0.19$), ICU free days (ECMO 6.9 [9.1] days; CONV 7.7 [14.6] days; $p = 0.86$), and vent free days (ECMO 17.6 [28.9]; CONV 10.1 [17.4] days; $p = 0.41$) were not statistically significant between the groups. Mortality in the ECMO group was significantly reduced compared to the CONV group (ECMO 14.3%; CONV 64%; $p = 0.018$). Timing from the onset of severe ARDS to ECMO intervention occurred at a mean 1.9 [1.4] days; mean days on ECMO was 8.1 [5.2] days.

Conclusion: Patients that were treated with ECMO for severe ARDS had an improved mortality compared to historical controls. ECMO should be considered at the early onset of severe ARDS to improve survival.

Session: XIIIA: Critical Care/Shock Papers 36-45
Paper 43: 3:50-4:10

INHIBITION OF HISTONE DEACETYLASE 6 RESTORES INNATE IMMUNE CELLS IN BONE MARROW IN A LETHAL SEPTIC MODEL

Zhao Ting, MD, Yongqing Li MD,Ph.D., Baoling Liu MD, Ihab Halaweish MD, Hasan Alam* MD, University of Michigan

Invited Discussant: Eileen Bulger, MD

Introduction: We have previously demonstrated that Tubastatin A (Tub A), a selective inhibitor of histone deacetylase (HDAC) 6, improves survival, and increases circulating monocyte count and bacterial clearance in a lethal model of cecal ligation and puncture (CLP) in mice. The aim of the present study was to characterize the effects of inhibition of HDAC6 on the bone marrow cell population.

Methods: C57BL/6J mice were subjected to CLP, and 1 h later given an intraperitoneal injection of either Tub A (70 mg/kg) dissolved in dimethyl sulfoxide (DMSO), or DMSO only (n=9/gr). Sham-operated animals were treated in an identical fashion, without CLP. Forty-eight hours later, bone marrow cells were flushed out from the femurs and tibias. Erythrocytes were lysed, and a single-cell suspension was made for analysis. Cells were washed, blocked with anti-mouse CD16/32, and stained with anti-mouse B220 PE-Cy7, CD3 APC-eFluor® 780, CD11b FITC, Gr-1 PerCP-Cy5.5 and F4/80 Antigen APC, and subjected to flow cytometry. Data was acquired on an LSRII Flow Cytometer (BD Biosciences) and analyzed with FlowJo (Flowjo, LLC).

Results: In comparison to the sham group, CLP animals showed decreased percentage of innate immune cells (CD11b+; 62.1±3.1 vs. 32.9±4.9%, p=0.0025; **Figure 1**) and macrophages (CD11b+ F4/80+; 44.6±3.4 vs. 19.8±2.6%, p=0.0002), and increased percentage of T lymphocytes (CD3+; 1.1±0.2 vs. 3.3±0.4%, p=0.0082) in the bone marrow 48 h after CLP. Treatment with Tub A restored the innate immune cells (32.9±4.9 vs. 54.0±4.1%, p=0.0112; **Figure 1**) and macrophages (19.8±2.6 vs. 47.1±4.6%, p=0.0001), and increased the percentage of neutrophils (CD11b+ Gr-1+; 28.4±3.9 vs. 48.0±4.0%, p=0.0075). The percentages of B (B220+) and T lymphocytes were not significantly altered by Tub A, compared to the vehicle-treated CLP animals.

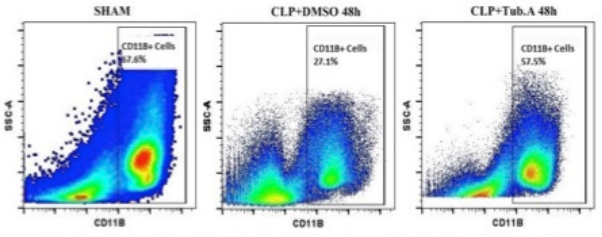


Figure 1. Tubastatin A restores the percentage of innate immune cells in bone marrow after CLP.

Conclusion: Selective inhibition of HDAC6 in this lethal septic model restored the innate immune cell and macrophage populations, and increased the neutrophil composition in the bone marrow. These results may explain the previously reported beneficial effects of Tub A treatment in a septic model.

Session: XIIIA: Critical Care/Shock Papers 36-45
Paper 44: 4:10-4:30

MODULATING THE ENDOTHELIOPATHY OF TRAUMA: FACTOR CONCENTRATE VS FRESH FROZEN PLASMA

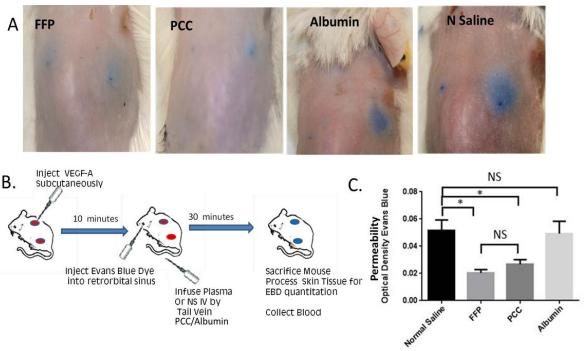
Shibani Pati MD,Ph.D., John B. Holcomb* MD, Martin A. Schreiber* MD, Blood Sytems Research Institute

Invited Discussant: Juan Duchesne, MD

Background: Transfusion of balanced ratios of plasma to platelets and red blood cells has been shown to reduce death from exsanguination in trauma patients. Aside from hemostasis, recent work has shown that plasma reduces vascular endothelial permeability, inflammation and organ edema after hemorrhagic shock, all components of the endotheliopathy of trauma (EOT) that develops soon after hemorrhagic shock and trauma. Plasma complex concentrates (PCCs) have been proposed as a replacement for plasma in trauma patients to stop uncontrolled bleeding. Based on these clinical observations, we hypothesized that PCCs could have protective effects on the EOT compared to plasma. We investigated this possibility using an established and novel in vivo model of vascular endothelial compromise.

Methods:***In vivo*:** A modified Miles assay was used in 8-10 week old NSG mice to study the effects of PCC and FFP on vascular permeability induced by relevant factors such as VEGF-A. (see **Figure B** model). Isoflurane-anesthetized mice were injected with FFP (200 ul), PCC (50 U/kg) or Albumin (6mg/kg- the amount in PCC) by tail vein. Control mice were treated with normal saline (NS). VEGF-A (100 ng) was injected in the dorsal skin of the mice to induce subcutaneous vascular leak of Evan's Blue Dye. 100 µl of a 0.5% Evans blue dye was injected into the retro-orbital sinus. Quantitative and qualitative vascular leak was assessed by the accumulation of Evans blue dye into the injection site for VEGF-A. Quantitation of extracted dye was conducted at 620 nm. Statistical analysis was conducted by paired t- test.

Results: ***In vivo*:** We found that PCC and FFP both significantly inhibited vascular permeability induced by VEGF-A compared to NS. Permeability levels for Control vs. FFP was 0.05 +/- 0.01 vs. 0.018 +/-0.004 $p<0.05$, Control vs. PCC was 0.05 +/- 0.01 vs. 0.020 +/- 0.008, $p<0.05$. PCC vs. Albumin was 0.02 +/- 0.008 vs. 0.05 +/- 0.01, $p<0.05$. FFP vs PCC was not significant. Albumin vs. Control was not significant. (**Figure A&C**)



Conclusion: We found that FFP and PCC equivalently inhibit vascular permeability, whereas albumin did not affect permeability. These beneficial effects of PCC may be due in part to modulation of vascular stability by soluble factors present in factor concentrate rather than the clotting factors. The identity of these factors is currently unknown but warrants further investigation.

Session: XIIIA: Critical Care/Shock Papers 36-45
Paper 45: 4:30-4:50

HISTONE-COMPLEXED DNA LEVELS ARE ASSOCIATED WITH COAGULOPATHY, INFLAMMATION AND ENDOTHELIAL DAMAGE EARLY AFTER PEDIATRIC TRAUMA

Sarah C. Christiaans MD, Robert T. Russell MD,MPH, Tate Nice MD, Heather Edenfield RN, Vince Mortellaro MD, Jean-Francois Pittet MD, University of Alabama Birmingham

Invited Discussant: Hasan Alam, MD

Introduction:

The release of damage-associated molecular pattern molecules (DAMPs) after injury has been suggested to activate innate immunity and may form a key link between inflammation and coagulation in trauma. We aimed to study the presence of circulating DAMPs in the form of histone-complexed DNA (hcDNA) in our pediatric trauma population and investigated the association between hcDNA, trauma induced coagulopathy, inflammation and endothelial damage.

Methods: We conducted a prospective cohort study of pediatric trauma patients at a level 1 pediatric trauma hospital. Inclusion: highest level trauma activation and arrival within 6 hours of injury. Exclusion: >18 years of age, burns > 20% TBSA and primary asphyxiation. Blood samples were collected within 20 minutes of arrival, analyzed for hcDNA and linked to biomarkers of hypoperfusion, coagulopathy, fibrinolysis, endothelial glycocalyx shedding, complement and outcome. In addition platelet function was assessed by measuring platelet responsiveness to adenosine diphosphate (ADP) and thrombin receptor-activating peptide (TRAP) using multiple electrode impedance aggregometry.

Results: A total of 120 consecutive patients were enrolled. The mean age was 9.16 ± 10.73 years with 84% sustaining blunt trauma. Mean injury severity (ISS) was 25±20 and overall mortality was 12%. The median hcDNA level at admission was 4.49 AU. HcDNA levels were higher in patients with ISS >25 versus <25 (5.5 AU ± 4.7 vs 3.6 AU ± 3.6 $p<$ 0.0258) and in patients with a base deficit <6 mEq/L versus >6 mEq/L (6.9 AU ±4.7 vs 3.6 AU ±3.4 $p < 0.0001$). The overall incidence of coagulopathy, defined by PT ratio >1.2 was 26%. Coagulopathic patients had higher levels of hcDNA (6.3AU ±4.8 vs 4.1AU ±3.8 $p <0.0143$). Patients with aggregometry levels below normal range for ADP and TRAP had significantly higher levels of hcDNA (ADP 5.3 AU ±4.2 vs 3.7 ±3.6 AU $p < 0.0243$ and TRAP 4.8 AU ±4.0 vs 2.6 AU ±3.0 $p < 0.0003$). HcDNA levels correlated with fibrinolytic marker D-dimer, syndecan-1 and terminal complement complex (sC5b-9) (all $p < 0.0001$). Finally, significantly higher hcDNA levels were seen in non-survivors versus survivors, 7.0 AU ±3.9 and 4.2 AU ±3.7 respectively ($p <$ 0.0105).

