Scientific Session I - Raymond H. Alexander, MD Resident Paper Competition

Paper #1
January 12, 2022
8:30 am

DON'T FORGET THE PLATELETS: BALANCED TRANSFUSION AND THE INDEPENDENT IMPACT OF RBC/PLT RATIO ON MORTALITY IN MASSIVELY TRANSFUSED TRAUMA PATIENTS

Ander Dorken Gallastegi, MD, Leon Naar, MD, Apostolos Gaitandis, MD, Anthony Gebran, MD, Charlie Nederpelt, BSc, Jonathan Parks, MD*, John Hwabejire, MD, MPH, Jason Fawley, MD*, April E. Mendoza, MD, MPH*, Noelle Saillant, MD*, Peter J. Fagenholz, MD, George Velmahos, MD, PhD, MSEd, Haytham Kaafarani, MD, MPH*
Massachusetts General Hospital

Presenter: Ander Dorken Gallastegi, MD

Discussant: Jordan Liliestein, MD, UCSF-Fresno

Objectives: Balanced blood component administration during massive transfusion (MT) is standard of care. Most literature focuses on the impact of red blood cell (RBC)/fresh frozen plasma (FFP) ratio while the value of balanced RBC/platelet (PLT) administration is less established. The aim of this study was to evaluate and quantify the independent impact of RBC/PLT on 24-hr mortality in trauma patients receiving MT.

Methods: Using the 2010-18 ACS-TQIP database, adult patients who received MT (≥10 units of RBC/24-hr) and ≥1 unit of RBC, FFP and PLT within 4-hr of arrival were included. To mitigate survival bias, only patients with steady RBC/PLT and RBC/FFP ratios between 4- and 24-hr were analyzed. Balanced FFP or PLT transfusions were defined as having RBC/PLT and RBC/FFP of ≤2, respectively. Multivariable regression analysis was used to compare the independent relationship between RBC/FFP, RBC/PLT, balanced transfusion and 24-hour mortality.

Results: A total of 7,520 MT patients were included; only 5.5% of patients had a balanced PLT transfusion compared to 82.6% of patients with a balanced FFP transfusion (Figure 1; $p<0.001$). Both RBC/PLT and RBC/FFP independently predicted 24-hr mortality (OR: 1.11 [1.10–1.13], $p<0.001$; OR: 1.06 [1.02–1.11] $p=0.004$, respectively). Patients with both FFP and PLT balanced transfusion had the lowest adjusted risk for 24-hr mortality, followed by those with unbalanced FFP (OR: 1.94 [1.47–2.56]), unbalanced PLT (OR: 2.19 [1.21–3.95]) and finally unbalanced FFP and PLT transfusions (OR: 3.02 [2.25–4.06]) (Figure 2).

Conclusions: Trauma patients receiving MT significantly more often have unbalanced PLT rather than unbalanced FFP transfusion. The impact of unbalanced PLT transfusion on 24-hr mortality is independent and potentially more pronounced than unbalanced FFP transfusion, warranting serious system-level efforts for improvement.

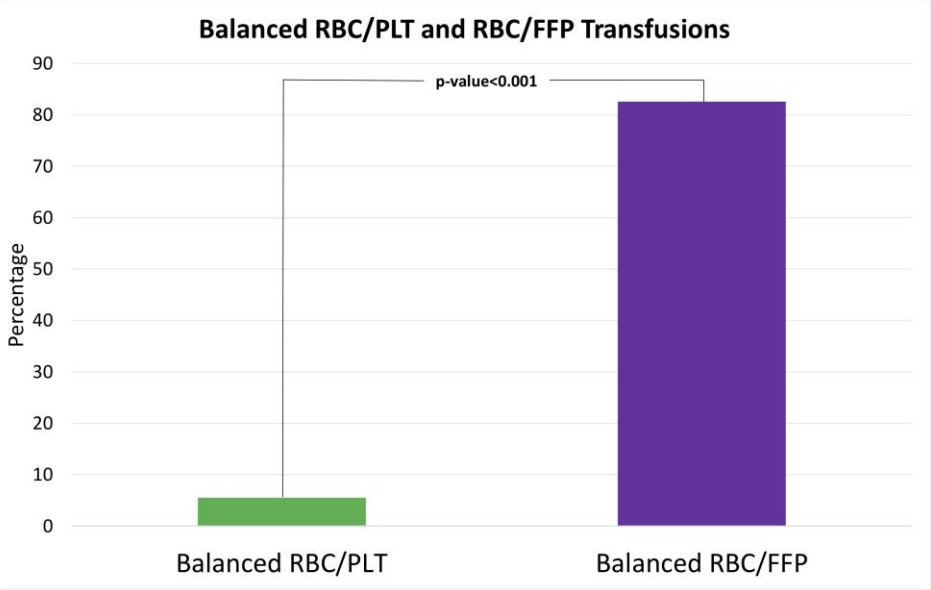

Figure 1. Balanced RBC/PLT and RBC/FFP administration during massive transfusion in ACS-TQIP participating trauma centers

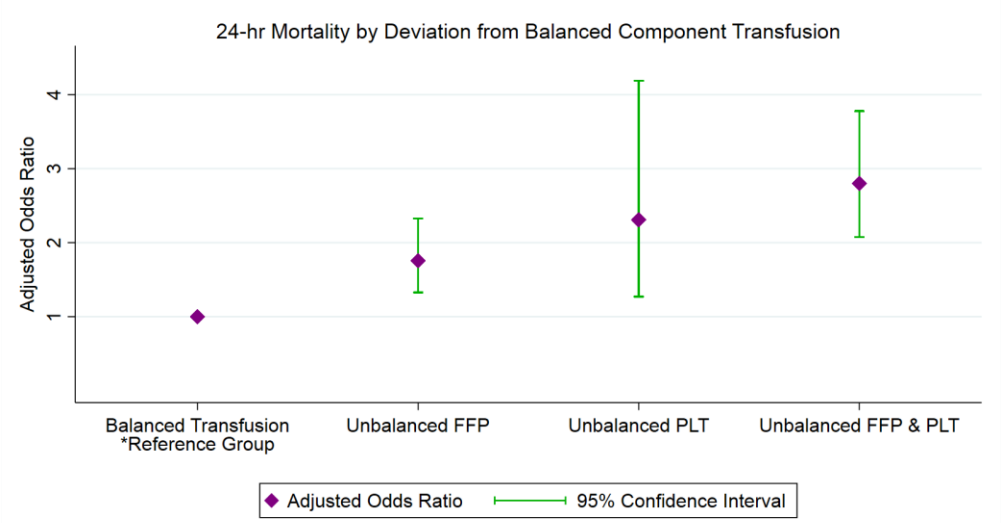

Figure 2. Patients who received balanced component transfusion (RBC/FFP≤2 and RBC/PLT≤2, Reference Group) had the lowest risk for 24-hour mortality followed in order of increasing risk by patients who received unbalanced FFP (RBC/FFP>2 and RBC/PLT≤2), unbalanced PLT (RBC/FFP≤2 and RBC/PLT>2) and unbalanced FFP and PLT transfusion (RBC/FFP>2 and RBC/PLT>2)

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Paper #2
January 12, 2022
8:45 am

PLASMA RESUSCITATION IMPROVES AND RESTORES INTESTINAL MICROCIRCULATORY PHYSIOLOGY FOLLOWING HEMORRHAGIC SHOCK

Jessica Schucht, MD, PhD, Brian G. Harbrecht, MD*, Logan Bond, MD,
Paul Matheson, PhD, Jason W. Smith, MD, PhD, MBA, FACS*
University of Louisville

Presenter: Jessica Schucht, MD, PhD

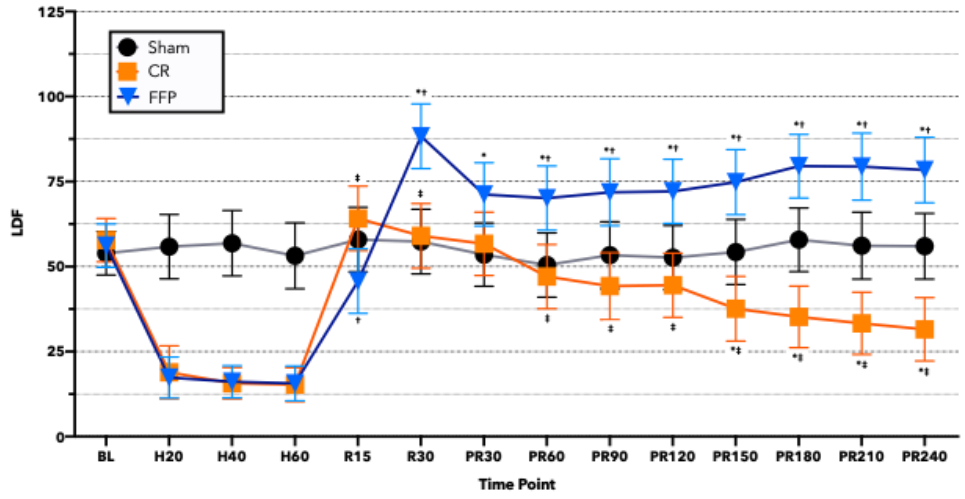
Discussant: Jennifer Leonard, MD, PhD, Washington University School of Medicine

Objectives: We previously demonstrated that resuscitation with fresh frozen plasma (FFP), decreases enterocyte damage, preserves the endothelial glycocalyx and decreases intestinal barrier breakdown following hemorrhagic shock (HS). This experiment sought to examine the effects resuscitation on the intestinal microcirculation and endothelial function.

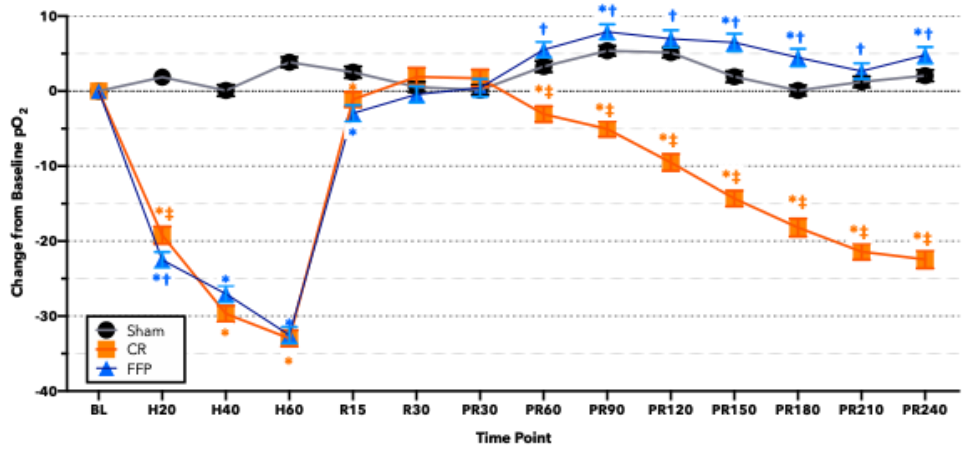
Methods: Male Sprague-Dawley rats were randomized to three groups (n=8): Sham, HS (40% MAP, 60min) + CR (shed blood+2 volumes saline), HS+FFP (shed blood+ eq.vol. FFP). MAP, HR, ileal perfusion (laser doppler flow, LDF), pO_2 and pCO_2 levels were measured with microelectrodes placed on the surface of the ileum. Values were recorded at baseline, throughout hemorrhagic shock, resuscitation and for 4 hours following resuscitation. Following the post-resuscitation period, Ileum was washed first washed with in situ with Krebs solution (no glucose, 37.0°, pH=7.40). Endothelial responsiveness to vasoactive mediators and functional vasodilatory capabilities were evaluated through measurement of LDF following the application of topical acetylcholine (10^{-5}M, endothelial-dependent vasodilation) and nitroprusside(10^{-4}M, endothelial independent vasodilation via NO donation), respectively.

