DETERMINANTS OF LONG-TERM PHYSICAL AND MENTAL HEALTH OUTCOMES AFTER INTENSIVE CARE ADMISSION FOR TRAUMA SURVIVORS

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Invited Discussant: Libby Schroeder, MD,

Introduction: We sought to identify determinants of post-intensive care physical and mental health outcomes 6 to 12 months after in ury.

Methods: Adult trauma patients ISS ≥ 9 admitted to one of three Level-1 trauma centers were interviewed 6-12 months post-in ury to evaluate health-related quality of life (SF-12v2), chronic pain, new limitations for activities of daily living (ADLs), and screening for PTSD. Intensive care unit (ICU) survivors (≥ 3 days in the ICU) were compared to survivors who did not require ICU admission. Multivariable regression models were built to identify factors associated with poor outcomes among ICU survivors.

Results: 2,407 patients were followed 598 (25%) ICU and 1,809 (75%) non-ICU survivors . Mean age 52y, SD= 20.1 (ICU) vs. 60y, SD= 20.5 (non-ICU), p<0.001 and ISS 20, SD= 9.5 (ICU) vs. 12, SD= 4.4 (non-ICU), p<0.001 differed by study group. Median ICU stay was 5 days (IQR= 3-9). Among ICU survivors, 506 (85%) reported physical or mental health symptoms. Of them, 265 (52%) had physical symptoms only, 15 (3%) had mental symptoms only, and 226 (45%) had both physical and mental symptoms. In ad usted analyses, compared to non-ICU survivors, ICU survivors were more likely to have new limitations for ADLs (OR= 1.41; 95% CI= 1.10, 1.82), and worse SF-12 mental (mean Δ= -1.44; 95% CI= -2.79, -0.09) and physical component scores (mean Δ= -1.77; 95% CI= -3.09, -0.45). Female se   (OR= 1.76; 95% CI= 1.01, 3.08), Black race (OR= 2.32; 95% CI= 1.07, 5.02), polytrauma (OR= 2.06; 95% CI= 1.16, 3.67), ventilator use (OR= 2.68; 95% CI= 1.35, 5.33), history of psychiatric illness (OR= 1.83; 95% CI= 1.14, 2.98), and delirium during ICU stay (OR= 1.34; 95% CI= 1.07, 1.69) were associated with poor outcomes in the ICU group.

Conclusions: Physical impairment and mental health symptoms following ICU stay are highly prevalent among trauma survivors. Modifiable ICU specific factors such as early liberation from ventilator support and prevention of delirium are potential targets for intervention. Future studies should investigate the causes and mediators that influence the se   and race disparities observed to identify further modifiable factors.

HISTORIC RACISM AND CONTEMPORARY GUN VIOLENCE INCIDENCE IN ATLANTA, GA

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Invited Discussant: D Andrea Joseph

INTRODUCTION: The Home Owner's Loan Corporation (HOLC), created a practice known as redlining, effectively sequestering racial minorities in underdeveloped, economically disadvantaged neighborhoods throughout the US. The health effects associated with redlining are far reaching and include gun violence. The ob ective of this study is to e plore the geographic association between historic racism, resulting residential segregation and contemporary hot spots of gun violence in Atlanta, Georgia.

METHODS: Patient zip codes, socio-demographics, in ury characteristics, disposition and year of in ury were obtained from the registry of the only nationally verified Level 1 trauma center in Atlanta for firearm in uries between 2016 and 2021. Geospatial data were obtained by mapping 1938 HOLC neighborhoods to zip code tabulation area (TCA) crosswalk via Census data. ip codes were then assigned a HOLC GPA, calculated as the average HOLC grade for all CTAs in a zip code. We identified the risk of firearm in ury among acute trauma patients using multilevel logistic regression models.

RESULTS: There were 4,298 individuals in ured by guns, rifles, or other firearms during the study period. The ma ority were male (88.2%) and Black (84.7%), with a median age of 28y (IQR 22,38). The mortality rate was 14.8%. Adults in ured in zip codes with lower HOLC GPAs face a higher risk of firearm in uries (OR = 1.52; 95% CI: 1.11, 2.06; p=0.008). Home zip codes of firearm-in ured adults were not associated with HOLC GPAs.

DISCUSSION: Individuals in ured in places that were deemed by HOLC in the 1930s to have high lending risk face a higher rate of firearm-related in ury. Due to these policies, neighborhoods with a higher concentration of Black residents and working-class laborers suffered housing and economic disinvestment – factors that continue to inform where gun violence concentrates today. Given the histories of structural racism and violence in Atlanta, violence prevention interventions should prioritize a framework of anti-racism and health equity that removes un ust barriers to health and well-being for historically marginalized populations.

FIREARM INJURY SURVIVAL IS ONLY THE BEGINNING: THE IMPACT OF SOCIAL DETERMINANTS OF HEALTH ON UNPLANNED READMISSION AFTER INJURY

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Invited Discussant: Tanya Zakrison

Introduction: Firearm injuries remain a national crisis in the United States, particularly in minority populations who continue to be disproportionately impacted by firearm violence. Continued exposure to risk factors associated with firearm violence increases the likelihood of recidivism. However, risk factors leading to readmission after injury remain unclear. We hypothesized that social determinants of health have a major impact on unplanned readmission following assault-related firearm injury.

Methods: The 2016-2019 Nationwide Readmission Database of the Healthcare Cost and Utilization Project was used to identify hospital admissions with assault-related firearm injury. After adjusting for severity, comorbidity, and hospital, factors associated with 90-day unplanned readmissions were assessed.

Results: Over 4 years, 20,666 assault-related firearm injury admissions were identified that resulted in 2,033 injuries with subsequent 90-day unplanned readmission. Those with readmissions tended to be older (31.9 vs 30.3), had a drug or alcohol diagnosis at primary hospitalization (27.1% vs 24.1%), and had longer hospital stays at primary hospitalization (15.5 vs 8.1) [all $P<.05$]. Overall cost of the primary hospitalization was significantly higher than those without readmissions ($138,945 vs $255,209 [$P<0.001$]). The mortality rate in the primary hospitalization was 4.5%. Primary readmission diagnoses included: complications (29.6%), infection (14.5%), mental health (4.4%), trauma (15.6%), and chronic disease (30.6%). Over half of the patients readmitted with a trauma diagnosis were coded as new trauma encounters. 10.3% of readmission diagnoses included an additional 'initial' firearm injury diagnosis. Independent predictors of 90-day unplanned readmission were government insurance (aOR 1.21, $P=0.008$), lowest income quartile (aOR 1.23, $P=0.048$), living in a larger urban region (aOR 1.49, $P=0.01$), discharge to a hospital or with care (aOR 1.61, $P<0.001$), and discharge against medical advice (aOR 2.39, $P<0.001$).

Conclusions: Here we present the first data showing risk factors for unplanned readmission after assault-related firearm injury. Better understanding of this population can lead to improved outcomes, decreased readmissions, and decreased financial burden on hospitals and patients. A potential target for mitigating interventions is the use of hospital-based violence intervention programs in this population.

EARLY VERSUS DELAYED THORACIC ENDOVASCULAR AORTIC REPAIR FOR BLUNT THORACIC AORTIC INJURY: A PROPENSITY SCORE-MATCHED ANALYSIS

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Invited Discussant: Stephanie Berry, MD

Objectives: Following blunt thoracic aortic injury (BTAI), current guidelines recommend delayed thoracic endovascular aortic repair (TEVAR). However, this recommendation was based on small studies that did not focus on endovascular management. In this study, we examined the effect of TEVAR timing on BTAI outcomes using a nationwide database.