Conclusion:

HcDNA levels are elevated in response to injury and correlate with coagulopathy, inflammation and endothelial damage observed early after severe pediatric trauma.

Session: XIIIB: Papers 46-55
Paper 46: 1:30-1:50

GERIATRIC TRAUMA: COGNITIVE IMPAIRMENT AND PHYSICAL FRAILTY PREDICT 6-MONTH OUTCOMES

Cathy A. Maxwell Ph.D., Kaushik Mukherjee* MD, Mary S. Dietrich Ph.D., Addison May* MD, Lorraine C. Mion Ph.D., Ann Minnick Ph.D., Richard S. Miller* MD, Vanderbilt University

Invited Discussant: Anne Mosenthal, MD

Introduction: Frailty and cognitive decline predict poor outcomes of hospitalization but their influence on 6-month outcomes after injury for those surviving to discharge is unreported. We hypothesized that pre-injury physical frailty and cognitive decline would be predictive of functional decline and overall mortality in geriatric trauma patients at 6-month post-hospitalization.

Methods: Design: Prospective cohort study. Sample: Patients ≥ age 65 admitted to a level I trauma center between October 2013 and March 2014 with a primary injury diagnosis. Procedure: Research assistants interviewed surrogates of 188 patients within 48 hours of hospital admission to determine pre-injury cognitive and physical function impairments using previously validated brief screening instruments (i.e., Alzheimer Dementia screen [AD8], Vulnerable Elder Survey [VES-13], Barthel Index [BI]). Additional variables, including demographics, injury severity and co-morbidities were obtained from the medical record. Follow-up phone calls were made at 6-months to determine post-hospitalization status and outcomes. Of those, 34 (19%) died, either in the hospital or within 6-months of discharge: 138 of the remaining 146 completed the cognitive and frailty measures 6-month after discharge. Data Analysis: descriptive statistics, multivariate linear and logistic regression.

Results: Pre-injury (N=180). Mean age: 77.6 (SD 9.0), Median ISS: 10 (IQR 9-17), Mechanism: Falls-124 (69%), MVC-45 (25%), Pre-injury impairments: cognitive impairment (AD8 >/= 2): n=93 (52%), physical frailty (VES-13 /= 3): n=122 (68%). After controlling for pre-injury functional status, univariate predictors of functional status 6-months post-discharge included age (*beta*=-0.19.*p*=0.003), pre-injury cognitive status (AD8: *beta*=-.25,*p*<0.001), and pre-injury frailty (VES-13: *beta*=-0.38.*p*<0.001), but not comorbidities or injury severity (ISS)($p > 0.05$). A multiple regression analysis that included all the prior variables except age (which is included in the VES-13) revealed that pre-injury cognitive impairment appeared to be a stronger predictor of function 6-months post-discharge than did pre-injury frailty status (AD8: *beta=-0.37*, *p*<.001 vs. VES-13: *beta=-0.26*, *p*=0.002). Thirty of 34 (88%) patients who died in the hospital or by 6-months, screened positive for pre-injury frailty (VES-13); and 20 of 34 (59%) screened positive for both pre-injury frailty and cognitive impairment (AD8).Age (OR=1.08,95% CI=1.02-1.13*p*=0.004), injury severity (ISS: OR=1.08,95% CI=1.02-1.14,*p*=0.004),and pre-injury functional status (BI: OR=0.84,95% CI=0.74-0.94,*p*=0.003) were uniquely contributive to the likelihood of mortality by 6-months post-discharge.

Geriatric Trauma 6-Month Mortality (N=34)			
		Physical Frailty (VES-13 >/=3)	
		No	Yes
Cognitive Impairment (AD8 >/=2)	No	3/53 (6%)	10/40 (25%)
	Yes	1/10 (10%)	20/77 (26%)

Conclusion: Pre-injury cognitive impairment and frailty are prevalent in geriatric trauma patients and predict poor outcomes after injury. Screening patients for pre-injury impairments may help to select patients at high risk for poor outcomes.

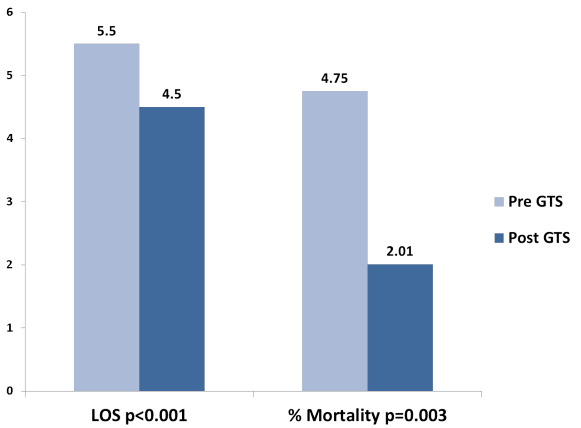
Session: XIIIB: Papers 46-55
Paper 47: 1:50-2:10

CREATION OF A GERIATRIC TRAUMA SERVICE SIGNIFICANTLY DECREASES MORTALITY AND HOSPITAL LENGTH OF STAY

Douglas J.E. Schuerer* MD, Robert Winfield* MD, Julie Nash RN, MSN, Cristina Loomis RN, William Carroll CSTR, Grant Bochicchio* MD, Washington University in St. Louis

Invited Discussant: Jeffrey Young, MD

Introduction: As our elderly population continues to grow, trauma centers must prepare for this influx of older patients with multiple co-morbidities. We identified in our trauma center that the majority of these older patients were admitted to other specialty services which lead to delay in care and potentially a higher morbidity and mortality. The objectives of this study were to determine whether the implementation of a comprehensive Geriatric Trauma Service (GTS) would impact the outcome of these patients. **Methods:** A quasi-experimental time interrupted series design was performed in which prospective data was collected in 2012 on all geriatric trauma patients (Pre GTS) with mild to moderate injury > 55 years of age followed by an implementation period of 9 months. A 15 month post implementation phase (Post GTS) was then evaluated. During the implementation phase, we worked with a multidisciplinary team to develop our GTS. Key elements were: 1) Hire and train nurse practitioners to run the service with trauma attending supervision, 2) Develop a GTS team based (instead of floor based) social work and case management group, 3) Hire more therapy personnel and change shifts to ensure therapy intensity including weekends, 4) Identify appropriate patients and ensure admission to the geriatric trauma service, 5) Develop standard treatment protocols for care, including Beers medication review, 6) Develop protocols with anesthesia for efficient pre-operative work up and expedited time to the OR, and 7) Communicate with PCP before discharge. We compared the outcome of the Post GTS group to the Pre GTS group. **Results**: There were a total of 652 patients in the Pre-GTS group compared to 782 patients in the Post GTS group. There was no significant difference in ISS and gender between the 2 groups, however the post GTS patients were significantly older (78 vs 74.5years, p=0.0001). Most importantly, there was a significant decrease in mortality (p=0.003) and hospital length of stay (LOS) (p<0.001) in the Post GTS group. (Fig). **Conclusion**: The implementation of a comprehensive GTS at our institution significantly decreased mortality and LOS, despite an older population and similar baseline characteristics.



Session: XIIIB: Papers 46-55
Paper 48: 2:10-2:30

25 YEARS LATER: MESS (MANGLED EXTREMITY SEVERITY SCORE) REVISITED

Yasaman Kavousi Shahram Aarabi MD,MPH, Jeffrey B. Friedrich MD, Niten Singh MD, Eileen M. Bulger* MD, Harborview Medical Center

Invited Discussant: Mark Midwinter, CBE, QHS, MD

Introduction:

Mangled Extremity Severity Score (MESS) was developed at our institution 25 years ago and has been a widely used scoring system for prediction of lower extremity amputation after trauma. Here we re-evaluate MESS using a contemporary cohort of patients at our institution, in order to evaluate its continued usefulness given the many changes in clinical care over the past three decades. Further, we look the prognostic value of MESS with regards to cost and resource utilization.

Methods:

A retrospective review of all trauma patients >18 years of age admitted to our institution with extremity injury and ischemia requiring revascularization between 2011 and 2014. Data sources included direct chart review, institutional trauma registry, and institutional financial records. Logistic and linear regression analyses were performed to evaluate the correlation of MESS with need for eventual amputation (primary outcome) as well as with length of stay, number of inpatient procedures, hospitalization cost, and discharge status (secondary outcomes). Statistical analyses were performed using JMP 11.0 software (SAS International Inc., Cary NC).

Results:

Between April 2011 and October 2014, a total of 48 trauma patients with lower extremity injury requiring revascularization were identified (mean age 37 years, range 18-87 years). 85% of patients were male and 46% had blunt mechanism of trauma. Of the 48 extremity injuries, 39 (81%) were ultimately salvaged (mean MESS 4.8 ± 1.3) and 9 (19%) required amputation (mean MESS 9.1 ± 1.3). Mean MESS between these groups showed statistically significant difference ($p<0.0001$) and MESS≥8 predicted amputation in 100% of patients. For amputated patients, definitive amputation occurred at a range of 1 to 14 days after injury. Furthermore, MESS was an independent direct predictor of cost of hospitalization ($p=0.0195$), hospitalization length ($p=0.0039$), and number of inpatient procedures performed ($p=0.0020$). Finally, patients with MESS≥8 who did not undergo early amputation, went on to delayed amputation with average 4.4 day longer hospitalization ($p=0.0053$), 4.9 more inpatient procedures performed ($p=0.0065$), and a trend towards increased hospital costs compared with controls.

Conclusion:

MESS remains a clinically reliable yet simple scoring system to assist with early prognosis of trauma patients with serious extremity injuries. Over the past 25 years, mean MESS for salvaged and amputated limbs has not changed. However, the threshold for MESS predicting 100% need for eventual amputation *has* increased, possibly due to improvements in clinical care. Further, we find that MESS is an independent direct predictor of hospitalization cost and resource utilization in our contemporary cohort. Patients with high MESS who do not undergo early amputation, go on to delayed amputation with increased morbidity and cost of care.

Session: XIIIB: Papers 46-55
Paper 49: 2:30-2:50

CLASSIFICATION OF SOFT-TISSUE INJURIES IN OPEN FEMUR FRACTURES: RELEVANT FOR SYSTEMIC COMPLICATIONS?

