HARD, SOFT, & IRRELEVANT: HEMORRHAGIC & ISCHEMIC SIGNS BETTER DISTINGUISH IMPORTANT CHARACTERISTICS OF EXTREMITY VASCULAR INJURIES

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Invited Discussant: Mark Seamon, MD

Introduction: Hard & soft signs, developed decades ago to guide management decisions in the setting of potential extremity vascular injury, fail to distinguish optimal evaluation or management in an era of advanced imaging and capabilities. A hemorrhagic vs. ischemic distinction may be more useful in guiding the management of extremity vascular injuries.

Methods: Femoral and popliteal arterial injuries with recorded hard/soft & hemorrhagic (HEM-overt hemorrhage, expanding hematoma, hypotension)/ischemic (ISC-absent/diminished pulses, frank ischemia) signs, were compiled from the AAST PROspective Observational Vascular Injury Treatment database. Presentation, pathology, treatment, & outcome variables from records with any HEM signs were compared with those with only ISCH signs. Workups of those with any hard and only soft signs were examined.

Results: Hard signs were documented in 386 records; 35% had diagnostic CTA. Only soft signs were present in 175; 39% had operation for diagnosis w/o imaging. Of 521 eligible (284 femoral, 237 popliteal), 310 had one or more HEM; 211 had only ISC signs. HEM & ISC had distinct mechanism (Penetrating: HEM 69% vs ISC 41%, P<.0001), SBP (112±35 mmHg vs 127±29, P=.005), fracture (37% vs 53%, P<.0001), concomitant vein (50% vs 33%, P=.001) & nerve injuries (16% vs 8%, P=.008), & arterial pathology (Transection: 63% vs 39%; Occlusion: 16% vs 37%, P<.0001). HEM went to intervention sooner (20% vs 12% <1h from injury, P=.001) & more likely without imaging (63% vs 46%, P<.0001). HEM more likely to undergo damage control ligation (19% vs 9%, P=.002) & primary repair (18% vs 10%); less likely endovascular repair (3.5% vs 6.2%, P=.05). HEM used more PRBC/24h (4 vs 2u, P<.0001). Amputation similar (12%); mortality was higher in HEM (8.9% vs 1.9%, P=.001). ICU, hospital LOS, graft-related outcomes similar.

Conclusion: Hard & soft signs no longer effectively guide evaluation & management of extremity vascular injuries. A new paradigm distinguishing hemorrhagic & ischemic signs is more appropriate to guide early workup and treatment decisions in the modern era.

IMPACT OF TIME TO SURGERY ON MORTALITY IN HYPOTENSIVE PATIENTS WITH NON-COMPRESSIBLE TORSO HEMORRHAGE: AN AAST MULTICENTER PROSPECTIVE STUDY

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Invited Discussant: Lawrence Lottenberg, MD

Introduction: Death from non-compressible torso hemorrhage (NCTH) may be preventable with improved pre-hospital care and shorter in-hospital times to hemorrhage control. We hypothesized that shorter times to surgical intervention for hemorrhage control would decrease mortality in hypotensive patients with NCTH.

Methods: This was an AAST-sponsored multicenter, prospective analysis of hypotensive patients aged 15+ years who presented with NCTH from to May 2018-December 2020. Hypotension was defined as an initial systolic blood pressure (SBP) $\leq$ 90 mmHg. Primary outcomes of interest were time to surgery and mortality.

Results: There were 242 (53.9%) hypotensive patients, of which 48 died (19.8%). The deceased cohort had higher mean age (38.8 vs 47.3;P=0.02), higher New Injury Severity Score (38 vs 29; P<0.001), lower admit SBP (68 vs 79;P<0.01) and shorter time from injury to OR start (79.8 vs 115.8; P<0.001) than did survivors. Multivariable regression controlled for confounders showed no association between time from ED arrival to OR start and mortality (P=0.65).

Conclusions: The total mean time from injury to start of surgical hemorrhage control in NCTH was 109 minutes. Patients who expired presented in greater physiological distress and had significantly shorter times to surgical hemorrhage intervention than did survivors. This suggests that even expediting a critically ill patient 35 minutes faster through the current trauma system is not sufficient time to save their lives from NCTH.

Table. Time intervals for hypotensive NCTH patients.

Time intervals, minutes	Alive (n = 194, 80.2%)	Dead (n = 48, 19.8%)	P
Injury to ED	37.4 (27.7)	35.7 (19.5)	0.71
ED time	65.1 (95.4)	39.9 (78.3)	0.06
OR prep time	22.3 (44.8)	15.9 (13.6)	0.33
ED to OR start	87.6 (118.6)	55.8 (80.1)	**0.03**
ED to end of OR	239.7 (340.8)	134.4 (102.6)	**<0.001**
Injury to OR start	115.9 (102.8)	79.8 (41.0)	**0.001**
Injury to end of OR	251.1 (269.4)	153.9 (72.1)	**0.03**

Values are mean (SD)

AFTER 9,000 LAPAROTOMIES FOR BLUNT TRAUMA, RESUSCITATION IS BECOMING MORE BALANCED AND TIME TO INTERVENTION SHORTER: HOW LOW CAN WE GO?

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Invited Discussant: Bryan Cotton, MD

Introduction: Several advancements in hemorrhage control have been advocated for in the past decade, including balanced transfusions and earlier times to intervention. The aim of this study is to examine the effect of these advancements on outcomes of blunt trauma patients undergoing emergency laparotomy.

Methods: This is a 5-year (2013-2017) analysis of the Trauma Quality Improvement Program. Adult (age ≥18 years) blunt trauma patients with early (≤4 hours) PRBC and FFP transfusions and an emergency (≤4 hours) laparotomy for hemorrhage control were identified. Time-trend analysis of 24-hour mortality, PRBC/FFP ratio, and time to laparotomy was performed over the study period. The association between mortality and PRBC/FFP ratio, patient demographics, injury characteristics, transfusion volumes, and ACS verification level was examined by hierarchical regression analysis adjusting for inter-year variability.

Results: A total of 9,868 blunt trauma patients with emergency laparotomy were identified. Mean age was 44±18 years, 67.5% were male, and median ISS was 34 [24-43]. Mean SBP at presentation was 73±28 mm Hg, and median transfusion requirements were PRBC 9 [5-17] and FFP 6 [3-12]. During the 5-year analysis, time to laparotomy decreased from 1.87 hours to 1.37 hours (p<0.001), PRBC/FFP ratio at 4 hours decreased from 1.93 to 1.71 (p<0.001), and 24-hour mortality decreased from 23.0% to 19.3% (p=0.014). **(Figure)** On multivariate analysis, PRBC/FFP ratio was independently associated with 24-hour mortality (OR 1.09; p<0.001) and in-hospital mortality (OR 1.10; p<0.001).

Conclusion: Resuscitation is becoming more balanced and time to emergency laparotomy shorter in blunt trauma patients, with a significant improvement in mortality. Future efforts should be directed towards incorporating transfusion practices and timely surgical interventions as markers of trauma center quality.
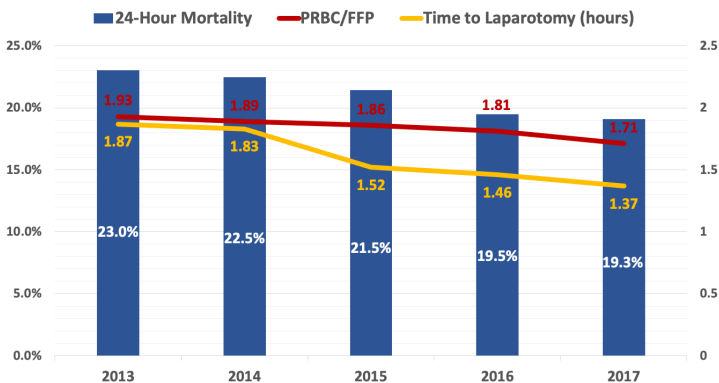
ADMISSION THROMBOELASTOGRAPHY REFLECTS THE RELATIONSHIP BETWEEN CYTOKINES AND COAGULOPATHY: A PROPPR SUB-ANALYSIS

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Invited Discussant: Ronald Maier, MD

Introduction: Acute traumatic coagulopathy (ATC) has many phenotypes and varying morbidity and mortality. The MA-R ratio, calculated from the admission thromboelastogram (TEG), serves as a biomarker to identify one phenotype of ATC and has previously been associate with significant derangements in the cytokine response. This study aims to evaluate outcomes related to abnormal MA-R ratios, including cytokine responses, in a heterogeneous patient population.

Methods : 660 patients from the PROPPR dataset were included. The MA-R ratio was calculated at admission utilizing TEG and a low ratio (LOW) was defined as ≤ 11. Key inflammatory mediators were identified *a priori*. Cytokine expression was assessed at admission and 24 hours using multivariable logistic regression. A similar model was utilized to assess key outcomes between LOW and HIGH (MA-R > 11) patients.

Results : At admission, LOW patients had significant elevations in IL-6, IP10, Eotaxin, MCP 1 and GM CSF. IL 13 was significantly lower (Table). Differences had resolved by 24 hours. LOW patients had significantly lower survival at all measured 24 hour timepoints (1, 3, 6, 12 and 18 hours). When excluding patients who died in the first 24 hours, LOW patients demonstrated significantly increased incidence of Adult Respiratory Distress Sydrome (1.843 (95% CI 1.103, 3.079), p=0.0195), which was associated with fewer ICU-free (LOW 18 days (IQR 2, 26) v. HIGH 23 days (10, 26), p=0.031) and fewer ventilator free days (LOW 25 (IQR 7, 28) v. HIGH 27 (17, 28), p=0.0191). LOW patients were protected against Systemic Inflammatory Response Syndrome (0.536 (95% CI 0.355, 0.807), p=0.0029).

Conclusions : The subtype of ATC identified by the low MA-R ratio is associated with significant elevates in multiple pro-inflammatory cytokines at admission. Early mortality remains elevated in the LOW group, in part due to coagulopathy. In patients who survive the first 24 hours, LOW patients have significantly increased incidence of ARDS and fewer ICU and ventilator free days. The adverse pulmonary outcomes are inversely related to SIRS however. More work is needed to understand the interaction between inflammation and coagulopathy in this subset of patients.

EMERGENCY GENERAL SURGERY TRANSFER TO LOWER ACUITY FACILITY: THE ROLE OF RIGHT-SIZING CARE IN EGS REGIONALIZATION

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Invited Discussant: Lillian Kao, MD, MS

Background: Planning and resources have focused on regionalization of emergency general surgery (EGS) to expedite care of high acuity patients through interfacility transfers. In contrast, triaging low-risk patients to a non-designated trauma facility has not been evaluated. This study evaluates a one-year experience of a 5-surgeon team triaging EGS patients at a tertiary care, Level 1 (TC) to an affiliated community hospital 1.3 miles distant.
Methods: All EGS patients who presented to the Level 1 TC emergency department (ED) from 12/2019-12/2020 were analyzed. Patients were screened by EGS surgeons covering both facilities for transfer appropriateness including hemodynamics, resource need, and comorbidities. Patients were evaluated for disposition, diagnosis, comorbidities, length of stay (LOS), surgical intervention, 30-day mortality, and 30-day readmission.
Results: Of 695 patients reviewed, 229 (33.0%) were transferred to the affiliated community hospital, 112 (16.1%) were discharged home, and 354 (50.9%) were admitted to the Level 1 TC. Common diagnoses were biliary disease (18.7%), bowel obstruction (15.8%), and appendicitis (15.1%). Compared to Level I TC admissions, Charlson Comorbidity Index was lower (2.06 vs. 4.43; $p<0.001$) and LOS was shorter for transfers (2.45 vs. 5.80 days; $p<0.001$). Transfers had a higher rate of surgery (71% vs. 51%; $p<0.001$) and lower readmission and mortality (6% vs. 9%; $p<0.001$; 1% vs. 4%; $p=0.037$). Reasons not to transfer were emergency evaluation, comorbidity burden, OR availability, and established care. No transfers required transfer back to higher care (undertriage). Bed days saved at the Level 1 TC were 562 (484 inpatient). Total OR minutes saved were 18,751 (12,594 between 0700AM and 1700PM).
Conclusions: Transfer of appropriate patients maintains high quality care and outcomes, while improving OR and bed capacity and resource utilization at a tertiary care, Level 1 TC. EGS regionalization should consider triage of both high-risk and low-risk patients.

FINANCIAL VULNERABILITIES OF AMERICAN COLLEGE OF SURGEONS VERIFIED TRAUMA CENTERS: A STATEWIDE ANALYSIS

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Invited Discussant: Grant Bochicchio, MD, MPH

Objective: Although trauma centers represent an integral part of healthcare in the United States, characterization of their financial vulnerability has not been reported. We sought to characterize the financial health/ vulnerability among California trauma centers and identify associated factors associated with high and low vulnerability.

Methods: The RAND Hospital Data financial dataset was used to evaluate all verified trauma centers in California. Financial vulnerability of each center was calculated using six metrics to calculate a composite Financial Vulnerability Score (FVS). Tertiles of the FVS were generated to classify trauma centers as High, Medium, or Low financial vulnerability. Hospital characteristics were also analyzed and compared.

Results: 44 trauma centers were identified (9 Level I, 27 Level II, 8 Level III). Level I centers had the greatest proportion of the high FVS tier (44%), while Level II and III centers were most likely to be in the middle and lower tiers, respectively (44% and 63%, see Figure for breakdown). Lower FVS centers had greater asset: liability ratios, operating margins, and days cash on hand compared to the two higher tiers, while high FVS centers showed a significantly greater proportion of uncompensated care, outpatient share rates, outpatient surgeries, and longer days in net accounts. High FVS centers were more likely to be teaching hospitals (T1=71%; T2=53%; T3=47%) and members of a larger corporate entity (T1=85%; T2=73%; T3=67%).

Trauma Center Distribution by Financial Vulnerability Category
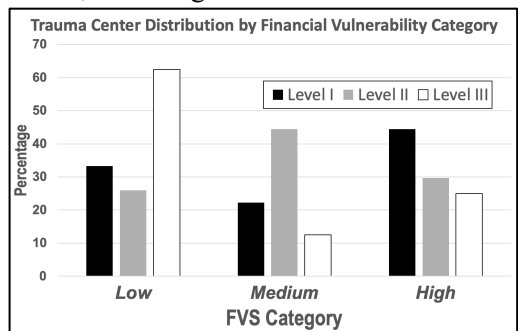
Conclusion: Up to 66% of trauma centers were at moderate/high risk for financial vulnerability and disparate impacts of stressor events such as the COVID-19 pandemic. There were wide disparities seen by key center characteristics, patient mix, and financial metrics that may represent targets for focused improvement and financial preparation efforts.

EARLY METABOLIC SUPPORT FOR CRITICALLY ILL TRAUMA PATIENTS – A PROSPECTIVE RANDOMIZED CONTROLLED TRIAL

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Invited Discussant: Alicia Mohr, MD

Introduction: There is a lack of consensus regarding the optimal timing and components of nutritional support for critically ill patients after significant trauma. Trauma patients are typically younger, often with fewer co-morbidities, and generally are well nourished at the time of their injury. We hypothesize that early post injury metabolic support focusing on adequate protein would modify the metabolic signature and alter the inflammatory environment for critically ill trauma patients.

Methods: We conducted a prospective randomized controlled pilot trial for adult patients admitted to the surgical intensive care unit (SICU) following traumatic injury. Patients were randomized to receive early metabolic support (EMS) (peripheral amino acid (AA) infusions) or standard of care (enteral nutrition as soon as feasible). In addition to routine laboratory assessments, nitrogen balance, cytokines, and metabolomics analyses were assessed at baseline and day 5 after intervention.

Results: A total of 42 trauma patients were randomized into well balanced groups with similar age (32 yrs), ISS (25), and BMI (27.4 kg/m^2) at baseline. EMS provided significantly more protein (1.43 g/kg vs. 0.35 g/kg; p<0.0001) and more calories (12.6 Kcal/kg vs. 7.5 g/kg; p=0.0012) over the first 5 days as compared to the standard of care. EMS resulted in modified protein catabolism and synthesis as demonstrated by a larger median negative nitrogen balance (-16.3 g vs. -5.3 g; p=0.03) and a unique metabolomic profile at day 5. The biochemical profile of patients who received EMS was defined by greater declines in circulating levels of stress hormone precursors and increased levels of AAs. The inflammatory response following EMS resulted in a greater decrease in IL-1B (p=0.02) and increase in sIL-6-receptor (p=0.01) between baseline and day 5 as compared to the standard of care. The EMS group had a decreased median length of stay (LOS) (15 vs. 22 days) and decreased SICU LOS (8 vs. 9 days), however this disappeared after adjustment for ISS in this small population.

Conclusions: Early metabolic support with AA is safe, modifies protein metabolism, and may down regulate the inflammatory state associated with significant trauma, warranting a larger trial to assess for improved outcomes.

ALIVE AND AT HOME: FIVE-YEAR OUTCOMES AMONG OLDER ADULTS WITH SEVERE TRAUMATIC INJURY

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Invited Discussant: Robert Barraco, MD, MPH

Background: While the short-term risks of severe injury among older adults (age ≥ 65) are well studied, little is known about long-term functional outcomes in this population. This knowledge gap impacts clinicians' ability to counsel patients and provide care aligned with their values. The objective of this study was to evaluate the association between severe injury and the likelihood of an older adult remaining alive and at home five years later.
Methods: This was a retrospective, population-based cohort study using administrative data from a large regional trauma system (2006-2019). Community-dwelling older adults (age ≥ 65) who sustained a severe injury were hard-matched with uninjured controls from the general population based on age, sex, rurality, social determinants of health, comorbidity, and frailty. Time from injury to nursing home admission or death was compared between cases and controls using Kaplan-Meier analysis and Cox models.
Results: A total of 20,217 community-dwelling older adults admitted with severe trauma were identified and matched with controls. Mean age was 79 (±8) years, median ISS was 16 (IQR 16-21), and in-hospital mortality was 22.8%. Compared to matched controls, patients who sustained a severe injury spent fewer years alive and at home (median 2.7 years for cases vs. >5 years for controls). After five years, the probability of remaining alive and at home was 40% for cases vs. 64% for controls. While the risk of nursing home admission or death was greatest within the first 90 days after injury (HR 15.99, 95% CI 14.60-17.52), severe injury remained associated with an elevated risk for the entirety of the five-year follow up period (years 2-5, HR 1.18, 95% CI 1.13-1.24). Baseline frailty significantly impacted the time spent alive and at home after injury. Among frail injured patients (n=3,819), median time spent alive and at home was 4 months vs. 2.8 years for frail matched controls. Likewise, the probability of remaining alive and home at five years was 14% for frail cases and 33% for matched controls.
Conclusion: Most severely injured older adults survive to live in their own home for several years following injury. Nonetheless, patients who survive their admission remain at increased risk of nursing home admission or death for at least five years. Additional long-term supports are necessary to ensure that patients remain alive and independent for years following their injury.

SOCIOECONOMIC DISADVANTAGE IS ASSOCIATED WITH HIGHER MORTALITY AFTER EMERGENCY SURGERY

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Marta L. McCrum, MD MPH; University of Utah
Invited Discussant: Cherisse Berry, MD

Introduction: Socioeconomic disadvantage (SD) is associated with worse outcomes after elective surgery, but the effect on patients seeking emergent surgical care is unknown. We examined the association of SD and outcomes after emergency general surgery (EGS) procedures and investigated whether Level-1 (L1) trauma centers, with comprehensive clinical and social services and quality improvement programs, mitigated this effect.

Methods: Adults who underwent one of the 10 most burdensome high- and low-risk EGS procedures were identified in six 2014 State Inpatient Databases. SD was assessed using Area Deprivation Index (ADI) of patient residence. Multivariable logistic regression models adjusting for patient and hospital factors were used to evaluate the association between ADI quartile (high >75%ile vs low <25%ile), in-hospital mortality, 30-day readmission and discharge disposition. Effect modification between ADI and L1 trauma status was assessed.

Results: 97,087 patients were analyzed: 69,413 (71.5%) low-risk and 27,674 (28.5%) high-risk procedures. High-SD patients had a higher proportion with ≥3 comorbidities (39.6% vs 29.9%),

High-Risk EGS Procedures	OR (95% CI)
30-Day Readmission	1.03 (0.87, 1.22)
In-Hospital Mortality	1.34 (1.03, 1.73)
Home/Routine Discharge	0.97 (0.84, 1.11)
Low-Risk EGS Procedures	
30-Day Readmission	1.03 (0.90, 1.18)
In-Hospital Mortality	1.29 (0.72, 2.30)
Home/Routine Discharge	0.85 (0.75, 0.97)

minority race/ethnicity (57.7% vs 33.6%) and Medicaid (28.6% vs 14.5%) and were less-likely to be treated at L1 trauma centers (18.1% vs 27.3%) p<0.01 for all. Adjusting for competing factors, high-SD patients had 34% higher risk-adjusted probability of mortality for high-risk EGS procedures (OR 1.34, 95%CI 1.03-1.73, p=0.03). SD was not associated with mortality after low-risk EGS or 30-day readmission. High-SD patients were also less likely to discharge home after low-risk procedures (OR 0.85, 0.75-0.96, p=0.012). L1 trauma status did not modify the effects of ADI on outcomes.