Results: Initial resuscitation restored ileal perfusion and visceral arteriole pO_2 and pCO_2 in both groups. Post resuscitation, perfusion, pO_2 and pCO_2 were maintained in the FFP group, but not in the CR group. Although endothelial dilatory capabilities remained intact in both groups, responsiveness to the vasoactive mediator acetylcholine was preserved relative to sham in the FFP group, but not in the CR group ($p<0.05$).

Conclusions: FFP based resuscitation helps restore intestinal perfusion following resuscitation, improves oxygenation and decreases CO_2 at the microcirculatory level and preserves endothelial responsiveness to vasodilatory mediators following hemorrhagic shock.



Results of Laser Doppler Flow measurements at baseline, HS (H), RES (R), and post-RES (PR). Values are mean±95%CI; ***** p<0.05 vs. Sham, **†** p<0.05 vs. CR, **‡** p<0.05 vs. FFP



Change from baseline arteriole pO_2 measurements at each time point, HS (H), RES (R), and post-RES (PR). Values are mean±95%CI; ***** p<0.05 vs. Sham, **†** p<0.05 vs. CR, **‡** p<0.05 vs. FFP

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Paper #3
January 12, 2022
9:00 am

FIBRINOGEN SUPPLEMENTATION FOR TRAUMA PATIENTS: SHOULD YOU CHOOSE FIBRINOGEN CONCENTRATE OVER CRYOPRECIPITATE?

Omar Obaid, MD, Michael Ditillo, DO, FACS*, Raul Reina, MD, Lourdes Castanon, MD*,
Molly J. Douglas, MD*, Letitia Bible, MD*, Tanya Anand, MD, MPH*,
Adam C Nelson, MD*, Bellal Joseph, MD, FACS*
The University of Arizona

Presenter: Omar Obaid, MD

Discussant: Justin Dvorak, MD, MetroHealth Medical Center

Objectives: Trauma-induced coagulopathy is frequently associated with hypofibrinogenemia. Cryoprecipitate (Cryo), and fibrinogen concentrate (FC) are both potential means of fibrinogen supplementation. The aim of this study was to compare the outcomes of traumatic hemorrhagic patients who received fibrinogen supplementation using FC versus Cryo.

Methods: We performed a 2-year (2016-2017) retrospective cohort analysis of the American College of Surgeons (ACS) Trauma Quality Improvement Program database. All adult trauma patients (≥18years) who received FC or Cryo as an adjunct to resuscitation were included. Patients with bleeding disorders, chronic liver disease, and those on preinjury anticoagulants were excluded. Patients were stratified into those who received FC, and those who received Cryo. Propensity score matching (1:2) was performed. Outcome measures were transfusion requirements, major complications, hospital and ICU lengths of stay (LOS), and mortality.

Results: A matched cohort of 255 patients who received fibrinogen supplementation (85 in FC, 170 in Cryo) was analyzed. Overall, the mean age was 41±19 years, 74% were male, 74% were white and median ISS was 26 [22-30]. Compared to the Cryo group, the FC group required less units of packed red blood cells (pRBC), fresh frozen plasma (FFP), and platelets, and had shorter in-hospital and ICU LOS. There were no significant differences between the two groups in terms of major in-hospital complications and mortality (**Table**).

Conclusions: Fibrinogen supplementation in the form of FC for the traumatic hemorrhagic patient is associated with improved outcomes and reduced transfusion requirements as compared to Cryo. Further studies are required to evaluate the optimal method of fibrinogen supplementation in the resuscitation of trauma patients.

Table 1. Outcomes of Patients

Outcomes	FC (n=85)	Cryo (n=170)	*p*-Value
24-hours Transfusion Requirements			
pRBC, median [IQR]	4 [3-9]	8 [6-14]	**0.01**
FFP, median [IQR]	3 [1-6]	6 [4-14]	**0.01**
Platelets, median [IQR]	1 [0-2]	2 [1-4]	**0.01**
In-Hospital Complications, n (%)			
Deep Venous Thrombosis	3 (4)	9 (5)	0.75
Pulmonary Embolism	4 (5)	6 (4)	0.74
Myocardial Infarction	0 (0)	1 (1)	1.00
Cerebrovascular Accident	1 (1)	6 (4)	0.43
In-hospital LOS, days, median [IQR]	6 [1-16]	9 [2-23]	**0.04**
ICU LOS, days, median [IQR]	4 [1-9]	5 [2-12]	**0.02**
Mortality, n (%)	37 (43)	72 (42)	0.85

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Paper #4
January 12, 2022
9:15 am

PERSISTENT BLUNTING OF NEUTROPHIL MOBILIZATION TO THE BLOOD-BRAIN BARRIER BY BETABLOCKADE WEEKS AFTER TBI - AN IN VIVO STUDY.

Alfonso Lopez, MD, Mohamed Alaaeldin Elsaadani, MD,
Christina Jacovides, MD*, Anastasia Georges, BA, Hailong Song, MBBS, PhD,
Lewis J. Kaplan, MD, FACS, FCCM, FCCP*, Monisha A. Kumar, MD,
Douglas Smith, MD, Jose L. Pascual, MD, PhD, FRCS(C), FACS, FCCM*
Department of Surgery, Perelman School of Medicine, University of Pennsylvania

Presenter: Alfonso Lopez, MD

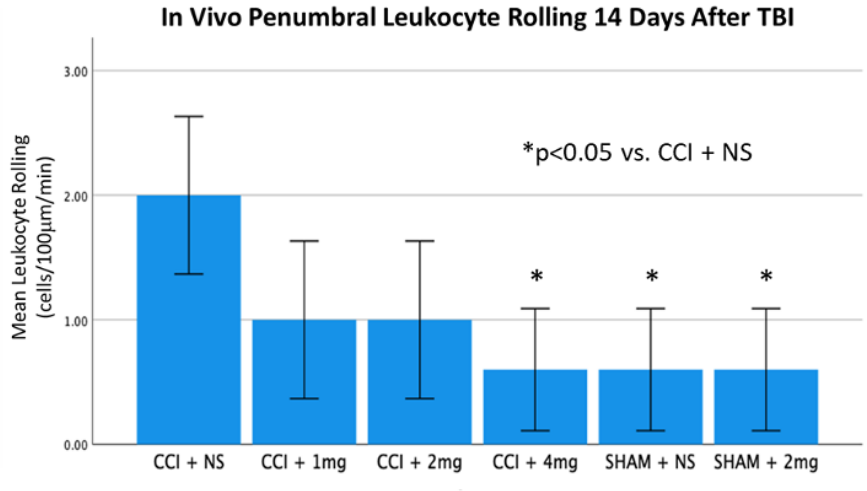
Discussant: Tatiana Cardenas, MD, MS, Dell Medical School UT Austin/ Dell Seton Medical Ctr

Objectives: Beta-blockers (BB) after traumatic brain injury (TBI) accelerate recovery of learning and memory two weeks after injury. Separately, recent reports have shown that BBs also inhibit leukocyte (LEU) mobilization to the penumbral blood-brain barrier (BBB) 48 hours post-injury. It is unclear whether these cellular effects persist weeks post-injury to explain this pervasive cognitive improvement. We hypothesized that BB after TBI inhibit BBB endothelial-LEU interactions and microvascular permeability 2 weeks after injury.

Methods: Thirty CD1 male mice were randomized to severe TBI (controlled cortical impact, CCI: 6 m/sec velocity, 1mm depth, 3mm diameter) or sham craniotomy (SHAM) followed with twice daily intraperitoneal injection of saline or propranolol (1, 2, or 4mg/kg) for 14 days. On post-injury day 14, *in-vivo* pial intravital microscopy visualized live endothelial-LEU interactions and BBB microvascular fluorescent albumin leakage. Differences were assessed by the Kruskal-Wallis test ($p < 0.05$).

Results: LEU adhesion as defined by standard criteria was completely absent in all recordings in both injured and uninjured animals. LEU rolling was greatest in CCI+NS animals (Figure). Propranolol reduced post-CCI LEU rolling, but only 4mg/kg significantly reduced LEU rolling to sham levels ($p=0.028$). *In-vivo* BBB albumin leakage was not impacted by injury or by treatment after 14 days.

Conclusions: LEU rolling was influenced by BB therapy 14 days after TBI; however, neither LEU adhesion nor microvascular permeability was impacted. This data suggest that certain penumbral neuroinflammatory cellular effects of BB therapy in TBI persist up to two weeks after injury and may explain the pervasive neurological improvement in learning and memory post-TBI. Understanding these mechanisms can help identify or develop therapeutics targeting specific events to enhance post-TBI recovery.



CCI: Controlled cortical Impact

NS: normal saline (placebo)

1, 2, 4mg: 1, 2, 4mg/kg propanolol BID x 14 days

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Paper #5
January 12, 2022
9:30 am

EFFECTS OF ANTI-FIBRINOLYTIC THERAPY ON SYSTEMIC AND NEUROINFLAMMATION AFTER TRAUMATIC BRAIN INJURY

Taylor Wallen, MD*, Kathleen E Singer, MD, Jackie Youngs, BS, Lisa England, RVT, Rebecca Schuster, MS, Michael Goodman, MD*
University of Cincinnati

Presenter: Taylor Wallen, MD

Discussant: Jeremy H. Levin, MD, IU Health Methodist Hospital/Indiana Univ School of Medicine

Objectives: Post-injury administration of anti-fibrinolytic medications including tranexamic acid (TXA), may reduce overall head injury-related mortality. Whether these medications have the potential to ameliorate post-TBI inflammatory response is unknown. The goal of this study was to investigate the role of current anti-fibrinolytic medications on both systemic and neuroinflammation post TBI.

Methods: An established murine weight drop model was utilized to induce a moderate TBI. Mice were then administered 1mg/kg TXA, 10mg/kg TXA, 100mg/kg TXA, 400mg/kg Amicar, 100 KIU/kg aprotonin, or equivalent volume of normal saline (NS) 10 minutes after recovery. Mice were euthanized at 1, 6, or 24 hours and serum and cerebral tissue were analyzed for neuron-specific enolase (NSE) as well as inflammatory cytokines IL-6, TNF-α, and MCP-1, via ELISA. Hippocampal histology was evaluated at 30 days for assessment of phosphorylated tau (p-tau) accumulation.