Methods: Patients undergoing TEVAR for BTAI in the TQIP between 2010-2019 were included. Transfer patients and patients with grade 4 aortic injury were excluded. Outcomes included in-hospital mortality and complications, and we assessed the proportion of delayed TEVAR use over time. A 1:1-propensity score-matched cohort was created based on time to repair (early: ≤24hrs vs. delayed: >24hrs). Matching was based on demographics, comorbidities, injury severity score (ISS), vital signs, aortic injury grade which was dichotomized based on reporting standards in TQIP (grade 1 vs. grade 2-3). We performed log binomial regression to assess outcomes in the matched sample.

Results: Overall, 2,101 patients were included, 1,562 (74%) patients underwent early TEVAR. Compared with patients who underwent delayed TEVAR, those who underwent early TEVAR had a higher injury burden (ISS>25; 80% vs. 74%), and higher aortic injury severity (grade 2-3: 32% vs. 18%). After matching, the final sample included 454 matched patients. Compared to early TEVAR, delayed TEVAR was associated with a lower risk of in-hospital mortality (RR:0.48; 95%CI[0.31-0.75], p<0.005). Additionally, patients who underwent delayed TEVAR had a higher risk of acute kidney injury (RR:1.8; 95%CI[1.1-3.1]; p=0.030), compared with early TEVAR. However, the delayed TEVAR cohort had a statistically significantly longer ICU LOS (7 vs. 10 days; p<0.001). Finally, there was a decrease in delayed TEVAR use over time (2010-2016: 27% vs. 2017-2019: 24%).

Conclusion: In this propensity score matched analysis, delayed TEVAR was associated with significantly lower mortality. However, since the guideline recommendation, the use of delayed TEVAR has decreased over time. Future studies should aim to optimize the window of intervention based on patient injury characteristics.

OPIOID EXPOSURE IN TRAUMA PATIENTS WITH A POSITIVE URINE DRUG SCREEN: A SUBGROUP ANALYSIS OF A RANDOMIZED CONTROLLED TRIAL

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Invited Discussant: Bethany Strong, MD

Introduction: The Multi-modal Analgesic Strategies for Trauma (MAST) trial was a randomized trial of two opioid-reducing multi-modal pain regimens (MMPR). We hypothesized that patients with a positive urine drug screen (+UDS) are at increased risk for higher opioid exposure and among +UDS patients, the MAST MMPR was associated with reduced opioid exposure.

Methods: The population was drawn from the MAST trial which randomized patients to the institutional MMPR or the MAST MMPR, the latter based on generic medications. Patients without a UDS on admission were excluded. Bayesian models were developed to compare opioid exposure (measured in morphine milligram equivalents [MMEs]) and pain scores between +UDS and -UDS patients. Next, +UDS patients were compared based on randomization to the institutional versus the MAST MMPR. Models were adjusted by age, injury severity score (ISS), and actual unit of admission from the emergency department (floor, IMU, and ICU).

Results: Of 1,012 included patients, 37.3% had a +UDS. +UDS patients were younger, male, had prior opioid use, and were smokers. There were no differences in ISS or surgical operations received. +UDS patients had higher MMEs/day (RR 1.3 [1.2-1.5], posterior probability (PP) >0.99), total MMEs (RR 1.3 [1.1-1.5], PP >0.99) and reported higher pain scores (difference 0.58 [0.32-0.84], PP >0.99). Among +UDS patients on each MMPRs there were no differences in demographics, ISS, or surgical operations received. +UDS randomized to the MAST MMPR had a high probability of decreased risk of MMEs/day (RR 0.78 [0.65-0.92], PP=0.91), total MMEs (RR 0.86 [0.69-1.07], PP>0.99), and receiving an opioid at discharge (OR 0.63 [0.40-0.99], PP=0.98).

Discussion: Patients with a +UDS had higher opioid exposure and experienced more pain despite no difference in ISS. In +UDS patients, the MAST MMPR was associated with decreased opioid exposure. Generic MMPRs are effective in opioid-minimization without detriment to pain control in high-risk patient populations.

ACHIEVING THE DAMAGE CONTROL RESUSCITATION GOALS DECREASES MORTALITY IN MASSIVELY TRANSFUSED TRAUMA PATIENTS

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Invited Discussant: Kazuhide Mazushima, MD

Background: After 15 years of Damage Control Resuscitation (DCR), with improved outcomes, studies still report high mortality rates for the massively transfused trauma patients. Our mature high-volume trauma service runs a continuous quality improvement program including updated resuscitation strategies. We hypothesized that in the era of DCR the formalization of a 24/7 attending trauma surgeon in 2013 would further improve our system's performance through more balanced transfusions and improved survival.

Methods: Retrospective analysis of all early massively transfused ($\geq$10 RBCs within 12 hours of admission) trauma patients over an 11-year period (2009-2019) at a high-volume Northern European Trauma Center was conducted. The cohort was divided in Period 1 (P1): January 2009-August 2013, and Period 2 (P2): September 2013-Desember 2019 for comparison of outcomes.

Results: A total of 141 patients were included, 81 in P1 and 60 in P2. Baseline characteristics were similar between the groups for ISS, Lactate, GCS, and base deficit. Patients in P2 received more units of plasma (16 units vs 12 units; p<0.01), resulting in a more balanced plasma:RBC ratio (1.00 vs 0.74; p<0.01), and platelets:RBC ratio (1.11 vs 0.92; p<0.01). All-cause mortality rates decreased from P1 to P2; at 6-hours (22% to 8%; p=0.03), at 24-hours (36% vs 13%; p < 0.01), and at 30-days (48% vs 30%, p=0.03), respectively. Simultaneously, hemorrhage related deaths decreased (28% vs 12%; p=0.01). A stepwise logistic regression model predicted an odds ratio of 0.27 (95% CI 0.08 to 0.93) for dying when admitted in P2.

Conclusions: An improvement in resuscitation strategies and a formalization of a 24/7 dedicated attending trauma surgeon coincides with a reduction in all-cause mortality and hemorrhage related deaths in massively transfused trauma patients at 6- and 24-hours, and 30-days.

DEVELOPING AN AI PREDICTION MODEL FOR TRAUMA-INDUCED ACUTE KIDNEY INJURY

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Invited Discussant: Brandon Bruns, MD

Introduction: Trauma-induced Acute Kidney Injury (TAKI) occurs in ~20% of trauma patients admitted to Intensive Care (ITU). Accurate prediction of which patients will develop TAKI requiring intervention such as renal replacement therapy (RRT) can ensure early resource allocation and treatment, minimizing mortality. We aimed to develop an artificial intelligence (AI) risk prediction model (TAKI-BN) for TAKI using information available at two time points: on first assessment in the emergency department (ED) and on admission to ITU.

Methods: Training and validation data was from the Activation of Coagulation and Inflammation in Trauma study, including adult trauma patients admitted to a UK Major Trauma Centre <2 hours since injury. Patients with length of stay ≤1 day or no serum creatinine measurement were excluded. The algorithm is a Bayesian Network (BN). BN structure was developed from literature and expert knowledge, to include known variables that influence TAKI risk and reflect known causal relations. Parameters were learned from data. Model outcome was risk of TAKI, classified as worst AKI state within first 3 days. KDIGO states 0, 1, 2&3 were classified as None, Mild, Severe.

10-fold cross-validation was undertaken and performance assessed through discrimination (Area under the receiver operator curve (AUROC)) and calibration (Slope and intercept) for binary outcome (None vs Mild/Severe), and accuracy for both binary and categorical outcomes.

Results: Dataset comprised 1234 patients with median age 36, 81% male, median Injury Severity Score 17, 20% penetrating mechanism, mortality 11%. Overall, 32% developed AKI within 3 days of admission, of which 68% were mild and 32% severe. Mortality was 7% and 33% respectively. Internal validation demonstrated excellent performance at ED time point (AUROC 0.93, calibration slope 1.034 and intercept -0.018, accuracy 0.87), as well as excellent at the ITU time point (AUROC 0.93, slope 1.020, intercept -0.005, accuracy 0.88).