Conclusion: Socioeconomic disadvantage is associated with increased mortality after high-risk, but not low-risk EGS procedures. The added resources of Level-1 centers did not mitigate this effect. Interventions that extend beyond hospital walls and address social and community needs are likely needed if we are to make significant improvements in clinical outcomes for socially vulnerable EGS patients.
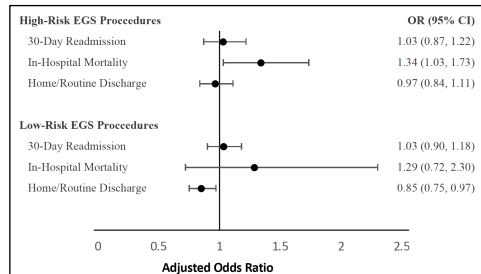
A REVISED AAST GRADING SYSTEM FOR ACUTE CHOLECYSTITIS RESULTS IN SIGNIFICANTLY IMPROVED OUTCOME PREDICTIONS

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Invited Discussant: Nicole Stassen, MD

Introduction: Grading systems for acute cholecystitis are essential to compare outcomes, improve quality and advance research. The original AAST grading system for acute cholecystitis was only moderately discriminant when predicting multiple outcomes and underperformed the Tokyo guidelines and Parkland grade.

Methods: A modified Delphi approach was used to revise the AAST grading system. The revised version was assessed using prospectively collected data from an AAST multicenter study and minor adjustments were made. The revised grading system was then evaluated based on predictive capacity for conversion from laparoscopic to an open procedure, use of a surgical "bail-out" procedure, bile leak, other morbidity and discharge home. A pre-operative AAST grade was defined based on pre-operative, clinical and radiologic data and the Parkland grade was also substituted for the operative component of the AAST grade (AAST/Parkland). Discriminatory power was assessed by comparing the receiver operating characteristic curves (AUC) using the methods of Delong.

Results: Using prospectively collected data on 861 patients with acute cholecystitis the revised version of the AAST grade has an improved distribution (figure) and outperformed the original AAST grade for predicting operative outcomes and discharge disposition (table).

Conclusions: The revised AAST grade and the pre-op AAST grade demonstrated improved discrimination. Follow up validation will be necessary given new clinical and imaging variables in the revised grading system.

A NOVEL PREOPERATIVE SCORE TO PREDICT SEVERE ACUTE CHOLECYSTITIS

Kali Kuhlenschmidt, MD; Luis Taveras, MD; Majed El Hechi, MD; Ruchir Puri, MBBS, MD, MS, FACS; Thomas J. Schroeppel, MD, FACS; Haytham M. Kaafarani, MD, MPH; Marie Crandall, MD, MPH; Kevin M. Schuster, MD, MPH, FACS; Michael Cripps, MD, MSCS, FACS
Invited Discussant: Peter Hammer, MD

Introduction: In a multicenter trial, the Parkland Grading Scale (PGS) for acute cholecystitis outperformed other grading scales and has a positive correlation with complications but is limited by its inability to preoperatively predict high grade cholecystitis. We sought to identify preoperative variables predictive of high-grade cholecystitis (PGS 4 or 5).

Methods: In a six-month period, all patients undergoing cholecystectomy at a single institution were analyzed. Stepwise logistic regression models were constructed to predict PGS 4 or 5 and relative weight of the variables were used to derive a novel score, the Severe Acute Cholecystitis Score (SACS). This score was compared to the Emergency Surgery Acuity Score (ESS), American Association for the Surgery of Trauma (AAST) preoperative score and Tokyo Guidelines. SACS was then validated using the database from the AAST multicenter validation of the grading scale for acute cholecystitis.

Results: Of the 575 patients that underwent cholecystectomy, 172(29.9%) were classified as PGS 4 or 5. The stepwise logistic regression modeling identified 7 independent predictors of high-grade cholecystitis [Table] from which the SACS was derived. Scores ranged from 0 to 9 points with a C statistic of 0.76, outperforming the ESS (C statistic of 0.60), AAST (0.53), and Tokyo Guidelines (0.70)(p-value <0.001) [Figure]. A cutoff of 4 or more on the SACS correctly identifies 76.2% of cases with a specificity of 91.3% and a sensitivity of 40.7%. In the multicenter database, there were 464 patients with a prospectively collected PGS. The C statistic for SACS was 0.74and the cutoff of 4 correctly identifies 71.6% of cases with a specificity of 83.8% and a sensitivity of 52.2%.

Conclusions: The Severe Acute Cholecystitis Score can preoperatively predict high-grade cholecystitis. This data, used to counsel the patient and better preoperative planning, may improve outcomes in patient with severe acute cholecystitis.

Multivariate logistic regression and points for predicting high grade cholecystitis

Variable	Odds Ratio	Points	95% Confidence Interval	p-value
Age > 50 years	2.05	1	1.24-3.41	0.005
Male gender	2.97	2	1.90-4.62	<0.001
Presence of comorbidities	1.68	1	1.05-2.70	0.03
Duration of Pain ≥ 4 days	1.71	1	1.09-2.68	0.019
White Blood Cells ≥ 14k	2.20	1	1.35-3.59	0.002
Temperature > 37.5 C	2.18	1	1.17-4.07	0.014
Gallbladder Wall ≥ 4 mm	3.11	2	1.70-5.71	<0.001
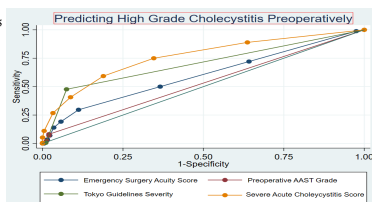
ANALYSIS OF REACTIVE ASCITES COLLECTED IN ACUTE APPENDICITIS OR SMALL BOWEL OBSTRUCTION

Melissa Hausburg, PH.D.; Erica Sercy, MSPH; Raphael Bar-Or, BS; Jennifer Bocker, MD; Rebecca Ryznar, PH.D.; Robert Madayag, MD; Thaddeus Liniewicz, DO; M. Jacob Ott, MD; Allen Tanner II, MD; Charles Mains, MD, FACS; David Bar-Or, MD; Swedish Medical Center
Invited Discussant: Kazuhide Matsushima, MD

Introduction: Pathological adhesions in the abdomen can cause bowel obstructions, female infertility, pain, and surgical complications. Appendicitis increases the expression of adhesion proteins, and appendix-associated adhesions may be observed during appendectomy. Acute appendicitis (AA) patients show increased oxidized proteins in serum and inflammatory cytokines in serum and reactive ascites (rA). We seek to comprehensively characterize the redox and inflammatory status of rA collected during appendectomy or fibrinolysis for small bowel obstruction (SBO) with the goal of identifying strategies to treat and prevent pathological adhesions.

Methods: This is a non-randomized, prospective observational study recruiting patients with non-perforated AA or SBO from four Level 1 trauma centers in the United States. To date, 44 AA and 7 SBO rA samples have been collected, and samples with sufficient volume were further analyzed via liquid chromatography-mass spectrometry (LC-MS) (n=20), bead-based quantification of 71 cytokines and chemokines and 14 soluble receptors (n=41), and identification of the top 200 metabolites (n=24).

Results: LC-MS of samples showed that all samples contained high levels of serum proteins, i.e., albumin, apolipoprotein A1, and transthyretin. Multiplex analyses showed that levels of 23 cytokines and chemokines and 5 soluble receptors were significantly different in AA versus SBO rA. The top proteins increased in AA rA by 59.28- and 24.63-fold, respectively, were interleukin (IL)-1R antagonist and granulocyte-colony stimulating factor. Conversely, C-X-C motif chemokine ligand (CXCL) 1 and IL-21 were more abundant in SBO rA by 18.80- and 9.51-fold, respectively. Arachidonic acid was the most decreased metabolite in AA vs SBO rA. Pathway analyses of these data predict that AA rA drives activation of leukocytes, as well as production of nitric oxide and reactive oxygen species in macrophages.

Conclusion: These data implicate oxidative stress and inflammation as major contributing factors to adhesion formation. Our goal is to further explore whether attenuation of these factors may decrease pathologic adhesion formation without compromising healing.

THE UNEQUAL IMPACT OF INTER-HOSPITAL TRANSFERS ON EMERGENCY GENERAL SURGERY PATIENTS: PROCEDURE RISK MATTERS

Raul Coimbra, MD, PhD; Robert Barrientos, BS; Timothy
Allison-Aipa, BS; Bishoy Zachary, MPH; Matthew Firek, BS;
Riverside University Health System
Invited Discussant: Angela Ingraham, MD, MS

The impact of inter-hospital transfer on outcomes of patients undergoing emergency general surgery (EGS) procedures is unclear. We set out to determine if transfer prior to definitive surgical care leads to worse outcomes in EGS patients.Using the NSQIP database (2013-2019), 9 procedures encompassing 80% of the burden of EGS diseases, performed on an urgent/emergent basis were identified and further classified as low risk (open and laparoscopic appendectomy and laparoscopic cholecystectomy) and high risk (open cholecystectomy, laparoscopic and open colectomy, lysis of adhesions, perforated ulcer repair, small bowel resection, and exploratory laparotomy). Time to intervention was recorded in days. The impact of inter-hospital transfer on outcomes (mortality, complications, reoperations, and 30-d readmissions), length of stay (LOS), and time to intervention according to procedure risk were analyzed by univariate and multivariate models. A total of 329,613 patients were included in the study (284,783 direct admission, and 44,830 transfers). Unadjusted mortality (3.1% vs. 10.4%), complications (6.7% vs. 18.9%), reoperations (3.1% vs. 6.4%), readmission rates (5.8% vs. 7.8%) and LOS (2 vs. 5) were higher in transferred patients. Delayed surgery >48h after admission was also associated with worse outcomes. Multivariate analysis revealed that inter-hospital transfer is associated with higher mortality (AOR=1.26), complications (AOR=1.34) and reoperations (AOR=1.22),although no differences regarding 30-d readmission were observed between groups. In addition, the transfer process did not affect any of the outcome measured in patients undergoing low risk procedures, whereas the outcome measures were negatively affected by the transfer process

Risk level	Post-operative outcome	Direct admission[a]	Transfer	AOR	Lower CI	Upper CI	p
High[b]	Mortality[c], n (%)	8729 (11.3)	4677 (18.7)	1.16	1.11	1.22	<.001
	N = 102283	77347	24936				
	Major complication[c], n (%)	17804 (23.0)	8333 (33.4)	1.20	1.16	1.25	<.001
	N = 102283	77347	24936				
	Reoperation[c], n (%)	6272 (8.1)	2600 (10.4)	1.13	1.08	1.19	<.001
	N = 102283	77347	24936				
	Readmission[cd], n (%)	8466 (12.1)	2703 (12.8)	1.01	0.96	1.06	.782
	N = 91232	70179	21053				

In conclusion, we have demonstrated that delays to surgical intervention affects outcomes and that inter-hospital transfer of EGS patients for definitive surgical care has a negative impact on mortality, development of post-operative complications, and reoperations in patients undergoing high risk EGS procedures. These findings may have important implications for regionalization of EGS care.

REOPERATIVE SURGERY FOLLOWING CAWR: WE SHOULD LOOK PAST 30 DAYS

Matthew McGuirk, MD; Agon Kajmolli, MD; Abbas Smiley, MD, MSc, PhD; David Samson, MS; Kartik Prabhakaran, MD, MHS, FACS; Peter Rhee, MD; Rifat Latifi, MD, FACS, FICS; Westchester Medical Center
Invited Discussant: Preston Miller, MD

Background: Re-operation following complex abdominal wall reconstruction (CAWR) is a problem that leads to increased morbidity and mortality. The aim of this study is to assess and identify independent predictors of re-operation following CAWR.

Methods: This was a prospective cohort study consisting of 220 patients who underwent CAWR at a tertiary care center between 2016-2020. Re-operation was defined as any unplanned return to the operating room. Patient demographics of the entire cohort were compared with those who required re-operation. A multivariable logistic regression model was created to identify independent predictors of re-operation.

Results: In our group of 220 patients, 44 (20%) patients required a re-operation. Re-operation occurred after discharge 75% of the time, with an average of 40 days (2-189) after the index procedure. The majority were due to infection (54.5%), followed by seroma (11.4%), and small bowel obstruction (9.1%). On average, patients required 2.2 (1-9) re-operations following CAWR. On multivariable regression (Table 1), mesh explantation during CAWR increased the odds of re-operation by 4.23 times (p=0.001), prior surgery for diverticulitis increased the odds by 4.16 times (p=0.001), and fistula takedown during CAWR increased the odds by 6.85 times (p=0.017).

Conclusion: The majority of re-operations occur after discharge and are caused by infection, seroma, and small bowel obstruction. Mesh explantation during CAWR, prior surgery for diverticulitis, and fistula takedown during CAWR are all independent predictors of re-operation following CAWR.

Table 1. Univariable and multivariable logistic regression model showing the predictors of re-operation following CAWR.

Variable	Univariable OR (CI)	p-value	Multivariable OR (CI)	p-value
Mesh explantation during CAWR	3.99 (1.89-8.39)	<0.001	4.23 (1.87-9.57)	0.001
Prior surgery for diverticulitis	3.27 (1.47-7.26)	0.004	4.16 (1.75-9.91)	0.001
Fistula takedown	7.39 (1.69-32.25)	0.008	6.85 (1.41-33.38)	0.017
BMI≥35	2.59 (1.32-5.10)	0.006	2.06 (0.98-4.32)	0.056
VHWG class III/IV	1.53 (0.78-2.99)	0.211	REMOVED BY BACKWARDS REGRESSION	
Recurrent hernia	2.52 (1.28-4.97)	0.008		
Smoking history	1.00 (0.44-2.27)	1.000		
Urgent/Emergent setting	1.24 (0.61-2.55)	0.549		

READY OR NOT? A COMPARISON OF IN-THEATER AND STATESIDE TRAUMA EXPOSURE AMONG MILITARY OTOLARYNGOLOGISTS

Matthew Ward, MD; Maria Alexander, BA; Travis Newberry, MD; Scott Bevans, MD; Brooke Army Medical Center
Invited Discussant: Travis Polk, MD

Introduction: Deployed otolaryngologists play a vital role in the management of complex craniofacial and laryngotracheal (CFLT) injuries. Maintaining mission readiness among non-deployed otolaryngologists is critical to supporting the Department of Defense (DoD) in its strategic objectives. To date, no analysis of military otolaryngologist exposure to CFLT injury management at Military Treatment Facilities (MTFs) has been performed.

Methods: A retrospective review of the Department of Defense Trauma Registry (DoDTR) was performed from 2003-2019, selecting for procedures done at Bagram Air Base, Afghanistan and Baghdad, Iraq. A retrospective review of procedures performed by otolaryngologists at 27 Army and Air Force MTFs from 2015-2019 was performed via query of the Military Health System Management Analysis and Reporting Tool (M2) database.

Results: The 2004-2008 timeframe recorded the greatest volume of CFLT procedures performed in Iraq and Afghanistan in a 5-year period. During this timeframe, deployed surgeons performed a total of 672 tracheostomy, 283 mandible, 160 midface, 116 orbit, and 40 laryngotracheal procedures. In comparison, approximately 90 military otolaryngologists stationed at 27 MTFs performed a total of 267 tracheostomy, 297 mandible, 221 midface, 176 orbit, and 78 laryngotracheal procedures from 2015-2019. Over half (51.1%) of these procedures were performed at Brooke Army Medical Center (BAMC), the only DoD Level 1 trauma center. Thirteen of 27 MTFs (48.2%) had 10 or fewer CFLT procedures combined, and 10 MTFs (37.0%) had no recorded tracheostomies performed by otolaryngologists during the 5-year time period.

Conclusion: CFLT procedures are commonly required of deployed otolaryngologists during the height of modern conflict. Military otolaryngologists had minimal exposure to these procedures at a majority of MTFs over the past 5 years. Access to stateside civilian trauma care greatly improves military otolaryngologists' exposure and should be considered a critical component of maintaining surgeon readiness for future conflicts.

HYPER-REALISTIC ADVANCED SURGICAL SKILLS PACKAGE WITH CUT SUIT SURGICAL SIMULATOR IMPROVES SURGERY TRAINEE CONFIDENCE IN OPERATIVE TRAUMA

Michael Klein, MD; Anna Liveris, MD; Tricia Yusaf, MD; Gabriela Batista; Dajelyn Diaz; Juan Cruz, MICP; Alex-Sungbae Lee, RRT; Jessica Pohlman, MPA, Med; Katie Walker; Marko Bukur, MD; Spiros Frangos, MD, MPH; Sheldon Teperman, MD; Edward Chao, MD; New York University School of Medicine, Bellevue Hospital Center
Invited Discussant: Elizabeth Benjamin, MD, PhD

Introduction: Adequate exposure to operative trauma is not uniform across U.S. surgical residencies, and therefore it can be challenging to achieve competency during residency alone. We introduced a novel and high-fidelity open-surgical simulator called the "Advanced Surgical Skills Package (ASSP) / Cut Suit," which can realistically replicate traumatic organ injury and bleeding, as part of our training curriculum to address this deficit. Our objective is to evaluate the use of the ASSP as a training instrument for civilian surgeons. **Methods:** Groups of 3-5 trainees from 6 different training programs, all with level 1 trauma centers within the largest public healthcare network in the United States, participated in this prospective, observational trial. The surgery residents were of different post-graduate levels and were instructed on operative tasks including resuscitative thoracotomy, exploratory laparotomy, splenectomy, hepatorrhaphy, bowel resection, retroperitoneal exploration, arterial shunt placement, nephrectomy, and temporary abdominal closure. Pre- and post-course surveys were used to evaluate trainees' experience and confidence performing these procedures utilizing a 5-point Likert scale. **Results:** Forty-five surgery residents participated in the evaluation. The surgical scenario was rated as highly stressful and realistic, with average scores of 3.1 and 4.5 out of 5, respectively. Across all procedures, there was a 1.2 point increase in average confidence rating for all residents (from 2.7 to 3.7 out of 5). The percentage of residents who were *most* confident in performing the procedures (rating of 4 or 5) increased from 33% to 61%. **Conclusions:** The ASSP with the Cut Suit surgical simulator is a realistic and useful adjunct in training young surgeons to manage complex operative trauma. Further studies are necessary to determine the most appropriate application of this simulator in surgical residency program curricula.

Resident's Confidence in Performing Surgical Procedures Pre- and Post- "Cut Suit" Simulation (n=45)
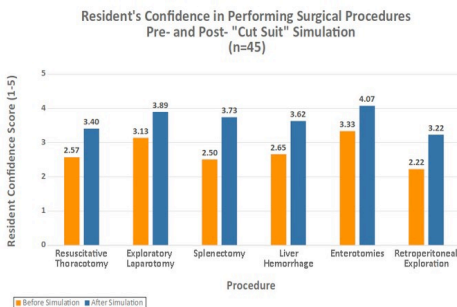
ERROR REDUCTION IN TRAUMA CARE: LESSONS FROM AN ANONYMIZED, NATIONAL, MULTI-CENTER MORTALITY REPORTING SYSTEM

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Invited Discussant: Ali Salim, MD

Introduction: The importance of system solutions to overcome human fallibility and prevent medical errors has been recognized as critical for a safer healthcare system. Yet over time rates of preventable deaths, particularly in trauma care, have not changed. We developed a mortality reporting system (MRS) to aggregate deaths with an opportunity for improvement from > 300 trauma centers. This study evaluates provider and system level strategies used by participating centers to prevent future harm.
Methods: Deaths are reported to the MRS if there is an identified opportunity for improvement, along with a mitigation strategy to avoid recurrence of the error. Using a validated framework based on the hierarchy of intervention effectiveness and consensus by three independent reviewers, we mapped mitigation strategy effectiveness from person-focused to system-oriented interventions.
Results: Over a 2-year period, 395 deaths were reviewed. 33.7% of mortalities were unanticipated, and frequently occurred after failure to rescue (36.1%). Errors frequently pertained to management (50.9%), clinical performance (54.7%) and communication (56.2%). Human failures were involved in 61% of errors. Person-focused strategies like education were common (56%), while more effective strategies such as automation, standardization and fail-safe approaches were seldom used. In 7% of cases, centers were unable to identify a specific strategy to prevent future harm.
Conclusion: Most strategies to reduce errors in trauma centers focus on changing the performance of providers rather than system-level interventions. Higher-level interventions may help reduce variability in clinical care. Centers require additional support to develop more effective mitigation strategies that will prevent recurrent errors and patient harm.
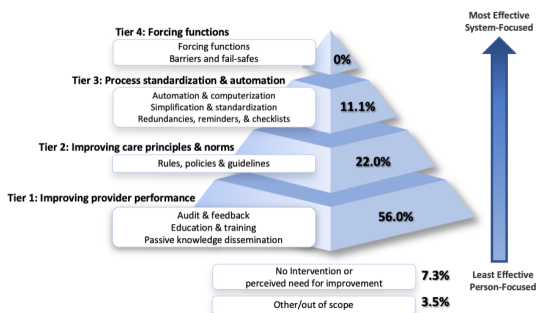
FALL RISK IDENTIFICATION THROUGHOUT THE CONTINUUM OF CARE

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Invited Discussant: Alicia Mangram, MD

Introduction: Falls are the most common mechanism of injury leading to trauma admission. Identifying patients at risk for falling and initiating an intervention has the potential to reduce serious injuries and even mortality, especially in the elderly. Researchers aimed to quantify the volume of patients age 65 and older admitted to a Level 1 trauma center for a fall, who were incidentally determined to be at risk for falling in the 12 months prior to their admission.