Christian D. Weber MD, Rolf Lefering Ph.D., Thomas Dienstknecht MD, Philipp Kobbe MD, Richard M. Sellei MD, Frank Hildebrand MD,Ph.D., Hans-Christoph Pape* MD, FACS RWTH Aachen University

Invited Discussant: Sharon Henry, MD

Introduction: A broad range of systemic complications has been described to occur in patients with open major fractures. Various causes have been claimed to play a role. We therefore surveyed a nationwide trauma registry to assess risk factors associated with open femur fractures and concomitant soft-tissue injuries.
Methods: Cohort study in a nationwide population-based prospective database.Inclusion criteria for selection from database: individuals with an Injury Severity Score ≥9 points, age ≥16 years, femur fracture and survival until primary admission. Two main groups: closed (CFF) and open femur fracture (OFF). Patient demographics, injury severity, surgical fracture management, length of stay (LOS) and systemic complications (e.g. multiple organ failure (MOF), sepsis, mortality) were collected and statistically analyzed using SPSS statistics. Linear regression analysis was performed to stratify subgroups for the degree of open soft-tissue injury according to Gustilo and Anderson.
Results: Among 32582 documented trauma victims (01/01/2002-31/12/2010), a total of 5761 met the inclusion criteria (mean NISS 30±14 points). Main groups: 4423 CFFs (76.8%) and 1338 OFFs (23.2%). Open fracture subgroups were divided into I° (334, 28.1%), II° (526, 44.3%) and III° (328, 27.6%). Despite lower ISS values (p=0.017), open fractures were associated with an increased risk for pre-hospital hemorrhagic shock (CFF 22.4%, OFF 26.0%, p=0.01), higher resuscitation requirements (p<0.001), MOF (CFF 24.3%, OFF 28.8%, p=0.001) and longer in-hospital (p<0.001) and intensive care stay (p=0.001).While ISS (NISS) values showed a minor increase of +1.3 (+1.8) points per subgroup, the prevalence of MOF, sepsis and mortality multiplied with the degree of open soft-tissue injury.

	OFF I°	OFF II°	OFF III°	Total	Slope coefficent	p-value
Number (n), %	334, 28.1	526, 44.3%	328, 27.6%	1188, 88.8%	-	-
ISS, mean (±SD), median	22.2±12.4, 18	24.9±12.5, 22	24.±14.1, 22	24.1±13, 22	+1.3 points	0.011
Ext. Fixation % (n)	45.8 (153)	58.0 (305)	71.3 (234)	58.2 (692)	+12.8%	<0.001
Prehospital shock %, n	19.5 (59)	27.8 (133)	29.7 (85)	26.0 (277)	+5.1%	0.009
Shock in ER % (n)	12.9 (40)	20.2 (98)	28.3 (86)	20.4 (224)	+7.7%	<0.001
Mass transfusion %(n)	8.4 (28)	13.2 (69)	28.2 (92)	16 (189)	+6.4%	<0.001
Sepsis %, (n)	6.0 (20)	9.5 (50)	16.2 (53)	10.4 (123)	+5.1%	<0.001
MOF %, (n)	22.2 (74)	30.2 (159)	36.0 (118)	29.5 (351)	+6.9%	<0.001
Mortality %, (n)	8.1 (27)	9.9 (52)	17.1 (56)	11.4 (135)	+4.5%	<0.001

Conclusion: Open femur fractures are associated with higher in-hospital complications related to ICU stay, hospital days and incidence of multiple organ failure when compared with closed femur fractures. For prediction of in-hospital complications the degree of soft-tissue injury outweighs the relevance of injury severity scoring.

Session: XIIIB: Papers 46-55
Paper 50: 2:50-3:10

LOWER EXTREMITY DUPLEX SURVEILLANCE DOES NOT REDUCE THE INCIDENCE OF PULMONARY EMBOLISM: A PROSPECTIVE STUDY OF TWO CENTERS

Steven Shackford* MD, Mark Cipolle* MD,Ph.D., Jayraan Badiee MPH, Danielle Mosby MPHc, M. Margaret Knudson* MD, Paul Lewis DO, Victoria McDonald MD, Erik Olson MD, Kimberly Thompson MD, Jan-Michael Van Gent DO, Ashley Zander DO, CLOTT Study Group Scripps Mercy Medical Center

Invited Discussant: Elliott Haut, MD, PhD

Introduction: Venous thromboembolism (VTE) remains a significant cause of morbidity and mortality in trauma. Controversy exists regarding the use of lower extremity duplex ultrasound screening and surveillance (LEDUS). Advocates cite earlier diagnosis and treatment of deep venous thrombosis (DVT) to prevent pulmonary embolism (PE), thrombus propagation, and later complications of venous hypertension. Opponents argue that LEDUS identifies more DVT (surveillance bias), but does not prevent nor reduce the incidence of PE. The magnitude of the increase in DVT identified by LEDUS and the effect on PE incidence remain speculative. We sought to describe the magnitude of this surveillance bias and test our hypothesis that LEDUS does not decrease the incidence of PE after injury.

Methods: We compared data from two level 1 trauma centers: Center A using aggressive serial LEDUS and Center B using LEDUS only for symptomatic patients. Beginning in 2014, both centers prospectively collected data on demographics, injury severity, and VTE risk using the same dataset, receptacle (REDCap), and uniform definitions derived from a consensus of 17 trauma centers concurrently studying VTE in trauma. Both centers utilized mechanical prophylaxis (MechPx) and pharmacologic prophylaxis (PharmPx) based on risk assessment.

Results: Centers A and B treated patients with similar injury severity and VTE risk (Table). Center A had a 4-fold greater incidence of lower extremity DVT (LEDVT) than Center B, but used significantly less PharmPx and significantly more MechPx. Of the 80 patients who developed a DVT, PE, or both, 99% received prophylaxis prior to the event. Among those patients who received PharmPx, VTE occurred in 49 at Center A (11.3%) and in 10 (2.9%) at Center B ($p<0.0001$).

	Center A	Center B	p value
Patients (N)	772	454	
ISS (median, IQR)	10 (6-17)	10 (6-17)	0.52
Head AIS > 3 (%)	228 (30%)	106 (34%)	0.27
LEDVT (%)	67 (9%)	8 (2%)	<0.0001
Above knee DVT (%)	12 (1.5%)	2 (0.4%)	<0.0001
Below knee DVT (%)	55 (7.5%)	6 (1.6%)	<0.0001
PE (%)	3 (0.4%)	2 (0.4%)	0.89
PharmPx (%)	439 (57%)	361 (80%)	<0.0001
MechPx (%)	722 (94%)	274 (60%)	<0.0001

Conclusion: LEDUS is associated with a 4-fold increase in the rate of LEDVT, but no reduction in PE. Neither PharmPx nor MechPx are completely effective in preventing VTE in trauma patients. VTE should not be considered a "never event" in this cohort. The earlier detection and treatment of LEDVT in asymptomatic patients does not affect the incidence of PE. The impact on venous hypertension cannot be addressed without long term follow-up.

Session: XIIIB: Papers 46-55
Paper 51: 3:10-3:30

EXTENDING THE GOLDEN HOUR: PARTIAL RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA (p-REBOA) IN A HIGHLY LETHAL LIVER INJURY MODEL

Rachel M. Russo MD, Timothy K. Williams MD, Christopher M. Lamb FRCS, Jeremy W. Cannon* MD, Joseph M. Galante* MD, J. Kevin Grayson DVM, Ph.D, Lucas P. Neff MD, Clinical Investigation Facility, Travis AFB

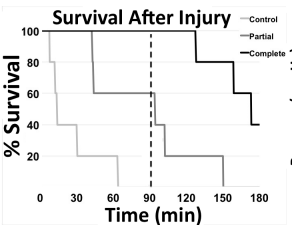
Invited Discussant: Todd Rasmussen, MD

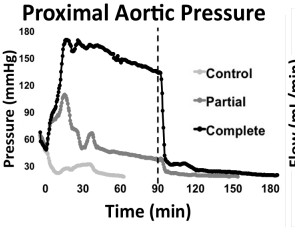
Introduction: Prior proof-of-concept studies with controlled hemorrhage have indicated that partial resuscitative endovascular balloon occlusion of the aorta (p-REBOA) can achieve a 90% aortic luminal occlusion and augment central aortic pressure with less distal ischemia than complete REBOA (c-REBOA). Yet, the ability of p-REBOA to confer benefit during uncontrolled hemorrhage remains unclear. The aim of this study was to evaluate the ability of p-REBOA to extend survival and maintain homeostasis in a highly lethal liver injury model.

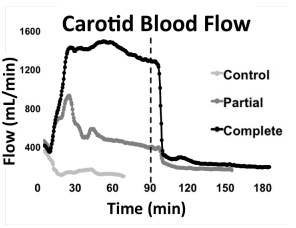
Methods: Fifteen Yorkshire-cross swine were anesthetized, instrumented, splenectomized, and subjected to rapid 10% total blood volume loss followed by traumatic amputation of ~30% of the liver. Coagulopathy was created through hemodilution. Swine were randomized to treatment with p-REBOA, c-REBOA, or no intervention. Aortic pressure (proximal and distal to the balloon), carotid blood flow and serum markers of ischemia were recorded. Balloons remained inflated in the p-REBOA and c-REBOA groups for 90 minutes (T90), followed by damage control laparotomy (DCL), limited whole blood resuscitation, and graded balloon deflation. The study ended at 180 minutes after onset of hemorrhage, or death of the animal.

Results: Without intervention, liver injury was rapidly lethal. Mean survival times in the control, p-REBOA, and c-REBOA arms were 25±21, 86±40 and 163±20 minutes, respectively (p<0.001). P-REBOA resulted in maintenance of near-baseline carotid flow and proximal aortic pressure, while c-REBOA generated extreme proximal hypertension and prolonged supraphysiologic carotid flow through T90. Lactate levels through T90 were similar for p-REBOA and c-REBOA. Both experimental groups experienced profound hypotension following balloon deflation at DCL.

Conclusions: In the setting of severe ongoing hemorrhage, p-REBOA increased survival time beyond the golden hour while maintaining global perfusion. A prolonged survival model with aggressive blood resuscitation is needed to determine if p-REBOA reduces the ischemia-reperfusion injury seen in c-REBOA and confers a survival advantage.