Results: One hour post-TBI, mice given TXA displayed decreased cerebral cytokine concentrations of IL-6, TNF-α, and MCP-1 compared to the TBI+NS group (A). However, serum concentrations of IL-6 and TNF-α were significantly elevated from 1 to 24 hours in TBI+TXA groups compared to TBI+NS (B). The concentration of p-tau was significantly decreased in a dose dependent manor in TBI+TXA groups compared to TBI+ NS (C). By contrast, Amicar administration increased cerebral cytokine levels of IL-6, TNF-α, and MCP-1 from 1 to 24 hours (A) but did not impact serum cytokine concentrations (B), aprotonin was neither beneficial nor harmful after TBI.

Conclusions: TXA administration may provide acute neuro-inflammatory protection in a dose-dependent manner. Amicar administration may be detrimental after TBI with increased neuroinflammation and minimal systemic inflammatory effects. These data suggest that TXA may provide the most beneficial inflammatory modulation after TBI.

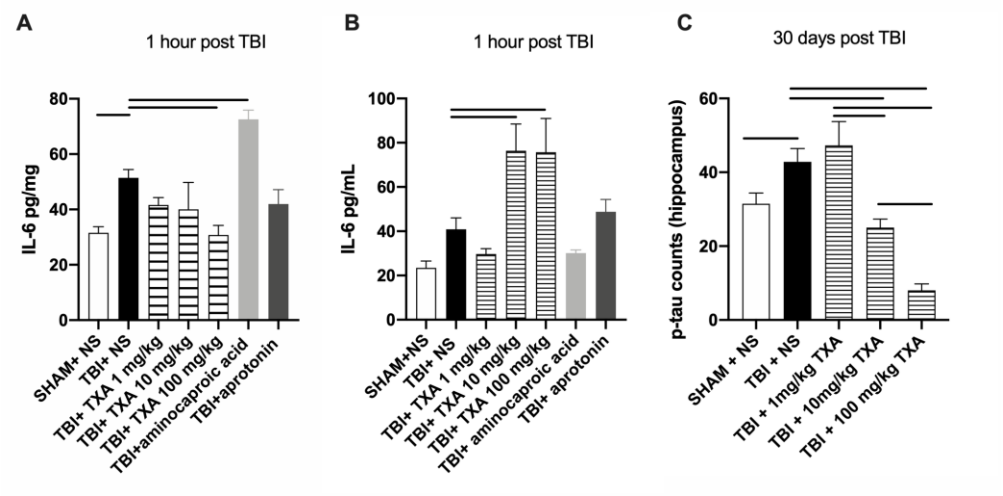

Figure: Anti-fibrinolytic therapy administration differs systemic and neuro-inflammatory profiles 1 hour post traumatic brain injury**.** A**.** IL-6 cerebral concentration pg/mg protein **B**. IL-6 serum concentration pg/mL **C.** 30-day p-tau counts. Line indicates $p<0.05$ between indicated groups.

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Paper #6
January 12, 2022
9:45 am

WHOLE BLOOD RESUSCITATION IN TRAUMA REGULATES CALCIUM HOMEOSTASIS AND MINIMIZES SEVERE HYPOCALCEMIA SEEN WITH COMPONENT THERAPY

Chad Hall, MD*, Cameron Colbert, BS, Elizabeth Dewey, MS, Martin A. Schreiber, MD, FACS*
Oregon Health and Science University

Presenter: Chad Hall, MD

Discussant: Tanya Anand, MD, MPH

Objectives: Blood component resuscitation is associated with severe hypocalcemia (SH, iCal <0.9) that contributes to coagulopathy and death in trauma patients. The impact of SH in whole blood (WB) resuscitation is unknown. We hypothesized that calcium homeostasis is maintained and mortality improved in patients who only receive WB.

Methods: Prospectively collected data were reviewed on all adult trauma patients who received WB from July 2018-December 2020. Variables included transfusions, ionized calcium levels and calcium replacement. Patients were characterized by blood products received: WB or WB+components. Groups were compared with respect to rates of SH, correction of SH, 24-hour and 30-day mortality.

Results: Out of 335 trauma patients who received whole blood, 223 met inclusion criteria. 103 (46%) received WB only, median 2 units (range 1-21). SH occurred in 9 WB patients (4%) compared to 33 WB+component patients (14.8%) (p=0.0002). SH was associated with more MTP activations (83% vs 16%, p<0.0001) and total transfusions (median 11 units vs 3 units, p<0.0001). SH was not associated with increased ISS (median 25 vs 23, p=0.23). SH was identified within 66±86 minutes of arrival and was strongly associated with mortality at 24 hours (38.1% vs 8.8%, p<0.0001) and 30 days (66.7% vs 20%, p<0.0001). WB patients received less calcium replacement (median 0 mg vs. 2,000 mg, p<0.0001). Failure to correct hypocalcemia was associated with higher 24-hour mortality (Figure 1, 70.6% vs 16.0%, p<0.0001). Median time to death in SH patients that failed to correct was 7.5 hours after admission (p=0.0003).

Conclusions: SH rarely occurs in WB only resuscitations. WB+component resuscitation is associated with a significant increase in SH, contributing to increased mortality. Aggressive calcium supplementation should be prioritized if component therapy is utilized in hemorrhaging trauma patients.

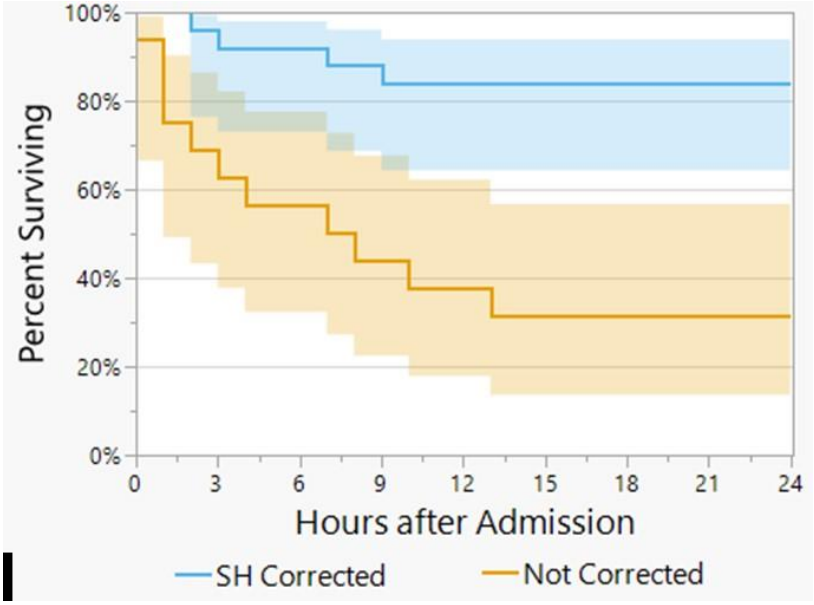

Figure 1: Survival is decreased in severe hypocalcemic patients who fail to correct hypocalcemia. Shaded areas represent the range of the 95% Confidence Interval around the estimated survival curves.

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Paper #7
January 12, 2022
10:30 am

BEYOND PAIN AND DISABILITY: THE LASTING EFFECTS OF TRAUMA ON LIFE AFTER INJURY

Justin Hatchimonji, MD, MBE*, Elinore J Kaufman, MD, MSHP*, Deborah Babalola, Katelyn Candido, Kristen Chreiman, MSN, Sunny Jackson, MSN, Patrick M. Reilly, MD*, Mark J. Seamon, MD, FACS*
University of Pennsylvania

Presenter: Justin Hatchimonji, MD, MBE

Discussant: Anne Stey, MD, MSc, Northwestern Memorial Hospital

Objectives: The impact of traumatic injury likely extends beyond direct physical consequences and lasts well beyond the acute injury phase. Data collection is sparse after hospital discharge, however. We hypothesized that sequelae of injury would last at least 6 months and sought to prospectively determine patient reported physical, emotional, and social outcomes during this post-injury period.

Methods: We surveyed patients admitted to our Level I trauma center (7/2019-5/2021) regarding baseline functioning and quality of life after injury, using the PROMIS-29 instrument, a primary care PTSD screen (PC-PTSD-5), and questions on substance use, employment, and living situation. Patients were re-surveyed at 6 months. PROMIS-29 scores are reported as t-scores compared to the U.S. population. Differences between groups were analyzed using chi square, signed-rank, and t-tests, with paired tests used for changes over time.

Results: 618 patients completed the baseline, 129 of whom completed 6-month follow-up. Those completing the 6 month survey were similar ages (43.1±18.1 vs 44.2±18.8 years, p=0.53), mechanism (24.8% vs 27.2% shot or stabbed, p=0.70), and severities (median ISS 9 vs 9) as those who only completed the baseline. 49.2% reported being hospitalized for an injury previously. Patients reported decreases in ability to participate in social roles and activities (mean t-score 51.5 vs 55.2, p=0.014) and increases in anxiety (53.6 vs 50.5, p=0.017) and depression (50.8 vs 48.8, p=0.043) (Figure 1). 28.1% screened positive for PTSD at 6 months. Employment decreased at 6 months, with 67.7% reporting being “occasionally” employed or unemployed at 6 months, vs 45.2% pre-injury (p<0.001) (Figure 2).

Conclusions: The effects of injury extend beyond pain and disability, impacting several realms of life for at least 6 months following trauma. These data support the development of screening and intervention protocols for post-injury patients.

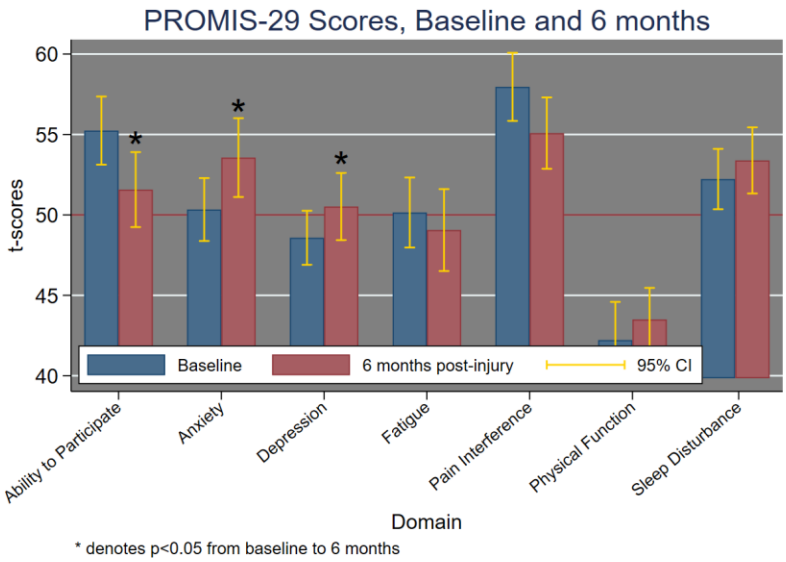

Figure 1. PROMIS-29 t-scores.