Methods: The trauma registry was queried to identify patients age 65 and older, who sustained a ground level fall, and were admitted to an inpatient unit over 36 months. The electronic medical record (EMR) was reviewed to determine if a patient was identified as being at risk for sustaining a fall in the 12 months prior to the index fall admission. The EMR was additionally queried for repeated falls within 12 months after discharge, and to determine if formal falls prevention education was provided at discharge.

Results: 597 patients met inclusion criteria; 68.2% were female. 58.7% of patients were identified in our system as being "at risk" for falling within the 12 months before their hospital fall admission. Only 2% of these patients had documented fall prevention education at discharge. 32% of patients sustained a repeat fall within a year after discharge and 19.6% were readmitted for a fall. Patients at high risk for falls based on the Hester-Davis score were significantly more likely to be readmitted to the hospital (p=0.004) and expire within six months (p=0.015) than patients at moderate and low risk. Mortality at 12 months for all patients after initial admission was 19.4%.

Conclusion: This large study demonstrates that one out of five geriatric fall patients die within 12 months of their fall admission. Surprisingly, most patients admitted to our trauma service for a fall were identified at risk for falling in the 12 months prior to their admission. This is a startling, and novel finding that presents a major prevention opportunity for health care systems. Implementation of proven techniques to reduce falls in patients when initially identified at risk has the potential to change the course for a patient who may not only fall but fall again. This proactive approach could significantly impact the fall epidemic in our elderly population.

IMPROVED MORTALITY PREDICTION WITH NSQIP COMPARED TO TRISS AND ASA IN ELDERLY TRAUMA PATIENTS UNDERGOING SURGERY

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Invited Discussant: Hayatham Kaafarani, MD

Introduction: The Trauma and Injury Severity Score (TRISS) utilizes injury and physiologic variables to prognostication outcomes. For a given TRISS, elderly ($\geq$ 65 years old) trauma patients undergoing surgery have increased morbidity and mortality compared to younger patients. However, functional status and comorbidities are noticeably absent from TRISS, but are incorporated within the National Surgical Quality Improvement Program Surgical Risk-Calculator (NSQIP) and the American Society of Anesthesiologists Physical Status (ASA) both of which are validated for non-trauma general surgery patients. We hypothesize NSQIP is superior at predicting mortality, length of stay (LOS) and complications in elderly trauma patients undergoing surgery.

Methods: A secondary analysis of a prospective multicenter observational study was performed. All trauma patients $\geq$ 65 years-old undergoing surgery within 24 hours of admission at four Level-I trauma centers were included. Using logistic regression, we compared five scoring models: ASA vs. NSQIP vs. TRISS vs. TRISS + ASA vs. TRISS + NSQIP. Brier scores and AUROC curve were calculated to compare predictive ability for mortality. We used the adjusted R^2 and root mean squared error (RMSE) to evaluate each scoring model's ability to predict LOS and number of complications.

Results: From 122 trauma patients $\geq$ 65 years-old, 9 died (7.4%) during index hospitalization. NSQIP was superior to ASA and TRISS at predicting mortality (AUROC 0.978 vs 0.768 vs 0.903, p=0.007). Adding TRISS to NSQIP had no additional benefit to predict mortality. The overall cohort median LOS was 12.9 days and number of complications was 0.88. NSQIP was the most accurate at predicting LOS (R^2: 25.9% vs 13.3% vs 20.5%) and number of complications (R^2: 34.0% vs. 22.6% vs 29.4%) compared to TRISS and ASA respectively. The addition of TRISS to NSQIP improved the predictive ability compared to NSQIP alone for number of complications (R^2 35.5% vs 34.0%, p=0.046).

Conclusion: NSQIP, which includes comorbidities and functional status, had superior ability to predict mortality, LOS, and complications compared to TRISS or ASA alone. Future incorporation of NSQIP to better prognosticate elderly trauma patients undergoing surgery is warranted.

INTERCOSTAL LIPOSOMAL BUPIVACAINE INJECTION FOR RIB FRACTURES

Taylor E Wallen MD; Kathleen E Singer MD; Amy T Makley MD; Krishna Athota MD; Christopher F Janowak MD; Ann Salvator MS; Richard Strilka MD; Christopher A Droege PharmD; Michael D Goodman MD; University of Cincinnati
Invited Discussant: Andrew Kerwin, MD

Introduction: Blunt chest wall injury accounts for 10% of trauma related admissions. Previous studies have shown that the number of rib fractures predicts inpatient opioid requirement, raising concerns for pharmacologic effects including hypotension, delirium, and opioid dependence. The aim of our study was to evaluate the use of liposomal bupivacaine as a regional analgesic to improve early pulmonary function and reduce opioid use.

Methods: A prospective, double-blinded, randomized placebo-control study was conducted at a Level 1 trauma center as an FDA investigational new drug study. Enrollment criteria included patients ≥ 18 years admitted to the ICU with blunt chest wall trauma who could not achieve greater than 50% goal inspiratory capacity. Patients were randomized to receive either targeted intercostal liposomal bupivacaine injection or subcutaneous saline in up to six intercostal spaces. Patients were monitored with incentive spirometry and a non-invasive thoracic impedance device to determine respiratory rate, tidal volume, and minute ventilation. Pain scores and breakthrough pain medications were recorded for 96 hours.

Results: 100 patients were enrolled with 50 in each cohort. Enrolled patients had a mean age of 60.5 ± 18.1 years, 47% were female, and cohorts had similar demographics and comorbidities. Rib fracture number (mean 6.8 bupivacaine, 7.7 saline), distribution, and bilateral targets for intercostal injection were similar between groups. The bupivacaine group achieved higher incentive spirometry volumes over days 1 (1095.3 mL bupivacaine vs. 900.3 mL saline) and 2 (1063.1 mL bupivacaine vs. 866.3 mL saline). There was no change in daily mean pain scores in either group, but both groups showed a decrease in opioid use over time. Hospital and ICU lengths of stay were similar between groups. Also, there were no differences in post-injection pneumonia, use of epidural catheters, or adverse events.

Conclusion: While intercostal liposomal bupivacaine injection is a safe method for rib fracture-related analgesia, it was not effective in reducing pain scores, opioid requirement, or hospital length of stay compared to placebo. Intercostal injection did transiently improve incentive spirometry volumes, however, without a reduction in the development of pneumonia.

IMPLEMENTATION OF BRAIN INJURY GUIDELINES (BIG) FOR ISOLATED TRAUMATIC BRAIN INJURY IN ADULTS DECREASES RESOURCE USE WITHOUT ADVERSELY IMPACTING OUTCOMES

Ken Kuruvilla, MD; James Clark II, BS; Oscar Estrada Munoz, MD; Allison McNickle, MD, FACS; Douglas R. Fraser, MD, FACS; Deborah A. Kuhls, MD, FACS, FCCM; John Fildes, MD, FACS; Paul J. Chestovich, MD, FACS; University of Nevada Las Vegas
Invited Discussant: Lena Napolitano, MD, MPH

Background: Traumatic brain injury (TBI) is a potentially life-threatening clinical condition with ~3 million hospital visits to trauma centers annually. The published Brain Injury Guidelines (BIG) have shown that patients at low risk for bleed progression can be safely managed without intensive care unit (ICU) admission or neurosurgery consultation. The purpose of this study is to compare the management and outcomes of patients with TBI before and after the implementation of BIG.

Methods: A retrospective cohort study was performed comparing pre- and post-BIG implementation at a Level 1 Trauma Center between 2014 and 2019. BIG was implemented in June 2017. Patients were stratified into three groups, BIG 1 (mild),2 (moderate), or 3 (severe). Primary outcome measures were hospital and ICU length of stay, repeat Head CT, neurosurgery consultation, and in-hospital mortality

Results: A total of 927 (Pre-BIG: 663, Post-BIG: 264) patients with isolated TBI were identified and had similar baseline characteristics except ISS which was higher in Pre-BIG patients. Overall adherence to BIG was 82.5%. Implementation of BIG resulted in significant reduction in ICU admissions (69% vs 53%, p<0.001), ICU length of stay (2.4 vs. 1.8, p=0.046), neurosurgery consultations (70% vs. 52%, P<0.001), and repeat imaging (74% vs. 60%, p<0.001). There was no increase in death, need for neurosurgical intervention, or upgrade to the ICU.

Conclusions: Implementation of BIG resulted in decreased neurosurgery consultations, repeat imaging, and ICU admission in patients without increase in mortality or need for neurosurgical intervention.

	Pre-BIG (N=663)	Post-BIG (N=264)	P-value
Groups			
BIG 1	87 (13)	43 (16)	
BIG 2	80 (12)	69 (26)	
BIG 3	496 (75)	152 (58)	
Age	57.2 ±21.3	59.0±20.6	
ISS	14.6 (0.28)	12.2 (0.45)	0.00
BIG 1	9.9 (0.49)	8.2 (0.62)	0.04
BIG 2	10.9 (0.53)	8.5 (0.45)	0.00
BIG 3	16 (0.33)	15 (0.64)	0.14
GCS on admission	13.36 ± 0.15	13.68 ± 0.22	0.23
BIG 1	13.85 ± 0.3	13.98 ± 0.45	0.81
BIG 2	13.26 ± 0.44	13.34 ± 0.44	0.90
BIG 3	13.28 ± 0.17	13.75 ± 0.30	0.19

Table 1: Demographic features of pre- and post-BIG patients

	Pre-BIG	Post-BIG	P-value
ICU Length of stay	2.4 ± 0.1	1.8 ± 0.2	0.05
BIG 1	0.8 ± 0.1	0.02 ± 0.02	<0.001
BIG 2	0.7 ± 0.1	0.4 ± 0.1	0.1
BIG 3	2.9 ± 0.2	3 ± 0.2	0.76
Neurosurgery consultation	461 (70)	138 (52)	<0.001
BIG 1	59 (68)	2 (5)	<0.001
BIG 2	33 (41)	14 (20)	0.01
BIG 3	369 (74)	122 (80)	0.14
Repeat head CT	519 (80)	182 (69)	<0.001
BIG 1	53 (61)	10 (23)	<0.001
BIG 2	54 (65)	26 (38)	0.001
BIG 3	411 (86)	147 (97)	<0.001
Alive at discharge	605 (91)	254 (96)	0.01
BIG 1	87 (100)	43 (100)	
BIG 2	80 (100)	69 (100)	
BIG 3	438 (88)	142 (93)	0.07

Table 2: Outcomes of patients pre- and post-BIG implementation

DETERIORATION INDEX IN CRITICALLY INJURED PATIENTS: A FEASIBILITY ANALYIS

Rebecca Fabian, BS; Alison Smith, MD, PhD; Tommy Brown, MD; John P. Hunt, MD, MPH, FACS; Patrick Greiffenstein, MD; Alan Marr, MD, FACS; Lance Stuke, MD, MPH, FACS; Sharven Taghavi, MD, MPH; Rebecca Schroll, MD; Chrissy Guidry, DO; Jonathan Schoen, MD; Patrick McGrew, MD; Olan Jackson-Weaver, PhD; Juan Duchesne, MD; Tulane University School of Medicine
Invited Discussant: Jennifer Gurney, MD

Introduction: The emergence of continuous prediction surveillance modeling could give dynamic insight into a patient's condition with potential mitigation of adverse events (AE) and failure to rescue. The Epic[TM] Electronic Medical Record developed a Deterioration Index (DI) algorithm that generates a prediction score every 15 minutes using pre-determined objective clinical data. A previous validation study determined by the Matthews Correlation Coefficient showed rapid increases in DI score ($\geq$14) predicted a worse prognosis. The aim of this study was to demonstrate the utility of DI scores in the trauma ICU population. **Methods:** A prospective, single-center study of Trauma ICU patients in a Level 1 Trauma Center was conducted during a three-month period, ending in January 2021. Charts were reviewed every 24 hours for minimum and maximum DI score, largest score change (Δ), and adverse events. Patients were grouped as Low Risk (ΔDI <14) and High Risk (ΔDI $\geq$14). **Results:** 224 patients were evaluated. Patients with increasing DI scores were more likely to experience adverse events (95.6% vs. 62.5%, p<0.01). No patients with DI scores < 30 were re-admitted to the ICU after being stepped down to the floor. Patients that were re-admitted and subsequently died all had DI scores of $\geq$60 when first stepped down from the ICU. **Conclusion:** This study demonstrates that DI scores predict decompensation risk in the trauma ICU, not readily apparent to providers. This can be used to identify ICU patients at risk of AE when transferred to the floor. Employing the DI model could alert providers to increase surveillance in high risk patients to minimize returns to the ICU and failure to rescue.

	Low Risk (ΔDI <14) n=64	High Risk (ΔDI $\geq$14) n=160	p value
ICU LOS, avg. days (SEM)	3.0 (0.3)	5.8 (0.5)	*< 0.01*
ICU Re-admission, n (%)	3 (4.7)	32 (20.0)	*< 0.01*
Re-admission Deaths n (%)	0 (0)	6 (3.8)	*< 0.01*
Unplanned OR Trip, n (%)	7 (14.0)	42 (21.3)	*< 0.01*
Adverse events, n (%)	40 (62.5)	153 (95.6)	*< 0.01*
Death, n (%)	10 (15.6)	40 (25.0)	*< 0.01*

DOES TREATMENT DELAY FOR BLUNT CEREBROVASCULAR INJURY AFFECT STROKE RATE?: AN EAST MULTICENTER TRIAL

Rachel Appelbaum, MD; Rovinder Sandhu, MD; Emily Esposito, DO; Timothy Wolff, DO; M. Chance Spaulding, DO, PhD, FACS; Joshua P Simpson, MD; Julie Dunn, MD; Linda B Zier, RN; Sigrid Burruss, MD; Paul P Kim, BS Lewis E Jacobsen, MBChB; Jamie M Williams, MSML, BSN, RN, CCRP; Jeffry Nahmias, MD; Areg Grigorian, MD; and EAST BCVI Trial Group; Wake Forest Baptist Medical Center
Invited Discussant: Louis Magnotti, MD

Introduction: The purpose of this study was to analyze injury characteristics and stroke rates between blunt cerebrovascular injury (BCVI) with delayed vs non-delayed medical therapy. We hypothesized there would be increased stroke formation with delayed medical therapy.

Methods: This is a sub-analysis of a 16 center, prospective, observational trial on BCVI. Delayed medial therapy was defined as initiation >24 hrs after admission. BCVI which did not receive medical therapy were excluded. Subgroups for injury presence were created using Abbreviated Injury Scale (AIS) score >0 for AIS categories.

Results: 636 BCVI were included. Median time to first medical therapy was 62 hours in the delayed group and 11 hours in the non-delayed group (p<0.001). The injury severity score (ISS) was greater in the delayed group (25.6 vs the non-delayed group 22.3, p< 0.001) as was the median AIS head score (2.0 vs 1.0, p< 0.001). The overall stroke rate was not different between the delayed vs non-delayed groups respectively (5.0% vs 4.6%, p=1.00). Further evaluation of carotid vs vertebral artery injury showed no difference in stroke rate. Additionally, within all AIS categories there was no difference in stroke rate between delayed and non-delayed therapy, Table 1.

Conclusion: Modern BCVI therapy is administered early. BCVI with delayed therapy were more severely injured. However, a higher stroke rate was not seen with delayed therapy, even for BCVI with head or spine injuries. This data suggests with contraindications there is not an increased stroke rate with necessary delays of medical treatment for BCVI.

Table 1. Two AIS categories and stroke rate with delayed vs non-delayed therapy

Variable (AIS)	Delayed, Stroke, n (%)	Non-delayed, Stroke, n (%)	P value
AIS Head >0	29 (7.80%)	15 (4.00%)	0.20
AIS Spine >0	25 (6.10%)	17 (4.10%)	0.63

THE USE OF PREDEFINED SCALES AND SCORES WITH EYE-TRACKING DEVICES TO SYMPTOM IDENTIFICATION IN CRITICALLY ILL NON-VERBAL PATIENTS

Christopher Ull, Oliver Jansen, Uwe Hamsen, Christina Weckwerth, Robert Gaschler, Thomas Schildhauer, Christian Waydhas;
Berufsgenossenschaftliches Universitätsklinikum Bergmannsheil
Invited Discussant: Jason Smith, MD

Introduction: Eye-tracking (ET) may be a novel tool to enable non-verbal communication with intubated and mechanically ventilated critically ill patients. We hypothesized that ET could be used successfully by intensive care unit (ICU) patients with artificial airways to express their levels of pain and mood, quality of life and self-esteem with predefined scales and scores.

Methods: Prospective, monocentric, observational study including patients between February and November 2020 with an endotracheal tube or tracheostomy tube and a history of mechanical ventilation of more than 48 hours, who were at least 18 years of age and without delirium. The ICU-patient´s pain was assessed with an 11-point numeric rating scale (NRS), their mood was tested with a 6-item smiley analogue scale (SAS). Quality of life and self-esteem were measured with the European quality of life-5 dimensions-5 levels-score (EQ-5D-5L) and the visual analogue self-esteem scale (VASES). The investigations were performed by a physician with the support of a psychologist following a standardized study protocol.

Results: A total of 75 patients with a mean age of 58.3 years were included. Main diagnoses for ICU admission were major trauma (45.3%), non-abdominal sepsis (22.6%), and acute abdomen (13.3%). Mean time from ICU admission to ET examination was 17.8 days. All patients showed moderate levels of pain and sadness with a mean of 3.9 points on the NRS and a mean of 3.6 points on the SAS. The general health status on the EQ-5D-5L was rated as poor in our study collective (0.06). On the VASES, most of the included patients felt trapped (90.7%) and not confident (72%), were frustrated (64%) or felt not being understood (56%). However, despite their severe illness, the patients classified themselves as intelligent (30.6%), not mixed up (38.6%), outgoing (38.6%) and optimistic (44%).

Conclusion: The use of ET in ICU patients with impaired communication is feasible, allowing them to express their levels of pain and mood, quality of life and self-esteem with predefined scales and scores. The results of our study may provide guidance for improvement measures in the care of patients in the ICU who are unable to speak. We believe that ET is useful to symptom identification and therefore may be capable of improving patient-medical team interaction and patient satisfaction.

VALIDATING THE BRAIN INJURY GUIDELINES (BIG): RESULTS OF AN AAST PROSPECTIVE MULTI-INSTITUTIONAL TRIAL

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Invited Discussant: A. Britton Christmas, MD

Introduction: BIG was developed to effectively utilize healthcare resources including repeat head CT (RHCT) scan and neurosurgical (NSG) consultation in traumatic brain injury (TBI) patients **(Table).** The aim of this study is to prospectively validate BIG at a multi-institutional level. **Methods:** This is a prospective, observational, multi-institutional trial across 9 Level I and II trauma centers. Adult (age ≥16 years) blunt TBI patients with a positive finding on initial head CT-scan were identified. Patients were categorized into BIG 1, BIG 2, and BIG 3 based on their neurologic exam, alcohol intoxication, anti-platelet/anti-coagulant use, and head CT-scan findings **(Figure).** Primary outcome measure was NSG intervention. Secondary outcome measures were neurologic exam worsening, progression on RHCT, post-discharge ED visit, and 30-day readmission.
Results: A total of 2,432 patients met inclusion criteria, of which 2,033 had no missing information and were categorized into BIG 1 (301; 14.8%), BIG 2 (295; 14.5%), and BIG 3 (1437;70.7%). In BIG 1, no patient worsened clinically, 4/301 (1.3%) patients had progression on RHCT with no subsequent change in management, and no patient required NSG intervention. In BIG 2, 2/295 (0.7%) patients worsened clinically, and 21/295 (7.1%) patients had progression on RHCT. Overall, 7/295 (2.4%) patients would have required upgrade from BIG 2 to BIG 3 due to neurologic exam worsening or progression/new bleed on RHCT, but no patient required NSG intervention. There were no TBI-related post-discharge ED visits or 30-day readmissions in BIG 1 and BIG 2 patients. All patients who required NSG intervention were BIG 3 (280/1437; 19.5%). The agreement between the assigned and final BIG categories was excellent (κ=99%). In this cohort, implementing BIG would have decreased CT-scan utilization and NSG consultation by 29% overall, with a 100% reduction in BIG 1 patients and a 98% reduction in BIG 2 patients.
Conclusion: BIG is safe and defines the management of TBI patients by acute care surgeons without the routine need for RHCT and NSG consultation.

Variables	BIG 1	BIG 2	BIG 3
LOC	Yes/No	Yes/No	Yes/No
Neurologic Examination	Normal	Normal	Abnormal
Intoxication	No	No/Yes	No/Yes
CAMP	No	No	Yes
Skull Fracture	No	Non-displaced	Displaced
SDH	≤ 4 mm	5-7 mm	≥ 8 mm
EDH	≤ 4 mm	5-7 mm	≥ 8 mm
IPH	≤ 4 mm	5-7 mm; 2 locations	≥ 8 mm; multiple locations
SAH	Trace	Localized	Scattered
IVH	No	No	Yes

Management Plan	BIG 1	BIG 2	BIG 3
Hospitalization	Observation (6hrs)	Yes	Yes
RHCT	No	No	Yes
NSG Consultation	No	No	Yes

BIG: brain injury guidelines; LOC: loss of consciousness; CAMP: Coumadin, Aspirin, Plavix; SDH: subdural hemorrhage; EDH: epidural hemorrhage; IPH: intraparenchymal hemorrhage; SAH: subarachnoid hemorrhage; IVH: intraventricular hemorrhage; RHCT: repeat head CT; NSG: neurosurgical consultation

PREDICTING ARDS EARLY IN CRITICAL SURGICAL ILLNESS: A MODEL USING SERUM INFLAMMATORY MARKERS AND CLINICAL DATA

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Uniformed Services University of the Health Sciences
Invited Discussant: Karyn Butler, MD

Introduction: Acute respiratory distress syndrome (ARDS) remains a common and serious complication of critical injury and illness. While increasing evidence supports an association between ARDS and various systemic markers of inflammation, their prognostic value remains uncertain. We hypothesized that an accurate predictive model for ARDS could be developed using clinical and systemic markers of inflammation.