Conclusions: An individual patient's risk of TAKI can be reliably predicted from information available at initial assessment as well as following resuscitation. This information can be used to allocate treatment and resources to those who need it most.

SURGEON COMPASSION MAY MITIGATE QUALITY OF LIFE DISPARITIES ASSOCIATED WITH HEALTH LITERACY

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Invited Discussant: Tasce Bongiovanni, MD

Introduction: Patients with health literacy disparities are less likely to comprehend hospital discharge instructions and less satisfied with physician communication. In this study, we sought to examine the interaction of health literacy, physician communication, and quality of life after hospital discharge among post-operative emergency surgery and trauma patients.

Methods: Emergency surgery and trauma patients were prospectively enrolled between December 2020 and December 2021 at an urban level 1 trauma center. Newest Vital Sign (NVS) instrument was used to measure health literacy (HL) during hospitalization. Following hospital discharge, patients were administered Revised Trauma Quality of Life (rTQOL) and Interpersonal Processes of Care (IPC) instruments. An adjusted regression model was used to determine associations among NVS, rTQOL, and IPC.

Results: 94 patients completed all instruments. HL was proficient (HIGH HL) in 59.6% and less than proficient (LOW HL) in 40.4%. HL was positively associated with rTQOL emotional well-being ($r = 0.212$, P=0.040). However, higher rating of surgeon compassion/respect on IPC moderated the relationship between HL and emotional well-being such that patients with LOW HL and positive perception of physician compassion/respect had similar emotional well-being as the HIGH HL group (P=0.042, Figure).

Conclusion: Favorable patient perception of surgeon compassion and respect was correlated with higher emotional well-being, independent of HL proficiency. Although the allocation of resources toward improving HL disparities remains warranted, improving patient perception of caregiver compassion during hospitalization may be a target of opportunity with respect to improving quality of life after hospital discharge.
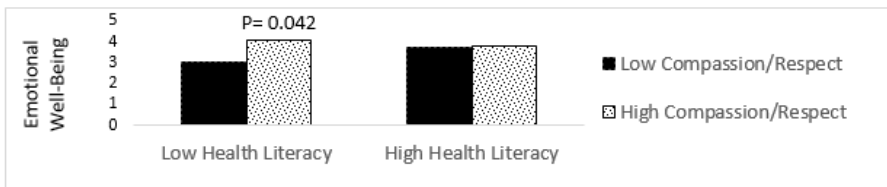
MESOTHELIAL CELL RESPONSE TO ACUTE APPENDICITIS OR SMALL BOWEL OBSTRUCTION REACTIVE ASCITES

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Invited Discussant: Todd Costantini, MD

Introduction: Abdominal adhesions may cause bowel obstruction. Trauma and peritoneal inflammation, e.g., acute appendicitis (AA), activate mesothelial cells (MCs) on the outermost layer of the peritoneum to form adhesions. Pathologic adhesions may arise if normal adhesion fibrinolysis is disrupted. Disruptive signaling molecules may originate from peritoneal reactive ascites (rA). Here, we describe the morphological response of human MCs treated with rA collected during appendectomy (appy) or adhesiolysis for small bowel obstruction (SBO). **Methods:** This is a prospective observational IRB-approved study at four level 1 trauma centers where peritoneal rA is collected prior to surgical intervention for non-perforated AA or SBO. MCs were subjected to 48h of neat rA stimulation. To date, 4 appy and 3 SBO rA samples met the criteria required for this cell analysis. Control MCs were treated with human serum (hs) or medium. Cellular responses were queried by light and fluorescent microscopy, Alcian Blue quantification of extracellular glycosaminoglycans (GAG), and MC proteomics with liquid chromatography mass spectrometry. **Results:** rA-treated MCs increased cell-to-cell interactions compared to controls (low interaction=1, processes between cells=2, dense thread-like fibers=3, mean score ± SD: controls 1.71 ± 0.46, rA-treated 2.31 ± 0.55, p < 0.05). rA-treated MCs observed with light microscopy were live-cell fluorescently stained, revealing either a dense cottony-like matrix or end-to-end cell connections. Select appy and SBO rA caused MCs to produce a GAG-positive gelatinous substance (GS) when compared with controls (mean optical density at 630nm ± SD: hs 0.0602 ± 0.01, appy 1.10 ± 0.24, SBO 0.83 ± 0.30, p<0.01). Proteomics analysis of the GS and associated MCs showed enrichment in innate immune and coagulation proteins compared to hs-treated MCs. **Conclusions:** MCs robustly respond to rA, and some rA samples drive the cells to produce a GAG-rich GS of unknown consequence. Investigation of the effects of GS production on cell-cell adhesion and the molecular basis of this phenomenon are ongoing. These data may support development of prevention and treatment strategies for pathophysiologic adhesions.

BIAS IN THE TRAUMA BAY: A MULTICENTER QUALITATIVE STUDY ON TEAM COMMUNICATION

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Invited Discussant: Mackenzie Cook, MD

Introduction: Team communication and bias in and out of the operating room has been shown to impact patient outcomes. Limited data exist regarding the impact of communication bias during trauma resuscitation and multidisciplinary team performance on patient outcomes. We sought to characterize bias in communication among healthcare clinicians during trauma resuscitations.

Methods: Participation from multidisciplinary trauma team members (emergency medicine and surgery faculty, residents, nurses, medical students, EMS personnel) was solicited from verified level 1 trauma centers. Comprehensive, semi-structured interviews were conducted and recorded for analysis; sample size was determined by saturation. Interviews were led by a team of doctorate communications experts. Central themes regarding bias were identified using Leximancer analytic software.

Results: Interviews with 28 team members (54% female, 82% white) from 5 geographically diverse Level 1 trauma centers were conducted. Over 14,000 words were analyzed. Statements regarding bias were analyzed and revealed consensus that multiple forms of communication bias are present in the trauma bay. The presence of bias is primarily related to gender, but was also influenced by race, experience, and occasionally the leader's age, weight, and height. The most commonly described targets of bias were females and non-white providers unfamiliar to the rest of the trauma team. Most common sources of bias were white male surgeons, female nurses, and non-hospital staff. Participants perceived bias being unconscious but affecting patient care.

Conclusion: Bias in the trauma bay is a barrier to effective team communication. Identification of common targets and sources of biases may lead to more effective communication and workflow in the trauma bay.

HYPOXICALLY STORED BLOOD IMPROVED RESUSCITATION FROM HEMORRHAGIC SHOCK AFTER TRAUMATIC BRAIN INJURY COMPARED TO CONVENTIONALLY STORED BLOOD.

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Invited Discussant: William Chiu, MD