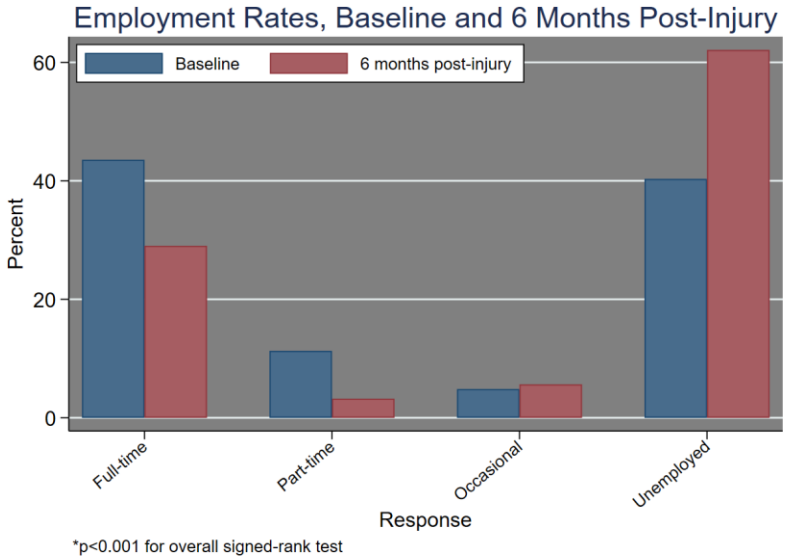

Figure 2. Pre- and post-injury employment status.

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Paper #8
January 12, 2022
10:45 am

A POPULATION-BASED ANALYSIS OF TRAUMA ACCESS: DO NEW TRAUMA CENTERS PROVIDE NEEDED OR REDUNDANT ACCESS?

Alexandra C. Ferre, MD*, Jacqueline Curtis, PhD, James A Flippin, MD*,
Jeffrey A. Claridge, MD, MS, FACS*, Esther S. Tseng, MD FACS*,
Laura Brown, MD, PhD*, Vanessa P. Ho, MD, MPH, FACS*
MetroHealth Medical Center

Presenter: Alexandra C. Ferre, MD

Discussant: John W. Scott, MD, MPH, University of Michigan

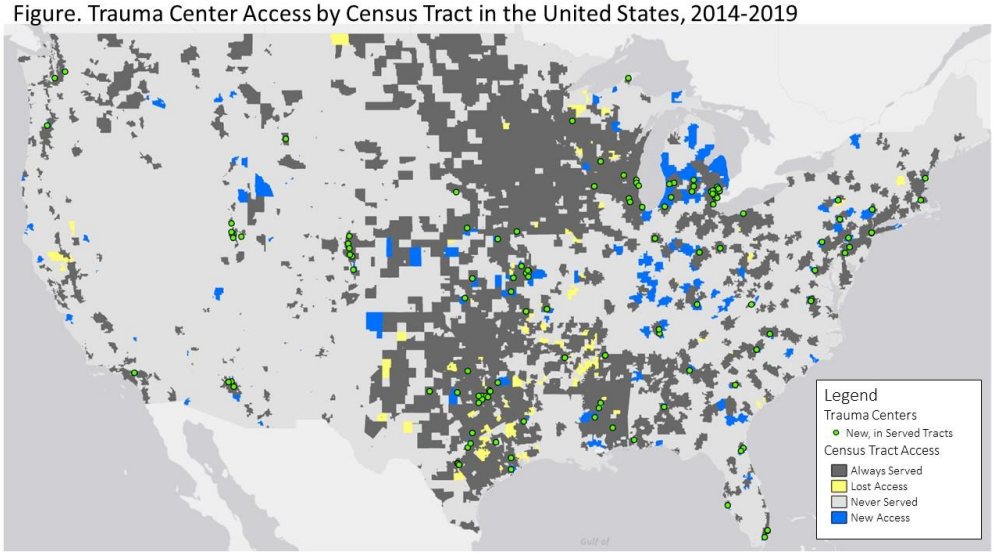
Objectives: Our prior research has demonstrated that increasing the number of trauma centers (TC) in a state does not reliably improve state-level injury-related mortality. We hypothesized that many new TC would serve populations already served by existing TC, rather than in “trauma deserts.” We also hypothesized that new TC would also be less likely to serve economically disadvantaged populations.

Methods: All state-designated adult TC registered with the American Trauma Society in 2014 and 2019 were mapped using ArcGIS Pro. TC were grouped as Level 1-2 (Lev12) or level 3-5 (Lev345). We also obtained census tract-level data (73,666 tracts), including population counts and % of the population below the federal poverty threshold. Thirty-minute drive-time areas were created around each TC. Census tracts were considered “served” if their geographic centers were located within a 30-minute drive-time area to any trauma center. Data were analyzed at the census tract-level.

Results: 2140 TC were identified in 2019, representing an overall net increase of 256 TC. 82% of new TC were designated Level 3-5. Nationwide, coverage increased from 75.3% of tracts served in 2014 to 78.1% in 2019, representing an increased coverage from 76.0% to 79.4% of the population (Figure). New TC served 17,532 tracts, of which 87.3% were already served. New Lev12 TC served 9,100 tracts, of which 91.2% were already served; New Lev345 TC served 15,728 tracts, of which 85.9% were already served. Of 2,204 newly served tracts, those served by Lev345 TC had higher mean % poverty compared with those served by Lev12 TC (15.7% vs 13.2% poverty, $p<0.05$).

Conclusions: Overall, access to trauma care has been improving in the United States. However, the vast majority of new TC are opened in locations with pre-existing access to trauma care. Nationwide, Level 3, 4, and 5 TC have been responsible for expanding access to underserved populations.

Figure. Trauma Center Access by Census Tract in the United States, 2014-2019



Scientific Session II - Raymond H. Alexander, MD Resident Paper Competition

Paper #9
January 12, 2022
11:00 am

ULTRASOUND SAFELY REPLACES CHEST RADIOGRAPH AFTER TUBE THORACOSTOMY REMOVAL IN TRAUMA PATIENTS

M. Victoria P. Miles, EMT-P, MD*, Elizabeth Crowder, BS, Lauren Favors, MD, Blake Behrman, MD, John Woody Major, MD, Lani Gao, PhD, Vicente A. Mejia, MD*
University of Tennessee-Chattanooga

Presenter: M. Victoria P. Miles, EMT-P, MD

Discussant: Sarah Lombardo, MD, MSc, University of Utah

Objectives: A chest radiograph (CXR) is routinely obtained in patients following tube thoracostomy (CT) removal to assess for residual pneumothorax (PTX). However, CXR is a poor diagnostic exam for apical and small PTX, and 15-50% are missed utilizing this method. Ultrasound (US) is a portable imaging modality which may be performed bedside, without radiation exposure, and at minimal cost. We hypothesized that transitioning from CXR to US following CT removal in trauma patients would prove safe and provide superior imaging detection of residual PTX.

Methods: A practice management guideline was established calling for the performance of a CXR and bedside US 2 hours after CT removal in all adult trauma patients diagnosed with a PTX or hemoPTX at a level 1 trauma center. All surgical interns completed a 30-minute, standardized US training course utilizing the handheld GE Vscan™ extended R2 US device. CTs were removed at full exhalation in a standard fashion. US findings were interpreted by the surgical intern prior to reviewing CXRs. CXRs were interpreted by staff radiologists blinded to the US findings. Data was retrospectively collected.

Results: Forty-six trauma patients met inclusion criteria. Surgical interns performed all US evaluations. CXR detected 11 residual PTX (23.9%); bedside US detected 12 (26.1%). When compared to CXR, bedside US had a higher positive rate of detection. Three patients had residual PTX detected by CXR and not by US; four had residual PTX detected by US but not CXR. None required intervention and all proved clinically insignificant. The cost of care for the study cohort may have been reduced over $4,000 should US alone have been employed.

Conclusions: Bedside US may be an acceptable alternative to CXR to assess for residual PTX following trauma CT removal and potentially offers multiple patient benefits to include decreased radiation exposure, time to imaging interpretation and cost.

Scientific Session II - Raymond H. Alexander, MD Resident Paper Competition

Paper #10
January 12, 2022
11:15 am

NOT ALL IS LOST: FUNCTIONAL RECOVERY IN OLDER ADULTS FOLLOWING EMERGENCY GENERAL SURGERY

Matthew P. Guttman, MD, Bourke W. Tillmann, MD, Avery B. Nathens, MD, PhD, MPH*, Susan Bronskill, PhD, Refik Saskin, MSc, Ajie Huang, MSc, Barbara Haas, MD, PhD*
Sunnybrook Health Sciences Center

Presenter: Matthew P. Guttman, MD

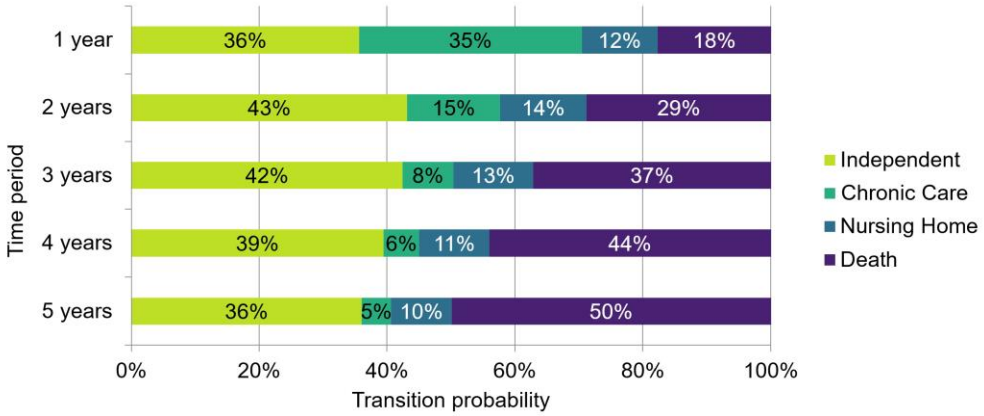
Discussant: Catherine Sharoky, MD, MS, Perelman School of Medicine at the University of Pennsylvania

Objectives: Although functional decline and death are common long-term outcomes among older adults following emergency general surgery (EGS), we hypothesized that patients' post-discharge function may wax and wane over time. Periods of fluctuation in function may represent opportunities to intervene to prevent further decline. Our objective was to describe the functional trajectories of older adults following EGS admission.

Methods: This was a population-based retrospective cohort study of all independent, community-dwelling older adults (age>65) in Ontario with an EGS admission (2006-2016). A multistate model was used to examine patients' functional trajectories over the 5 years following discharge. Patients were followed as they transitioned back and forth between functional independence, dependence on chronic care (in-home assistance for personal care, homemaking, or medical care for at least 90 days), nursing home admission, and death.