Session: XIIIB: Papers 46-55
Paper 52: 3:30-3:50

EFFICACY OF A NOVEL FLUOROSCOPY-FREE ENDOVASCULAR BALLOON DEVICE WITH PRESSURE RELEASE CAPABILITIES IN THE SETTING OF UNCONTROLLED JUNCTIONAL HEMORRHAGE

Kyle K. Sokol MD, George Black MD, Robert Shawhan MD, Matthew J. Eckert MD, Nam T. Tran MD, Benjamin W. Starnes MD, Matthew J. Martin* MD, Madigan Army Medical Center
Invited Discussant: Michael Sise, MD

Introduction: Resuscitative endovascular balloon occlusion of the aorta (REBOA) has emerged as a promising alternative to gauze packing in the setting of non-compressible torso hemorrhage (NCTH). Our study objectives are to describe the placement and physiologic impact of a novel REBOA device in treatment of uncontrolled junctional hemorrhage. We hypothesize that this device can be successfully deployed without fluoroscopic guidance, minimize intraaortic barotrauma, and effectively function to increase survival in the setting of profound shock dyshomeostasis.
Methods: Fourteen adult swine (35-50kg) underwent a hemorrhage and ischemia/reperfusion injury protocol to produce shock physiology and dilutional coagulopathy similar to major trauma victims, and then randomized to REBOA (N=8) vs standard gauze packing (GP) (N=6) groups. A complex contra-lateral groin soft tissue and vascular injury was then created, followed by 30 sec of free bleeding and gauze packing for 5 min. Control group received no further intervention and the REBOA group then had the aortic balloon inflated until the pressure release valve opened. Subjects were allowed to survive for 45 minutes post-packing, after which native and balloon-exposed aortae were harvested and assessed for local endothelial injury.
Results: Control and REBOA groups showed similar baseline hemodynamics (HD) (HR 74±7 vs 91±6, p=0.078; MAP 32±6 vs 43±6, p=0.228) levels of coagulopathy (PTT 21±5 vs 22±5, p=0.228; INR 1.3±0.1 vs 1.2±0.2, p=0.476; fibrinogen 108±17 vs 135±67, p=0.747) and hemorrhage/ischemia/reperfusion insult (Hct 16±2 vs 20±5, p=0.118 ; pH 7.3±1 vs 7.4±2, p=0.518 ; lactate 7±3 vs 7±5, p=0.950 ; BD 9±7 vs 5±11, p=0.491). All REBOA devices were successfully deployed into zone III of the distal aorta without fluoroscopic assistance or evidence of gross aortic injury in proximity of the deployed balloon. The REBOA group had significantly decreased residual hemorrhage volumes (0.5±0.2L vs 0.2±0.2, p=0.014) and increased survival times (45±0 min vs 8±4 min, p<0.001), with all REBOA subjects surviving to end of study time.
Conclusion: This study reinforces results found in previous studies that REBOA is an effective measure of generating a temporary window of HD stability and, to the authors knowledge, is the first to confirm that this specific REBOA device can be blindly guided into the appropriate zone of the aorta without generating gross vascular damage during unmeasured balloon inflation. Furthermore, REBOA remains superior to standard GP technique in the setting of non-compressible junctional hemorrhage despite profound HD instability, coagulopathy, hypothermia and acidosis, significantly decreasing volume of hemorrhage and dramatically increasing survival time.

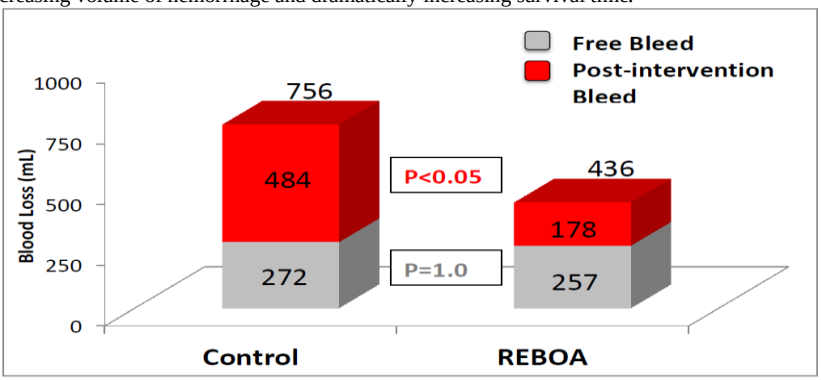


Figure 1. Average total blood loss proportionately represented by 30-second pre-intervention free bleed volume and experimental post-intervention bleed volumes in control and REBOA groups.

Session: XIIIB: Papers 46-55
Paper 53: 3:50-4:10

Randomized Controlled Trial Comparing Dynamic Simulation to Static Simulation in Trauma

Anthony J. Carden MD, Edgardo Salcedo* MD, David Leshikar MD, Garth Utter* MD, Machelle Wilson Ph.D., Joseph Galante* MD, University of California, Davis

Invited Discussant: M. Margaret Knudson, MD

Introduction: With the American Board of Surgery requiring only 10 open trauma operations for certification and a trend towards nonoperative management, current general surgery residents have limited exposure to open trauma operative cases. Simulation supplements variable rotation volume and provides experience with critical but rarely performed procedures. Open simulation classically focuses on static models with anatomic accuracy, but lacks practicality when hemorrhage control is the life-saving maneuver. The purpose of this study is to determine whether training on a dynamic simulator is more effective than training on an anatomically accurate, but static cadaver for temporary vascular shunt (TVS) placement.

Methods: We enrolled 54 general surgery residents at all PGY levels in a randomized controlled trial comparing training of TVS placement on a dynamic simulator of original design (n= 28) versus a cadaver arm (n= 26). Our research team developed an inexpensive, reusable simulator with ongoing hemorrhage to duplicate the steps of TVS. After standardized video didactics, trainees practiced on either the simulator or cadaver arm. After trainees achieved competency, as judged by the supervising surgeons based on predetermined criteria, they were recorded placing a TVS in a live swine femoral artery. Two blinded trauma surgeons evaluated the recorded performances using a validated skills assessment modality, Objective Structured Assessment of Technical Skills (OSATS). Additional outcomes included times to hemorrhage control and procedure completion. Outcomes were compared using the Satterthwaite t-test.

Results: The simulator was successfully created from simple parts for $40.00, compared to a cadaver arm ($380.00) or a training swine ($1250.00) cost at our institution. After completing training, all residents in both groups successfully completed the task. Subjects trained on the simulator placed the TVS faster than those trained on a cadaver (584s vs. 751s, p=0.0096), with a trend towards faster time to hemorrhage control (110s vs. 148s, p=0.086). There was no significant difference in OSATs score (3.70 vs. 3.60, p=0.53).

Conclusion: Skills acquisition is at least as effective on the simulator as a cadaver arm, at a fraction of the cost. The addition of dynamic hemorrhage control provides a critical training element required for trauma skills development. Observationally, residents trained on the dynamic simulator were more comfortable in the face of active hemorrhage than those trained on a cadaver. These simulators could also be used for periodic skills maintenance to keep important skills sharp when clinical opportunities may be scarce. Use of dynamic simulation for hemorrhage control operations is an inexpensive and effective way to supplement low operative volume for training in critical open trauma skills.

POST-HOSPITALIZATION TREATMENT REGIMEN & RE-ADMISSION FOR C. DIFFICILE COLITIS IN MEDICARE BENEFICIARIES

Charles M. Psoinos MD, Courtney E. Collins MD, Didem Ayturk MS, Julie M. Flahive MS, Frederick A. Anderson Ph.D., Heena P. Santry* MD, MS, FACS University of Massachusetts

Invited Discussant: Sasha Adams, MD

Introduction: Over the last two decades C. difficile (CD) has become a significant cause of morbidity and mortality among elderly Americans. Post-discharge treatment targeting CD may play a role in readmission rates.

Methods: We queried a 5% random sample of Medicare beneficiaries (2009-2011 Part A inpatient and Part D prescription drug claims; n = 864,604) for any hospitalization with the primary or secondary diagnosis of CD. Patients who died during index admission or were transferred to another hospital were excluded. We compared patient demographics, co-morbidities, and CD treatment regimen after index hospitalization discharge (no treatment, oral metronidazole only, oral vancomycin only, or both) between patients who were readmitted with a primary diagnosis of CD colitis within 90 days of index hospitalization discharge and patients who were not readmitted for any reason within 90 days of discharge using univariate tests of association and multivariate models. To measure the impact of post-discharge CD treatment on readmission specifically for recurrent CD, patients who were readmitted within 90 days with any primary diagnosis other than CD were excluded.

Results: During the study period, 945 patients discharged with a diagnosis of CD colitis were readmitted within 90 days with CD while 1953 patients discharged with a diagnosis of CD did not require any hospital readmission for any reason. Age and race distribution were comparable between groups. However, those readmitted had higher baseline comorbidities (average Elixhauser index 5.9 vs. 4.7 [$p<0.0001$]) than those patients not readmitted. Index hospitalization length of stay (LOS) was significantly shorter for those readmitted (9.2 vs. 11.8 days [$p<0.0001$]). In multivariable models patients discharged on either oral metronidazole only or oral vancomycin only had reduced 90 day readmission rates compared to patients discharged without any CD treatment (OR 0.30 [95% CI 0.24, 0.37] and 0.49 [95% CI 0.37, 0.64], respectively). Conversely, patients discharged on both oral vancomycin and metronidazole had increased risk of readmission [OR 1.29 [95% CI 0.99, 1.69]). (Table 1) Readmitted patients had higher all-cause 90-day mortality (17.8% vs. 8.9% [$p<0.0001$]) with 1.77 times increased odds [1.37, 2.27] of dying within 90 days.

Conclusion: More than 10% of patients with CD at the time of discharge are readmitted for CD within 90 days. Patients who presumably completed treatment during index hospitalization (no treatment group) and those prescribed a single drug for ongoing treatment have lower readmission rates than those requiring two drugs on discharge. Elderly patients with ongoing severe CD infections may benefits from continued inpatient treatment rather than discharge on a two drug regimen. Our findings have important implications for reducing readmissions among Medicare beneficiaries with this increasingly frequent disease.