Methods: We examined the records of 181 (136 trauma, 45 non trauma) critically ill surgical patients and used machine learning to estimate the development of ARDS during hospitalization. Clinical data and 46 systemic markers of inflammation were evaluated as possible predictors of ARDS. Models were trained using the least absolute shrinkage and selection operator (LASSO) and performance after cross-validation was evaluated by the area under the receiver operating characteristic curve (AUC), sensitivity, and specificity.

Results: Seventy-two patients developed ARDS (50 trauma, 22 non-trauma) and the mean time to diagnosis was 4.4 days. Analysis showed MIG ($p<0.01$), IL-6 ($p=0.02$) and IL-16 ($p<0.01$) were the strongest individual predictors of ARDS upon admission in trauma, non-trauma and all patients respectively. By hospital day 2, the strongest predictor for ARDS in all patients was MCP-1 ($p<0.01$). A model was trained using data from the same hospital day 2 for both trauma and non-trauma patients based on MCP-1, MIP-1beta, HGF and systolic blood pressure revealing an AUC of 0.93, sensitivity of 0.97 and specificity of 0.89 to predict the development of ARDS during the hospital stay (Figure).

Conclusion: Systemic markers of inflammation were strong predictors of ARDS at hospital admission and patients with a high risk for the developing ARDS may be identified as early as hospital day 2 per our model. This highly performing model may be utilized to develop a clinical decision support tool.

PLATELET TRANSFUSION REDUCES PLATELET DYSFUNCTION IN TRAUMATIC BRAIN INJURY

Victoria P. Miles MD; Chace Hicks MD; Caroline Brown BA; Abigail Edwards BS; Kathryn Stewart RN-BSN; Robert Maxwell MD
Invited Discussant: Lucy Kornblitth, MD

Introduction: Platelet dysfunction occurs after traumatic brain injury (TBI) and early correction may prevent progression of brain hemorrhage. We hypothesized that transfusion of platelets would improve ADP and AA inhibition and maximum amplitude as measured by thromboelastography (TEG) with platelet mapping assay and reduce brain hemorrhage after TBI.
Methods: A practice management guideline was established calling for the collection of a routine TEG with platelet mapping on all trauma patients with intracranial bleed associated with TBI. If ADP or AA inhibition was noted to be > 60%, 1 unit of platelets was administered, and a repeat platelet mapping assay was performed. Demographics, hospital data and platelet assay results were recorded. Using Wilcoxon-Mann-Whitney, chi-square, and Fisher's exact tests where appropriate, analyses were performed.
Results: Protocol adherence of 71.8% over the 8-month study period resulted in 73 patients receiving platelets for ADP and/or AA inhibition. With the administration of platelets, ADP (median 62.60 to 41.80, p=0.0001), AA (86.60 to 66.80, p=0.0001) and MA (68.40 to 69.60, p=0.0006) all improved as demonstrated below. If ADP improved, mortality (median 6 to 2, p=0.0163) and neurosurgical intervention (7 to 3, p=0.0141) decreased. If AA or MA improved, no significant change was appreciated in terms of mortality, neurosurgical intervention, LOS, discharge GCS nor progression.

Conclusion: Patients with TBI and platelet inhibition may benefit from the administration of platelets to correct platelet dysfunction.
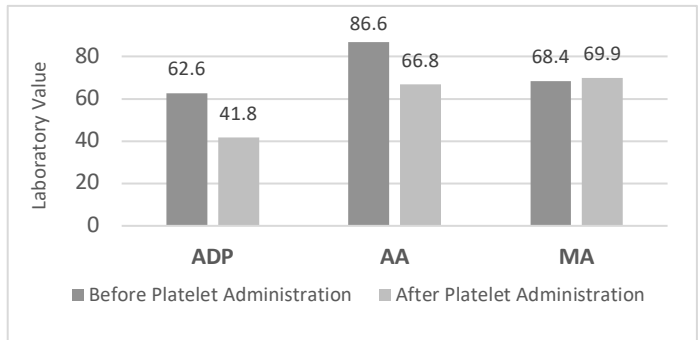
LOW PREVALENCE BUT HIGH IMPACT OF COVID-19 POSITIVE STATUS IN ADULT TRAUMA PATIENTS: A MULTI-INSTITUTIONAL ANALYSIS OF 28,904 PATIENTS

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Invited Discussant: Sheldon Teperman, MD

INTRODUCTION: Few large investigations have addressed the prevalence and impact of COVID-19 infection in trauma patients. The purpose of this study was to estimate COVID prevalence among trauma patients on arrival and during hospitalization and determine its impact on morbidity and mortality.

METHODS: Adults admitted 4/1/20 to 10/31/20 were selected from the registries of 46 level I/II Trauma Centers and grouped by COVID status as "+Day1", "+Day2-6", "+Day≥7", "Negative" or "Unknown". Groups were compared on outcomes (TQIP complications) and mortality using univariate analysis and adjusted logistic regression.

RESULTS: There were 28,904 patients (60.7% male, mean age 56.4, mean ISS 10.54). Of 13,274 (46%) with known COVID status, 266 (2%) were +Day1, 119 (1%) were +Day2-6, 33 (0.2%) were +Day≥7, and 12,856 (97%) tested Neg. The Pos. group had significantly worse outcomes than the Neg. group, with a longer mean LOS, higher rates of ICU stay, Vent use, ARDS, and Mortality (Table). Adjusted OR (for age & ISS) showed COVID+ patients had increased mortality odds (3.0, 95% CI:2.0-4.4) and ARDS (6.1, 95% CI:2.5-15.1) compared to Neg. patients.

VARIABLE	COVID-19 STATUS					
	Day of First + Test			All (+) Pts	All (-) Pts	Not known
	Day1	Day2-6	Day≥7			
	n=266 (2.0%)	n=119 (0.9%)	n=33 (0.2%)	n=418 (3.1%)	n=12,856 (96.9%)	n=15,630
ISS (mean)	11.5	11.3	11.8	11.5	11.5	9.7*
Age (mean)	56.0*	64.7*	59.5	58.5	60.5	53.0*
Male (%)	59.8	48.7	60.6	57.1	57.1	63.7*
LOS (mean)	8.1	11.3*	33.4*	11.2*	7.4	3.7*
ICU (%)	56.4*	54.6	78.8*	58.1*	45.7	34.4*
Vent (%)	21.8*	20.2	36.4*	22.9*	16.9	8.5*
VTE (%)	1.9	0.8	6.1*	1.7	1.5	0.3*
DVT (%)	1.1	0.8	3.0	1.0	1.1	0.3*
ARDS (%)	1.5*	0.8	6.1*	1.7*	0.4	0*
Died (%)	8.3*	8.4*	6.1	8.4*	3.4	3.0

*Indicates group differs statistically significantly from Negative group at p<.05

CONCLUSION: In this large, multicenter study, few trauma patients were COVID+, suggesting relatively low exposure risk to trauma care providers. COVID+ status was associated with significantly higher mortality and morbidity. Further analysis of associations with poorer outcomes is needed with consideration for care guidelines specific to COVID+ trauma patients.

Respiratory Complications After Intensive Care Unit Discharge in Trauma Patients: A High Consequence Event

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University of Washington
Invited Discussant: Paula Ferrada, MD

Introduction: The period after transfer from the ICU to the acute-care ward is a vulnerable time for trauma patients to experience respiratory complications. However, relatively little is known about the epidemiology of these events. This study focused on the timing, outcomes, and risk factors associated with respiratory events after transfer from the ICU.

Methods: This is a retrospective cohort study of all trauma patients age > 18, transferred to the ward after initial ICU admission in a Level 1 trauma center from 2015-2019. Respiratory events were defined as 1) escalation in oxygen therapy beyond nasal cannula or facemask for >= 3 consecutive hours, or 2) unplanned intubation for a primary pulmonary cause. All intubation events were adjudicated to identify those of primary pulmonary etiology. Patient factors associated with events were analyzed using logistic regression.

Results: 6,561 patients met inclusion criteria with a mean age of 52.3 (SD=21.3) years and median injury severity score of 18 (IQR=13-26). 262 patients (4.0%) experienced a respiratory event, 58 requiring intubation. Respiratory events occurred early after transfer (median day 2, IQR 1-5), were associated with high mortality (16% vs. 1.8%, p<0.001) and long length of stay (19 vs 8 days, p<0.001).

Covariate	Odds Ratio (95% CI)	p-value
Age >= 65	1.67 (1.19-2.35)	0.003
Female Sex	0.66 (0.49– 0.91)	0.011
Alcohol use disorder	1.61 (1.14 – 2.27)	0.007
Congestive Heart Failure	2.16 (1.34 – 3.49)	0.002
Chronic Obstructive Pulmonary Disease	1.69 (1.09 – 2.62)	0.018
Diabetes	1.79 (1.25 – 2.57)	0.001
Injury Severity Score >16 (vs. <10)	2.51 (1.41 – 4.48)	0.002
Intubated at Admission	1.74 (1.30 – 2.33)	<0.001
>=3 Rib Fractures or Flail Chest	1.90 (1.40 – 2.57)	<0.001
Pulmonary Contusion or Laceration	1.38 (1.01 – 1.91)	0.046

Conclusions: Respiratory events after floor transfer occur close to the time of transfer and are associated with poor outcomes. Older patients with more severe chest injury are at higher risk. Efforts to reduce respiratory complications should focus on these high-risk groups at the time of floor transfer for maximum impact.

AGITATION IN THE TRAUMA BAY AS AN EARLY INDICATOR OF SEVERE INJURY AND HEMORRHAGIC SHOCK

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Invited Discussant: Linda Ding, MD

Introduction: Agitation on arrival in trauma patients may be attributed to head injury or intoxication. We hypothesized that agitation in the trauma bay is an early indicator for hemorrhage in trauma patients. The specific aim of this study is to compare trauma patients who present in an agitated state to those who do not.

Methods: We performed a prospective study from September 2018 to December 2020 that included any trauma patient who arrived agitated, defined as a Richmond Agitation-Sedation Scale (RASS) of +1 to +4. Variables collected included demographics, admission physiology, and injury severity. The primary outcomes were need for emergent therapeutic intervention for hemorrhage control and massive transfusion (>10 units).

Results: Of 4657 trauma admissions, 77 (1.6%) arrived agitated. Agitated patients were younger (42 vs. 48, p=0.01), more often male (94% vs. 66%, p<0.0001) sustained more penetrating trauma (31% vs. 12%, p<0.0001), more often arrived tachycardic (107 vs. 88, p<0.0001) and hypotensive (13% vs. 3%, p<0.0001), and had a higher injury severity score (19 vs. 10, p<0.0001).

	Agitation	No Agitation	p-value
Transfusion	57%	15%	<0.0001
Massive Transfusion	19%	4%	<0.0001
Emergent Intervention	29%	5%	< .0001

After logistic regression controlling for other variables, agitation was independently associated with massive transfusion (OR: 3.0 [95% CI 1.4-6.6, p=0.006) and emergent therapeutic intervention (OR: 3.2 [95% CI 1.7-6.2, p=0.0005). When looking only at patients who arrived hemodynamically stable, agitation remained independently associated with emergent therapeutic intervention (OR: 2.5 [95% CI 1.2-5.3, p=0.01).

Conclusions: Agitation in trauma patients is uncommon but may serve as an early indicator of severe injury and hemorrhagic shock, as agitation is independently associated with a three-fold increase in the need for massive transfusion and emergent therapeutic intervention for hemorrhage control.

PEDIATRIC TRAUMA IN THE CALIFORNIA-MEXICO BORDER REGION: INJURY DISPARITIES BY AREA DEPRIVATION INDEX

Alicia Sykes, MD; Alexandra Rooney, MPH; Kevin Smith, BSN; Andrew Avila, BS; Claudio Ghetti, BA; William Sisson, MD; Matthew Martin, MD; Vishal Bansal, MD, FACS; Michael Sise, MD, FACS; Romeo Ignacio, Jr., MD, MSc, FACS; Scripps Mercy Hospital
Invited Discussant: Jeffrey Upperman, MD

Introduction: The California-Mexico border region (CA-MX) is a high-volume trauma area with populations of widely disparate socioeconomic status. We analyzed differences in demographics and mechanism of injury in children using the Area Deprivation Index (ADI), a composite measure of 17 markers of neighborhood disadvantage/disparities.

Methods: Retrospective review of pediatric patients in the CA-MX region evaluated at our Level I Pediatric Trauma Center (2008-2018). Data included demographics, injury characteristics, and health care outcomes. Patient address was correlated to neighborhood disadvantage level using ADI quintiles, with higher quintile representing greater socioeconomic disadvantage.

Results: 9,715 children were identified, of which 4,307 (44%) were Hispanic. Hispanic children were more likely to live in more disadvantaged neighborhoods than non-Hispanic children ($p<0.001$). There were markedly different injury mechanisms in neighborhoods with greater socioeconomic disadvantage (higher ADI) compared to those with less socioeconomic disadvantage (Figure 1). Sports-related and non-motorized vehicular trauma predominated in less disadvantaged neighborhoods, while higher ADI quintiles were strongly associated with pedestrian vs vehicle, motorized vehicle crashes, and non-accidental/abusive trauma ($p<0.001$).

Conclusion: This analysis represents the first study to characterize pediatric traumatic injury patterns based upon the neighborhood ADI metric. ADI can be a useful resource in identifying disparities in pediatric trauma and those at increased risk for vehicular and abusive injury who may benefit from increased resource allocation, social support, and prevention programs.

Figure 1. Mechanism of Injury by Area Deprivation Index (ADI) Quintile
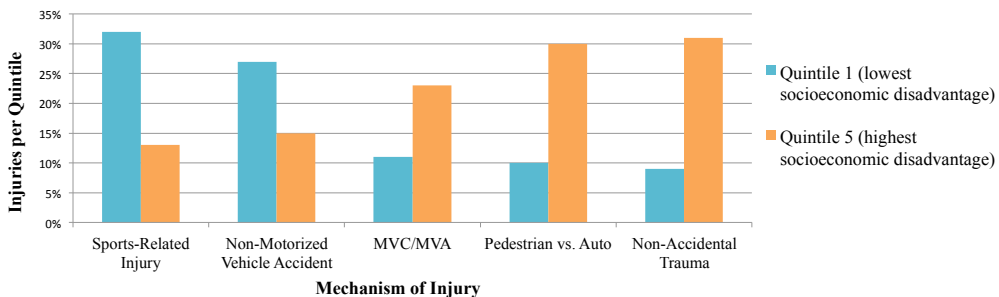
SEX DIMORPHISMS IN COAGULATION CHARACTERISTICS IN THE PEDIATRIC TRAUMA POPULATION APPEAR AFTER PUBERTY

Katherine Hrebinko, MD, Stephen Strotmeyer, PhD, Ward Richardson, MD, Barbara A. Gaines, MD, Christine M. Leeper, MD, MSc; University of Pittsburgh Medical Center
Invited Discussant: Chrissy Guidry, DO

Introduction: Observational studies have demonstrated a relative survival benefit in premenopausal female patients following severe trauma. Animal studies implicate a potential role of sex hormones in mediating coagulation characteristics. We hypothesize that thromboelastography (TEG) profiles are equivalent across genders in younger children and diverge after puberty.
Methods: Consecutive pediatric trauma patients were identified from a university-affiliated, level I, pediatric trauma center (2016-2020). Demographics, injury characteristics, and TEG parameters were collected by review of the electronic medical record. Children were categorized by sex and age (younger: $\leq$11 years, older: >11 years). Baseline characteristics, outcomes, and TEG parameters were compared using nonparametric tests as appropriate.
Results: 647 subjects were identified, of which 70.2% were male. Among 395 younger children ($\leq$11 years), there were no differences in TEG characteristics between sexes. Among 252 adolescents (> 11 years) males had greater K times (1.8 vs 1.4 min, $p<0.001$), decreased alpha angles (69.6 vs73.7 deg, $p<0.001$), lower maximum amplitudes (59.4 vs 61.5 mm, $p=0.01$) and higher fibrinolysis at 30 minutes (1.0% vs 0.4%, $p=0.02$) compared to females. Comparing within each sex, there were no differences in TEG profiles between younger and older female children except for fibrinolysis, which was decreased in older females (0.4% vs. 1.5%, $p<0.001$). Compared to younger male children, adolescent males had greater K times (1.8 vs 1.4, $p<0.001$), decreased alpha angles (73.5 vs. 69.6 deg, $p<0.001$), lower maximum amplitudes (59.4 vs 62 mm, $p<0.001$) and lower fibrinolysis (1.0% vs 1.3%, $p=0.03$). There were no differences in length of stay, disability, or mortality between age groups or sexes.
Conclusions: Sex dimorphisms in TEG coagulation profiles, appear after puberty. This divergence appears to be driven by a shift in male coagulation profiles to a relatively hypocoagulable state after puberty, suggesting a potential important role of testosterone in mediating coagulation.

ASSOCIATION OF SOCIAL VULNERABILITY INDEX WITH RISK-ADJUSTED TRAUMA OUTCOMES

Pooja U. Neiman, MD MPA; Zhaohui Fan, MD MPH; Naveen F. Sangji, MD MPH; Mark R. Hemmila, MD; John W. Scott, MD MPH; University of Michigan Medical Center
Invited Discussant: Marta McCrum, MD, MPH

Introduction: Social determinants of health (SDOH) are known to impact patient-level outcomes, though are often difficult to measure. The Social Vulnerability Index (SVI) was created by the CDC to identify vulnerable communities using population metrics. Trauma patients represent a high-risk group with known SDOH needs, however, the relationship between SVI and trauma outcomes remains poorly understood.

Methods: SVI data from the CDC was merged with statewide trauma collaborative quality initiative data at the census tract level. Three analytic models evaluated the association between SVI quartile and inpatient trauma mortality: (i) an unadjusted model, (ii) a model using only covariates available to claims-based datasets, and (iii) a model incorporating robust clinical detail in line with the National Trauma Data Standard (see **Table**).

Results: 85,986 trauma patients were identified. Higher SVI was associated with worse mortality in the unadjusted and claims-based adjusted models. This association was no longer present in the fully adjusted model. (**Table**)

Conclusion: Patients living in communities with greater social vulnerability were more likely to die after trauma admission. While some differences remain after adjusting with claims data, the association became insignificant after risk adjustment with robust clinical covariates. These findings suggest that improving trauma survival among vulnerable communities will require policies that impact upstream, pre-admission factors.

Table. Association of SVI with Inpatient Mortality among Trauma Admissions

SVI Quintile	Unadjusted (95%CI)	Claims-based* (95%CI)	Clinical-based** (95%CI)
Lowest quintile (least vulnerable)	*Reference*	*Reference*	*Reference*
2nd quintile	**1.18 (1.04-1.34)**	1.08 (0.93-1.25)	1.10 (0.91-1.32)
3rd quintile	**1.26 (1.11-1.42)**	1.16 (1.00-1.34)	1.12 (0.93-1.35)
4th quintile	**1.53 (1.35-1.74)**	**1.35 (1.16-1.57)**	1.26 (1.04-1.54)
Highest quintile (most vulnerable)	**1.72 (1.48-2.00)**	**1.40 (1.16-1.70)**	1.07 (0.82-1.38)

*Claims-based covariates: Age, gender, race/ethnicity, Abbreviated Injury Scale (6 body regions), Injury Severity Score group, 16 comorbidity flags, insurance type, bed size, teach, profit, urban, RN-to-bed ratio, trauma level

**Clinical-based covariates: As above plus prior meds (beta blocker, steroid, statin, chemo, anticoagulant/antiplatelet), vitals (BP, pulse, GCS motor score), transfer, pre-CPR, ventilation

RACE AND TRAUMA: THE EFFECT OF HOSPITAL BLACK-WHITE PATIENT RACE DISTRIBUTION ON MORTALITY

Sami K. Kishawi MD; Esther S. Tseng MD; Victoria J. Adomshick BS; Christopher W. Towe MD; Vanessa P. Ho MD MPH; MetroHealth Medical Center
Invited Discussant: Andre Campbell, MD

Introduction: Research on institutional-level disparities has demonstrated that in some medical settings, Black patients have better outcomes in high Black-serving hospitals. We hypothesized that Black patients would have lower mortality after trauma in high Black-serving hospitals.

Methods: We identified all adult patients with Black or White race and with an injury severity score (ISS) of 4 or more from the 2017 National Inpatient Sample. We collected hospital identifier, penetrating mechanism, age, sex, Elixhauser comorbidities, urban-rural location, insurance, zip code income quartile, and calculated ISS from ICD-10 codes. We used a published hospital service ranking system to group hospitals by proportion of Black trauma patients served: high Black-serving (H-BS, top 5%), medium (M-BS, >5% and <25%), and low (L-BS, bottom 75%). Adjusted logistic regression using an interaction variable between race and hospital service rank (reference group = White patients in H-BS) was used to identify factors associated with mortality. Median [IQR], chi-square p-values, and odds ratios (OR [95% CI]) are shown.