Introduction: This study aims to investigate the effects of resuscitation with hypoxically stored red blood cells (hRBCs) from severe hemorrhagic shock (HS) after traumatic brain injury (TBI). Blood was collected into citrate phosphate double dextrose, leukodepleted, and stored at 4°C with additive solution 3 (AS3). The RBCs were made hypoxic using an O2 depletion system developed by Hemanext Corp. (Lexington, MA) before cold storage for 3 weeks. Rats were randomly divided into 3 experimental groups depending on the RBCs used for resuscitation, namely: fresh RBCs (fRBCs), hypoxically stored RBCs (hRBCs), and conventionally stored RBCs (cRBCs). Animals were anesthetized using isoflurane (5%), artery and vein catheterized, and placed on a stereotaxic frame for craniotomy. The dura mater was impacted using a 5 mm diameter tip at a velocity of 5 m/s with a dwell time of 200 ms. Then, severe HS was induced by withdrawing blood to maintain a mean arterial pressure (MAP) of 40 mmHg for 90 minutes. Resuscitation was provided via transfusion equivalent to 70% of the shed volume and animals were followed for 2 hours. At the end of the study, animals were euthanized, and blood and tissues were harvested for analysis of organ function and injury. Animals resuscitated with cRBCs presented lower MAP compared to hRBCs and fRBCs after resuscitation. To assess lung inflammation and neutrophil activity we evaluated CXCL-1 (chemokine ligand 1), and CD45+neutrophils. CXCL-1 and neutrophils levels were higher for the cRBCs compared to fRBCs and hRBCs. Hepatic injury was evaluated using classical markers of liver damage (aspartate transaminase-AST / alanine transaminase- ALT) and CXCL-1. The results showed that resuscitation with cRBC increased liver CXCL-1 and AST, with no effect on ALT compared to fRBC and hRBCs. Remarkably, hRBCs presented similar levels of AST and liver CXCL-1 compared to fRBCs. Markers of cardiac injury (tumor necrosis factor alpha -TNF-alpha, Interleukin 6- IL-6, and C-Reactive Protein- CRP) showed lower levels for resuscitation using hRBCs compared to cRBCs, and no difference from fRBCs. Resuscitation with hRBCs presented lower levels of cardiac monocyte chemoattractant protein-1 (MCP-1), and troponin compared to cRBCs. Moreover, atrial natriuretic peptide (ANP) levels were higher for cRBCs compared to fRBCs. cRBCs presented higher levels of serum IL-6 and CXCL-1 when compared to fRBCs. Although hRBCs had higher levels of IL-6 and CXCL-1 compared to fRBCs, these levels were lower in comparison to cRBCs. IL-10 was higher only in the cRBCs. Finally, in comparison to Sham and fRBCs, cRBCs showed a decrease in superoxide dismutase (SOD) and catalase, while T-bars (thiobarbituric acid reactive substances) showed an increase, suggesting an oxidative imbalance post-transfusion. However, resuscitation with hRBCs ameliorated this status, presenting a higher level of SOD and catalase when compared to cRBCs and similar to fRBCs. These results suggest that hRBCs for 3 weeks show no difference from fRBCs in resuscitating from TBI accompanied with severe HS. Furthermore, hRBCs decreased organ injury and ameliorated oxidative status when compared to cRBCs, suggesting that storing RBCs hypoxically is safer when compared to conventional methods. However, more studies are necessary to confirm the ability of hRBCs to restore oxygen delivery in different models.

THE GENDER GRADIENT IN ACUTE CARE SURGERY: PEAKS AND PLATEAUS

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Invited Discussant: Tanya Anand, MD

Introduction: In 2020, Foster et al reported on the female representation of the Trauma/Acute Care Surgery/Surgical Critical Care organizations. The AAST was identified as having the lowest proportion of female members with the highest proportion of female executive leadership. The purpose of this study was to further assess female participant contributions to the AAST organization by expanding on leadership roles, expert roles, committee interest, and presentation categories of interest.

Methods: Gender data was collected retrospectively from 2013 to 2021 digital programs. Presentations were categorized according to major topic of focus by two separate reviewers. Gender was assigned based on self-identification in demographic information, established relationships, or public sources by two separate reviewers. Expert roles included invited lecturers, panelists, moderators and discussants. Three groups were created: 2013-2015, 2016-2018, 2019-2021. ANOVA was performed to compare the effect of time on mean gender distribution. Post-hoc analysis utilized Tukey's HSD for multiple comparisons.

Results: Executive leadership in 2019 – 2021 was 35% female; 33% in 2016-2018; and 25% in 2013-2015 [p=.609]. Committee chairs in 2019-2021 were 40% female; 30% in 2016-2018; and 25% in 2013-2015 [p=.224]. Committee members were 33% female in 2019 – 2021; 24% in 2016-2018; and 22% in 2013-2015 [p<.001]. Expert roles for women in 2019 – 2021 was 39%; 20% in 2016-2018; and 18% in 2013-2015 [p<.001]. Presenters in 2019-2021 were 34% female; 37% in 2016-2018; and 31% in 2013-2015 [p =.330]. Gender distribution for presenters amongst acute care surgery topics was not significantly different.

Conclusion: While women may not have achieved complete parity, there are promising trends in almost all metrics. The AAST continues to see a rising trend in female senior roles. These roles are primarily at the discretion of the organization and thusly represent a conscious effort towards inclusion – aided by the creation of the DEI committee, formed in 2019. However, this trend has not been mirrored in more junior roles. This agrees with prior studies that senior roles continue to expand while junior roles have remained essentially unchanged. This further emphasizes that though women continue to advance in promotion in the organization through conscious efforts, further work is required to achieve parity in more junior roles. This can likely only be achieved by establishing an avenue to recruit more women into the organization and the field of Acute Care Surgery in general. It is of importance to note that information was obtained for gender without comment on race and ethnicity, and further studies are warranted on this topic to improve visibility in these populations as well.

REDEFINING TRAUMA DESERTS: NOVEL TECHNIQUE TO ACCURATELY MAP PREHOSPITAL TRANSPORT TIME

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Invited Discussant: Bradley Dennis, MD

Introduction: Prehospital transport time has been directly related to mortality for hemorrhaging trauma patients. "Trauma deserts" were previously defined as being outside of a five-mile radial distance of an urban trauma center. We postulated that the true "desert" should be based on transport time rather than transport distance.

Methods: Utilizing the Chicagoland area that was used to describe "trauma deserts," a sequential process to queries a commercial travel optimization product to map transport times over coordinates that covered the entire urban area at a particular time of day. This produces a heat map representing prehospital transport times. Travel times were then limited to 15 minutes to represent a temporal-based map of transport capabilities. This was repeated over high and low traffic times and for all centers across the city.

Results: We demonstrated that the temporal-based map for transport to a trauma center in an urban center differs significantly from the radial distance to the trauma center. We were further able to map variations in traffic patterns and thus transport times by time of day. The truly "closest" trauma center by time changed based on time of day and was not always the closest hospital by distance.

Conclusion: This novel technique of geomapping transport times can be used to create accurate trauma deserts in an urban setting with multiple trauma centers. Further this technique can be used to quantify the potential benefit or detriment of adding or removing firehouses or trauma centers.

Travel Time
Three Representative Level 1 Trauma Centers
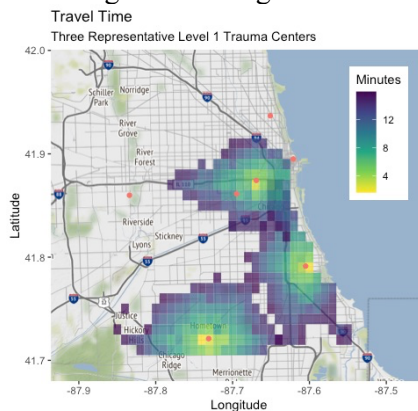
OUTCOMES OF SURGICAL VS NON-SURGICAL TREAMENT FOR MULTIPLE RIB FRACTURES: A US HOSPITAL DATABASE ANALYSIS

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Invited Discussant: Nikolay Bugaev, MD