Table 1: Risk of Primary CD Readmission within discharge + 90 days for Medicare Beneficiaries Surviving an Initial Hospitalization for Clostridium difficile 2009-2011 (N =2898)

Session: XIIIB: Papers 46-55
Paper 55: 4:30-4:50

DUI Histories in Intoxicated Injured Bicyclists

Steven Maximus MD, Cesar Figueroa MD, Jacqueline Pham BS, Cristobal Barrios MD,
University of California, Irvine - Orange County

Invited Discussant: A. Britton Christmas, MD

When creating your abstract, the only section headers to be used are listed below and they need to be in this format:

Introduction: It has been well documented that the use of alcohol correlates with injury risk, especially in DWI (driving while intoxicated) and DUI (driving under the influence). Consumption of alcohol in patients presenting with bicycle-related injuries is associated with greater injury severity, longer hospitalization, and higher health care costs. We hypothesized that intoxicated patients operating a bicycle with traumatic injuries have previous DUI or DWI convictions and had lost their privilege to drive a motor vehicle, using bicycling as an alternate mode of transportation and had continued alcohol consumption despite negative consequences.
Methods: We retrospectively collected data on injured bicyclists over the age of 18 with positive blood alcohol levels (BAC's) treated from the dates 1/2009 to 6/2014 at a large level 1 urban trauma center. We then matched each patient by name and date of birth and were able to obtain public criminal records through the Superior Court of California for the local of county. Specifically, the search queried for DUI/DWI convictions with suspension of driving privileges. Secondary datapoints such as age, BAC, hospital length of stay, other convictions, race, gender, drug test results, and insurance status were also analyzed.

Results: A total of 149 injured bicyclists with positive blood alcohol levels were identified. Their average BAC was 236.0 mg/dL and their average age was 41 years old. 66 patients (44.2%) had prior DUI/DWI convictions with suspension of driving privileges, with 45 identifying as White (30.2%) and 19 as Hispanic (12.8%). 132 were male and 17 were female. 87 patients were White (58.4%), 51 were Hispanic (34.2%), 7 were Asian (0.05%), 3 (0.02%) were identified as other, and 1 was black (0.006%). 51 patients (34.2%) tested positive for other drugs, with the most common being methamphetamine and THC. 63 patients (42.3%) had other misdemeanor or felony charges, with the most common being public intoxication. There were 95 patients (63.8%) who had no health insurance, including 76.5% of Hispanic patients who did not have health insurance coverage. Intoxicated bicyclists trended towards longer hospital length compared to non-intoxicated bicyclists (4.60 vs. 3.44 p=0.07). Of interest, only 3 out of 149 patients (0.02%) were charged with bicycling while intoxicated.
Conclusion: Intoxicated bicyclists involved in trauma are more likely to have previous DUI/DWI, have other drug use, tend to have longer hospital stays, and are less likely to have insurance. These patients persistently exhibit high risk alcohol behavior patterns, despite previous negative consequences. Bicycle safety education and behavior modification targeting DUI/DWI offenders is warranted. The data also highlights the need to aggressively charge and prosecute intoxicated bicyclists who are injured, as the vast majority of offenders do not get charged for their violation. Furthermore, in order to promote injury prevention, resources to increase awareness of this underestimated public health issue should be promoted.

All images, charts and tables must be placed and uploaded in the body of your abstract exactly as you want them.

Session: XIV: Papers 56-67
Paper 56: 8:00-8:20

INTIMATE PARTNER VIOLENCE-IT IS PREVALANT HERE TOO: THE FEASIBILITY OF DETERMINING PREVALENCE AT COMMUNITY HAIR SALONS

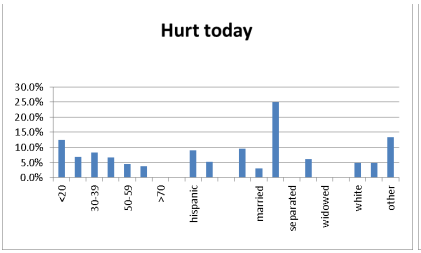
D'Andrea K. Joseph* MD, Susan Divietro Ph.D., Eric Klein MD, Rebecca Beebe Ph.D., Megan Clough BS, Garry Lapidus PA-c Hartford Hospital

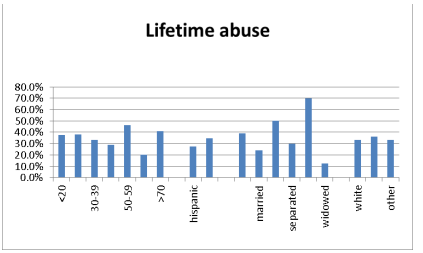
Invited Discussant: Eric Toschlog, MD

Introduction:Intimate partner violence (IPV) is an under recognized cause of detrimental health outcomes. As a result, many health care organizations have recommended routine IPV screening. Implementing health-related screening programs outside of health care facilities is a beneficial public health initiative, but to date, IPV screening outside of healthcare facilities remains negligible. The objective of this study is to determine the prevalence of IPV among women receiving services at hair salons. We hypothesized that women would disclose IPV in this setting and that rates of abuse would reflect national averages.

Methods:We recruited a convenience sample of 6 hair salons in 2014. Hair stylists were trained on how to recognize and refer IPV victims. Self-reported IPV of salon clients was measured by a tablet-based validated screening tool, the Patient Satisfaction and Safety Survey.

Results:Of the participating hair salons, 2 were urban, 2 were suburban, and 2 were rural. Of the 266 women, 45% were <50 years old, 62% were white, 31% were black, and 4% were of Hispanic origin. Half were married, 39% held bachelor's degrees or higher, and 68% reported incomes >$50,000/yr. Overall, reported past year prevalence of physical abuse was 3.6%, past year prevalence of sexual abuse was 2.7%, lifetime prevalence of emotional or physical abuse was 34.2%. Importantly, 5.3% of the sample reported that they had been hurt that day by their current or former partner. Past year physical abuse was more common among women 30-39 years old (9.1%), blacks (9%), and single women (7.5%). Past year sexual abuse was more common among women 20-29 years old (13.8%), other races (6.7%), and single women (5.4%). Lifetime abuse was most common among women 50-59 years old (13.8%), blacks (36.1%), and divorced women (69.7%). The demographics of women who were most commonly hurt the day of the survey were <20 years old (12.5%), other races (13.3%), and women in common law relationships (25%).





Conclusion: Women in our study reported IPV prevalence rates consistent with national data. Documentation of IPV prevalence in hair salons will provide much-needed support for novel interventions such as Cut it Out, a national program designed to train hair stylists on how to recognize and refer IPV victims.

Session: XIV: Papers 56-67
Paper 57: 8:20-8:40

AIRWAY MANAGEMENT FOLLOWING REPAIR OF CERVICAL TRACHEAL INJURIES: A RETROSPECTIVE, MULTICENTER STUDY

John A. Harvin MD, Bryan A. Cotton* MD,MPH, Jason Brocker MD, Deborah M. Stein* MD,MPH, Evren Dilektasli MD, Kenji Inaba* MD, Michael A. Vella MD, Oscar Guillamondegui* MD, Lisa M. Kodadek MD, Elliot R. Haut* MD,Ph.D., Cory R. Evans MD, Jordan A. Weinberg* MD, Michael D. Goodman MD, Bryce R. Robinson* MD, John B. Holcomb* MD, University Of Texas Health Science Center At Houston

Invited Discussant: J. Wayne Meredith, MD

Introduction: Optimal airway management following repair of cervical tracheal injuries is unknown. "Protective" tracheostomy had been commonly employed, but recent studies question the practice. This study aims to describe the current airway strategies being used and determine the optimal airway management following cervical tracheal injury repair.
Methods: Patients with cervical tracheal injuries admitted 01/2000-01/2014 at seven U.S. Level I trauma centers were identified. Patients were placed into one of three groups depending on the post-operative airway management: immediate or early extubation (≤24 hours, EXT), prolonged intubation (>24 hours, INT), and immediate tracheostomy (TRACH). Following univariate analysis, a multivariate model was developed to evaluate for surgical site infection (SSI) and ICU-free and ventilator-free days, comparing INT and TRACH to EXT as the reference. Continuous variables presented as median (IQR).
Results: Over the study period, 382,529 patients were admitted to seven Level I trauma centers. 594 (0.16%) had a laryngotracheal injury with 120 (0.03%) cervical tracheal injuries. Ten patients were excluded for incomplete data and seven died within 24 hours of admission, leaving 103 patients included in the study. Patients were grouped based on airway management: 40 (39%) in EXT, 30 (29%) in INT, and 33 (32%) in TRACH. There were no differences in demographics or injury mechanism. The INT and TRACH groups were more severely injured than the EXT group (ISS INT 25 [16, 29] and TRACH 17 [12, 33] vs EXT 16 [10, 17], p<0.01). The INT and TRACH groups had a trend towards higher rates of destructive injuries (INT 20% vs TRACH 34% vs EXT 13%, p=0.08). Despite a higher SSI rate, the TRACH group had a lower mortality and more hospital-, ICU-, and ventilator-free days compared to the INT cohort. On multivariate analysis, tracheostomy was associated with an increased risk in the odds of SSI (OR 9.56, 95% CI 1.35-67.95) compared to both EXT and INT, while INT was associated with fewer ICU-free days (corr. coef. -9.64, 95% CI -12.66 to -6.62) and ventilator-free days (corr. coef. -9.24, 95% CI -12.30 to -6.18) compared to both EXT and TRACH.

	EXT	INT	TRACH	p
Surgical Site Inection	2 (5%)	4 (13%)	7 (21%)	0.11
Pneumonia	0 (0%)	7 (23%)	3 (9%)	<0.01
Hospital-free days	27 (24, 28)	12 (5, 22)	16 (10, 22)	<0.01
ICU-free days	29 (28, 30)	22 (8, 25)	26 (21, 29)	<0.01
Ventilator-free days	30 (29, 30)	25 (12, 27)	28 (28, 30)	<0.01
In-hospital mortality	0 (0%)	4 (13%)	0 (0%)	<0.01

Conclusion: In patients with a cervical tracheal injury, immediate or early extubation was common and safe. However, among those with more severe injuries, immediate tracheostomy versus prolonged intubation presents a risk-benefit decision. While immediate tracheostomy placement is associated with increased risk of SSI, prolonged intubation is associated with higher risk of pneumonia and mortality and fewer ICU-free and ventilator-free days.

Session: XIV: Papers 56-67
Paper 58: 8:40-9:00

A STATEWIDE ANALYSIS OF TRAUMA CENTER LEVEL DESIGNATION AND MORTALITY FOR THE MODERATE TO SEVERE HEAD INJURED TRAUMA PATIENT

Daniel Wu DO, FACOS, FACS, Brian W. Gross BS, Frederick B. Rogers* MD, MS, FACS, Nathan McWilliams MPA, RHIA Lancaster General Hospital

Invited Discussant: Ronald Gross, MD

Introduction: We sought to compare rates of neurosurgical intervention and patient outcomes between level I and level II trauma centers in the state of Pennsylvania. It was hypothesized that level I trauma centers would exhibit greater rates of neurosurgical intervention and lower mortality compared to level II trauma centers.