Results: We identified 78,820 older adults with an EGS admission (mean age 77, 53% female). In the 5 years following admission, 32% (n=24,928) required new chronic care, 21% (n=5,249) of whom had 2 or more episodes of chronic care separated by periods of independence. The average time spent in chronic care was 11 months, and 50% (n=12,679) of chronic care episodes ended with functional recovery to independence. For patients requiring chronic care, the probability of long-term functional recovery ranged from 36-43% annually over 5 years (Figure).

Conclusions: Not all is lost for older adults who experience functional decline following EGS admission. Half of those who become dependent on chronic care will recover to independence, and one-third will have a durable recovery, remaining independent after 5 years. Fluctuations in function in the years following EGS may represent a unique opportunity for interventions to promote rehabilitation and recovery among older adults.



The probability of functional outcomes after 1-5 years for older patients who require chronic care assistance (personal care, homemaking, or medical care for at least 90 days) following EGS admission.

Scientific Session II - Raymond H. Alexander, MD Resident Paper Competition

Paper #11
January 12, 2022
11:30 am

OUTCOMES AFTER EMERGENCY GENERAL SURGERY AND TRAUMA CARE IN INCARCERATED INDIVIDUALS: AN EAST MULTI-CENTER STUDY

Mary K. Bryant, MD, MSCR, Leah C Tatebe, MD FACS*, Nandini Rajaram Siva, MBBS, Pascal O. Udekwu, MD, MBA, MHA*, Mary Wurzelmann, MS, Marie L. Crandall, MD, MPH, FACS*, Yohan Diaz-Zuniga, CCRC, Virginia Tran, MD, Ariel Santos, MD, MPH, FACS, FCCM*, Cassandra Krause, MD, MA, David Turay, MD, PhD*, Kristen Nordham, BA*, Sharven Taghavi, MD, MPH, MS, FACS*, Elizabeth Dreesen, MD*, Sara Scarlet, MD MPH, Andrew Synder, BS, Megan Applewhite, MD, Pooja Patel, MD, Thomas J. Schroeppel, MD*, Jennifer Rodriquez, CRC, Lucy Z. Kornblith, MD*, Marissa A Boeck, MD, MPH*, Stephanie Bonne, MD*, Ann Tufariello, MPH, Rebecca G Maine, MD, MPH*
University of North Carolina

Presenter: Mary K. Bryant, MD, MSCR

Discussant: Adam Nelson, MD, University of Arizona

Objectives: The US incarcerates more individuals than any other country. Prisoners are the only population guaranteed health care by the US constitution, but little is known about their surgical needs. This multicenter study aimed to describe the acute care surgery (ACS) needs of incarcerated individuals.

Methods: Twelve centers prospectively identified incarcerated patients evaluated in their emergency department (ED) by the ACS service. Centers collected diagnosis, treatment, and complications from chart review. We compared the general surgery (GS) and trauma cohorts with descriptive statistics. We examined whether self-harm was associated with complications using univariate logistic regression.

Results: In 12 months, 1001 patients from jail: 740 (74.2%), prison: 236 (23.7%), and other facilities: 25 (2.1%), were evaluated in the ED by ACS. Most were men (90.3%) with a mean age 38 years (±14); 474 (47.3%) presented with injuries. Centers varied in the number and percent of patients evaluated for trauma (Figure 1). The most common comorbidities were mental health disorders (32%), substance use disorders (24.3%), and hypertension (22.6%). Admissions were similar between trauma (61.5%) and GS patients (62.1%). Table 1 shows the incidence of admission, operation, complication, re-presentation, and follow-up for the five most common trauma and GS conditions. Self-harm resulted in one hundred twelve (20.5%) injuries and were associated with increased odds of operation (OR 2.4, 95%CI 1.4–4.1) and re-evaluation within 90 days (OR 9.1, 95%CI 5.6–14.9), $p<0.001$.

Conclusions: Incarcerated patients presented with a range of EGS conditions, nearly half due to trauma. The high rate of self-harm, mental health and substance use disorders, coupled with low proportion of clinic follow-up highlight the vulnerability of this population. Interventions are needed to decrease self-inflicted injuries while in custody.

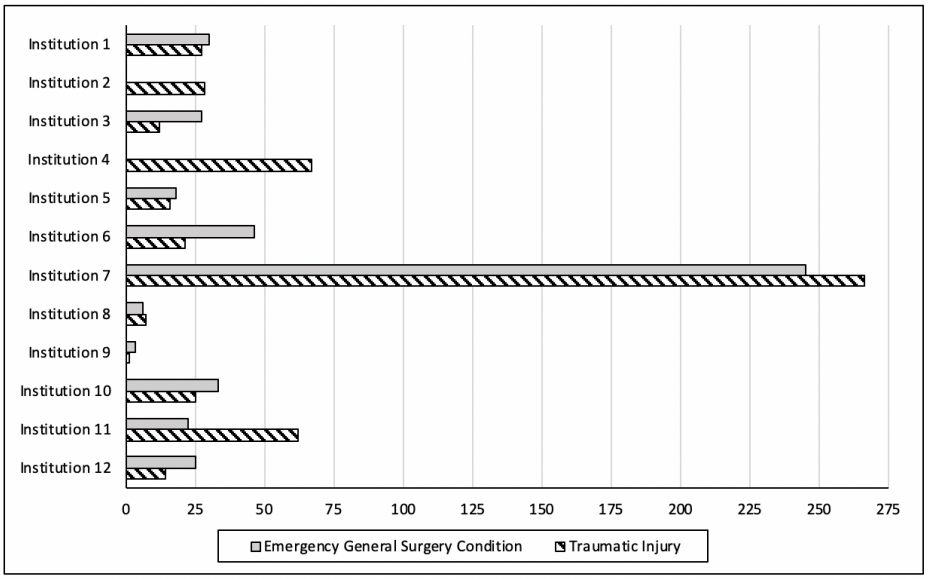


Figure 1. Enrollment of Incarcerated Patients with Emergency General Surgery or Traumatic Injuries by Participating Center

Traumatic Injury	N (%) trauma patients	Admitted	Operative intervention[a]	Composite complications[a,**]	Follow-up outpatient within 90 days[b]	Return to ED[b]
All injuries	546	336 (61.5)	75 (13.8)	23 (4.2)	132 (24.9)	99 (18.6)
TBI	164 (30.0)	109 (67.3)	2 (1.2)	3 (1.9)	37 (23.0)	15 (9.3)
Soft tissue injury	154 (28.2)	76 (49.4)	19 (12.3)	5 (3.3)	35 (23.0)	28 (18.4)
Facial fracture	74 (13.6)	50 (68.5)	10 (13.7)	1 (1.4)	23 (32.9)	8 (11.6)
Orthopedic fracture or joint injury	54 (9.9)	37 (68.5)	23 (42.6)	1 (1.9)	20 (40.0)	12 (23.5)
Pneumothorax or hemothorax	31 (5.7)	30 (96.8)	6 (19.4)	4 (12.9)	6 (21.4)	4 (14.3)
Emergency Surgical Condition	N (%) general surgery patients	Admitted	Operative intervention[a]	Composite complications[a,**]	Follow-up outpatient[b]	Return to ED[b]
All EGS	455	282 (62.1)	128 (28.4)	61 (13.4)	145 (32.5)	100 (22.4)
Soft tissue infection	97 (21.3)	68 (70.1)	42 (43.8)	23 (23.7)	38 (40.4)	23 (24.2)
Biliary disease	34 (7.5)	30 (88.2)	26 (76.5)	7 (20.6)	19 (55.9)	5 (14.7)
Bowel obstruction	29 (6.4)	27 (93.1)	8 (29.6)	10 (34.5)	10 (38.5)	6 (23.1)
Appendicitis	18 (4.0)	18 (100)	14 (77.8)	4 (22.2)	7 (38.9)	2 (11.1)
GI bleed	13 (2.9)	11 (84.6)	3 (23.1)	1 (7.7)	6 (46.2)	2 (15.4)

[a]Includes index hospitalization only

[b]90 days after discharge from hospital evaluation

*Abbreviations: ED, emergency department; TBI, traumatic brain injury; EGS, emergency general surgery; GI, gastrointestinal

**Recorded complications included organ failure, hemorrhagic and thrombotic, systemic and local infections, stroke, ileus, unplanned intubation or reoperation, death

Table 1. Top 5 most common traumatic injury and emergency general surgery conditions in incarcerated patients presenting to the ED over one year

Scientific Session II - Raymond H. Alexander, MD Resident Paper Competition

Paper #12
January 12, 2022
11:45 am

MACHINE LEARNING AND MURINE MODELS EXPLAIN FAILURES OF CLINICAL SEPSIS TRIALS

Allan E. Stolarski, MD, MS*, Jiyoun Kim, PhD, Kevin Rop, BA,
Qiuyang Zhang, BA, Daniel Remick, MD
Boston University | Boston Medical Center

Presenter: Allan E. Stolarski, MD, MS

Discussant: Christopher A. Guidry, MD, University of Kansas Medical Center

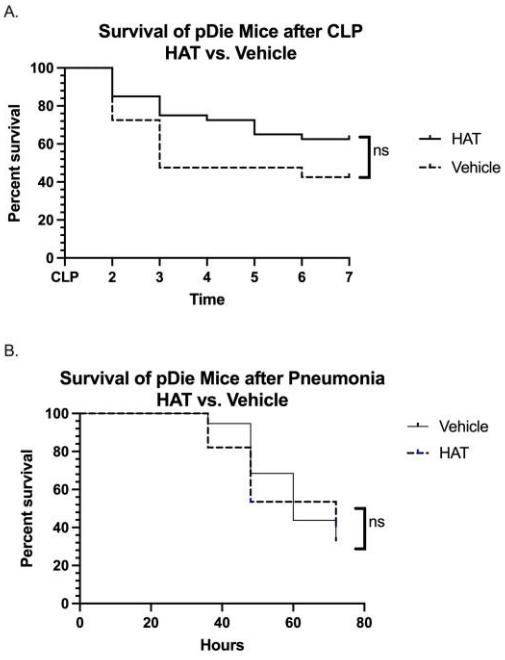
Objectives: Multiple clinical trials have failed to demonstrate the efficacy of Hydrocortisone, Ascorbic Acid, and Thiamine (HAT) in sepsis. However, these trials have not accounted for potential differences in the inflammatory responses across patients as well as the varying etiologies of injury/illness. Our objective was to investigate the impact of HAT in various combinations of sepsis responses and etiologies of sepsis.

Methods: Using cecal ligation and puncture (CLP) and pseudomonas aeruginosa pneumonia (PNA), high-risk sepsis responders (pDie) were identified early after infection (6 or 24 hours) using machine learning. Stratified mice were randomized into HAT or vehicle (VEH). Vitals, cytokines, vitamin-C, and markers of liver and kidney function were assessed in the blood, bronchoalveolar lavage (BAL), peritoneal lavage (PL), and organ homogenates.