OBJECTIVES: Treatment for multiple rib fractures (MRF) may include surgical rib fixation (SRF) or non-operative care. Recent meta-analyses have demonstrated that SRF results in faster recovery and lower long-term complication rates. Our study evaluated characteristics, treatments, and immediate postoperative outcomes of MRF patients with and without SRF.
METHODS: All patients with inpatient hospitalization with a diagnosis of MRF in the PREMIER hospital database from 10/01/2015 to 09/01/2020 were identified. Demographics, comorbidities (as per Elixhauser comorbidity index (ECI), injuries at index (categorized by first 2 digits of ICD-10 diagnosis code), abbreviated injury scale (AIS) and injury severity scores (ISS), and provider characteristics (hospitals size, urban vs. rural, teaching status) were determined for all patients. Patients were excluded from the cohort if they had a thorax AIS < 2 (low severity patient) or a Glasgow coma score < 8 (extreme high severity patient). Two cohorts were created based on the presence of SRF at index: the SRF and the non-SRF cohort. Patients were matched using direct matching on AIS thorax and thorax injuries, and propensity score matching (PSM, method: nearest neighbor, caliper = 0.2) on other demographic, comorbid, and injury diagnoses.
RESULTS: Before matching, 2,520 SRF and 183,957 non-SRF patients were identified. The SRF cohort was significantly more severely injured, with thorax AIS > 2 in 70.8% SRF (vs 21.9% for non-SRF), and ISS of 14.07 (standard deviation (SD): 8.80) for SRF vs 10.19 (SD: 7.56) for non-SRF. In the unmatched cohort, more SRF patients were discharged home (or to home health) vs non-SRF (home or home health discharge: 61.2% SRF vs 58.4% non-SRF, p = 0.005). After excluding patients with extreme injuries such as spinal cord fracture and head/neck crushing injuries, and matching the remaining cohorts, 2,340 patients were analyzed, 1,170 SRF and 1,170 non-SRF (average age: 61.6 (SD): 16.0); Elixhauser: 2.6 (SD: 2.1); ISS: 8.74 (SD: 3.9). Major thorax and lung injuries included pneumothorax (22.5%), lung contusion (26.1%), pleural effusion (14.1%). Key comorbidities included hypertension (42.9%) and chronic pulmonary disease (21.7%). Home or home health discharge was observed in 72.1% of

IMAGING THE INFLAMED GALLBLADDER, ULTRASOUND, CT OR MRI, AN AAST MULTICENTER STUDY

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Invited Discussant: David Blake, MD, MPH

Introduction: Patients with right upper quadrant pain are often imaged using multiple modalities with no established gold standard. Patients may undergo multiple studies based on clinician preference despite previous imaging. We hypothesized that a single imaging study would provide adequate information for diagnosis and management. **Methods:** The database from a multicenter study of patients with acute cholecystitis was queried for patients who underwent multiple imaging studies on admission. Common parameters were compared across studies including wall thickness (WT), common bile duct diameter (CBDD), pericholecystic fluid and signs of inflammation. Cutoff for above normal values were 3mm for WT and 6 mm for CBDD. Parameters were compared using chi-square tests and areas under the receiver-operating characteristic curves (AUC). **Results:** Of 861 patients with acute cholecystitis, 759 had ultrasounds, 353 had CT and 74 had MRIs. There was statistically significant agreement for all parameters between imaging studies. Although some were considered discordant by an arbitrary cutoff value, differences between wall thickness and bile duct diameters were small with nearly all <1mm (table). Large differences (>2mm) were rare (<5%) for WT and CBDD. Using CBDD to predict choledocholithiasis there was minimal difference between AUC for ultrasound (0.626) and CT (0.655). The binary parameter of pericholecystic fluid differed in less than one third of cases. **Conclusions:** Imaging studies in acute cholecystitis generate nearly equivalent results for all typically measured parameters. With current imaging technology repeating imaging studies to compare or confirm findings is unnecessary and should be discouraged.

	Concordant n (%)	Discordant n (%)
Gallstones		
US vs. MRI	54 (88.6)	7 (11.4)*
Gallbladder thickened wall		
US vs. CT	92 (65.3)	49 (34.8)*
Mean difference (95% CI)	-0.22 mm	(-1.02 mm - 0.58 mm)
Common bile duct dilated		
US vs. CT	50 (84.8)	9 (15.3)*
Mean difference (95% CI)	-0.27 mm	(-0.74 mm - 0.20 mm)
Inflammatory changes		
CT vs. MRI	31 (85.8)	6 (15.2)*
Pericholecystic fluid		
US vs. CT	182 (70.0)	78 (30.0)*
US vs. MRI	39 (63.9)	22 (36.1)*
CT vs. MRI	27 (73.0)	10 (27.0)*
Gallbladder wall air		
US vs. CT	257 (98.8)	3 (1.2)*
US vs. MRI	61 (100.0)	0 (0.0)*
CT vs. MRI	37 (100.0)	0 (0.0)*

US - ultrasound, CT - CT scan, MRI - magnetic resonance imaging, CI - confidence interval, *p <0.01 for agreement

THE CHICKEN OR THE EGG: CORRELATION OF LOW PLATELETS & POST-INJURY ACUTE RESPIRATORY DISTRESS SYNDROME

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Invited Discussant: Thomas Wertin, MD

Introduction: Pathophysiologic origins of post-injury Acute Respiratory Distress Syndrome (ARDS) remain elusive. Platelet transfusion has been proposed as a possible mechanism. The lung has recently been shown to be the key site of primary platelet biogenesis and sequestration. The interaction between initial thrombocytopenia, lung platelet production post-injury, and ARDS is undefined. This study investigates the correlation of platelet counts, ARDS risk, and platelet recovery in the first 7 days post-injury.

Methods: Secondary data analysis was performed of a prospective cohort of highest-level activations who were followed for 28 days. Demographics, injury characteristics, labs, and outcomes were collected. ARDS was defined prospectively using Berlin criteria including adjudicated radiographs. Correlation (Pearson's) between ISS, daily lowest platelet count, and ARDS was assessed. Logistic regression was performed.

Results: 2003 patients were enrolled with 10.3% (n=207) developing ARDS. ARDS patients had higher median age, lower GCS, higher ISS, more likely to be thrombocytopenic and hypotensive on presentation (Table). Overall median

	ARDS	No ARDS	p
	(n = 207)	(n = 1796)	
Age, median (IQR)	44 (28 to 59)	36 (26 to 53)	0.0003
Male sex, (%)	82.6%	81.6%	0.7763
Glasgow Coma Scale score, median (IQR)	3 (3 to 5)	13 (3 to 15)	<0.0001
Initial SBP <=90 mmHg	11.6%	6.2%	0.0065
Blunt Injury, %	85.0%	54.3%	<0.0001
Initial Platelet counts,			
Median (IQR), in thousands	166 (104 to 229)	232 (178 to 287)	0.3113
% with count < 150 in thousands	41.5%	14.2%	<0.0001
Injury severity score, median (IQR)	30 (25 to 41)	10 (1 to 25)	<0.0001(W)
% with score < 15	10.1%	62.4%	<0.0001(F)
% with 15 ≤score <25	12.1%	12.4%	
% with score >=25	77.8%	25.3%	
Logistic multiple regression	OR ARDS	95% CI	
Platelet count (every 10,000 increase)	0.936	(0.918-0.955)	
ISS (each 5 point increase)	1.357	(1.292-1.425)	

platelet count across the first 7 days was lower in the ARDS patients (p<0.0001). Platelet recovery as measured by total counts appeared to begin at day 7 with higher daily median counts compared with day 1-6 (p<0. 05), and no day 7 difference between groups (p=NS). Lower platelet count in the first 7 days and ISS were independent predictors of ARDS (Table).

Conclusion: ARDS risk persists in the first week and is correlated with persistently lower platelet counts. Sequestration and decreased primary lung platelet production may be factors in the persistent thrombocytopenia.

COAGULOPATHY AND POSTINJURY MULTIPLE ORGAN FAILURE: IDENTIFYING THE HIGHEST RISK PATIENTS THROUGH THROMBELASTOGRAPHY

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Invited Discussant: Kaushik Mukherjee, MD

Introduction: Postinjury multiple organ failure (MOF) is costly and associated with late death. Postinjury coagulopathy has been associated with MOF; however, the relationship between specific coagulation abnormalities and MOF is incompletely understood. We undertook this study to determine features of postinjury coagulopathy that would be associated with MOF.

Methods: We conducted a retrospective review of patients at high postinjury MOF risk. Patients were included if they underwent trauma activation, had ISS of ≥ 9, required ICU admission, and had an admission TEG. Patients were excluded for death within the first 48 hours of admission, preinjury coagulopathy, or preinjury anticoagulant therapy. Patients were divided into four groups (hypercoagulable, hypocoagulable, mixed, and normal coagulation) based on TEG measurements. The primary outcome was MOF, defined as SOFA score greater than five during hospitalization.