Methods: All 2003-2013 admissions to Pennsylvania-accredited level I and level II trauma centers with moderate to severe head injuries (GCS<13; Head AIS≥3) were extracted from the Pennsylvania Trauma Systems Foundation State Registry. Rates of neurosurgical intervention (craniotomy, craniectomy, ventriculostomy, and intracranial pressure [ICP] monitor placement) were extracted and compared between level I and level II trauma centers. A multivariable logistic regression model controlling for age, admitting systolic blood pressure, admitting temperature, GCS, and neurosurgical intervention was used to asses mortality differences between level I and level II trauma centers. A p-value <0.05 was considered significant.

Results: A total of 22,229 moderate to severe head injured patients were admitted to Pennsylvania's 30 level I and II trauma centers over the 11-year study period. Intervention rates for craniotomy (p=0.926), craniectomy (p=0.244), ICP monitor placement (p=0.875), and ventriculostomy (p=0.808) were statistically indistinguishable between level I and level II trauma centers. Similarly, when controlling for age, admitting systolic blood pressure, admitting temperature, GCS, and neurosurgical intervention, no statistical difference between trauma center level and mortality was observed (p=0.975).

Conclusion: Rates of neurosurgical intervention and patient outcome are statistically indistinguishable between level I and level II trauma centers. These results suggest management of the moderate to severe head injured trauma patient are equally effective at level I and level II centers.

Table 1: Adjusted odds ratios for mortality

Variable	Adjusted Odds Ratio (95% CI)	p-value
Trauma Level	0.99 (0.92-1.08)	0.975
Age	1.04 (1.04-1.05)	<0.001
Systolic BP	0.99 (0.99-0.99)	<0.001
Temperature	1.00 (0.99-1.00)	0.096
GCS	0.78 (0.77-0.79)	<0.001
Intervention	0.99 (0.92-1.08)	0.959
Constant	0.10 (0.05-0.19)	-
N = 22,229		
AUROC: 0.77		

Session: XIV: Papers 56-67
Paper 59: 9:00-9:20

CRANIECTOMY FOLLOWING URGENT EVACUATION OF INTRACRANIAL HEMORRHAGE IMPROVES INTRACRANIAL AND CEREBRAL PERFUSION PRESSURES IN SEVERE TRAUMATIC BRAIN INJURED PATIENTS

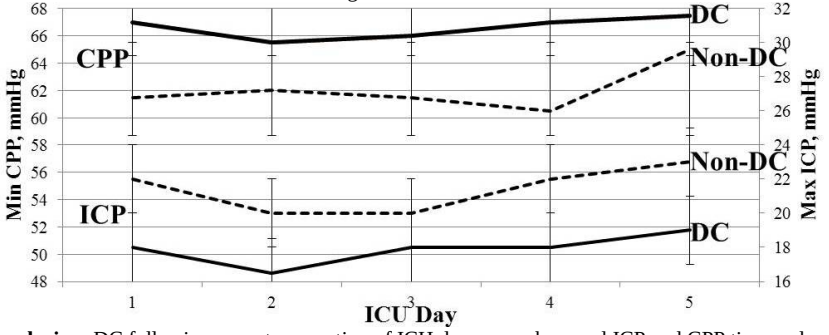
Casey J. Allen MD, Jonathan P. Meizoso MD, Juliet J. Ray MD, Mena Hanna MD, Ronald J. Manning RN, Carl I. Schulman* MD,Ph.D., Nicholas Namias* MD, Malcolm R. Bullock MD, Jonathan R. Jagid MD, Kenneth G. Proctor* Ph.D., University of Miami

Invited Discussant: Travis Polk, MD

Introduction: The use of decompressive craniectomy (DC) is controversial and its benefit following urgent evacuation of intracranial hemorrhage (ICH) is not known. We hypothesize that the use of DC following urgent evacuation of ICH improves intracranial pressure (ICP) and cerebral perfusion pressure (CPP) following severe traumatic brain injury (TBI).

Methods: From 01/2008 to 01/2013, 227 TBI patients requiring invasive ICP monitoring at a single level 1 trauma center were prospectively observed. Patients who underwent DC following ICH evacuation within 24 hours were identified. Propensity scores were assigned to each patient using a logistic regression model for predicting the need for DC which incorporated patient demographics, admission hemodynamic and laboratory data, Glasgow Coma Scale (GCS), injury severity score (ISS), abbreviated injury severity (AIS) of the head, blood transfusion requirements, and the need for vasopressor therapy. Patients who underwent DC were propensity score matched in a 1:1 "nearest neighbor" fashion to non-DC patients. Data is mean ± standard deviation or median (interquartile range). Groups were compared using a Mann Whitney U test or Fisher's exact test with significance at $p \leq 0.05$.

Results: The cohort was age 41±17 years, 82% male, ISS 28±11, GCS 6±4, AIS head 4±1, LOS 32(15) days, and 27% mortality. Excluding early deaths (<48h), 50 DC following ICH evacuation were matched to 50 non-DC patients, effectively achieving similar demographics, hemodynamics, ISS, GCS, AIS head, transfusion requirements, and need for vasopressor therapy between the groups. In comparing DC vs non-DC groups, hours of abnormal ICP (>20mmHg) were 1(10) vs 7.5(16) (p=0.017), hours of abnormal CPP (<60mmHg) were 0(6) vs 4(9) (p=0.008), daily minimum CPP (mmHg) was 67(13) vs 62(17) (p=0.010), daily maximum ICP (mmHg) was 18(9) vs 22(11) (p<0.001), LOS 33(47) vs 25(34) (p=NS), and mortality of 24% vs 30% (p=NS). Daily minimum CPP and maximum ICP values are in the figure.



Conclusion: DC following urgent evacuation of ICH decreases abnormal ICP and CPP time and improves overall ICP and CPP thresholds. These findings give evidence of benefit of early DC in severe TBI patients.

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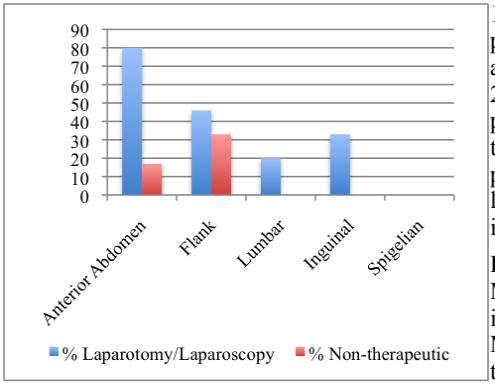
Paper 60: 9:20-9:40

TRAUMATIC ABDOMINAL WALL HERNIAS: LOCATION MATTERS

Jamie J. Coleman MD, Evan Fitz MD, Ben Zarzaur* MD,MPH, Scott Steenburg MD, Brian Brewer MD, David Feliciano* MD, Timothy Pohlman MD, Robert Reed* MD, Grace Rozycki* MD, MBA, Indiana Univesity School of Medicine

Invited Discussant: John Como, MD, MPH

Introduction: Abdominal wall hernias resulting from blunt trauma are uncommon and often have several layers of tissue destruction. They present a unique reconstructive challenge and optimal management is unclear. This study was performed to identify the incidence of associated injuries, the need for urgent operative intervention, and hernia recurrence rates.



Methods: A retrospective review of patients diagnosed with a traumatic abdominal wall hernia from January 2002 to December 2014 was performed. Data were collected from the trauma registry and included patient demographics, length of stay, location and type of hernia, operative interventions, and complications.

Results: Eighty patients (64% Male; Median Age 36; Mean ISS = 22) were identified during the study period. Motor vehicle collision (MVC) was the most frequent mechanism of injury (n= 58). Overall, 36 patients (45%) underwent urgent laparotomy or laparoscopy, and 8 (22%) were non-therapeutic excluding acute hernia repair. Of interest, 19 (53%) required bowel resection. Notably, the need for operative intervention and non-therapeutic rate differed depending upon hernia location (Figure). Twenty-three patients underwent hernia repair, the majority of which (78.3%) were repaired within five days of injury. There were six recurrences, four of which were repaired acutely, with an overall first time hernia recurrence rate of 26.1%.

Conclusion: In the largest series to date, we found traumatic abdominal wall hernias to be associated with a high percentage of intra-abdominal injuries requiring urgent laparotomy or laparoscopy. Rates of therapeutic interventions varied by hernia location with anterior abdominal wall hernias associated with the highest need for a therapeutic operation. Acute repair was associated with the majority of recurrences.

Session: XIV: Papers 56-67
Paper 61: 9:40-10:00

OVER-TRANSFUSION OF PACKED RED BLOOD CELLS IN MASSIVE TRANSFUSION PATIENTS

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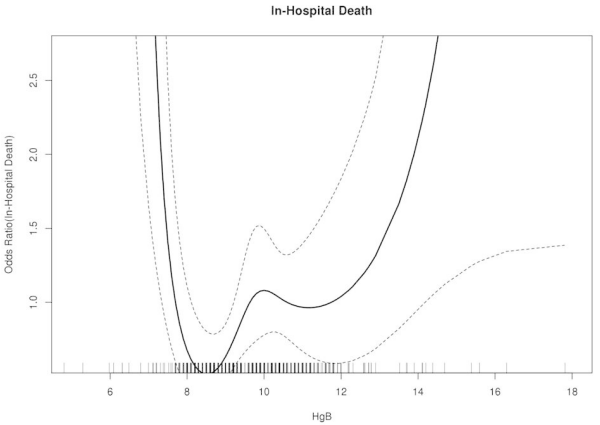
Invited Discussant: H. Gill Cryer, MD, PhD

Introduction: Over-transfusion (OT) of packed red blood cells (pRBCs) increases the risk of death in stable critically ill patients. With the delineation of minimum transfusion ratios in hemorrhaging patients complete, attention must be turned to the other end of the massive transfusion (MT) spectrum to define the maximum transfusion of pRBCs. We aimed to define OT of pRBCs in hemorrhaging patients hypothesizing that a hemoglobin (Hgb) value greater than 12 mg/dL 24 hours after hemorrhage control would be associated with increased mortality.