Results: We analyzed 184,080 trauma patients (age 72 [55-84], ISS 9 [4-10]), of whom 11.7% were Black. 4% of patients died. Of 2,376 hospitals, 126 (5.3%) were H-BS and 469 (19.7%) M-BS. 29.8% of Black and 3.6% of White patients were treated at H-BS hospitals, while 71.7% of White and 23.6% of Black patients were treated at L-BS hospitals (p<0.001). Black patients had the lowest mortality at H-BS hospitals (OR 0.76 [0.64-0.92]) and the highest mortality (OR 1.42 [1.13-1.80]) at L-BS hospitals. White patients had the lowest mortality at L-BS hospital (OR 0.76 [0.64-0.92]).

Discussion: After adjusting for injury and hospital factors, disparities exist in the treatment of Black and White patients such that the best outcomes occur in hospitals that treat those patients most frequently. This is suggestive of racial bias at the institutional level. Further efforts must be made to promote equitable treatment at all hospitals and reduce these racial disparities.

A NATIONAL STUDY DEFINING 1.0 FULL-TIME EMPLOYMENT FOR TRAUMA/ACUTE CARE SURGERY

Patrick Murphy, MD, MSc, MPH; Jamie Coleman, MD; Basil S. Karam, MD; Juan F. Figueroa, MD; David Deshpande, BS; Marc de Moya, MD, FACS; Medical College of Wisconsin
Invited Discussant: Kristan Staudenmayer, MD, MSc

Introduction: Trauma and acute care surgery (ACS) staffing models vary widely across the USA, resulting in large discrepancies in staffing, compensation, schedule, and clinical/non-clinical expectations. An urgent need exists to define clinical, academic, and schedule expectations for a full-time equivalent (FTE) of a trauma and ACS surgeon in the US.
Methods: A survey was distributed to departmental leaders at Level I, II, III trauma centers across the US regarding current workload. Variables concerning the responsibilities of surgeons, compensation models, and clinical expectations were collected. This was followed by virtual semi-structured interviews of agreeable respondents. A thematic analysis was used to describe current staffing challenges and 'ideal' staffing and compensation models of trauma centers.
Results: 68 of 483 Division Chiefs/Medical Directors responded (14%), the majority (66%) representing Level I centers. There were differences in clinical responsibilities, elective surgery coverage as well as number of and reimbursement for call (Table 1). In our qualitative interviews we identified themes of administration/surgeon conflict and difficulty balancing staff needed for both call and daytime clinical activities.
Conclusion: Defining the workload of a full-time trauma and ACS surgeon depends upon the type and frequency of call and the number of duties during the day. The average clinical coverage is 26 weeks of service a year, 5 in-house call shifts or 8 home call shifts and 4 elective operative days per month. Leaders in ACS had difficulty defining the service and described conflict between covering call and having enough day-time clinical volume.

Table 1: Survey responses by Trauma Center Level

Trauma Center Level	I (n=45)	II (n=15)	III (n =8)	p-value
SICU Coverage (%)	98%	73%	38%	<0.001
Elective Surgery (%)	67%	93%	88%	0.08
Number of Service Weeks	26 (12)	17 (20)	22 (9)	0.09
Shifts (12 hrs) / month	5 (6)	12 (6)	20 (7)	<0.001
Call Stipend (%)	42%	53%	75%	0.21

LENGTH OF STAY AND TRAUMA CENTER FINANCES: A TALE OF TWO PAYERS

Marvin Chavez, MD; Kristina Chapple, PH.D.; James Bogert, MD; Jordan Jacobs, MD; Hahn Soe-Lin, MD; Jordan A. Weinberg, MD; St. Joseph's Hospital and Medical Center
Invited Discussant: Michael Rotondo, MD

Background: In an effort to reduce costs, hospitals focus efforts on reducing length of stay (LOS) and often benchmark LOS against the geometric LOS (GMLOS) as predicted by the assigned diagnosis-related group (DRG) used by the Centers for Medicare and Medicaid Services. The objective of this study was to evaluate the impact of exceeding GMLOS on hospital profit/loss with respect to payer source.

Methods: Contribution margin for each insured patient admitted to a level 1 trauma center between July 1, 2016 and June 30, 2019 was determined. LOS, DRG (surgical vs medical), ISS, complications, illicit drug/alcohol screen, discharge disposition, and exceeding GMLOS were regressed on contribution margin to determine significant predictors of profitability. Frequency of exceeding GMLOS was compared among patients according to payer source.

Results: Among 2,449 insured trauma patients, the distribution of payers was Medicaid (54.6%), Medicare (24.0%), and commercial (21.4%). 35% (n=867) of patient length of stays exceeded GMLOS. Exceeding GMLOS by 10 or more days was significantly more likely for Medicaid and Medicare patients in stepwise fashion (Commercial 2.7%, Medicaid 4.5%, Medicare 6.0%; P=.030). Median contribution margin was positive for commercially insured patients ($16,913) and negative for Medicaid (-$8,979) and Medicare (-$2,145) patients. Adjusted multivariate modeling demonstrated that exceeding GMLOS was inversely associated with contribution margin for both Medicaid (P<.001) and Medicare (P<.001) patients, but was not associated with contribution margin for commercially insured patients (P=.203).

Conclusion: Government insured patients, despite having a payer source, are a financial burden to a trauma center. Excess length of stay among government insured patients, but not the commercially insured, exacerbates financial loss. A shift toward a greater proportion of government insured patients may result in a significant fiscal liability for a trauma center.

INSURANCE CHURN AFTER TRAUMATIC INJURY: NATIONAL EVALUSATION AMONG A LARGE PRIVATE INSURANCE DATABASE

Sue Fu, MD; Katherine Arnow, MS; Nicolas Barreto, PH.D.; Marion Aouad, PH.D.; Amber Trickey, PH.D.; David Spain, MD; Arden Morris, MD; Lisa Knowlton, MD; Stanford School of Medicine
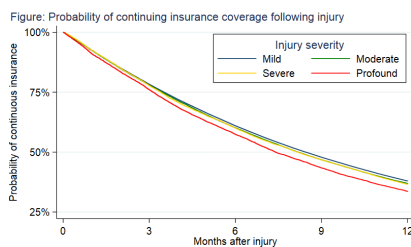Invited Discussant: Adil Haider, MD, MPH

Introduction: Traumatic injury can lead to significant disability, with injured patients often requiring substantial healthcare resources to return to work and baseline health. Inability to work can result in loss of employer-based insurance coverage, which in turn may significantly impact healthcare access and outcomes. Among privately insured patients, we hypothesized worsening instability in coverage based upon severity of injury.

Methods: Patients presenting to a hospital with traumatic injury were evaluated for insurance churn using Optum Clinformatics® Data Mart private-payer claims. Insurance churn was defined as cessation of enrollment in an Optum health insurance plan. Using injury severity score (ISS), we compared insurance churn over the year following injury between patients with mild (ISS 0-8), moderate (ISS 9-15), severe (ISS 16-25), and profound (ISS>26) injuries. We excluded patients who did not present to an emergency department or require hospital admission, and those who died in the year following injury. Kaplan-Meier analysis was used to compare time to insurance churn by ISS category. Cox proportional-hazards regression was used to estimate hazard ratios for insurance churn.

Results: Among 788,163 privately insured hospitalized trauma patients, 62% dropped insurance within 1 year after injury. Compared to patients who remained on their insurance plan, patients who dropped insurance were younger (39 vs 43 years, p<0.001) and more likely non-white (42% vs 38%, p<0.001). The median time to insurance churn was 11.0 months for those months months months profound analysis, 10.8 months (IQR 4.3-24.3 months) with mild traumatic injury, 10.8 (4.3-23.6) for moderate, 10.8 (4.1-23.1) for severe, and 9.6 (3.8-21.5) for those with profound injuries (log rank p<0.001 [Figure]). In multivariable analysis, all ISS categories had increasingly higher rates of insurance churn compared with mild injury: moderate ISS (HR 1.04, 95% CI 1.03-1.05), severe ISS (1.05, 1.03- 1.07), and profound ISS (1.11, 1.09-1.14).

Figure: Probability of continuing insurance coverage following injury

Conclusion: Increasing severity of traumatic injury is associated with higher levels of health coverage churn amongst the privately insured. Lack of access to health services may prolong recovery and further aggravate the medical and social impact of significant traumatic injury.

IT'S TIME TO LOOK IN THE MIRROR: INDIVIDUAL SURGEON OUTCOMES AFTER EMERGENT TRUMA LAPAROTOMY

Parker Hu, MD; Rondi Gelbard, MD; Daniel Cox, MD; Jan Jansen, MBBS, PhD; Jeffrey Kerby, MD, PhD; John Holcomb, MD; University of Alabama at Birmingham
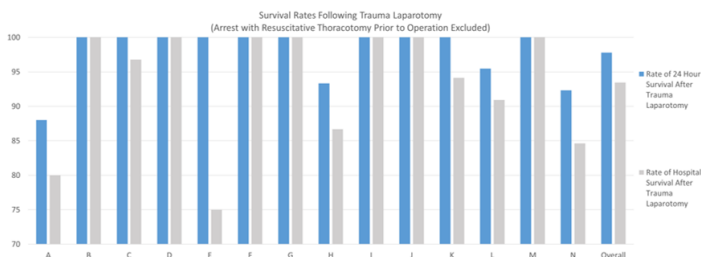Invited Discussant: Carlos Brown, MD

Introduction: Multiple quality indicators are utilized by trauma programs to decrease variation and improve outcomes. However, little if any provider level outcomes related to surgical procedures are reviewed. Emergent trauma laparotomy (ETL) is arguably the signature case that trauma surgeons perform on a regular basis, but few data exist to facilitate benchmarking of individual surgeon outcomes. As part of our comprehensive performance improvement program, we examined outcomes by surgeon for those who routinely perform ETL.

Methods: Retrospective review of patients undergoing ETL directly from the trauma bay by trauma faculty from 12/2019-2/2021. Patients were excluded from mortality analysis if they required resuscitative thoracotomy (RT) for arrest prior to ETL. Surgeons were compared by rates of damage control (DCL) and mortality at multiple time points.

Results: There were 242 ETL ((7-32 ETL)/surgeon) performed by 14 faculty. RT was performed in 7.0% (n=17) prior to ETL. Six patients without RT died intraoperatively and DCL was performed on 31.9% (n=72/226). Mortality was 4.0% (n=9) at 24 hours and 7.1% (n=16) overall. Median ISS (p=0.21), NISS (p=0.21), and time in ED were similar overall among surgeons (p=0.15) while operative time varied significantly (40-469 minutes; p=0.005). There were significant differences between rates of individual surgeon's mortality (Range (Hospital Mortality): 0-25%) and DCL (Range: 14-63%) in ETL.

Conclusion: Significant differences exist in outcomes by surgeon after ETL. Benchmarking surgeon level performance is a necessary natural progression of quality assurance programs for individual trauma centers. Additional data from multiple centers will be vital to allow for development of more granular quality metrics to foster introspective case review and quality improvement.

Survival Rates Following Trauma Laparotomy
(Arrest with Resuscitative Thoracotomy Prior to Operation Excluded)

NATIONAL ADHERENCE TO THE ASGE-SAGES GUIDELINES FOR MANAGING SUSPECTED CHOLEDOCHOLITHIASIS

Brett M. Tracy, MD; Benjamin K. Poulouse, MD MPH; Andrew Young, MD; Cameron J. Paterson, MD; Daniel Dante Yeh, MD, MHPE; April Mendoza, MD; Apostolos Gaitanidis, MD; Jonathan Saxe, MD; Martin D. Zielinski, MD; Rondi Gelbard, MD; Ohio State University
Invited Discussant: Caroline Reinke, MD

Introduction: The ASGE-SAGES provides guidelines for diagnosing and managing choledocholithiasis (CDL). We sought to evaluate adherence to these guidelines using a national sample of patients undergoing cholecystectomy (CCY) for CDL and gallstone pancreatitis (GSP).
Methods: We prospectively identified patients who underwent same stay cholecystectomy (CCY) for CDL and/or GSP from 2016-2019 at 12 U.S. medical centers. Patients presenting with cholangitis and those with a history of ERCP were excluded. ASGE-SAGES predictors of CDL were abstracted: very strong (common bile duct [CBD] stone on transabdominal US; bilirubin > 4), strong (CBD > 6 mm; bilirubin $\geq$ 1.8 to $\leq$ 4); moderate (abnormal LFTs other than bilirubin; age > 55 years; clinical GSP). Patients were then grouped by likelihood of CDL: high ($\geq$ 1 very strong predictor or both strong predictors), low (no predictors present), or intermediate (any other combination of predictors). The actual management of each group was compared to ASGE-SAGES guidelines, i.e. low (CCY only), intermediate (CCY + IOC and/or endoscopic ultrasound [EUS] OR CCY + preoperative EUS/MRCP), and high (preoperative ERCP). The primary outcome was deviation from guidelines.
Results: The cohort was comprised of 844 patients; 2.3% (n=19) had low likelihood of CDL, 53.9% (n=455) had intermediate, and 43.8% (n=370) had high. In the low likelihood group, 78.9% (n=15/19) patients deviated; in the intermediate group, 41.8% (n=190/455) patients deviated; in the high group, 39.7% (n=147/370) patients deviated. After adjusting for all predictors, only GSP increased the risk of deviation in the high likelihood group (OR 2.9, 95% CI 1.6-5.3, p<.001) and only age > 55 y increased risk of deviation in the intermediate group (OR 1.9, 95% CI 1.1-3.3, p=0.02).
Conclusion: In a nationally representative sample of patients with CDL, >40% were managed differently than ASGE-SAGES guidelines. Future studies in this population are needed to better understand deviation in guidelines in patients with GSP and age > 55 years.

A PROSPECTIVE RANDOMIZED TRIAL COMPARING TWO STANDARD DOSES OF ENOXAPARIN FOR PREVENTION OF THROMBOEMBOLISM IN TRAUMA

Laure E. Trujillo, MD; Heather Hamilton, MS; Samantha Underwood, MS; Cassie Barton, PharmD, BCCP, FCCM; Elizabeth Dewey, MS; Alex Schlitt, DO; Laura Martin, BS; Christopher Connelly, MD; Jeffrey Barton, MD, FACS, FASCRS; Mackenzie Cook, MD; Martin A. Schreiber, MD, FACS, FCCM; Oregon Health & Science University
Invited Discussant: Elliott Haut, MD, PhD

Introduction: Deep venous thrombosis (DVT) and related complications are a preventable source of morbidity and mortality in hospitalized trauma patients. The optimal dosing schedule of subcutaneous enoxaparin for prevention of DVT is debated. We hypothesize that a single daily dose (QD) of 40mg enoxaparin is equally as efficacious and safe as 30mg twice daily (BID) in preventing DVT in our hospitalized trauma patients.

Methods: Trauma patients at least 15 years of age admitted to a Level 1 trauma center between 2014 and 2020 were prospectively randomized to receive 40mg enoxaparin QD or 30mg BID. Those who had bleeding risk precluding prophylaxis, were already receiving prophylactic enoxaparin outside of the study protocol, were receiving therapeutic anticoagulation or antiplatelet therapy, had CrCl <30 mL/min, or were not able to consent were excluded. Whole leg duplex was performed weekly for screening. Demographic data included age, sex, body mass index (BMI), injury severity score, and mechanism of injury. Primary outcome measured was DVT incidence. Secondary outcomes were rates of missed doses, bleeding complications, and hospital length of stay. Power analysis performed on pilot data determined that our sample size was adequate.

Results: Of the 267 randomized patients who met criteria, 139 (52%) received 40mg enoxaparin QD. The QD arm had 99 (71%) male patients versus 90 (70%) in the BID arm, with an average age of 49 years and average BMI of 28 in both groups. DVT developed in 15 patients (11%) in the QD arm and 12 (9%) in the BID arm. Bleeding complications were present in 26 patients (19%) versus 18 (14%), QD versus BID. Median hospital length of stay was 7 days in the QD arm versus 7.5 days in the BID arm. There were no significant differences in all above comparisons ($p>0.05$). Only 26 (19%) patients in the QD arm missed one or more doses of prophylaxis versus 41 (32%) in the BID arm ($p<0.05$).

Conclusion: The QD dose of 40mg enoxaparin was similar to the BID dose of enoxaparin for prevention of DVT and rate of bleeding complications. Notably, significantly fewer patients had missed doses in the daily arm. Enoxaparin 40mg QD appears equally efficacious and safe as 30mg BID while reducing the number of missed doses of prophylaxis per patient.

THE VOLUME OF THORACIC IRRIGATION AFFECTS LENGTH OF STAY IN PATIENTS WITH TRAUMATIC HEMOTHORAX
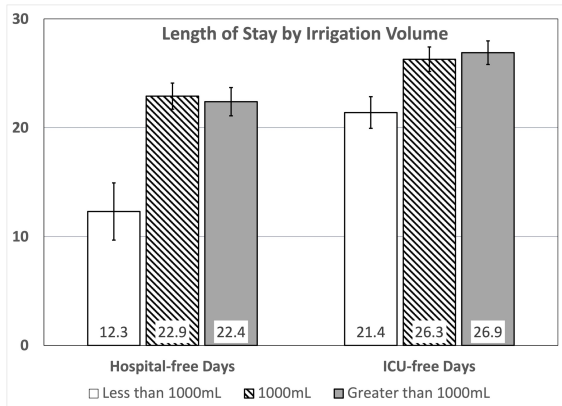
Laura Crankshaw, MD; Allison G. McNickle, MD; Kavita Batra, PhD;
Deborah A. Kuhls, MD; Paul J. Chestovich MD; Douglas R. Fraser; MD;
UNLV School of Medicine
Invited Discussant: Todd Constantini, MD

Introduction: Irrigation of the thoracic cavity at tube thoracostomy (TT) placement may decrease the rate of retained hemothorax; however, other resource utilization outcomes have not yet been quantified. This study evaluated the effect of thoracic irrigation during TT on length of stay and outcomes in patients with traumatic hemothorax (HTX).

Methods: A retrospective chart review was performed of patients ≥18 years of age receiving a TT for HTX at a single, urban Level 1 Trauma Center from January 2019 – July 2020. Those who underwent irrigation during TT were compared to a control of standard TT without irrigation. Death within 30 days as well as TTs placed at outside hospitals, during arrest, or for isolated pneumothoraces were excluded. Primary outcomes include hospital-free, ICU-free, and ventilator-free days (30-day benchmark). Subgroup analysis by irrigation volume was conducted using one-way ANOVA testing with $p<0.05$ considered statistically significant.

Results: Seventy (39.5%) out of 177 patients underwent irrigation during TT placement. Secondary interventions, complications and TT duration were not different in the irrigated cohort. ICU-free days were significantly higher in the irrigated patients (25.1±1.35) than the controls (20.0±2.14, p=0.02). Groups irrigated with ≥1000mL had significant more hospital-free (p=0.01) and ICU-free (p=0.03) days than those receiving less than 1000mL. (Figure)

Length of Stay by Irrigation Volume

	Hospital-free Days			ICU-free Days		
	Less than 1000mL	1000mL	Greater than 1000mL	Less than 1000mL	1000mL	Greater than 1000mL
	12.3	22.9	22.4	21.4	26.3	26.9

Conclusion: Patients with traumatic HTX who underwent thoracic irrigation at the time of TT placement had decreased ICU days compared to standard TT placement alone. Furthermore, irrigation volumes ≥1000mL resulted in fewer days in the hospital compared to lower irrigation volumes.

SUCCESSFUL NON-OPERATIVE MANAGEMENT OF ADHESIVE SMALL BOWEL OBSTRUCTION: IS IT REALLY A SUCCESS?

W. T. Hillman Terzian, MD; Rachel D. Appelbaum, MD; Lindsay Duy, MD; Michael Y. Chen, MD; Raymond B. Dyer, MD; Preston R. Miller III, MD; Nathan T. Mowery, MD; Wake Forest School of Medicine
Invited Discussant: Martin Zielinksi, MD

Background: Water soluble contrast challenge (WSCC) has become the standard in differentiating operative from non-operative adhesive small bowel obstructions (ASBO). Literature has shown that shorter periods (8 hours) are as predictive as longer periods (24 hours) in determining the need for acute surgical intervention, but the long-term outcomes are unknown. We hypothesized that patient who require longer transit times to the colon have a higher recidivism of ASBO.

Methods: This was a 4-year review of patients with presumed ASBO undergoing successful NOM. Those requiring immediate operation or those with a SBO due to something other than ASBO were excluded. The patients were divided into two groups (8hr and 24hr) based on when contrast reached their right colon. Our protocol is 24 hours of nasogastric decompression followed by a WSCC. Abdominal films are obtained at 8 and 24 hours. Those without contrast in the colon by 24 hours undergo exploration.

Results: 137 patients underwent successful NOM; 112 in the 8hr group and 25 in the 24hr group. Demographics were similar between the two groups. One-year recurrence rate was 21.4% in the 8hr group and 40% in the 24hr group (p=0.047). Of those who recurred, the median time to recurrence was 113 days (IQR 14-236) in the 8hr group and 13 days (IQR 10-82) in the 24hr group. Of those that recurred in the 24hr group, 60% recurred within 30 days (vs. 33% in the 8hr group) (see figure). The relative risk of ASBO recurrence within one year for the 24hr group compared to the 8hr group was 1.8667 (1.0277-3.3907 95% CI, p=0.04).

Conclusions: ASBO patients undergoing NOM who required 24 hours for contrast to reach the colon had a recurrence rate nearly twice that of patients with colonic contrast by 8 hours with the majority recurring in the first 30 days. Patients who require more than 8 hours may benefit from an operative intervention at the index hospitalization. Contrast in the colon at 24 hours may define resolution of that particular episode of ASBO but discharge may be delaying the inevitable.