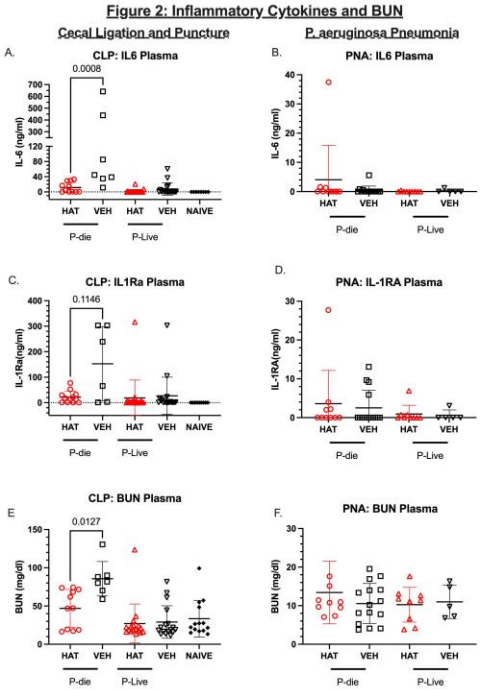
Results: Sepsis was induced in 181 outbred wild-type mice using CLP (91) and PNA (90). HAT led to a significant survival benefit as compared to VEH for pDie subjects with peritonitis (Figure 1A, $p=0.05$). Inflammatory markers present after CLP including IL-6, IL-1Ra, KC & MIP-2 in plasma were significantly down-regulated by HAT as compared to VEH (12 vs 185, 22 vs 153, 24 vs 106, 21 vs 92 ng/ml). Kidney injury in pDie CLP mice was significantly reduced with HAT vs. VEH (BUN 47 vs 86 mg/dl, $p<0.01$). HAT showed no survival benefit in pDie subjects with pulmonary sepsis (Figure 1B, $p=0.37$). IL-1RA levels were significantly lower in BAL for the HAT group compared to VEH, (1.198 ng/ml vs. 4.568 ng/ml, $p=0.007$). However, the remaining inflammatory cytokines and markers of liver and renal function showed no significant difference in plasma, BAL, or organ homogenates.

Conclusions: HAT therapy acts synergistically to reduce inflammation and end organ damage in intra-abdominal sepsis. All sepsis is not the same and invoke different systemic inflammatory responses requiring different therapies.

Figure 1: Survival of pDie Mice



Survival of pDie Mice in both CLP and PNA models.



Assorted inflammatory cytokines and BUN for CLP and PNA stratified by high risk (P-die) and low risk (p-Live) sepsis response.

Scientific Session III - Resuscitation & Emergency General Surgery

Paper #13
January 13, 2022
3:15 pm

VALIDATION OF A MINIATURIZED HANDHELD ARTERIAL PRESSURE MONITOR FOR GUIDING FULL AND PARTIAL REBOA USE DURING RESUSCITATION

Derek A. Benham, MD*, Matthew Car, MD, Lyndsey Wessels, MD, Joseph Lee, MD, Richard Calvo, PhD, Andrew Schrader, DVM, Tori Holtestaul, MD, Daniel T. Lammers, MD, Ian Jones, MD, Jeff Conner, MD, Jessica Weiss, MD, Matthew J. Eckert, MD*, Michael J. Krzyzaniak, MD*, Matthew J. Martin, MD, FACS*
Naval Medical Center San Diego

Presenter: Derek A. Benham, MD

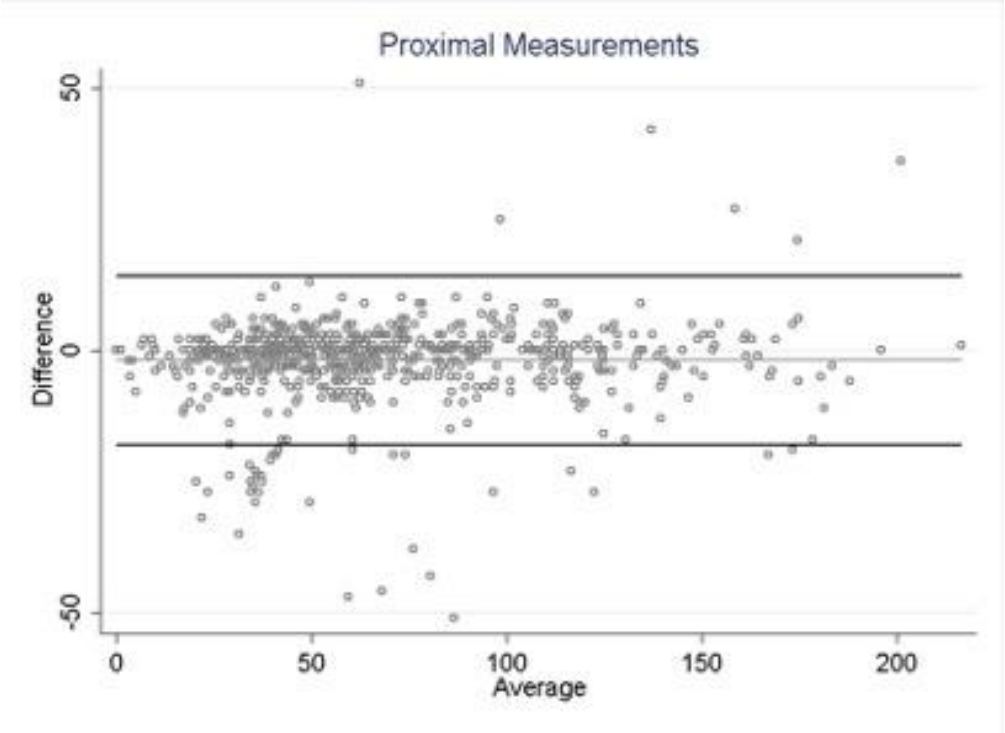
Discussant: Joseph Fernandez-Moure, MD, MS, Duke University Medical Center

Objectives: Resuscitative endovascular balloon occlusion of the aorta (REBOA) is increasingly used for truncal hemorrhage. In lower resource or battlefield settings, the requirement for arterial line setup and monitoring is prohibitive. We sought to evaluate the accuracy and precision of a minitiarized portable device (Centurion COMPASS) versus standard arterial pressure monitoring using both standard ER-REBOA and partial REBOA (pREBOA).

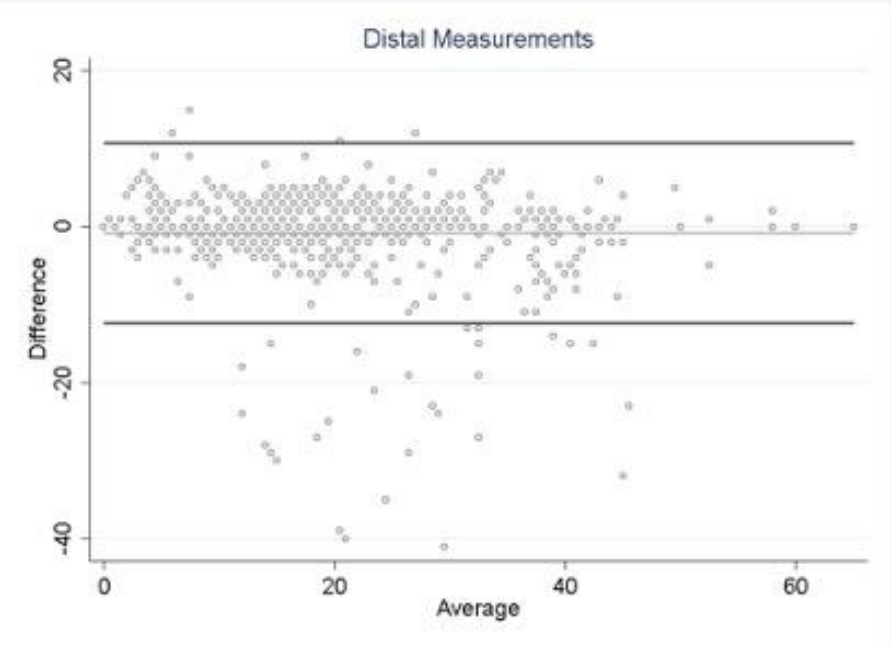
Methods: 40 swine underwent a 4-phase validation/precision study (each phase using 5 ER-REBOAs and 5 pREBOAs). Phases I/II evaluated accuracy with full and pREBOA in uninjured animals. Phases III/IV duplicated the previous phases but in a severe hemorrhagic shock model. Carotid and femoral pressures were monitored with both arterial line and COMPASS device, vascular flow was measured by aortic flow probes. Correlation and Bland-Altman analysis was performed.

Results: There was strong correlation in accuracy testing of proximal and distal COMPASS devices compared to standard arterial line monitoring ($r=0.94, 0.8$; $p<.005$) as well as during precision testing ($r = .98, .89$ $p < .005$) in the uninjured phases. Similar accuracy and reliability were demonstrated in hemorrhagic shock, with strong correlation for the proximal and distal COMPASS devices ($r =.98, .97$; $p<.005$), as well as during precision testing ($r=.99, .95$; $p<.005$) in both full and pREBOA scenarios. Bland-Altman analysis (Figures) showed extremely low bias between the COMPASS and arterial line for both proximal (bias=1.9) and distal (bias=0.8) pressure measurements.

Conclusions: The COMPASS provides accurate and precise pressure measurements during standard and partial REBOA in both uninjured and shock conditions. This device may help extend and enhance capability in low resource/battlefield settings, or even eliminate the need for standard arterial line setup and monitoring.



Bland-Altmas Analysis showing extremely low bias between the proximal COMPASS and arterial line measurements.



Bland-Altmas Analysis showing extremely low bias between the distal COMPASS and arterial line measurements.

Scientific Session III - Resuscitation & Emergency General Surgery

Paper #14
January 13, 2022
3:30 pm

CRESTING MORTALITY: DEFINING A PLATEAU IN ONGOING MASSIVE TRANSFUSION

Megan T. Quintana, MD*, Anita Vincent, MD, Parker Chang, BS,
Babak Sarani, MD, FACS, FCCM*, Maximillian Forssten, MD, Yang Cao, PhD,
Michelle Chen, MD, Colleen Corrado, BS, Shahin Mohseni, MD, PhD
George Washington University

Presenter: Megan T. Quintana, MD

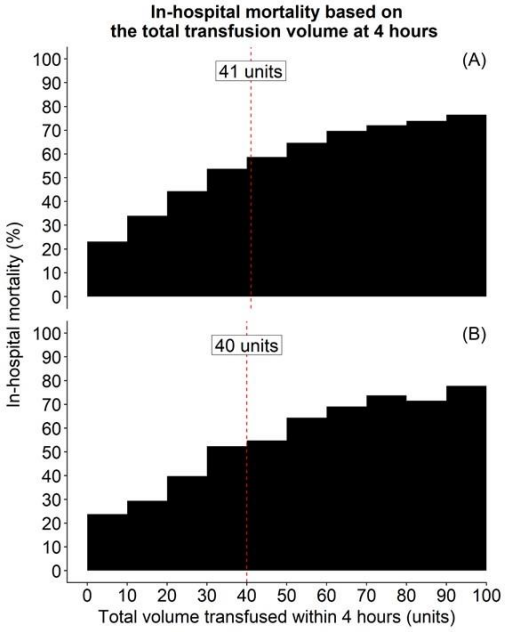
Discussant: Chrissy Guidry, DO, Tulane Medical School

Objectives: Blood-based balanced resuscitation is the standard of care in massively bleeding trauma patients. But there are no data as to when this therapy no longer significantly improves mortality. We sought to determine if there is a threshold beyond which further massive transfusion will not improve in-hospital mortality.