Results: 710 patients were assessed. The population was severely injured (mean ISS 26), had a mean age of 41, and were largely male (76%); the majority sustained blunt injury (75%). Groups were similar overall, with the hypercoagulable group having a greater proportion of females (32% vs. 14-24%, p=0.001) and the hypocoagulable group having a greater mortality rate (13% vs. 5-8%, p<0.001). The normal coagulation group had a lower crude rate of MOF relative to others (20% vs 30-34%, p=0.01). On multivariable logistic regression, admission creatinine (OR 1.72, 1.04-2.84, p=0.03) and ISS (OR 1.05, 1.03-1.07, p<0.001) were independently associated with increased odds of MOF, while normal coagulation status was associated with decreased odds of MOF (OR 0.57, 0.35-0.92, p=0.02).

Conclusion: Among a high-risk group of trauma patients, normal admission TEG was associated with a reduction in odds of MOF. The relationship between coagulation and inflammatory responses likely explains this finding; additional work to understand and modulate inflammatory responses beyond correction of coagulopathy is needed to reduce the burden of postinjury MOF.

ENHANCING UTILITY OF INTERFACILITY TRAUMA TRIAGE GUIDELINES USING MACHINE LEARNING: DEVELOPMENT OF THE GERIATRIC INTERFACILITY TRAUMA TRIAGE SCORE (GITTS)

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Invited Discussant: Alison Smith, MD, PhD

Background: Prehospital under-triage of injured older adults to tertiary trauma centers (TTCs) has been demonstrated by many studies. In predominantly rural regions, a majority (>70% in OK) of trauma patients are initially transported to non-tertiary trauma centers (NTCs). Current inter-facility triage guidelines identify risk markers for secondary triage, but this is an exhaustive list of more than 25 unweighted indications that do not allow for individual risk prediction. We sought to develop a transfer risk score that may simplify identification of injured older adults requiring transfer to TTCs and decrease under-triage.

Methods: This was a retrospective prognostic study of injured older adults >=55 years initially transported to an NTC from the scene of injury and subsequently transferred for definitive care elsewhere. The study utilized data reported to the Oklahoma State Trauma Registry between 2009 and 2019. The outcome of interest was either mortality or serious injury (ISS >=16) requiring a life-saving or operative intervention at the receiving facility. The prognostic model for risk scoring was developed and internally validated (bootstrap) using data for patients who were transferred to a TTC and was further validated using data for patients transferred to NTCs (n=4310). To reduce the number of candidate variables and assess potential interactions between predictors, variables *recorded at the initial facility* were screened for importance using random forests/boosted trees/classification trees, bivariate comparisons and a careful review of current interfacility triage guidelines.

Results: Of the 5913 injured older adults initially transported to an NTC before subsequent transfer to a TTC, 32.7% (1696) had the outcome of interest at the TTC. The final prognostic model (AUC, 75%; 95% CI: 74-76%) included the following predictors (weighted score contribution in parentheses): airway intervention (11), traffic-related femur fracture (6), spinal cord injury (5), ED GCS <=13 (5), hemodynamic support(4), polytrauma (3), head/face injury (3), shock index > 0.9(3), pre-existing coagulopathic disorder (3), prehospital EMS transport (2), RR<=10 or RR>=24 (3), pre-existing cardiac disease (2), thorax injury (2), internal organ injury (1), pelvic fracture (3), male gender (2), and traffic-related injury (1). Bias-corrected and validation AUCs were 74% and 72% respectively. A risk score of 7 yields a sensitivity of 81% and specificity of 50%. A risk score of 5 has > 94% sensitivity but leads to significant over-triage (specificity of 25%).

Conclusion: Identification of high-risk injured older adults requiring transfer to tertiary trauma centers could be improved by use of a risk score in addition to clinician assessment. Our study is the first to develop a risk stratification tool for injured older adults requiring transfer to a higher level of care.

AN ASSESSMENT OF THE SAFETY, HEMOSTATIC EFFICACY, AND CLINICAL IMPACT OF LOW-TITER GROUP O WHOLE BLOOD IN CHILDREN AND ADOLESCENTS

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Jason Brill, MD; Konstantinos Boukas, MD; Charles Cox, MD; Charles E.
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Invited Discussant: Romeo Ignacio, MD

Background: Low-titer group O whole blood (LTOWB) use has been associated with improved survival and less blood transfusions in adult trauma patients. Its use in pediatric trauma has been shown to be safe when using leukoreduced, LTOWB with anti-A, anti-B antibody titers of <1:50. A recent TQIP analysis noted that WB may decrease overall blood transfusion requirements in this patient population. We set out to evaluate the safety, hemostatic potential, and impact on pediatric outcomes at a center using non-leukoreduced, LTOWB with anti-A, anti-B antibody titers of <1:200.
Methods: Patients less than 18 years old, who received emergency-release, uncrossed matched blood, and presented to our trauma center 11/17-4/21 were included. Patients were divided into those receiving any LTOWB and those receiving only RBC and or plasma (COMP). Primary outcome was safety profile, with secondary outcomes evaluating hemostatic efficacy and clinical outcomes. Univariate and multivariate modeling was performed using STATA 12.1, with significance was set at $p<0.05$.
Results: During the study period, 164 patients arrived to our center and received emergency release blood products. Of these, 73 received at least one unit of LTOWB. The LTOWB group were younger (14 vs 13 yr), more likely to be male (87 vs 49%), and to have sustained penetrating trauma (44 vs 23%); all $p<0.05$. Given their field physiology, LTOWB patients received more blood than their COMP counterparts prior to arrival (Table). Serial hemolysis panels (K+, bilirubin, LDH, haptoglobin) obtained at 3-hrs, 24-hrs, and 48-hrs were similar between groups; all $p>0.05$. There was no difference in survival by univariate analysis, but there was a trend towards improved survival in the LTOWB group (OR 2.7, 95% C.I. 0.88-7.81 $p=0.080$), controlling for male sex, chest AIS, scene physiology, and lactate.
Conclusion: Non-leukoreduced, LTOWB in anti-A/anti-B antibody titers of <1:200 appear safe in children and adolescents. While patients receiving LTOWB had more evidence of shock, higher torso injury severity, and received more prehospital blood products, there may be a mortality benefit with whole blood. Larger, multi-center studies are needed.

MORTALITY AFTER MASSIVE TRANSFUSION: TEACHING HOSPITAL STATUS, NOT TRAUMA CENTER DESIGNATION, IS ASSOCIATED WITH IMPROVED SURVIVAL

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Invited Discussant: Mark Hemmila, MD

BACKGROUND: Previous studies have shown improved survival for patients treated at American College of Surgeons (ACS) verified level I trauma centers compared to level II, level III, and undesignated centers. This mortality difference is more pronounced in severely injured patients. As massive transfusion (MT) is associated with high mortality, we hypothesize that patients receiving MT will have lower mortality at level I/II trauma centers compared to level III or undesignated trauma centers.
METHODS: All patients ≥16 years of age with ISS >15 who underwent MT, defined as >10 units of packed red blood cells in the first 4 hours after arrival, in the 2019 Trauma Quality Improvement Project (TQIP) database were eligible. Patients with severe head injury (AIS Head ≥3), pre-hospital cardiac arrest, and interhospital transfers were excluded. Logistic regression models were used to assess the effects of trauma center designation and hospital teaching status on the adjusted odds of 3-hour, 6-hour, and 24-hour mortality.
RESULTS: 1,959 patients received MT [81.0% male, median ISS 27 (21-36)], 76.3% were admitted to level I/II centers, and 23.7% were admitted to level III or undesignated centers. Overall mortality was 42%; 16% patients died in 3 hours, 25% in 6 hours and 32% in 24 hours. Trauma center designation was not an independent predictor of mortality at any timepoint. However, non-teaching hospitals were associated with increased 6-hour (OR 1.77, 95% CI 1.22-2.57) and 24-hour (OR 1.60, 95% CI 1.12-2.30) mortality compared to teaching hospitals, controlling for sex, age, heart rate, ISS, injury mechanism, and trauma center designation.
CONCLUSIONS: Severely injured patients requiring MT experience significantly lower mortality at teaching hospitals compared to non-teaching hospitals, independently of trauma center designation. These findings may be partially explained by the rapid proliferation of non-teaching level I/II trauma centers across the country.