CHARACTERISTICS AND OUTCOMES OF PRE-HOSPITAL TOURNIQUET USE FOR TRAUMA IN THE UNITED STATES

Zain G. Hashmi, MBBS; Jan Jansen, MBBS, PhD; Eric Bank, LP, NRP; Jeffrey Kerby, MD, PhD; John Holcomb, MD; University of Alabama at Birimingham
Invited Discussant: D'Andrea Joseph, MD

Introduction: The use of extremity tourniquets in military environments have reduced preventable deaths due to exsanguinating hemorrhage, leading to their increased adoption in the civilian setting. However, the characteristics and outcomes of contemporary pre-hospital tourniquet use in the civilian setting are not well-described at a national level. The objective of this study was to describe the characteristics and outcomes following pre-hospital tourniquet use by Emergency Medical Services (EMS) in the US.
Methods: All trauma activations reported to the National Emergency Medical Services Information System 2019 (NEMSIS) were included. Patients who received ≥1 tourniquets were identified. Descriptive analyses were used to compare characteristics between tourniquet and no-tourniquet cohorts. Coarsened exact matching (CEM) was then performed to generate a k2k match (on age, sex, lowest-systolic blood pressure, initial patient acuity, provider's initial impression, mechanism of injury and presence of upper and/or lower extremity injuries) and used to compare outcomes.
Results: A total of 7,161 tourniquets were applied among 4,571,379 trauma activations identified in the NEMSIS (1.6 per 1000 activations). Patients in the tourniquet cohort were younger (40 ± 18 vs 52 ± 26 mean±sd years, $p<0.01$), male (79% vs 48%, $p<0.01$), more hypotensive (16% vs 3%, $p<0.01$) and had higher initial acuity (65% critical/emergent vs 21%, $p<0.01$). Stab/cut/pierce (27% vs 3%, $p<0.01$), firearm injuries (19% vs 1%, $p<0.01$), upper extremity (23% vs 12%, $p<0.01$) and lower extremity injuries (25% vs 8%, $p<0.01$) were the most common mechanisms and injury patterns in the tourniquet cohort. Matched analysis revealed that the patients in tourniquet cohort had a higher final acuity (79% critical/emergent vs 72%, $p<0.01$), lower scene time (15 ± 13 vs 17 ± 15 mean±sd minutes, $p<0.01$) and higher survival-to-hospital (84% vs 77%, $p<0.01$).
Conclusion: Pre-hospital tourniquet use by EMS in the US is associated with lower scene-time and improved survivability to hospital. It appears there are many patients that might benefit from wider tourniquet use in the civilian pre-hospital setting.

EVERY MINUTE COUNTS: GEOSPATIAL ACCESS TO TRAUMA CENTER CARE PREDICTS FIREARM INJURY MORTALITY

James P. Byrne MD, PhD; Elinore Kaufman MD, MS; Dane Scantling DO; Niels Martin MD; Shariq Raza MD; Jeremy W. Cannon MD, SM; CW Schwab MD; Patrick Reilly MD; Mark J. Seamon, MD; University of Pennsylvania
Invited Discussant: Robert Winchell, MD

Introduction: The epidemic of gun violence is a public health crisis. Firearm injuries frequently require life-saving care at level 1 or 2 trauma centers (TCs). However, access to TCs in US cities is variable and delays to care might impact survival. We hypothesized that the geographic proximity of firearm injury to the nearest TC is associated with risk of mortality.

Methods: Adult shooting victims injured in Philadelphia county (2015-2020) were identified using police data. Self-inflicted injury was excluded. Shooting locations and TCs were mapped. The exposure was the optimal ground transport time (TT) along public roads to the nearest TC (reflecting quickest-possible access-to-care), estimated for each shooting victim using geographic information systems. Two analytic approaches were then used. First, the risk-adjusted association between TT and mortality was measured. Second, the case fatality rate (CFR) and attributable proportion of deaths due to increasing TT was calculated for concentric 1-minute service areas (ranging <1 min to >14 min from TC). The population attributable fraction was calculated to estimate the number of shooting deaths that could be attributed to increasing delays in access to TC care.

Results: 8,783 adult shooting victims were identified and 19% died. Median TT was 5.5 mins (IQR 3.8-7.1 mins). There was a significant near-linear relationship between increasing TT and risk of death [**Figure A**]. Each minute increase in TT was associated with 3% increase in risk of death (OR 1.03; 95%CI 1.01-1.05). Head injury (OR 38; 95%CI 26-56), torso injury (OR 11; 95%CI 8-16) and injury indoors (OR 2.1; 95%CI 1.6-2.7) were associated with increased mortality risk. The risk-adjusted CFR for shooting victims increased from 12% (TT <1 min) to 29% (TT >14 min) with greater delay to nearest TC [**Figure B**]. After risk-adjustment, an estimated 38% of firearm deaths could be attributed to the cumulative effect of incremental increases to delay in access-to-care, or 647 fatalities during the study period (equivalent to a decrease in annual firearm homicide rate from 18 to 11 deaths/100,000 people). Sensitivity analysis excluding patients with head injury yielded similar results.
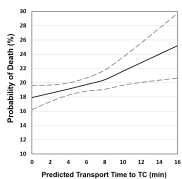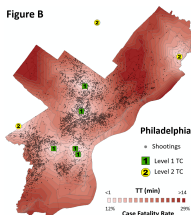

Figure A

Figure B

Conclusion: In a major US city where gun violence is common, each additional minute of delay in access to a TC negatively impacts shooting victim survival. These data highlight the potentially-preventable nature of deaths following firearm injury with prompt access to trauma care.

BEYOND RECIDIVISM: HOSPITAL BASED VIOLENCE INTERVENTION IMPROVES HEALTH AND SOCIAL OUTCOMES

Elizabeth Gorman, MD; Zachary Coles, BA; Nasza Baker, PhD; Ann Tufariello, MPH; Desiree Edemba, BA; Michael Ordonez, MPCS; Patricia Walling, DNP, APN, TCRN; David H. Livingston, MD; Stephanie Bonne, MD; Rutgers New Jersey Medical School
Invited Discussant: Rochelle Dicker, MD

Introduction: Hospital Based Violence Intervention Programs (HVIP) use recidivism to measure efficacy, which may be unmeasurable and subject to social factors that do not reflect the efficacy of the HVIP. We hypothesized HVIP intervention is best measured in the ability to meet the immediate health and social needs of patients following violent injury.

Methods: At an urban, level 1 trauma center's HVIP, a threefold approach to the assessment of patient needs and achievement of goals was undertaken: retrospective review of case management records, a validated, propensity-matched patient survey, and qualitative interviews. Logistic regression identified differences on each outcome; interviews were assessed by NVivo software for consistent codes, themes and iterative comparison.

Results: Of 295 HVIP patients, 89 (30%) had early disengagement from the program and 44 are within 6 months of enrollment and would not yet be expected to achieve goals, leaving 162 for evaluation. Median age was 29 years, 86% are male and 82% African American. 61 (21%) had unstable housing, and 98 (33%) were unemployed. 146 patients (90%) achieved at least one stated goals within 6 months (Figure 1). 68 patients participated in the survey arm of the study (32 HVIP, 36 non-HVIP). HVIP engagement resulted in less PTSD ($p<0.05$), higher positive affect, improved compliance with medical follow up (90% vs 60%), and early positive health and social outcomes. Prominent qualitative themes included satisfaction with program involvement, valuable personal relationship with case managers, achievement of goals, and hope for the future success.

Conclusion: HVIP patients successfully achieved short term health and social goals in 90% of patients who remained engaged. Improved relationship building with the HVIP team would decrease disengagement. Health and social outcomes should be used as a metric for efficacy of HVIP programs.

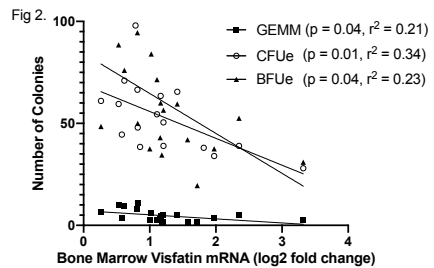# BONE MARROW ADIPOKINE EXPRESSION ASSOCIATED WITH DECREASED ERYTHROID COLONY GROWTH AFTER TRAUMA
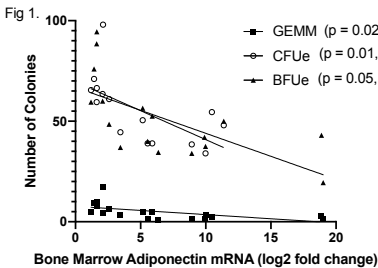
Lauren Kelly, LS; Kolenkode B. Kannan, PhD; Erick E. Pons, BS; Diojia B. Darden, MD; Philip A. Efron, MD, FACS, FCCM; Alicia M. Mohr, MD, FACS, FCCM; University of Florida College of Medicine
Invited Discussant: Hasam Alam, MD

Introduction: Severe trauma is associated with an inflammatory response that is linked to erythroid progenitor growth suppression. Proinflammatory adipokines like visfatin and the immunomodulatory adiponectin have been linked to inflammatory processes in critically ill patients. We hypothesized that severely trauma would lead to higher adipokine expression and an inverse correlation with bone marrow (BM) erythroid progenitor growth.
Methods: A prospective cohort study enrolled trauma patients (ISS>15) with hemorrhagic shock and a pelvic or femur fracture. BM was assessed for erythroid progenitor (CFU-GEMM, BFU-E, and CFU-E) growth and BM RNA for quantitative PCR (n=25). Differences in gene expression versus controls were detected using ANOVA and correlated with erythroid progenitor growth using simple linear regression on GraphPad Prism v9.0.
Results: There was increased transcription of both adiponectin and visfatin after trauma (p<0.05). Increased adiponectin (Fig 1) and visfatin (Fig 2) expression were associated with decreased CFU-GEMM, BFU-E and CFU-E colony growth following trauma. There was no correlation between erythroid colony growth, adiponectin, or visfatin with age or gender.
Conclusion: Following trauma, expression of adiponectin and visfatin negatively correlate with erythroid progenitor colony growth. These findings implicate adipokines in erythropoietic dysfunction after injury. Further study is needed to determine the mechanistic role of adipokines in BM dysfunction after trauma.

Fig 1. GEMM (p = 0.02, r² = 0.30); CFUe (p = 0.01, r² = 0.40); BFUe (p = 0.05, r² = 0.42)

Fig 2. GEMM (p = 0.04, r² = 0.21); CFUe (p = 0.01, r² = 0.34); BFUe (p = 0.04, r² = 0.23)

A NEW TRAUMA FRONTIER: PLATELET TRANSCRIPTOMICS

Alexander T. Fields, PH.D.; Man-Cheung Lee, MD, PHD; Fahima Mayer,
PH.D.; Cedric M. Bainton, Zachary A. Matthay, MD; Rachel A. Callcut,
MD, MSPH, FACS; Nasima Mayer, BS; Joseph Cuschieri, MD, FACS;
Kord M. Kober, PH.D.; Roland J. Bainton, MD, PhD; Lucy Z. Kornblith,
MD; University of Claifornia San Francisco
Invited Discussant: Carrie Sims, MD

Introduction: Platelets are endowed with precursor messenger ribonucleic acid (RNA) that is differentially spliced to support diverse platelet functions in response to physiologic signals. Altered platelet function following injury may be decipherable by transcriptomic platelet profiling. Supported by our prior work, we sought to characterize the platelet spliceform transcriptome and build platelet gene module networks associated with injury.
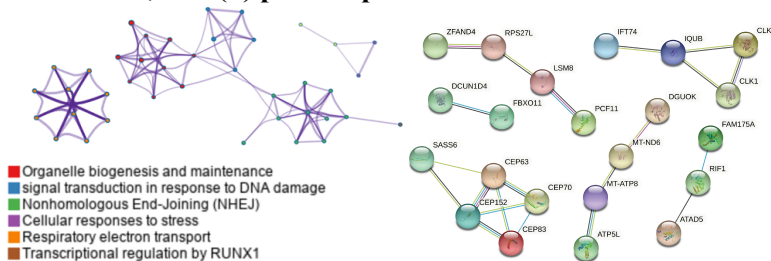
Methods: Pre-resuscitation platelets purified from trauma patients (n=11) and controls (n=6) were assayed using deep RNA sequencing. Differential alternative splicing (DAS) and gene coexpression network analysis were performed.

Table. Replicate multivariate analysis of transcript splicing (RMATs)	
Gene Symbol	Gene Function
MFN2	Mitochondrial fusion
ENKUR	Tethers signal transduction proteins to cation channels
FAXDC2	Megakaryopoiesis, modulation of runt-related transcription factor (RUNX1)
GPD2	Regulates macrophage inflammatory responses
KIF2A	Microtubule-associated motor proteins
LIMS1	Adaptor protein likely involved in integrin signaling
MAX	bHLHZ family of transcription factors
MBNL1	RNA splicing protein
NAP1L1	Chromatin modulation
PTMA	Component of Thymosin Fraction 5
RGS18	Regulator of G-protein signaling family
RUFY1	Interacts with tyrosine kinases
All with false discovery rate (FDR)<0.05	

Results: Twelve transcripts showed DAS (FDR<0.05, Table) in trauma vs. control platelets. Six pathways of cellular stress, metabolism, and megakaryopoiesis regulation (i.e., RUNX1) (Fig.1a) and protein-protein interactions (Fig.1b) were enriched between co-expressed genes.

Figure 1. Weighted gene coexpression analysis: (a) pathway enrichment, and (b) protein-protien interactions.

- Organelle biogenesis and maintenance
- signal transduction in response to DNA damage
- Nonhomologous End-Joining (NHEJ)
- Cellular responses to stress
- Respiratory electron transport
- Transcriptional regulation by RUNX1

Conclusions: This is the first study to identify differentially spliced transcripts and molecular pathways of higher-order cellular stress, metabolism, and regulation of megakaryopoiesis in post-injury platelets. Further investigations of this platelet homeostatic governance may uncover treatment targets of post-injury coagulopathy and organ failure.

THE EFFECT OF TRANEXAMIC ACID DOSING REGIMEN ON TRAUMA/HEMORRHAGIC SHOCK RELATED GLYCOCALYX DEGRADATION AND ENDOTHELIAL BARRIER PERMEABILITY: AN IN VITRO MODEL

Michael Carge, MD; David Liberati, MS; Lawrence Diebel, MD; Wayne State University
Invited Discussant: John Holcomb, MD

Introduction: Survival benefits of early Tranexamic Acid (TXA) administration has been demonstrated in trauma patients in both civilian and military settings. Overall survival benefit was most apparent in patients with shock and only with "early" administration (within 3 hours of injury). TXA has been shown to have anti-inflammatory properties as well. "Early" TXA administration protects against trauma hemorrhagic shock (T/HS), endothelial barrier dysfunction and glyxcocalyx (EGX) degradation. An important property of an intact EGC is modulation of adherence of neutrophils (PMN) and platelets to the endothelium. We hypothesized that TXA administration would protect the EGX from T/HS degradation and limit PMN transmigration through the endothelial cell barrier. This was studied in vitro using a microfluidic flow platform. **Methods:** Human umbilical vein endothelial cell (HUVEC) monolayers were established in microfluidic plates and subjected to flow under control or "shock" (hypoxia + reoxygenation and epinephrine) conditions. Normal media or media + TXA at 20μM or 150μM was added after 90 minutes (early TXA addition) or after 3hr delay (late TXA addition). EGC degradation was determined by supernatant hyaluronic acid (HLA), syndecan-1 (syn-1) and heparan sulfate (HS). Endothelial permeability was indexed by the relative concentrations (ratio) of angiopoietin 2 and 1 (Ang2/1). PMN transmigration in all HUVEC groups was indexed under flow conditions (ratio of transmigrated/adherent PMNs). **Results:** Mean ± SD (N = 6 for each group).
*$p < 0.05$ vs. HUVEC control, #$p < 0.05$ vs. HR + epi, \$$p < 0.05$ vs. HR + epi + TXA 20 and 150μM early **Conclusions:** There was a concentration and temporal effect of TXA administration on EGC degradation. This was associated with "vascular leakiness" as indexed by the relative ratio of Ang2/1 and PMN transmigration. TXA if administered in patients with T/HS should be administered "early"; this includes in the prehospital setting.

PLASMA AND WOUND FLUIDS FROM TRAUMA PATIENTS SUPPRESS NEUTROPHIL EXTRACELLULAR RESPIRATORY BURST

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Huang, PH.D.; Ingred Riça, PH.D.; David Gallo, BS; Christopher D.
Barrett, MD; Leo E. Otterbein, Kiyoshi Itagaki, PH.D.; Carl J. Hauser, MD;
Beth Israel Deaconess Medical Center
Invited Discussant: Jennifer Leonard, MD

Background: Trauma increases susceptibility to secondary infections but the root
causes of suppressed antimicrobial function are unclear. Neutrophils (PMN) use
DNA extracellular traps to ensnare bacteria and then to kill them with respiratory
burst (RB). We studied the effects of plasma and wound fluids from trauma patients
on PMN extracellular RB. **Methods:** Total and intracellular luminometry were used
to assess receptor-dependent (fMLF) and independent (PMA) RB generated by
volunteer PMN incubated 25 min in 10% plasma (Day 0, 1, 2) or 10% wound fluid
(Day 1, 2) from 15 blunt trauma patients. For controls, PMN were incubated in 10%
volunteer plasma (n=10). Cells were washed and studied in luminol with or without
SOD + catalase for 30min. RB is reported as area under the curve (AUC) for
relative light units (RLU). To ascertain if tissue necrosis plays a role in RB
regulation by trauma plasma, we compared pig PMN incubated in 10% control
plasma to 10% plasma from pigs who had undergone intra-peritoneal *(i.p.)*
instillation of liver slurry (10% of liver weight) 1 day prior. **Results:** PMN
incubation with clinical plasma or wound fluids suppressed total RB in response to
fMLF or PMA. Intracellular RB was unchanged. In all cases, maximal RB
suppression was caused by fluids present soon after injury and suppression decayed
over time **(Fig 1)**. Tissue necrosis (modeled by *i.p.* liver slurry) resulted in similar
plasma-induced deficits in receptor-dependent (LTB4, not shown) and receptor-
independent RB **(Fig 2)**. **Conclusion:** Trauma plasma and wound fluids suppress
extracellular PMN RB. The causative agents can be derived from necrotic tissues,
suggesting how retained necrotic tissues place the host at risk for systemic
infections.
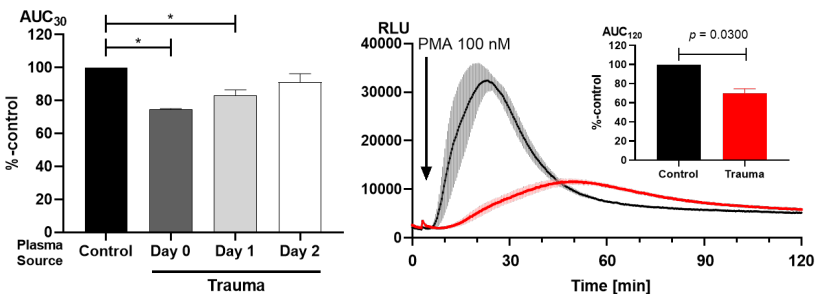
*p < 0.05 ANOVA/Tukey
Tukey

BETABLOCKADE IN TBI: DOSE DEPENDENT REDUCTIONS IN BBB LEUKOCYTE MOBILIZATION & PERMEABILITY IN VIVO

AJ Lopez, MD; M ElSaadani, MD; C Jacovides, MD; A Georges, BS; SM Ahmed, MD; LJ Kaplan, MD; DH Smith, MD; JL Pascual, MD, PhD; Penn Presbyterian Medical Center
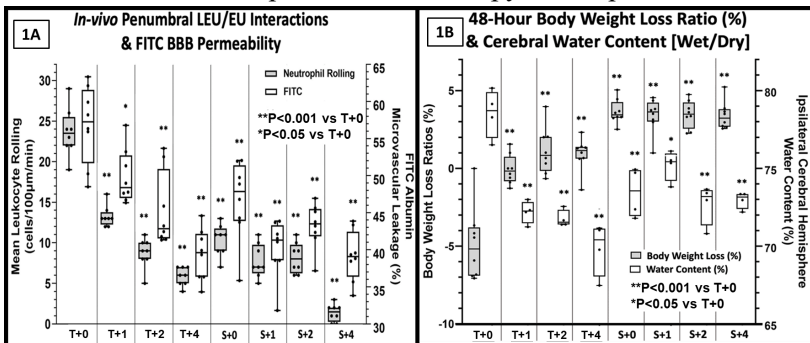Invited Discussant: Stephen Barnes, MD

Introduction: Traumatic brain injury (TBI) is associated with a hyperadrenergic catecholamine surge that can cause penumbral neuroinflammation. Prospective human studies demonstrate improved TBI survival with betablockade (bb), although mechanisms are unclear. We hypothesized that penumbral BBB leukocyte mobilization and permeability after TBI are altered by bb administration.

Methods: CD1 male mice (n=64) were randomly assigned to severe TBI (T) - controlled cortical impact: 6m/sec velocity, 1mm depth, 3mm diameter - or sham craniotomy (S), and IP injection of either saline (0) or propranolol (1, 2 or 4mg/kg) q12hours X 48h. At 48hrs, *in-vivo* pial intravital microscopy visualized live endothelial-leukocyte (LEU) interactions and BBB microvascular leakage. Twice daily clinical recovery was assessed by recovery of body weight loss and the Garcia Neurological Test (GNT: motor, sensory, reflex, balance assessments).