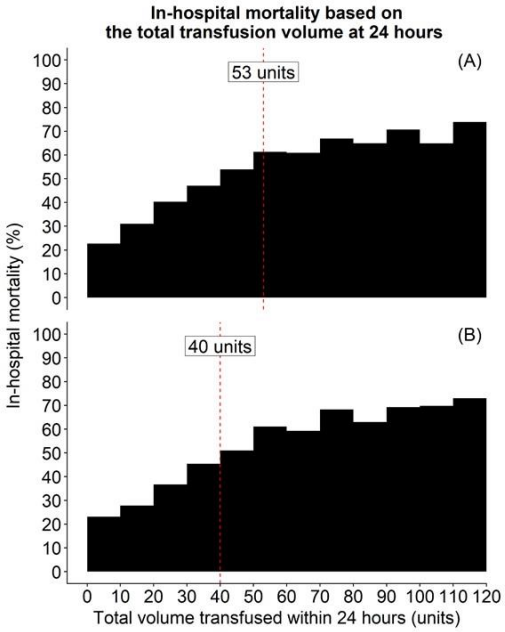
Methods: The Trauma Quality Improvement database was queried for all adult patients registered between 2013 and 2017 who received at least one unit of blood (PRBC) within 4 hours of arrival. In-hospital mortality was evaluated based on the total transfusion volume (TTV) at 4 and 24 hours in the overall cohort (OC) and in a balanced transfusion cohort (BC), composed of patients who received a transfusion at a ratio of 1:1 – 2:1 PRBC:plasma. A bootstrapping method in combination with multivariable Poisson regression (MVR) was used to find a cutoff after which additional transfusion of blood products no longer affected in-hospital mortality. MVR was used to control for age, sex, race, highest abbreviated injury score in each body region, comorbidities, advanced directives limiting care, and the primary type of surgery performed for hemorrhage control.

Results: The OC consisted of 99,042 patients of which 28,891 and 30,768 received a balanced transfusion during the first 4 and 24 hours, respectively. The mortality rate plateaued after a TTV of 41 (95% CI, 40-41) units in the OC at 4 hours and after a TTV of 53 (95% CI, 52-53) units at 24 hours following admission. In the BC, mortality plateaued at a TTV of 40 (95% CI, 36-41) units and 41 (95% CI, 41-42) units at 4 and 24 hours following admission, respectively (figures 1, 2).

Conclusions: Transfusion thresholds exist beyond which ongoing transfusion is not associated with any clinically significant change in mortality. These TTVs can be used as markers for resuscitative timeouts in order to assess the plan of care moving forward.



A: All patients, n=99,042
B: Patient who received a balanced transfusion only, n=28,891



A: All patients, n=99,042
B: Patient who received a balanced transfusion only, n=30,768

Scientific Session III - Resuscitation & Emergency General Surgery

Paper #15
January 13, 2022
3:45 pm

4-FACTOR PROTHROMBIN COMPLEX CONCENTRATE IS NOT INFERIOR TO ANDEXANET ALFA FOR THE REVERSAL OF FACTOR XA INHIBITORS: AN EAST MULTICENTER STUDY

Jordan Estroff, MD*, Joseph Devlin, MD, Lara Hoteit, MD, Adnan Hassoune, MD, Matthew D. Neal, M.D., Shannon R. Kotch, MD*, Joshua P. Hazelton, DO, FACS*, Ashton Christian, MD, Eric O Yeates, MD, Jeffry Nahmias, MD, MHPE, FACS, FCCM*, Lewis E. Jacobson, MD, Jamie Williams, MSML, BSN, RN, CCRP, Kevin M. Schuster, MD, MPH*, Rick O'Connor, RN, Gregory Semon, DO*, Daniel C. Cullinane, MD*, Tanya Egodage, MD*, Michelle Kincaid, MD*, Allison Rollins, PA-C, RIchard Amdur, PhD, Babak Sarani, MD, FACS, FCCM*
George Washington University

Presenter: Jordan Estroff, MD

Discussant: Brian Yorkgitis, DO, University of Florida-Jacksonville

Objectives: Andexanet Alfa (AA) is the only FDA approved reversal agent for apixaban and rivaroxaban (DOAC). There are no studies comparing its efficacy with 4-Factor Prothrombin Complex Concentrate (PCC).This study aimed to compare PCC to AA for DOAC reversal, hypothesizing non-inferiority of PCC .

Methods: We performed a retrospective multicenter study of adult patients admitted from July 1, 2018 to December 31, 2019 who had taken a DOAC within 12 hours of injury and received transfusion of red blood cells (PRBCs)) or had traumatic brain injury (TBI), and received AA or PCC. PRBC transfusion difference was the primary endpoint, with a zone of equivalence (ZOE) of +5% incidence. Secondary endpoints included mortality (with ZOE+/-0.5%) and ICU Length of Stay (ILOS, with ZOE +/- 0.5 days). Multivariable analysis for risk of transfusion was also performed.

Results: From 263 patients at 10 centers, 77 received PCC and 186 AA. Age, ISS, and Marshall score were significantly higher in the PCC group (table 1). Transfusion was not significantly associated with PCC vs AA (20% (95% CI 11-28%) v 24% (95% CI 18-30%), p=.52)and the upper CI of PCC was within 5% of the upper CI of AA. There was no significant difference in PRBC units transfused Mortality and ILOS were significantly lower in PCC vs AA (Table 1). In multivariable analysis associated risk of RBC transfusion was similar between AA vs PCC (OR 1.12, p=.88).

Conclusions: PCC is non-inferior to AA for the reversal of DOAC in bleeding trauma patients. A randomized study is needed to confirm these results.

Table 1. Patient characteristics and outcomes by group

Variable	**PCC (n=77)**	**AA (n=186)**	**p-value**
Age (years)	77 ± 12	70 ± 15	0.0001
Female, n(%)	36 (47%)	83 (45%)	0.79
Mean ISS	19.8 ± 7.7	14.9 ± 8.7	0.0003
Baseline hemoglobin	12.5 ± 2.5 g/dL	11.0 ± 2.6 g/dL	0.0002
Marshall Score on arrival	2.45 ± 1.0	2.09 ± 1.1	0.047
Received 2nd dose[SB4]	4 (5%)	5 (3%)	0.46
DOAC indication Afib VTE Stroke MI	 61 (79%) 10 (13%) 3 (4%) 2 (3%)	 34 (18%) 41 922%) 22 (12%) 5 (3%)	 <.0001 0.12 0.06 0.99
Outcome	*Incidence (95% ci)*	*Incidence (95% ci)*	
Died	19.5% (10.6-28.2%)	32.3% (25.5-39.0%)	0.05
Any PRBC Transfusion	19.5% (10.6-28.3%)	23.7% (17.5-29.8%)	0.52
	Mean (95% ci)	*Mean (95% ci)*	
PRBC Units transfused	2.2 (0 – 4.6)	1.5 (0.6 – 2.3)	0.45 [A]
ICU days	1.2 (1.0-1.4)	1.5 (1.3-1.7)	0.04

[A] Kruskal-Wallis p value.

DOAC = apixaban and rivaroxaban, ISS = injury severity score, Afib = atrial fibrillation, VTE = venous thromboembolic disease, MI = myocardial infarction, PRBC = packed red blood cells;

Scientific Session III - Resuscitation & Emergency General Surgery

Paper #16
January 13, 2022
4:00 pm

DIMETHYL MALONATE DECREASES SUCCINATE ACCUMULATION AND PRESERVES CARDIAC FUNCTION IN A SWINE MODEL OF HEMORRHAGIC SHOCK

Sharven Taghavi, MD, MPH, MS, FACS*, Sarah Abdullah, BS, Eman Toraih, MD, PhD*,
Jacob Packer, Robert Drury, Oguz Aras, Emma Kosowski, Farhana Shaheen,
Juan C. Duchesne, MD, FACS, FCCP, FCCM*, Olan Jackson-Weaver, PHD
Tulane University School of Medicine

Presenter: Sharven Taghavi, MD, MPH, MS, FACS

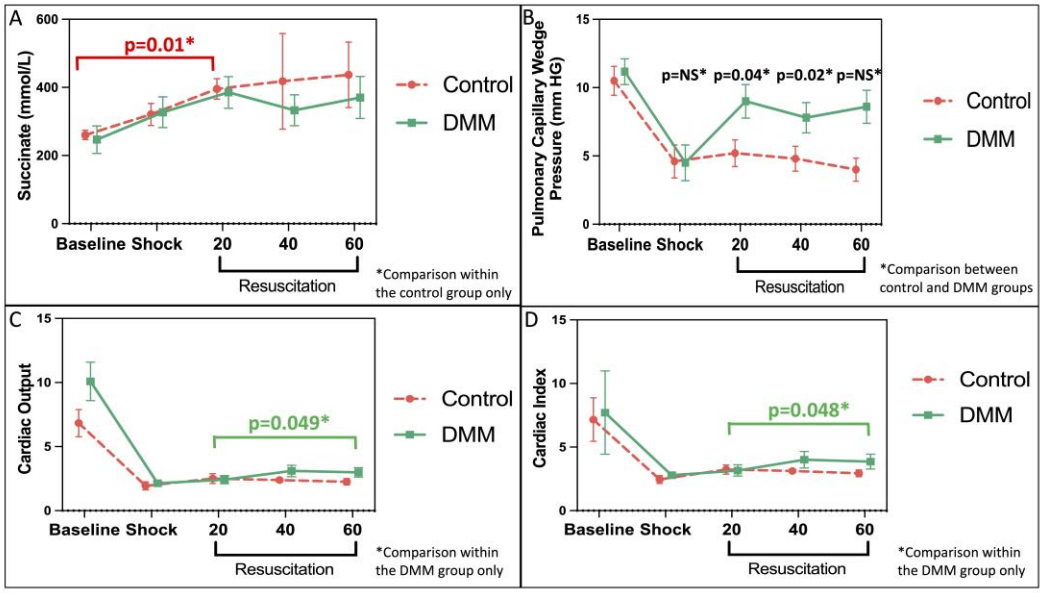
Discussant: Michael Goodman, MD, University of Cincinnati

Objectives: Succinate (SI) is a citric acid cycle metabolite that accumulates in tissues during hemorrhagic shock (HS) due to electron transport chain uncoupling. Dimethyl malonate (DMM) is a competitive inhibitor of succinate dehydrogenase, which has been shown to reduce SI accumulation and protect against reperfusion injury. Whether DMM can be therapeutic during resuscitation after severe HS is unknown. We hypothesized that DMM would prevent SI buildup during resuscitation in a swine model of hemorrhagic shock, leading to better physiological recovery after resuscitation (RES).