SETTLING THE DEBATE REGARDING OPTIMAL TIMING OF FRACTURE FIXATION FOR POLYTRAUMA TBI PATIENTS: A TQIP ANALYSIS

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Invited Discussant: Haytham Kaafarani, MD

Introduction: Initial care after traumatic brain injury (TBI) aims to minimize secondary insults by reducing exposures to physiologic stressors. Early fixation of femur fractures is associated with improved outcomes, however the optimal timing of definitive repair in patients with TBI remains controversial. We hypothesize that among polytrauma patients with moderate and severe TBI, early repair will be associated with increased risk of in-hospital mortality as compared to delayed intervention.

Methods: Adult patients with TBI that underwent definitive femur fracture repair within 2 weeks of admission were identified from the 2017-2019 American College of Surgeons Trauma Improvement Quality Program Participant Use Files. Operative timing was categorized as (1) < 24 hours, (2) 24-95 hours, or (3) ≥ 96 hours. Primary outcome of interest was in-hospital mortality, and secondary outcome was morbidity. Multivariate logistic regression modeling was used to adjust for potential confounders. Sensitivity analysis employed three strategies for regression modeling: complete case analysis, forward stepwise analysis, and multiple imputation with chained equations.

Results: 11,231 patients with TBI had definitive femur fixation within 2 weeks of admission. Operative timing was < 24 hours for 6385 (56.9%), 24 - 95 hours for 3943 (35.1%), and ≥ 96 hours for 903 (8.0%). Patient demographics and injury patterns differed significantly by operative timing and TBI severity. A trend towards higher mortality was seen with delayed fixation for mild TBI. Among patients with severe TBI delayed repair ≥ 96 hours was associated with a significantly reduced risk of in-hospital mortality (adjusted OR [aOR] 0.29, 95% confidence interval [CI] 0.13, 0.66; Figure 1) and increased morbidity (aOR 2.35, 95% CI 1.59, 3.46).

Conclusion: Early definitive femur fixation should not be delayed for mild TBI patients but is associated with increased risk of in-hospital mortality among patients with greater TBI severity.

A MAJORITY OF FAILURES-TO-RESCUE IN HOSPITALIZED TRAUMA PATIENTS WOULD BE AVOIDED WITH FULL SUPPORTIVE CARE

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Invited Discussant: Anupamaa Seshadri, MD

Background: Failure-to-rescue (FTR, defined as hospital death after adverse events) is increasingly being used as a discriminator of trauma center quality. The extent to which withdrawal/withholding of life-sustaining therapies (WOLST) decisions might contribute to FTR has not been previously examined. Our study sought to determine whether hospitalized trauma patients who forego life-sustaining therapies to treat hospital complications would have survived had they received full supportive care.

Methods: The 2017-2018 Trauma Quality Improvement Program (TQIP) database was used to identify patients who sustained one or more adverse events after being hospitalized for survivable injury (Injury Severity Score < 75). Patients in whom life-sustaining therapy was withdrawn or withheld (WOLST group) were propensity-matched with patients receiving full supportive care (FSC group) for demographics, comorbid conditions, injury severity, and the occurrence of specific adverse hospital events.

Results: 39,548 patients [34,963 (88.4%) FSC and 4,585 (11.6%) WOLST] were included for analysis. FTR occurred in 6,371 (16.1%) of patients. Propensity-matching techniques produced a cohort of 4,525 WOLST patients who were well-matched with an FSC counterpart. 3,481 FTR deaths (54.6% of all FTR deaths) occurred in WOLST patients whose propensity-matched FSC counterpart survived hospitalization.

Conclusions: Our study predicts that a majority of FTR deaths in trauma centers occur in patients who would have survived hospitalization had they received full supportive care, and that FTR may be driven more by patients' goals of care than by hospital quality. The contribution of WOLST decisions to FTR for trauma and other surgical disciplines merits further investigation.

TAKING CARE OF THE BLOCK: ASSOCIATES BETWEEN AREA DEPRIVATION INDEX AND OUTCOMES IN TRAUMA PATIENTS

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Invited Discussant: Rochelle Dicker, MD

BACKGROUND: Disparities between racial groups in outcomes and delivery of care in both trauma and non-trauma patients have been well documented. This study sought to further analyze these disparities by not only looking at differences between racial groups, but also discrepancies based on place of residence utilizing the state-level Area Deprivation Index
(ADI). ADI is a freely available measure of neighborhood socioeconomic disadvantage including access to educational institutions, internet access, health systems, not-for-profit organizations, and government agencies. A state-level ADI ranking of 1 represents the area of least deprivation within a state, while a ranking of 10 represents an area with the most deprivation. Our hypothesis was that worse outcomes would be seen in patients living within higher ADI areas.

METHODS: The National Trauma Registry of the American College of Surgeons at our level 1 trauma center was queried from January 2016 to December 2020. Inclusion criteria were trauma patients aged 18 years or older cared for at a level 1 trauma center with a primary residence in North Carolina. Federal Information Processing Standard (FIPS) codes were determined and used to assign their associated ADI decile, which were then categorized according to ADI rank (1-3, 4-6, 7-10). Generalized linear models (Logit and Poisson) were used to evaluate the association of ADI with risks of complications. Odds ratio (OR), relative risk (RR) and their associated 95% confidence intervals (CIs) are provided as measures of strength of association and precision, respectively. Results are adjusted for age, sex, and race.

RESULTS: 8,854 patients were included in the analysis. Of these, 14.2% were in ADI ranking 1-3, 24.8% in ADI ranking 4-6 and 61.1% in ADI ranking 7-10. Patients in the ADI rank group 7-10 were more likely to be male, minority, and younger (all p<0.0001). There was no difference in injury severity score (ISS) between ADI rank groups (p=0.769). Patients living in areas with higher ADI rankings were significantly more likely to present following violent trauma, such as gunshot wounds, stabbings, and assaults as well as vehicular trauma. Patients from lower ADI areas were more likely to have injuries related to falls, burns, bicycles, and animals. An ADI of 7-10 was associated with a statistically significant increased risk of developing ventilator associated pneumonia (VAP) compared to ADI of 1-6 (OR=2.375, 95% CI=1.162-4.854; p=0.018). Patients in the ADI rank 7-10 group are at increased risk of developing acute kidney injury (AKI) (OR=1.918, 95% CI=0.955-3.853;
p=0.067) as well as dying in the hospital (OR=1.260, 95% CI=0.999-1.590; p=0.051), although results did not reach statistical significance. Patients in the ADI 7-10 group as well as minorities had significant increase in hospital length of stay (RR=1.068 vs ADI 1-6, 95% CI=1.021-1.117; p=0.004 and RR=1.169 vs White, 95% CI=1.120-1.221; p<0.0001 respectively).

CONCLUSION: This study identifies the profound impact that poverty and other socioeconomic factors have on the mechanisms and outcomes in trauma patients. These trends are maintained despite similar ISS suggesting that impoverished patients suffer from a unique disadvantage. These differences may be related to a host of factors, alone or in combination, ranging from lack of primary care to lack of broadband access or undiagnosed medical conditions on admission. Further study is warranted to identify the community specific factors that most impact outcome. Identifying these factors may help trauma system better focus their outreach in areas that have the greatest need and margin for improvement.