Results: Propranolol after TBI reduced both *in-vivo* LEU rolling and BBB permeability in a dose-dependent fashion when compared to no treatment (Figure 1A: P<0.001). Propranolol also reduced cerebral edema (P<0.001) and hastened recovery of body weight loss at 48hrs (Fig 1B: P<0.01). Compared to no treatment (14.9+/-0.2), 24-hour GNT scores were improved with 2 (15.8+/-0.2, P=0.02) and 4 (16.1+/-0.1, P=0.001) but not 1mg/kg propranolol.

Conclusion: Propranolol reduces LEU mobilization and microvascular permeability in the murine post-TBI penumbral neurovasculature. This is associated with reduced cerebral edema and post-injury weight loss as well as improved neurologic recovery. The apparent dose-dependence, favors a mechanistic relationship between bb therapy and improved human outcomes after TBI.

1A In-vivo Penumbral LEU/EU Interactions & FITC BBB Permeability

1B 48-Hour Body Weight Loss Ratio (%) & Cerebral Water Content [Wet/Dry]

MESENCHYMAL STEM CELL EXTRACEULLULAR VESICLES MITIGATE VASCULAR PERMEABILITY AND INJURY IN MULTIPLE ORGANS IN HEMORRHAGIC SHOCK AND TRAUMA

Mark Barry, MD; Byron Miyazawa, BS; Alpa Trivedi, PhD; Praneeti
Pathipati, PhD; Deborah Stein, MD, MPH; Shibani Pati, MD, PhD; UCSF
Invited Discusant: Rosemary Kozar, MD, PhD

Introduction: Hemorrhagic shock and trauma (HS/T)-induced gut injury may play a critical role in the development of multi-organ failure. Novel therapies that target gut injury and vascular permeability early after HS/T could have substantial impacts on trauma patients. In this study we investigate the therapeutic potential of human mesenchymal stem cells (MSCs) and MSC-derived extracellular vesicles (MSC-EVs) in HS/T. We hypothesize that MSC-EVs will recapitulate the protective effects of MSCs and decrease vascular permeability and injury in both the small intestine and lungs of mice subjected to HS/T.

Methods: Using a mouse model of HS/T, vascular permeability to a 10 kD dextran dye is measured in the small intestine and lungs among four groups: (1) sham, (2) HS/T + lactated Ringer's (LR) resuscitation, (3) HS/T + MSCs, and (4) HS/T + MSC-EVs. MSCs and EVs are infused intra-arterially. Histopathological injury, inflammation, and vascular integrity are assessed in all groups.

Results: Following HS/T all groups had similar mean arterial pressures. MSCs and MSC-EVs significantly decreased HS/T-induced vascular permeability in the small intestine (**Fig 1.** Dextran fluorescence intensity units:

Figure 1. Permeability in mouse intestine and lungs to 10kD dextran after treatment. *p<.05.
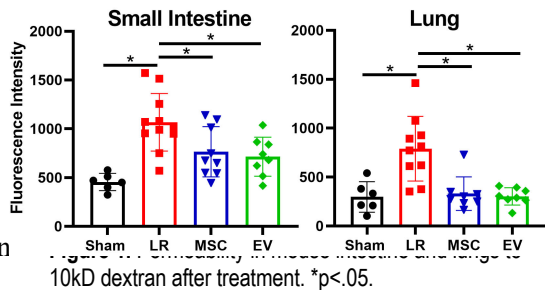
Sham 456±88, LR 1067±295, MSCs 765±258, MSC-EVs 715±200) and lungs (Sham 297±155, LR 791±331, MSCs 331±172, MSC-EVs 303±88). Organ injury was attenuated by MSCs and MSC-EVs.

Conclusions: MSCs and MSC-EVs reduce vascular permeability and injury in the small intestine and lungs, suggesting MSC-EVs may be a potential cell-free therapy targeting multi-organ failure in HS/T. This is the first study to demonstrate that MSC-EVs improve both gut and lung injury in an animal model of HS/T.

ADENOSINE, LIDOCAINE, AND MAGNESIUM (ALM) TO MITIGATE INJURY FROM RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA (REBOA)

Jack Franko, MD; Michael Vu, MD; Michael Parsons, MD; Jeffrey Conner, MD; Daniel Lammers, MD; Jason Bingham, MD; Matthew Eckert, MD
Invited Discussant: Jacob Glaser, MD

Introduction: Minimally invasive REBOA following non-compressible hemorrhage results in significant ischemia reperfusion injury (IRI), and can result in profound hemodynamic and molecular compromise. Here we assess physiologic outcomes and targeted molecular analysis of inflammation-associated cytokines/chemokines following REBOA-associated IRI in the context of ALM-based resuscitation using a porcine model.

Methods: Animals underwent a 20% controlled hemorrhage followed by 45 minutes of supraceliac balloon occlusion. They were randomized into two groups: control (n=9) and ALM intervention (n=10) to include a post-hemorrhage, pre-REBOA bolus (200cc of 3% NaCl ALM) followed by a continuous drip (2cc/kg/hr of 0.9% NaCl ALM) during the 4 hour resuscitative period. Primary outcomes included hemodynamic parameters and putative biomarkers of inflammation.

Results: The ALM cohort demonstrated a significant reduction in heart rate at 2, 3, and 4 hours post REBOA deflation relative to 1 hour after deflation (-26.5, p=<0.01; -23, p=<0.01; and -27, p=<0.01, respectively) whereas heart rate did not vary significantly at these time points in control animals. Plasma concentrations of inflammatory proteins IL-1α, IL-2, IL-4, and IL-10 were significantly lower 3 hours post-REBOA in animals treated with ALM (p<0.05, p<0.02, p<0.02, and P<0.03, respectively). IL-1α and IL-4 levels were also significantly lower at 4 hours post-REBOA (p<0.04 and p<0.02, respectively).

Conclusion: ALM therapy may attenuate the IRI hemodynamic response seen from REBOA as evidenced by a reduction in heart rate early during post-REBOA resuscitation, and a significant reduction in inflammation-associated cytokines/chemokines IL-1α, IL-2, IL-4, and IL-10.

CELLULAR MICRORNAS CORRELATE WITH OUTCOMES IN POLYTRAUMA PATIENTS

Diego Vicente, MD; Seth A. Schobel, PhD; Simone Anfossi, PhD; Hanna Hensman, BS; Felipe A. Lisboa, MD; Henry Robertson, PhD; Vivek Khatri, MHS; Matthew Bradley, MD; Masayoshi Shimizu, BS; Timothy G. Buchman, PhD, MD; Thomas Davis, PhD; Christopher Dente, MD; Allan Kirk, MD, PhD; George Calin, MD; Eric Elster, MD; Uniformed Services University of thee Health Sciences
Invited Discussant: Martin Schreiber, MD

Introduction: The mechanisms of the inflammatory response in polytrauma patients (PtP) have not been completely elucidated. Study of infection-mediated immune pathways have demonstrated that cellular microRNAs (CmiRs) may potentiate the inflammatory response. The authors hypothesize that the expression of CmiRs correlate to complicated recoveries (CR) in PtPs.

Methods: PtPs enrolled in the prospective observational Tissue and Data Acquisition Protocol, with Injury Severity Score (ISS) >15 were selected for this study. PtP were divided into CR and uncomplicated recovery (UR) groups. CR patients included PtPs with ICU admission >14 days, mechanical ventilation > 14 days, or mortality within 28 days. PtP plasma samples were obtained at the time of admission (T0). Established mediators of systemic inflammation, including cytokines and chemokines, and novel CmiRs were measured in plasma samples using separate multiplexed Luminex-based methods.

Results: PtPs (n = 180) had high ISS (26 [20-34]) and CR rate of 33%. CmiRs were differentially expressed in PtPs at T0 compared to healthy controls, and univariate analysis demonstrated that lower levels of CmiRs were associated with PtPs of older age and African America race as well as PtPs with acute respiratory distress syndrome, ventilator associate pneumonia, CR, and mortality within 28 days. Positive correlations were noted between CmiRs and IL-10, APACHE, and SOFA scores. Multivariate LASSO analysis of predictors of CR based on CmiRs, cytokines and chemokines, revealed that miR21.3p and MCP-1 were predictive of CR with an AUC of 0.78.

Conclusion: Systemic CmiRs were associated with poor outcomes in PtPs, and the results are consistent with previously described trends in critically ill patients. These early changes in CmiRs might provide predictive value for CR in PtPs. Given the known mechanisms of CmiRs in the inflammatory response, the findings in this study suggest that CmiRs may provide potential targets for immunomodulation in trauma patients.

SEX DIFFERENCES ASSOCIATE WITH LATE MICROBIOME ALTERATIONS AFTER MURINE SURGICAL SEPSIS

Philip A. Efron, MD, FACS, FCCM; Dijoia B. Darden, MD; Eric Li, MS; Lauren Kelly, MD; Brittany Fenner, MD; Dina Nanionales, MD; Ricardo Ungaro, BS; Marvin Dirain, BS; Christiaan Leeuwenburg, PH.D.; Frederick Moore, MD, FACS, MICCM; Scott brakenridge, MD, FACS; Lyle Moldawer, PH.D.; Alicia M. Mohr, MD, FACS, FCCM; Ryan Thomas, MD, FACS;
University of Florida
Invited Discussant: Susannah Nicholson, MD

Introduction: Sepsis-induced gut microbiome alterations have been shown to contribute to sepsis-related morbidity and mortality. We have previously demonstrated that older adult mice fail to recover gut microbiome alterations compared to their young counterparts immediately after sepsis. Given improved sepsis survival in females compared to males, we hypothesized that female mice maintain microbiome stability vs. their male counterparts which may explain these sex-based differences.

Methods: Mixed-sex C57BL/6 mice aged 3-5 months or 18-22 months underwent cecal ligation and puncture (CLP) with resuscitation that included 3 days intraperitoneal imipenem, 2 days saline resuscitation, followed by 2 hours daily cone stress (DCS) to recapitulate post-trauma stress and compared to naïve (non-sepsis) control. Mice were sacrificed at day 7 and 14 and 16S rRNA gene sequencing was performed on bacterial DNA isolated from stool. Alpha-and beta-diversity was determined by Shannon index and Bray-Curtis with principle coordinate analysis, respectively. False discovery rate (FDR) correction was implemented to account for potential housing (i.e. cage) effect.

Results: At baseline, there was no difference in alpha or beta-diversity for male vs. female mice (FDR=0.76 and 0.99, respectively). Further, there was no difference in beta-diversity between these cohorts (FDR=0.99). However, with the implementation of CLP+DCS, male mice had a decrease in microbiota alpha-diversity at 7 days post-CLP (Shannon FDR=0.005) which was sustained at 14 days post-CLP (Shannon FDR=0.001), compared to baseline. In contrast, female mice had a decreased microbiota alpha-diversity at 7 days post-CLP (Shannon FDR=0.03) but recovered this lost diversity by post-CLP day 14 (Shannon FDR=0.5). Similarly, beta-diversity was statistically different between female naïve vs. post-CLP day 7 (FDR=0.02) but reverted to a pre-sepsis microbiota by day 14 (FDR=0.07). Male mice maintained beta-diversity differences even at day 14 compared to naïve control (FDR<0.0001).

Conclusions: Although perturbations of the intestinal microbiota occur initially in both male and female C57BL/6 mice after a model of sepsis and stress, only females recover these changes to a pre-sepsis level (day 14). This recovery may play a role in outcome differences between sexes after sepsis.

# PRECISION TARGETING OF THE VAGAL ANTI-INFLAMMATORY PATHWAY ATTENUATES THE SIRS RESPONSE TO INJURY

Todd W. Costantini, MD; Jessica L.Weaver, MD, PhD; Raul Coimbra, MD, PhD; Brian P. Eliceiri, PhD; University of California San Diego Health
Invited Discussant: Tina Palmieri, MD

Background: The systemic inflammatory response (SIRS) drives late morbidity and mortality after injury. The α7 nicotinic acetylcholine receptor (α7 nAchR) expressed on immune cells regulates the vagal anti-inflammatory pathway that prevents an overwhelming SIRS response to injury. Non-specific pharmacologic stimulation of the vagus nerve has been evaluated as a potential therapeutic to limit SIRS, unfortunately results of clinical trials have been underwhelming. We hypothesized that directly targeting the α7 nAchR would more precisely stimulate the vagal anti-inflammatory pathway on immune cells and decrease gut and lung injury after severe burn.

Methods: C57BL/6 mice underwent 30% total body surface area steam burn. Mice were treated with an intraperitoneal injection of a selective agonist of the α7 nAchR (AR-R17779) at 30 minutes post-burn. Intestinal permeability to 4kDa FITC-Dextran was measured at multiple time-points post-injury. Lung vascular permeability was measured 6 hours after burn injury. Behavioral assessments were performed serially to quantify activity levels.

Results: Intestinal permeability peaked at 6 hours post-burn. AR-R17779 decreased burn-induced intestinal permeability in a dose-dependent fashion (p<0.001, see Figure). There was no difference in gut barrier function between sham and burn injured animals treated with 5 mg AR-R17779. While burn injury increased lung permeability 10-fold, AR-R17779 prevented burn-induced lung permeability with no difference compared to sham (p<0.01). Post-injury activity levels were significantly improved in burned animals treated with AR-R17779.

Conclusion: Directly stimulating the α7 nAchR prevents burn-induced gut and lung injury. Precision targeting of the vagal anti-inflammatory pathway should be considered as a therapy to limit SIRS-associated morbidity after severe injury.
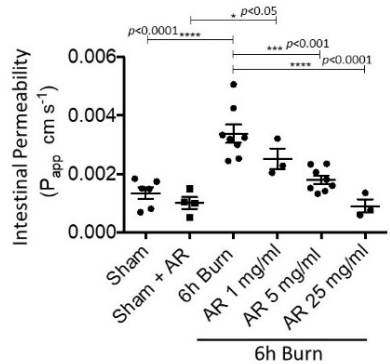
THE 35-MM RULE TO GUIDE PNEUMOTHORAX MANAGEMENT: INCREASES APPROPRIATE OBSERVATION AND DECREASES UNNECESARY CHEST TUBES

Juan F. Figueroa, MD; Basil S. Karam, MD; Jose Gomez, BS; Patrick Murphy, MD, MSc, MPH; Rachel Morris, MD; Thomas W. Carver, MD, FACS; Anuoluwapo Elegbede, MD; David Milia, MD; Christopher Dodgion, MD; Libby Schroeder, MD, FACS; Marc de Moya, MD, FACS;
Medical College of Wisconsin/Froedtert
Invited Discussant: Stanislaw Stawicki, MD

Introduction: Pneumothorax (PTX) management has changed due to more objective means of guiding criteria for drainage using the 35mm-rule on CT-Scan (CT). In 2017, our trauma center created a policy to observe any PTX ≤ 35mm. We hypothesize that this rule would decrease unnecessary chest tubes without affecting failure rates.

Methods: This is a single-center, retrospective review of all adult trauma patients who had a PTX diagnosed on CT before (2015-2016) and after (2018-2019) policy implementation. We excluded patients with chest tubes inserted before CT, concurrent moderate/large hemothoraces, mechanical ventilation, or mortality on the first 24 hours. Descriptive and logistic regression analyses were performed.

Results: 266 patients met our inclusion criteria. Ninety-nine (37.2%) and 167 (62.7%) patients were admitted before and after 2017, respectively. On subgroup analysis of patients with PTX ≤35mm, compliance rates were higher, chest tube usage and observation failure rates declined after policy implementation (Table). On logistic regression, patients with PTX ≤35mm admitted after 2017 were more than twice as likely to be observed (OR 2.1 95% [CI 1.1-5.5]). There were no statistically significant changes in hospital or ICU length-of stay, complications, or mortality.

Conclusion: Adherence to the 35-mm rule for PTX on CT resulted in a 2-fold increase in observation and decreased the number of unnecessary CTs.

Variable	Before 2017 n= 93	After 2017 n= 154	p-value
Chest tube use	19 (20,4%)	16 (10,4%)	0.02
Compliance with rule	76 (81,7%)	141 (91,6%)	0.02
Median Length of stay	4 (±2.9)	4 (26.18)	0.85
Complications, n (%)	3 (3,2%)	9 (5,8%)	0.54
Observation	76 (81,7%)	141 (91,6%)	0.02
Observation Failure	5 (5,4%)	5 (3,2%)	0.04

BLOOD PRODUCT RESUSCITATION MITIGATES THE EFFECTS OF AEROMEDICAL EVACUATION AFTER POLYTRAUMA

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Invited Discussant: Joshua Brown, MD

Introduction: The combined injury of traumatic brain injury (TBI) and hemorrhagic shock has been shown to worsen coagulopathy and systemic inflammation thereby increasing posttraumatic morbidity and mortality. Aeromedical evacuation to definitive care may exacerbate post-injury morbidity due to the inherent hypobaric hypoxic environment. We hypothesized that blood product resuscitation may mitigate the adverse physiologic effects of post-injury flight.

Methods: An established porcine model of controlled cortical injury was used to induce TBI. Intracerebral monitors were placed to record intracranial pressure (ICP), brain tissue oxygenation, and cerebral perfusion. Each of the 42 pigs were then hemorrhaged to a goal mean arterial pressure of 40 ± 5 mmHg for 1 hour. Pigs were grouped according to resuscitation strategy utilized - (Lactated Ringer's (LR) or shed whole blood (WB) - then placed into an altitude chamber for 2 hours at ground level, 8,000ft, or 22,000ft, and then observed for 4 hours. Hourly blood samples were analyzed for pro-inflammatory cytokines and lactate. Internal jugular vein blood flow was monitored continuously for microbubble formation with altitude changes.

Results: Cerebral perfusion, tissue oxygenation, and ICP were unchanged among the 6 groups. No internal jugular venous microbubbles were observed with differing altitude or resuscitation strategy. Serum lactate levels from hour-2 of flight to the end of the 4-hour observation were significantly elevated in 22,000+LR compared to both 8,000+LR and 22,000+WB. Serum IL-6 levels were significantly elevated in 22,000+LR compared to 22,000+WB from hour-1 of flight to end of observation. Serum TNF-α was significantly elevated hour-1 of flight in 8,000+LR vs ground+LR, and 8,000+WB vs ground+WB. IL-1b levels were not significantly different over time or between groups.

Conclusion: Crystalloid resuscitation during aeromedical transport may cause a prolonged lactic acidosis and pro-inflammatory response that can predispose polytrauma patients to secondary injury. This physiologic insult may be prevented by utilizing blood product predominant resuscitation strategies.

DIRECT TO OR RESUSCITATION OF ABDOMINAL TRAUMA: AN NTDB PROPENSITY MATCHED OUTCOMES STUDY

Theodore Habarth, BA; Arturo Rios-Diaz, MD; Stephen P. Gadomski, MD; Tiffani Stanley; Julie P. Donnelly, MSN, RN, TCRN; George J. Koenig, Jr., DO; Murray J. Cohen, MD; Joshua A. Marks, MD; Thomas Jefferson University
Invited Discussant: Laura Godat, MD

Introduction: Direct to operating room resuscitation (DOR) is employed by some trauma centers for severely injured trauma patients. It is unknown whether this results in favorable outcomes. We hypothesized that utilization of an emergency department operating room (ED-OR) for resuscitation of patients with abdominal trauma at an urban level-1 trauma center would be associated with decreased time to laparotomy and improved outcomes.

Methods: We identified patients >15 years old with abdominal trauma who underwent emergent laparotomy within 120 minutes of arrival at our institution between 2013-2016. Patients were matched from NTDB using 1:1 propensity score matching based on age, gender, mechanism of injury, ISS, and abdominal AIS score. The primary outcome was time to laparotomy incision. Secondary outcomes included blood transfusion requirement, ICU length of stay (LOS), ventilator days, hospital LOS, and in-hospital mortality.

Results: There were 128 patients in each cohort, 84.4% presented with penetrating trauma. Patients were 28 years old (IQR 23-39.5), 91% male, 30.5% white, with a median ISS 16.5 (IQR 9-29), initial SBP 97 mmHg (IQR 86-140), and AIS abdominal score 3 (IQR 2-4). These characteristics did not differ between groups (p>0.05). Treatment in the ED-OR was associated with decreased time to incision (40 vs. 25 min; p=<0.001), ICU LOS (4 vs. 2 days; p=0.001), transfusion requirement within 24 hours (4 vs. 2 units packed red blood cells; p=0.016), and ventilator days (2 vs. 1; p=<0.001). There were no significant differences in hospital LOS or in-hospital mortality.

Conclusion: The use of an ED-OR is associated with decreased time to hemorrhage control as evidenced by the decreased time to incision, blood transfusion requirement, ICU LOS, and ventilator days.

Table 1. Results of statisitcal analyses on matched samples from instutional and NTDB cohorts.