Methods: A review of trauma and surgical patients (excluding cardiopulmonary bypass) who underwent MT (≥ 10 units pRBCs w/in 24 hours) was performed from 2010–2013. The hemoglobin (Hgb) 24±6 hours after hemorrhage control stratified patients into under-transfused (UT; <8.0), reference (8.0-11.9), and OT (>12.0 g/dL) groups; patients not surviving to 24 hours were excluded. Data are presented as means±standard deviation with p<.05 considered significant. The critical administration threshold (CAT) was defined as ≥3 units pRBC in 60 minutes. **Results:** We identified 418 patients (351 reference [84%], 38 UT [9%], and 29 OT [7%]) with a mortality of 28%. UT patients had the greatest risk of death (OR 3.8; 95% CI 1.8-8.1) followed by OT patients (OR 2.9; 95% CI 1.2-7.0; **FIGURE**). *OT vs Reference*: OT patients were younger (54.6 vs 60.1 years) with a lower Charlson Comorbidity score (2.9±2.7 vs 4.9±3.2). Transfusion volumes were similar for pRBCs (18±10 vs 21±13 units), plasma (12.7±6.5 vs 10.8±9.4 units), and platelets (3±3 vs 4±4 units). Though pre-transfusion Hgb was similar (9.5±2.2 vs 9.5±2.3 g/dL), OT patients had greater Hgb values during MT (8.3±3.0 vs 6.9±1.4 g/dL) and at hospital dismissal/death (11.4±2.3 vs 9.6±1.1 g/dL). Both groups had similar rates of severe ARDS (38% vs 27%, p=.21) and CAT (88% vs 89%); however, OT patients had a shorter duration of transfusion (14.1±13.6 vs 27.0±18.4 hours). The causes of mortality was most commonly traumatic brain injury (44%) followed by cardiac in the OT group while the most common causes in the reference group were multisystem organ faikure (53%) and exsanguination (20%). **Conclusion:** Despite being younger with fewer comorbidities, OT patients had increased mortality akin to UT patients. Shorter MT durations foster a scenario in which patients are at high risk for OT. While further study is mandatory, a Hgb value 24 hours after MT shows promise as an OT definition.

"RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA (REBOA) MIGHT BE DANGEROUS IN PATIENTS WITH SEVERE TORSO TRAUMA — A PROPENSITY SCORE ANALYSIS SAYS —"

Jun-ichi Inoue MD, Atushi Shiraishi MD, Ayako Yoshiyuki MD, Koichi Haruta MD, Yasuhiro Otomo* MD,Ph.D., Department Of Acute Critical Care And Disaster Medicine, Graduate School Of Medical And Dental Sciences,Tokyo Medical And Dental University

Invited Discussant: Thomas Scalea, MD

【Introduction】 Resuscitative endovascular balloon occlusion of the aorta (REBOA) is a device to block aortic blood flow which can provide hemorrhage control and afterload augmentation in hemodynamically unstable torso trauma patients. Despite of these advantages, evidences supporting efficacy of REBOA have largely lacked. The study objective was to estimate the efficacy of REBOA in patients with severe torso trauma who underwent surgery or transcatheter arterial embolization (TAE).

【Methods】 In this retrospective cohort study based on the Japan Trauma Databank (JTDB), we included subjects who underwent an emergency surgery or TAE on chest, abdominal or pelvic region and excluded subjects whose systolic blood pressure of 0 mmHg, heart rate of 0 /minutes or the Abbreviated Injury Scale (AIS) on any region of 6 (unsurvivable injury). Missing values in important variables were multiply (m=25) imputed. A logistic regression analysis estimated a propensity score (PS) to predict use of REBOA from known predictors of mortality which were situations at the scene, prehospital and hospital vital signs, AIS on each region, comorbidities and indications for surgery. A PS matching (PSM) analyses compared ER mortality and in-hospital mortality in matched subjects with or without REBOA.

【Results】 A total of 9687 subjects from 146111 subjects in JTDB matched the selection criteria and PSM selected 374 and 374 subjects with or without REBOA, respectively. Standardized mean difference (SMD) of all the variables to estimate PS did not exceed 0.1, therefore PSM finely balanced baseline characteristics of PSM subjects with or without REBOA such as age (median of 54 versus 57 year old, SMD of 0.100), systolic blood pressure (median of 89 versus 92 mmHg, SMD of 0.040), the Glasgow Coma Scale (median of 12 versus 13, SMD of 0.007) and the Injury Severity Score (median of 34 versus 34, SMD of 0.009), respectively. Observed mortality in the emergency room (ER) was significantly higher in subjects with REBOA (16.3% versus 3.2%, absolute difference of +11.1%, $P<0.001$). Absolute difference of observed in-hospital mortality approximately doubled from those of observed mortality in ER in subjects with REBOA (59.1% versus 38.0%, absolute difference of +21.1%, $P<0.001$).

【Conclusion】 In this less biased PSM analysis, we found that undergoing REBOA might be dangerous in severely injured trauma patients who underwent emergency surgery or TAE. Further observational study to assess whether selected trauma subgroup could benefit from REBOA was expected.

Session: XIV: Papers 56-67
Paper 63: 10:20-10:40

Pattern of law enforcement related injuries in the US

David C. Chang MBA,MPH,Ph.D., Mallory Williams* MD,MPH, L.D. Britt* MD,MPH, Selwyn Rogers* MD,MPH, Massachusetts General Hospital

Invited Discussant: Alexander Eastman, MD, MPH

Introduction: The pattern of law-enforcement related injuries in the US is unknown.
Methods: Data were aggregated from FBI, Bureau of Justice Statistics, CDC Web-based Injury Statistics Query and Reporting System (WISQARS), and Nationwide Inpatient Sample (NIS) from 2003-2011. Law-enforcement related injuries in CDC and NIS were identified using E codes 970-976, which are meant to identify "injuries inflicted by the police or other law-enforcing agents, including military on duty, in the course of arresting or attempting to arrest lawbreakers, suppressing disturbances, maintaining order, and other legal action".
Results: A summary of the counts across years from the different data sources is presented in Table. CDC reported a total of 715,118 injuries in this time period, with 230,612 in whites, 252,756 in blacks, and 77,216 in Hispanics. The NIS identified a total of 3958 patients in this time period, ranging from 348 to 572 per year, which extrapolated to 1700 to 2884 nationally. Among them, 1548 (48.0%) were whites, 866 were blacks (26.8%), and 605 were Hispanics (18.8%); and 1011 patients (25.5%) were injured by firearms, 202 (5.1%) by blunt objects, and 2304 (58.2%) from blows or manhandling. Compared to white patients, black patients are significantly more likely to be injured by firearms (28.2% vs 21.8%, $p<0.001$). Similar patterns were seen in Hispanic patients (27.8% vs 21.8%, $p=0.003$). No significant difference in injury severity, lengths of stay, or in-patient mortality was observed.
Conclusion: The majority of law-enforcement related injuries are among whites. However, in contrast to population distributions, these injuries are disproportionately more common in blacks. Blacks and Hispanic patients are significantly more likely to be injured by firearms. Currently, data about these injuries are scattered across multiple data systems. A uniform national system to aggregate these data sources is needed to better understand the scope of the problem, for both law enforcement personnel and civilians.

Year	Arrests Total (FBI)	Police assaulted in line of duty (FBI)	Non-police Injuries (CDC)	Non-police inpatient admissions estimates (NIS)	Arrest Related Deaths (BJS)	Arrest Related Homicides (BJS)	Justifiable Homicide by Law Enforcement (FBI)	Police killed in line of duty (FBI)
2003	9,529,469	57,841	59,371	1946	627	376	373	52
2004	9,940,671	59,373	73,282	2056	673	375	367	57
2005	10,189,691	57,546	68,603	1700	689	377	341	55
2006	10,437,620	58,634	84,383	2121	721	447	376	48
2007	10,656,710	59,201	79,730	2057	455	455	398	57
2008	10,662,206	58,792	78,718	1874	629	404	378	41
2009	10,690,561	57,268	83,565	2336	729	497	414	48
2010	10,177,907	53,469	90,914	2884	n/a	n/a	397	56
2011	9,499,725	54,774	96,552	2508	n/a	n/a	393	72

Session: XIV: Papers 56-67
Paper 64: 10:40-11:00

CYTOCHROME C ADMINISTRATION IMPROVES ACIDOSIS AND OXIDATIVE STRESS AND LIMITS ORGAN INJURY IN A RAT MODEL OF HEMORRHAGIC SHOCK

Rebecca D. Powell Ph.D., Donna A. Goodenow BS, Iain H. McKillop Ph.D., Susan L. Evans* MD, Carolinas Medical Center

Invited Discussant: Saman Arbabi, MD, MPH

Introduction: Hemorrhagic shock and reperfusion (HSR) injury leads to a cascade of reactive oxygen species (ROS) production AND mitochondrial dysfunction, which leads to energy failure, cell death and multiple organ dysfunction (MOD). Cytochrome c (cytoc) is the final electron carrier in the mitochondrial electron transport chain, providing the electrochemical force for ATP production. We sought to determine whether exogenous cytoc administration would improve parameters of organ dysfunction and/or mitochondrial stability in a rat model of HSR.
Methods: Male Sprague-Dawley rats (225-275g) were cannulated via the carotid artery and hemorrhaged to a MAP of 33±2.0mmHg for 1-hr prior to resuscitation. Cytoc (40mg/kg) or saline (0.9%) was administered (*iv*) 30-mins prior to resuscitation. Sham animals were cannulated and held under anesthesia for 1-hr prior to recovery. Rats were sacrificed by exsanguination (cardiac puncture) 2-hrs post surgery. Blood was analyzed via iSTAT for clinical parameters (pH, lactate, base excess, AST, ALT, creatinine, PO_2), and ELISA performed on sera for the presence of mitochondrial damage associated molecular patterns (DAMPs). Tissues were collected and assayed for ROS as inidicated by lipid peroxidation (TBARS). Data were analyzed using one way ANOVA with SEM.
Results:HSR increased base deficit compared to sham (-7.2±2.8 *vs* 2.8±1.0mEq/L; $p<0.05$; n=5), but HSR-cytoc maintained base deficit to levels similar to sham (-5.0±2.8 *vs* 2.8±1.0). HSR-cytoc improved lactate clearance from time of administration to cardiac puncture as compared to HSR alone (Δ7.7±0.9 *vs* Δ3.2±3.0mg/dL; $p<0.05$; n=5). HSR increased PO_2 levels compared to sham, but HSR-cytoc restored PO_2 to levels not different from sham (95±17 [HSR] *vs* 31±6.6[sham] *vs* 65±15[HSR-cytoc] mmHg; $p<0.05$; n=5). HSR-cytoc increased creatinine compared to sham (0.95±0.07 *vs* 0.66±0.08mg/dL; $p<0.05$; n=5), but HSR did not. HSR significantly increased both AST and ALT compared to sham (330±80 *vs* 93±25IU/L [AST] 219±51 *vs* 52±4.9IU/L [ALT]; $p<0.05$; n=5) but HSR-cytoc restored both to levels not different from sham. HSR-cytoc decreased lipid peroxidation (TBARS) compared to sham in the liver (11±0.87 *vs* 14±0.82μM MDA; $p<0.05$; n=5), but no other differences were observed. Of interest, levels of the mitochondrial phospholipid cardolipin decreased in serum of HSR animals compared to sham, while HSR-cytoc administration restored cardiolipin to levels similar to sham animals (0.90 ±0.02[HSR] *vs* 1.0±0.03[sham] *vs* 0.94±0.01[HSR-cytoc] *vs* 1.0±0.03; $p<0.05$; n=5.)
Conclusion: These data suggest exogenous cytochrome c administration improves acidosis and oxidative stress in a model of HSR. Further work remains to determine if additional protection can be achieved by altering dose or time of administration.