THE COST OF LIVER DISEASE: THE CIRRHOSIS OUTCOMES SCORE IN TRAUMA STUDY

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Invited Discussant: Marie Crandall, MD, MPH

Background: Cirrhosis in trauma patients is an indicator of a poor prognosis, but current trauma injury grading systems do not take into account liver dysfunction as a risk factor. Our objective was to construct a simple clinical mortality prediction model in cirrhotic trauma patients: Cirrhosis Outcomes Score in Trauma (COST).

Methods: Trauma patients with pre-existing cirrhosis or liver dysfunction who were admitted to our ACS Level I trauma center between 2013 and 2019 were reviewed. Patients with liver dysfunction secondary to traumatic injury were excluded. Demographics as well as ISS, MELD, complications, and mortality were evaluated. COST was defined as the sum of age, ISS, and MELD. Univariate and multivariate analysis was used to determine independent predictors of mortality. The C-statistic was calculated to assess the ability of COST to predict mortality.

Results: A total of 109 patients were analyzed of which the majority were males (68%) who suffered blunt trauma (94.5%). Mortality at 30-days, 90-days, and 1year was 17%, 21%, and 33%, respectively. COST was associated with inpatient, 30-, and 90-day mortality on regression analysis and the C-statistic for COST predicting inpatient, 30-day, and 90-day mortality was 0.863, 0.869, and 0.891, respectively. COST > 110 has a 100% positive predictive value of death at 90 days.

Conclusion: There is not currently a readily available tool to assess trauma outcomes in cirrhotic patients. COST is highly predictive of mortality in cirrhotic trauma patients. It is easy to calculate real time in the clinical setting and may be useful in optimizing goals of care discussions. Further prospective studies to validate this prediction model are required prior to clinical use.

EFFECT OF TRANEXAMIC ACID ON ENDOTHELIAL VON WILLE-BRAND FACTOR/ADAMTS-13 RESPONSE TO IN VITRO SHOCK CONDITIONS

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Wayne State University
Invited Discussant: Lucy Kornblith, MD

Introduction: Traumatic/hemorrhagic shock (T/HS), sepsis and other inflammatory processes lead to endothelial activation and a loss of the endothelial glycocalyx. Von Willebrand Factor (vWF) is an acute phase reactant that is released from endothelial cells and megakaryocytes. Stimulated but not basal vWF leads to significant formation of ultralarge multimers (ULVWF) and thrombotic complications. ULVWF is cleaved by ADAMTS-13; alterations in ULVWF/ADAMTS-13 ratio may contribute to trauma induced coagulopathy (TIC). Salutary effects of tranexamic acid (TXA) on TIC have been described. These effects appear apart from antifibrinolytic actions of TXA. We hypothesized that TXA would mitigate the effects of shock conditions on endothelial vWF/ADAMTS-13 release and activity. This was studied in endothelial cells in vitro.

Methods: Human umbilical vein endothelial cell monolayers (HUVEC) established under flow conditions were then subjected to hypoxia/reoxygenation (HR; 1% oxygen) and epinephrine (epi) or control conditions. TXA was added after 90 minutes of perfusion. Tissue plasminogen activator (tPA) activity and plasminogen activator inhibitor 1 (PAI-1) activity were assayed at timed intervals as were vWF antigen and ADAMTS-13 activity. Western blot analysis was performed for vWF characterization from perfusion media.

Results: Mean ± SD, N = 4 for each group.

	tPA (pg/ml)		vWF (µg/ml)		ADAMTS-13 (pg/ml)	
	1hr.	6hr.	1hr. 6hr.		1hr.	6hr.
HUVEC control	4.4 ± 0.9	5.5 ± 1.4	8.4 ± 1.1	8.8 ± 0.5	736.5 ± 25	742.2 ± 21
HUVEC + HR + epi	380.5 ± 34*	374.8 ± 42*	26.8 ± 3.1*	25.8 ± 2.6*	202.5 ± 10*	221.5 ± 13*
HUVEC + HR + epi + TXA (20 µM)	11.6 ± 1.8*#	25.6 ± 1.4*#&	15.4 ± 1.2*#	15.8 ± 1.4*#	478.6 ± 12*#	469.8 ± 10*#
HUVEC + HR + epi + TXA (150 µM)	5.8 ± 1.3#	11.2 ± 2.5*#&	10.8 ± 0.8#	11.5 ± 1.2*#	551.3 ± 13*#	532.5 ± 18*#

*$p<0.05$ vs. HUVEC control, #$p<0.05$ vs. HUVEC + HR + epi, &$p<0.05$ vs. same group 1hr. PAI-1 activity decreased significantly following HR + epi exposure and was partially reversed by TXA administration. Western blot analysis revealed that vWF ultra large forms were predominant following HR + epi exposure. TXA lead to significant reductions in ULVWF consistent with the findings with ADAMTS-13 activity.

Conclusion: TXA ameliorated profibrinolytic and vWF/ADAMTS-13 effects of endothelial HR and epi exposure. This may be another mechanism whereby administration of TXA early following T/HS may mitigate microvascular perfusion abnormalities and subsequent organ failure. The resultant effects on platelet adhesion and aggregation require further study.

TRANEXAMIC ACID REGULATES PYRUVATE KINASE M2

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Introduction: Tranexamic acid (TXA) is widely used as antifibrinolytic agent in hemorrhagic trauma and cardiac surgery patients. However, the beneficial effects of TXA exceed the simple suppression of blood loss and includes the ability to decrease inflammation and edema. Our previous findings demonstrated that TXA enhances mitochondrial respiration, increases the size of mitochondria, and suppresses mitophagy. Using the method of Drug affinity Responsive Stability
(DARTS), we have recently found that TXA binds Pyruvate Kinase M2 (PKM2), a glycolytic enzyme responsible for production of pyruvate, a major fuel of mitochondrial respiration. We also demonstrated that TXA increases the activity of PKM2. Interestingly, PKM2 is known to increase mitochondrial biogenesis and stimulate angiogenesis. PKM2 is present in the cells as a metabolically active cytoplasmic homotetramer and a homodimer, which localizes in the nuclei and plays a role of transcriptional regulator enhancing the expression of proflammatory genes. In this study, we assessed the effects of TXA on oligomerization and nuclear localization of PKM2.

Methods: Human Umbilical Endothelial Cells (HUVEC) in full growth medium (EGM, Lonza) were pre-incubated for 3 days in presence or absence of 100 g/ml TXA. To study the effect of TXA on PKM2 oligomerization, HUVEC were collected by scraping, lysed in Laemmlie buffer, and the proteins were then resolved by PAAG electrophoresis in buffers with or without SDS. Then, immunoblotting with anti-PKM2 rabbit antibodies (Cell Signaling) was used to detect the monomers and oligomers of PKM2. To study the effect of TXA on PKM2 nuclear localization, cells pre-incubated with or without TXA were collected by scraping and fractionated using the QProteome kit (Qiagen). The nuclear and cytoskeletal fractions were then resolved by electrophoresis and immunoblotted with anti-PKM2 antibodies.

Results: TXA did not change the total amount of PKM2 in HUVEC as judged by the amount of PKM2 monomer detected after electrophoresis in SDS+ buffer (Figure1A). Electrophoresis in the buffer without SDS showed that without TXA PKM2 was predominantly present in a homodimer form and with TXA almost exclusively PKM2 tetramers were detected. (Figure 1A). Cell fractionation also showed that TXA decreased the presence of PKM2 in the nuclear and cytoskeletal fractions
(Figure 1B).

Conclusions: TXA stimulates the formation of metabolically active PKM2 tetramers and decreases the dimerization-related localization of PKM2 in the nuclei, where it plays a pro-inflammatory role (Figure 1C). We propose that the beneficial effects of TXA on PKM2 can result in the enhancement of energy metabolism and suppresses inflammation. The combination of PKM2-dependent effects of TXA and its well-known anti-fibrinolytic activity dependent on the suppression of plasmin production could explain its extensive beneficial effects in hemorrhagic trauma patients.