Factor	NTDB (N=128)	ED-OR (N=128)		ED-OR (Ref. NTDB)		
	median (IQR) / n (%)	median (IQR) / n (%)	p-value	Odds Ratio / Predicted mean diffference	95% CI	p-value
Time to Incision, min; median (IQR)	40.0 (28.0, 58.0)	25.0 (19.0, 38.0)	<0.001	-13.6	(19.4 - -7.8)	<0.001
In-Hospital Mortality	26 (20.3%)	30 (23.4%)	0.55	1.2	(0.66 - 2.2)	0.546
Units of Blood within 24 Hours, median	4.0 (2.0, 14.0)	2.0 (0.0, 8.0)	0.016	-2.3	(-6.9 - 2.3)	0.327
Hospital Length of Stay, d, median (IQR)	7.0 (4.0, 14.0)	5.5 (3.0, 14.5)	0.29	0.41	(-3.2 - 4.0)	0.822
ICU Length of Stay, d, median (IQR)	4.0 (2.0, 9.0)	1.0 (0.0, 3.0)	<0.001	-3.6	(-7.2 - -0.1)	0.044
Ventilator Dependent Days, d, median (IQR)	2.0 (1.0, 5.0)	1.0 (0.0, 1.0)	<0.001	-2.0	(-5.4 - 1.4)	0.256

PROSPECTIVE RANDOMIZED TRIAL OF METAL VS RESORBABLE PLATES IN SURGICAL STABILIZATION OF RIB FRACTURES

Dennis W. Ashley, MD; Dudley B. Christie III, MD; Eric Long, MD; Rajani Adiga, MS; Tracy J. Johns, MSN; Josephine Fabico-Dulin, RN; Anne Montgomery, PhD; The Medical Center, Navicent Health
Invited Discussant: Lewis Somberg, MD

Introduction: Surgical stabilization of rib fractures has gained popularity as both metal and resorbable plates have been approved for fracture repair. The objective of this study was to determine if resorbable plates would provide the same rib fracture alignment, hardware stability, control of pain, and quality of life scores as compared to metal fixation.

Methods: Eligible patients (pts) included ≥ 18 years with one or more of the following rib fracture patterns: flail chest, one or more bi-cortical displaced fractures (3 -10), nonunion and non-displaced fractures managed non operatively with failure of medical management. Pts were randomized to either metal (DePuy Synthes titanium) or resorbable plate (Acute Innovations BioBridge) fixation. Standard post-op pain control protocol (multimodal) was used in both groups. Primary objectives were fracture alignment and hardware failure. Secondary objectives were pain scores and opioid use in the hospital and outpatient setting. Quality of life (QOL SF-36) was assessed at 3 and 6 months.

Results: 30 pts were randomized (15 metal/15 resorbable). Total ribs plated 174 (95 metal/79 resorbable). Mean number ribs fractured per pt metal 6.6 vs resorbable 5.5. Mean number of plates per pt metal 6.3 vs resorbable 5.3. Number of pts with rib displacement at day of discharge (DOD) defining baseline displacement post-surgery metal 0/14 (1 pt died, not from plating) vs resorbable 9/15 or 60% (p=.001). Number of ribs displaced per pt at DOD metal 0/88 vs resorbable 22/79 or 28% (p<.001). Number of pts with additional rib displacement 3-6 months: metal 0/11 vs resorbable 3/9 or 33% (p=.038). Number of ribs with additional displacement 3-6 months metal 0/67 vs resorbable 10/49 or 20% (p<.001). Hardware failures: one screw dislodgement (metal)/5 plates broken after repeat trauma post discharge (resorbable). Pain scores & narcotic use at post-op day 1, 2, 3, DOD, 2 wks, 3 and 6 months showed no statistically significant difference between metal vs resorbable. QOL scores were similar between groups at 3 and 6 months.

Conclusion: Metal plates provided better initial alignment with no displacement over time compared to resorbable. This did not negatively affect clinical outcomes with regards to pain, narcotic use or QOL scores.

COVER WITH CAUTION: MANAGEMENT OF THE LEFT SUBCLAVIAN ARTERY IN TEVAR FOR TRAUMA

AN Romagnoli, MD; A Dua, MD, MS, MBA; DS Kauvar, MD, MPH; N Saqib, MD; C Miller; BW Starnes; A Azizzadeh, MD; JJ DuBose, MD; Massachusetts General Hospital
Invited Discussant: Todd Rasmussen, MD

Introduction: Elective Thoracic Endovascular Aortic Repair (TEVAR) with left subclavian artery coverage (LSA-C) without revascularization is associated with increased rates of ischemic stroke. However, in patients with blunt thoracic aortic injury (BTAI) undergoing TEVAR, LSA-C is frequently required in over 1/3 of patients. This study aimed to evaluate outcomes of TEVAR in BTAI patients with and without subclavian coverage.

Methods: The largest existing international multicenter prospective registry of BTAI, developed and implemented by the Aortic Trauma Foundation, was utilized to evaluate all BTAI patients undergoing TEVAR from March 2016-January 2021. Patients with uncovered left subclavian artery (LSA-U) were compared to patients who had left subclavian artery coverage (LSA-C) without revascularization. Outcomes included early and late ischemic strokes.

Results: Three hundred sixty-five patients with BTAI who underwent TEVAR were identified during the 5-year study period. Of these, 97 (26.6%) underwent LSA-C without revascularization, 10 (2.7%) underwent left subclavian artery coverage with revascularization (LSA-R), and 258 (70.7%) underwent TEVAR where the left subclavian artery was left uncovered (LSA-U).

Late and all ischemic strokes were more common in LSA-C patients than LSA-U patients ($p=0.01$, $p<0.05$). In the LSA-C group, the median age of IS patients was 29 [29,66], which was not different than stroke-free patients. While there was a higher rate of cervical spine fracture in ischemic stroke patients (43% vs 10%, $p=0.03$), no blunt cerebrovascular injuries were reported in this group.

Outcome	LSA-C N=97	LSA-U N=258	p
Early ischemic stroke	2, (2.1%)	0, (0%)	0.07
Late ischemic stroke	6, (6.2%)	2, (0.78%)	0.01
All ischemic stroke	8, (8.2%)	2, (0.98%)	0.007

Conclusion: While prior studies have suggested the relative safety of LSA-C in BTAI, preliminary multicenter prospective data suggests there is a significant increase in ischemic events when the left subclavian artery is covered and not revascularized. Additional prospective study and more highly powered analysis is necessary.

PRACTICAL MACHINE LEARNING APPLICATION TO CHARACTERIZE GERIATRIC TRAUMA FRAILTY

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Invited Discussant: Rachel Callcut, MD

Introduction: A geriatric trauma frailty index that captures only baseline conditions, facilitates rapid bedside calculation, and is validated nationwide remains underexplored. We developed and validated a practical prognostication tool, the geriatric trauma frailty index (GTFI).

Methods: We developed GTFI according to *Transparent Reporting of a Multivariable Prediction Model for Individual Prognosis* guidelines. Using nationwide US admissions of geriatric patients from 2016-2017 (10% development, 90% validation), partitioning around medoids clustering identified development subcohorts with previously-validated frailty characteristics. Ridge regression with penalty for multicollinearity aggregated baseline conditions most prevalent in the frail subcohort into GTFI scores. Jenks natural breaks classification delineated four frailty risk strata. Regression with adjustment for age, injury severity, and sex assessed associations between frailty risk strata and outcomes (OR [95%CI]).

Results: Our data compromised 1.6 million geriatric trauma admission encounters. Clustering and ridge regression on the development cohort identified 15 baseline conditions constituting GTFI. Among the validation cohort, increasing frailty risk (very low [reference group], low, moderate, high) was associated with stepwise worsening adjusted odds of mortality (2.2[2.0-2.4], 3.4 [3.1-3.7], 4.6 [4.2-5.0]), prolonged hospitalization (1.3[1.3-1.3], 1.6 [1.6-1.6], 2.0 [1.9-2.0]), and disposition to home (0.7[0.7-0.7], 0.6[0.6-0.6], 0.5[0.5-0.5]). We found direct correlations between increasing GTFI scores and worse outcomes (Figure).

Conclusion: Machine learning-generated GTFI predicts inpatient outcomes using 15 baseline conditions. We are developing a mobile application to facilitate clinical application and real-time GTFI use.

Figure. Locally Weighted Scatterplot Smoothing line showing association between Geriatric Trauma Frailty Index and outcomes of injured geriatric patients.
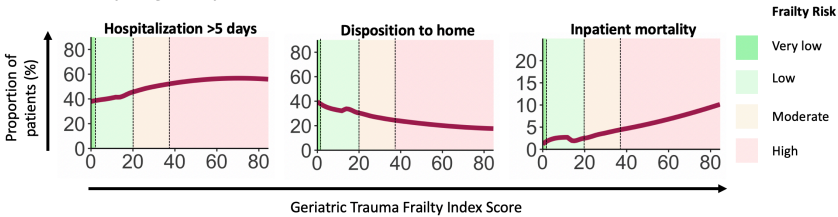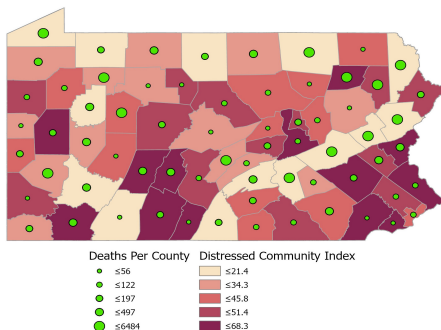
SOCIAL DETERMINANTS OF HEALTH AND PATIENT-LEVEL MORTALITY PREDICTION AFTER TRAUMA

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Invited Discussant: Tanya Zakrison, MD, MPH

Introduction: Social determinants of health (SDOH) impact patient outcomes in trauma. Census data are often used to account for SDOH; however, there is no consensus on which variables are most important. Social vulnerability indices offer the advantage of combining multiple constructs into a single variable. Our objective was to determine if social vulnerability indices have comparable performance to multiple individual SDOH variables in patient-level mortality models after injury.

Methods: We evaluated 2 social vulnerability indices at the zip code level: Distressed Community Index (DCI), National Risk Index (NRI). Individual variable combinations from AHRQ's SDOH Dataset were used for comparison. Patients we included from Pennsylvania Trauma Outcomes Study (PTOS) 2000-17. These measures were added to a validated PTOS base mortality prediction model with AUC and Bayesian information criterion (BIC) compared. Geospatial analysis identified geographic variation and spatial autocorrelation.

Deaths Per County — Distressed Community Index

Deaths Per County	Distressed Community Index
≤56	≤21.4
≤122	≤34.3
≤197	≤45.8
≤497	≤51.4
≤6484	≤68.3

Results: 449,541 patients were included with 22,304 deaths (5%). The DCI and NRI both improved the base model (AUC: DCI 0.9494; NRI: 0.9493 vs Base Model: 0.9493 & BIC: DCI 86608; NRI 86609 vs Base Model 86623). Best performance was backward selection that included 7 AHRQ variables (representing housing, income, transportation, insurance, and employment domains) with the same BIC and marginal AUC increase over DCI (AUC 0.9495). There is significant geographic variation in DCI and deaths across PA counties (Figure), but no significant spatial autocorrelation at the county level (DCI; Moran's I 0.11, p=0.11; mortality; Moran's I -0.003, p=0.70).

Conclusions: The DCI and NRI perform well at the patient-level, accounting for SDOH in trauma outcome research while minimizing the number of variables added to prediction models. These indices may also be useful in patient-centered assessments of trauma outcomes to identify community risk factors.

TRAUMA TRANSFERS DISCHARGED FROM THE EMERGENCY DEPARTMENT – IS THERE A ROLE FOR TELEMEDICINE

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Albrecht, MD; Oklahoma University Health Sciences Center
Invited Discussant: Jeffrey Kerby, MD, PhD

Objective: As the only level one trauma center (TC) in the state, our hospital has seen an increase in the number of traumas requiring transfer for a higher level of care, placing strain on an already strained health care system. Traumas that are transferred to our facility and subsequently discharged back home indicate a subset of patients who may not be appropriate to transfer. The aim of this study is to identify commonalities of the patients who were transferred for a higher level of care but do not require inpatient status and assess patients who may benefit from a telemedicine evaluation.

Methods: A two-year retrospective review of a prospective collected database of patients who were discharged from the ED following transfer to a Level 1 TC was conducted. Data included demographics, injuries, transferring facility, method of transport, activation criteria and level, additional imaging, consulting services, procedures and disposition.

Results: A total of 2350 patients were transferred. Of those, 27% (628) were discharged home directly from the trauma bay. The three most common injury patterns were face 51% (324), hand 31% (196), and isolated orthopedic injuries 8.5% (54). 36% (230) required a bedside procedure prior to discharge, of which 53% required a laceration repair, 24% an ophthalmology exam, 18% splinting, and 5% joint reduction. The top 10 transferring facilities accounted for 40% (948) of our transfer volume.

Conclusion: Our study demonstrates that patients who are transferred to our facility and subsequently discharged have a common pattern of injuries; typically isolated to hand and face/ophthalmology. This is likely attributed to the lack of resources in rural facilities to evaluate and develop treatment plans for these injuries; however, only 36% of discharged patients required a bedside procedure. Development and implementation of a telemedicine system could potentially reduce the transfer and ED discharge rate, thereby improving efficiency and allow for reallocation of resources as appropriate.

MEDICAL MANAGEMENT OF GRADE I-II SPLENIC INJURIES WITH ACTIVE EXTRAVASATION HAS A HIGH FAILURE RATE: AN EAST MCT

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Invited Discussant: Ben Zarzaur, MD, MPH

Introduction: Numerous studies suggest that hemodynamically stable patients with high grade splenic injuries and active extravasation/contrast blush (CB) should undergo splenic embolization; however, there is little evidence to guide the management of low grade traumatic splenic injuries (grade I-II) with CB. The aim of this study is to determine the failure rate of non-operative/angiographic intervention (NOM) of grade I-II splenic injuries with CB in hemodynamically stable patients.

Methods: A multicenter, retrospective, observational study examining all grade I-II splenic injuries with CB was performed at 25 institutions from January 1, 2014 to October 31, 2019. Inclusion criteria was patients > 18 years and grade I-II splenic injury due to blunt trauma with CB on CT scan. Patients with hemodynamic instability or medically-induced coagulopathy were excluded. The primary outcome was failure of NOM requiring angioembolization or surgery. Data collection included age, gender, mechanism of injury, co-morbidities, and outcomes such as hospital, ICU length of stay, discharge disposition, and mortality.

Results: A total of 236 patients from 25 institutions were included. There were 157 males, 78 females, and one patient not classified by gender. The median Injury Severity Score was 17. A majority of patients (159, 67%) had a BMI greater than 30. Motor vehicle collision was the most common cause of injury. There was a 22% failure rate for grade I and a 31% failure for grade II injuries. The combined rate of failure for grade I-II injuries was 28%. There was no statistical difference in failure of NOM between grade I and II injuries. Age > 47 years was significant (p 0.005) for failure of NOM. There was an increase in mean ICU (p=0.031) and hospital length of stay (p=0.008) as well as need for blood transfusion (p<0.001) and massive transfusion (p =0.009) in the failure of NOM patients. There was no difference in discharge disposition or death between the two groups. In total, 18 patients (7.6%) died and 155 (65.7%) were discharged home.

Conclusion: Non-operative management of grade I-II splenic injuries with AE fails in 28% of patients. Hemodynamically stable patients with grade I-II splenic injuries with CB should be considered for immediate angioembolization.

TIMING IS EVERYTHING: IMPACT OF COMBINED LONG BONE FRACTURE AND MAJOR ARTERIAL INJURY ON OUTCOMES

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Invited Discussant: David Efron, MD

Introduction: Timing of extremity fracture fixation in patients with an associated major vascular injury remains controversial. Some favor temporary fracture fixation prior to definitive vascular repair to limit potential graft complications. Others advocate immediate revascularization to minimize ischemic time. The purpose of this study was to evaluate the timing of fracture fixation on outcomes in patients with concomitant long bone fracture and major arterial injury.

Methods: Patients with a combined long bone fracture and major arterial injury in the same extremity requiring operative repair over 11-years were identified and stratified by timing of fracture fixation. Vascular-related morbidity (rhabdomyolysis, AKI, graft failure, extremity amputation) and mortality were compared between patients who underwent fracture fixation prior to (PRE) or post-revascularization (POST).

Results: 104 patients were identified: 19 PRE and 85 POST. Both groups were similar with respect to age (28 vs 27, p>0.99), % male (89 vs 84, p=0.52), ISS (7 vs 10, p=0.073), admission base excess (-3.4 vs -4, p=0.57), 24-hour PRBCs (4 vs 8 units, p=0.35), and concomitant venous injury (37 vs 36%, p=0.98). The PRE group had fewer penetrating injuries (32 vs 60%, p=0.024) and a longer ischemic time (9 vs 5.8 hours, p=0.0002). Although there was no difference in mortality (0 vs 2%, p>0.99), there were more vascular-related complications in the PRE group (58 vs 32%, p=0.03): specifically, rhabdomyolysis (42 vs 19%, p=0.029), graft failure (26 vs 8%, p=0.026), and extremity amputation (37% vs 13%, p=0.013). Multivariable logistic regression identified fracture fixation pre-revascularization as the only independent predictor of graft failure (OR 4; 95%CI 1.1-14.3, p=0.03) and extremity amputation (OR 3.9; 95%CI 1.3-12.1, p=0.02).

Conclusions: Fracture fixation prior to revascularization contributes to increased vascular-related morbidity and was consistently identified as the only *modifiable* risk factor for both graft failure and extremity amputation in patients with a combined long bone fracture and major arterial injury. For these patients, delaying temporary or definitive fracture fixation until post-revascularization should be the preferred approach.

TIME TO OR FOR PATIENTS WITH ABDOMINAL GUNSHOT WOUNDS: A POTENTIAL PROCESS MEASURE TO ASSESS THE QUALITY OF TRAUMA CARE?

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Invited Discussant: Maria Jimenez, MD

Introduction: Abdominal gunshot wounds (GSW) require rapid assessment and operative intervention to reduce the risk of death and complications. We sought to determine if time to the OR might be an appropriate process measure for the assessment of the quality of trauma care. We assessed whether there were trauma centers that performed consistently well and whether this was associated with lower rates of adverse outcomes.

Methods: We evaluated time to OR for adult patients with an abdominal GSW and shock presenting to ACS TQIP centers from 2016-19. We calculated the 75th percentile time to the OR for each center and then characterized each center as an average, a slow outlier, or a fast outlier. We compared patient and facility characteristics across outlier status as well as risk adjusted outcomes using hierarchical multivariable logistic models.

Table 1: Hospital characteristics of fast, average, and slow outliers

	Fast outlier (n=844)	Average (n=1912)	Slow outlier (n=460)
75th percentile time to OR (minutes) *	33 (31)	45 (30)	63 (47)
GSW-shock case volume/yr*	5.9	5.3	5.4
Surgeon case volume/yr*	4.7	2.9	3.4
Transfusion ≥6units, n (%)*	378 (47)	912 (52)	237 (56)
Risk adjusted complications	1.07 (0.82-1.40)	Ref	0.92 (0.66-1.27)
Risk adjusted mortality	1.17 (0.86-1.59)	Ref	0.92 (0.62-1.35)

*p<0.01

Results: 2965 patients cared for in 363 centers met inclusion criteria. Mortality was 28%. There were 43 (12%) slow and 51 (14%) fast centers. ISS and ED vital signs were similar across centers. Fast hospitals had higher case volumes, more cases per surgeon, and were more likely to be level 1 centers. Patients cared for in these centers required less blood transfusion, with similar risk-adjusted rates of complications and mortality (Table 1).

Discussion: Time to OR for patients with GSWs and shock might be a useful process measure to evaluate rapid decision making and OR access. Trauma center and surgeon experience and a rapid surgical response associated with level 1 trauma center requirements might be contributory. Prompt interventions are associated with lower blood requirements yet similar rates of complications and mortality.

LONG-TERM FUNCTIONAL AND PATIENT REPORTED OUTCOMES AFTER ISOLATED RIB FRACTURES

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Invited Discussant: Raminder Nirula, MD, MPH

Introduction: Despite the ubiquity of rib fractures in patients with blunt chest trauma and their association with increased short-term morbidity and mortality, long-term outcomes for patients with this injury pattern are not well described.

Methods: The Functional Outcomes and Recovery after Trauma Emergencies (FORTE) project has established a multi-center prospective registry with 6 to 12-month follow up for trauma patients treated at participating centers. We combined the FORTE registry with a detailed retrospective chart review investigating detailed admission variables and injury characteristics. We included all trauma survivors with complete FORTE data and isolated chest trauma (AIS≤1 in all other regions) with rib fractures. Outcomes included HRQoL (SF-12), Trauma Quality of Life, PTSD (Breslau), return to work, chronic pain, and both inpatient and discharge pain control modalities.

Results: Our cohort comprised 301 patients with a mean age of 65 years, 61.5% were male, and 84% were white. 57/301 (20.2%) patients underwent tube thoracostomy and 27/301 (9.6%) required mechanical ventilation. Patients were prescribed a mean oral morphine equivalent of 238.4 (SD = 232.5) at discharge. Older age, higher number of rib fractures, and ICU admission were independently associated with higher odds of receiving regional anesthesia. Long-term functional limitations were observed in the majority of patients (Table).

Conclusions: Isolated rib fractures are a non-trivial trauma burden that often result in functional impairments and reduced quality of life even 6-12 months after injury.

Long-term outcomes	All patients (n=301)
New limitation in activity of daily living	75 (24.9%)
New physical limitation	148 (56.7%)
New exercise limitation	127 (51.2%)
Did not return to work*	35 (31.3%)
New chronic pain	123 (46.9%)
Daily use of analgesics	30 (23.3%)
Post-traumatic stress disorder	27 (9.7%)
Quality of life	
SF-12 physical health score, mean (SD)	43.3 (11.2)
SF-12 mental health score, mean (SD)	51.4 (10.7)

*N=112; cohort who were working prior to their injury.