Session: XIV: Papers 56-67
Paper 65: 11:00-11:20

AN ANALYSIS OF NEUROSURGICAL PRACTICE PATTERNS AND OUTCOMES FOR MODERATE TO SEVERE HEAD INJURIES IN A STATEWIDE TRAUMA SYSTEM

Chet Morrison MD, FACS, FCCM, Brian W. Gross BS, Frederick B. Rogers* MD, MS, FACS, Daniel Wu DO, FACOS, FACS, Mathew Edavettal MD,Ph.D., John C. Lee* MD, FACS, Nathan McWilliams MPA, RHIA, William Monacci MD, Lancaster General Hospital

Invited Discussant: Joseph Minei, MD

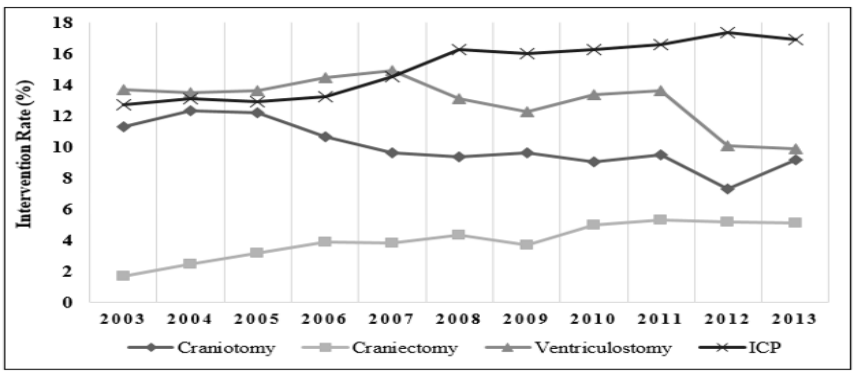
Introduction: We sought to characterize neurosurgical practice patterns from 2003-2013 in a mature, statewide trauma system. It was hypothesized that an increased rate of craniectomy would be observed over the study period with a reduction in overall mortality.

Methods: All 2003-2013 admissions to Pennsylvania-accredited Level I and Level II trauma centers with moderate (MOD; GCS 7-13, Head AIS ≥3) and severe (SEV; GCS≤8, Head AIS≥3) head injuries were extracted from the Pennsylvania Trauma Systems Foundation State Registry. Intervention rates (craniotomy, craniectomy, ventriculostomy, and intracranial pressure monitor [ICP] placement) and outcome measures (intensive care unit LoS, vent days, and mortality) were extracted and compared across the 11-year study period. A p-value <0.05 was considered significant.

Results: A total of 4,434 MOD and 17,795 SEV patients were admitted over the 11-year study period. Within the MOD population, no significant changes in rates of craniotomy or ventriculostomy were observed, however rates of craniectomy (2.18% to 5.33%; p=0.033) and ICP monitor placement (11.2%, to 16.9%; p=0.037) significantly increased. No significant changes in ICU LoS or vent days were observed, however mortality significantly decreased (17.5% to 11.3%; p=0.026) over the study period. Within the SEV population, a significant reduction in rates of craniotomy (11.7% to 9.27%; p=0.026), and ventriculostomy (14.0% to 9.46%; p<0.001) were observed, while rates of craniectomy (1.63 to 5.11; p<0.001) and ICP monitor placement (13.1% to 16.9%; p=0.002) significantly increased. No significant changes in mortality, ICU LoS, or vent days were observed.

Conclusion: General trends for combined MOD and SEV showed a reduction in craniotomies and an increase in craniectomies without an overall increase in survival. However, in MOD, increasing rates of craniectomy and ICP monitor placement were associated with overall improved survival.

Figure 1: Neurosurgical Intervention Rates for Combined MOD and SEV from 2003-2013 in a Mature Trauma System



Session: XIV: Papers 56-67
Paper 66: 11:20-11:40

VANISHING NEED FOR EXTRAPERITONEAL PELVIC PACKING ASSOCIATED WITH IMPROVED RESUSCITATION STRATEGIES

Iver Anders Gaski MD, Jeppe Barckman MD,Ph.D., Nils Oddvar Skaga MD,Ph.D., Jan Erik Madsen MD,Ph.D., Paal Aksel Naess* MD,Ph.D., Gunnar Flugsrud MD,Ph.D., Christine Gaarder* MD,Ph.D., Oslo University Hospital

Invited Discussant: Mark Bowyer, MD

Introduction: Extraperitoneal pelvic packing (EPP) was introduced at Oslo University Hospital Ulleval (OUH U) early 90's as an adjunct in the exsanguinating patient due to pelvic injury, where physiology did not allow the time to angiography. EPP is invasive with a high risk of complications. Published studies from other institutions have advocated its application in-lieu of angiography. The optimal treatment protocol remains controversial and depends on available resources and resuscitation. In line with international trends, we have changed over the last decade from damage control surgery to damage control resuscitation with an updated massive transfusion protocol from 2007, potentially reducing the need for EPP. We hypothesized a decreased need for EPP due to the major changes in resuscitation strategies.

Methods: Retrospective analysis of prospectively collected data between 2002 and 2012. All trauma patients diagnosed with a pelvic fracture AIS≥3 and/or who were transfused during initial resuscitation regardless of the grade of pelvic fracture were included. The population was analyzed for trends and differences between 2002-2006 (P1) and 2007-2012 (P2).

Results: The study population consisted of 648 patients; 67% were men, median age was 40 years (IQR 25, 55).

Characteristics	**Period 1 (n=297)**	**Period 2 (n=351)**	***p***
ISS, median (IQR)	29 (19,43)	30 (19,43)	
Pelvic AIS, median (IQR)	3 (3,4)	3(3,4)	
BD, mean	4.5 (5.8)	5.3 (5.2)	<0.01
RTS, mean	6.7 (1.9)	6.7 (1.7)	0.24
Transfusion, n (%)	117 (39)	144 (41)	0.78
PRBCs, mean (SD)	12 (12)	10 (12)	<0.01
EPP, n (%)	50 (17)	35 (10)	<0.01
Angiography, n (%)	45 (15)	34 (9)	0.04
30 day mortality n (%)	50 (17)	47 (13)	0.23
W statistics (CI)	6.24 (3.11; 9.36)	10.95 (8.02; 13.88)	

The EPP rate decreases gradually from 2008, with only one procedure performed in 2012. Reduction is also seen in angiographyrate, without an increase in mortality. W-statistics to show a trend towards increased survival. Simultaneously, while transfusing as many and on average sicker patients, the transfusion requirements per patient decreased.

Conclusion: EPP and angiography for exsanguinating pelvic injuries have become very infrequently needed and seem to be associated with improved resuscitation strategies, reduced transfusion requirements and with no increase in mortality.

Session: XIV: Papers 56-67
Paper 67: 11:40-12:00

TIME AND PLACE OF DEATH FROM AUTOMOBILE CRASHES: RESEARCH ENDPOINT IMPLICATIONS

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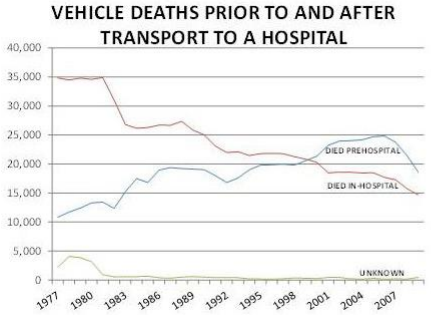
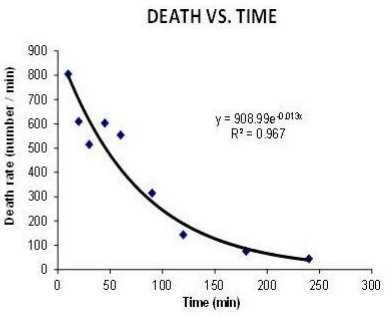
Invited Discussant: Karen Brasel, MD, MPH

Introduction: Vehicle crashes are a leading cause of injury and death in the United States. Early death and its predominant causes — hemorrhage and head injury — over time following injury, have almost entirely been studied in patients admitted to hospitals. New approaches to resuscitation will increasingly move into the prehospital arena. The US Department of Transportation Fatality Analysis Reporting System (FARS) is a close-to-census database that includes information from police, EMS, and hospital reports on incidents involving at least one road traffic death in the United States. Thus, it captures both prehospital and in-hospital mortality and allows for benchmarking risk of death in the early continuum of care.

Methods: FARS location and time of death were reviewed from 1977 through 2009. Patients in the database (n=55,537) from 2003 through 2005 were reviewed to analyze for risk of death over time.

Results: Since trauma centers and systems were introduced 30 years ago, there have been 1,436,178 vehicle-associated deaths, and there has been an overall decrease in deaths per 100 million vehicle miles travelled from 3.26 to 1.13. Although hospital deaths decreased by 57% (35,000/year to 15,000/year); prehospital deaths increased by 58% (12,000/year to 19,000/year). Excluding immediate deaths (within 5 minutes), the curve Y=908.99e – 0.013x establishes the relationship between time following injury and death in 55,537 deaths. Early hospital deaths from injury occur at a defined rate with a risk of 0.4%/minute for the first 30 minutes, 1%/minute for the next 60 minutes and 0.2%/minute and plateauing thereafter.





Conclusion: Many factors in EMS systems, vehicle design, seatbelt laws, and trauma care have resulted in reducing deaths by a third (approximately 45,000/year to 30,000/year) over 30 years. Risk of death over time should help define EMS, trauma system, and resuscitation goals. Deaths after 4 hours should not be a primary resuscitation research endpoint. Resuscitation research needs to focus on prehospital and early (<4 hours) endpoints, rather than arbitrary 24-hour or 30-day time periods, which add cost and confound analyses, detracting from therapeutic and system improvements.