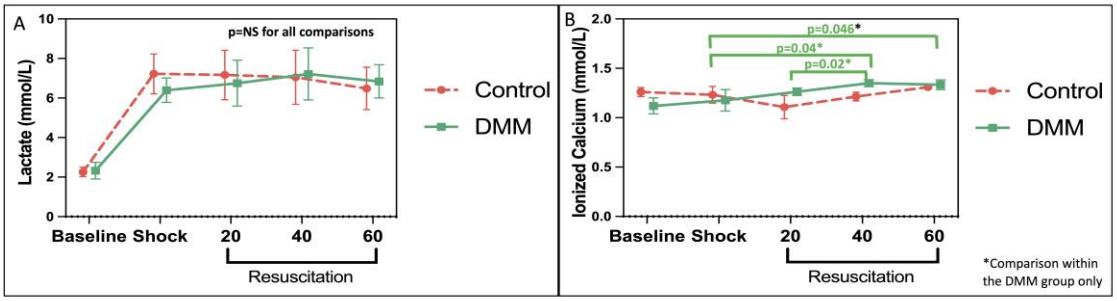
Methods: The carotid arteries of Yorkshire pigs were cannulated with a 5-French catheter. After placement of a Swan-Ganz catheter and femoral arterial line, the carotid catheters were opened and the animals were exsanguinated to a mean arterial pressure (MAP) of 45 mm HG. After 30 minutes in the shock state, the animals were resuscitated to a MAP of 60 mm HG using lactated ringers. A MAP above 60 mm HG was maintained throughout RES. One group received 10 mg/kg of DMM (n=6) while the control received sham injections (n=6). The primary end-point was SI levels. Secondary end-points included cardiac function and lactate levels.

Results: SI levels increased from baseline to the 20-minute RES point in the control, while the DMM cohort remained unchanged (Figure 1A). The DMM group required less IV fluid to maintain a MAP above 60 (450.0 vs. 229.0 mL, p=0.01). The DMM group had higher pulmonary capillary wedge pressure at the 20 and 40-minute RES points (Figure 1B). In addition, the DMM group had better recovery of cardiac output and index (Figure 1C-D) during RES, while the control had no improvement. While lactate levels were not different, DMM led to increased ionized calcium levels (Figure 2).

Conclusions: DMM reduces SI accumulation during HS and helps preserve cardiac filling pressures and function during RES. In addition, DMM protects against depletion of ionized calcium. DMM may have therapeutic potential during HS.



A Comparison of the A) Succinate levels, B) Pulmonary Capillary Wedge Pressures, C) Cardiac Output, and D) Cardiac Index in the Control and DMM Groups.



A Comparison of A) Lactate Levels and B) Ionized Calcium Levels in Control and DMM Group.

Scientific Session III - Resuscitation & Emergency General Surgery

Paper #17
January 13, 2022
4:15 pm

SOCIODEMOGRAPHIC RISK FACTORS FOR DELAYED DIAGNOSIS OF APPENDICITIS: A POPULATION-BASED ANALYSIS

Ana M. Reyes, BS, Joe Feinglass, PhD, Arielle Thomas, MD, MPH, Anne Stey, MD, MSc*
Northwestern University

Presenter: Ana M. Reyes, BS

Discussant: Marta McCrum, MD, MPH, University of Utah School of Medicine

Objectives: Minority race/ethnicity and Medicaid insurance have been associated with worse appendicitis outcomes. This study sought to determine the association of race/ethnicity and insurance status with delayed diagnosis of appendicitis, length of stay, and subsequent 30 day hospital use.

Methods: This was a retrospective cohort study using the Healthcare Cost and Utilization Project State Inpatient and State Emergency Department Databases from Florida, New York, Wisconsin, and Maryland from 2016-2017. Delayed diagnosis was defined as having a prior hospital visit within 7 days preceding appendectomy where an appendicitis-related diagnosis was made (abdominal pain, peritonitis, or gastritis). We performed multivariable Poisson regression to measure associations of age, sex, race/ethnicity, insurance status, and median income quartile with 1)delayed diagnosis, 2)length of stay > 5 days, and 3)emergency room visit or inpatient admission within 30 days of appendectomy. Standard errors were adjusted for clustering of observations within hospitals.

Results: Of 114,397 patients undergoing appendectomy, 3,304 (2.9%) of patients had delayed diagnoses. Non-Hispanic [NH]-Black (aIRR 1.17, 95% CI 1.04-1.32); and Medicaid patients (aIRR 1.39, 95% CI 1.26-1.54) were more likely to have delayed diagnoses compared to NH-white and privately insured patients respectively. Patients with delayed diagnosis were more likely to have related 30-day revisits (aIRR 1.48, 95% CI 1.33-1.64) after appendectomy and long length of stay at the time of appendectomy (aIRR 1.56, 95% CI 1.45-1.69) than patients without delayed diagnosis.

Conclusions: NH-Black and Medicaid patients were more likely to have delayed diagnoses of appendicitis than their NH-white and privately insured counterparts. Delayed diagnosis was associated with greater subsequent hospital use.

[a] Model includes 7-day prior hospital use and length of stay > 5 days as independent variables
[b] Model includes 7-day prior hospital use with appendicitis-related diagnosis and length of stay > 5 days as independent variables
[c] Model includes 7-day prior hospital use as independent variable
[d] Model includes 7-day prior hospital use with appendicitis-related diagnosis as independent variable

	All appendectomies	Prior 7-day Hospital Use (Any diagnosis)	aIRR (95% CI)	Delayed Diagnosis	aIRR (95% CI)	Related 30-day Revisit	aIRR (95% CI)[a]	aIRR (95% CI)[b]	LOS >5 days	aIRR (95% CI)[c]	aIRR (95% CI)[d]
TOTAL	N=114,397	6.59		2.89		7.65			12.68		
STATE											
Florida	39.17	6.74	Ref	3.17	Ref	8.81	Ref		13.92	Ref	Ref
Maryland	11.13	6.34	0.80 (0.60-1.06)	2.73	0.76 (0.61-.95)*	7.95	0.82 (0.74-0.92)*	0.82 (0.74-0.92)*	11.28	0.90 (0.75-1.09)	0.9 (0.74-1.09)
New York	36.28	6.28	0.79 (0.66-0.95)*	2.50	0.70 (0.58-0.83)*	6.74	0.77 (0.72-0.82)*	0.77 (0.72-0.82)*	12.33	1.05 (0.96-1.16)	1.05 (0.95-1.16)
Wisconsin	13.42	7.18	0.97 (0.83-1.14)	3.26	0.99 (0.83-1.17)	6.51	0.77 (0.70-0.84)*	0.77 (0.70-0.84)*	11.12	0.93 (0.74-1.15)	0.93 (0.75-1.15)
YEAR											
2016	50.48	6.70	Ref	2.94	Ref	7.96	Ref		12.95	Ref	Ref
2017	49.52	6.47	0.96 (0.90-1.03)	2.83	0.95 (0.88-1.03)	7.34	0.90 (0.86-0.94)*	0.9 (0.86-0.94)*	12.40	0.93 (0.89-0.96)*	0.93 (0.89-0.97)*
SEX											
Male	50.46	6.09	Ref	2.50	Ref	7.09	Ref		12.69	Ref	Ref
Female	49.54	7.09	1.29 (1.22-1.37)*	3.28	1.45 (1.34-1.56)*	8.22	1.15 (1.11-1.20)*	1.15 (1.11-1.2)*	12.66	0.88 (0.84-0.92)*	0.88 (0.85-0.92)*
AGE											
<18	16.56	14.60	2.55 (2.16-3.01)*	5.63	1.85 (1.53-2.23)*	7.73	1.05 (0.95-1.16)	1.08 (0.97-1.19)	10.00	2.5 (2.08-2.96)	2.6 (2.17-3.11)
18-24	13.57	5.60	Ref	3.05	Ref	6.76	Ref		3.60	Ref	Ref
25-34	17.54	5.86	1.00 (0.91-1.09)	3.05	0.95 (0.84-1.08)	7.54	1.1 (1.02-1.19)*	1.1 (1.02-1.19)*	4.92	1.38 (1.23-1.54)*	1.38 (1.23-1.54)*
35-44	13.99	5.107	0.91 (0.83-1.00)	2.47	0.80 (0.69-0.91)*	7.34	1.06 (0.98-1.16)	1.06 (0.98-1.16)	8.03	2.31 (2.06-2.60)*	2.31 (2.06-2.6)*
45-54	13.84	4.55	0.80 (0.72-0.89)*	2.07	0.67 (0.57-0.78)*	7.55	1.05 (0.97-1.14)	1.05 (0.97-1.14)	13.47	3.99 (3.58-4.46)*	3.99 (3.58-4.45)*
55-64	12.06	4.40	0.75 (0.66-0.84)*	1.68	0.53 (0.45-0.62) *	7.93	1.04 (0.96-1.14)	1.04 (0.96-1.14)	20.82	6.16 (5.51-6.88)*	6.16 (5.51-6.88)*
65+	12.43	4.12	0.48 (0.40-0.56)*	1.38	0.41 (0.32-0.52)*	8.88	0.75 (0.67-0.84)*	0.74 (0.66-0.84)*	33.54	6.78 (5.98-7.70)*	6.71 (5.91-7.62)*
RACE/ETHNICITY											
Non-Hispanic White	61.53	6.21	Ref	2.69	Ref	7.46	Ref		12.64	Ref	Ref
Non-Hispanic Black	9.99	8.32	1.12 (1.02-1.24)*	3.73	1.17 (1.04-1.32)*	10.21	1.12 (1.04-1.19)*	1.12 (1.04-1.2)*	19.71	1.71 (1.61-1.82)*	1.71 (1.61-1.82)*
Hispanic	18.56	6.98	0.84 (0.75-0.95)*	3.27	0.91 (0.81-1.03)	7.57	0.91 (0.85-0.97)*	0.91 (0.85-0.97)*	9.83	0.94 (0.88-1.01)	0.94 (0.87-1.00)**
Asian or Pacific Islander	2.94	5.46	0.78 (0.62-0.97)*	2.05	0.72 (0.54-0.95)*	6.21	0.87 (0.74-1.01)***	0.86 (0.74-1.00)***	10.27	0.94 (0.82-1.08)	0.93 (0.82-1.07)
Other/Unknown	6.98	6.90	0.89 (0.76-1.04)	2.82	0.92 (0.77-1.10)	6.53	0.86 (0.78-0.95)*	0.86 (0.78-0.94)*	11.46	1.08 (0.98-1.19)	1.07 (0.98-1.18)
INSURANCE STATUS											
Medicare	13.62	5.03	1.78 (1.56-2.03)*	1.63	1.21 (0.99-1.50)**	9.99	1.71 (1.54-1.8)*	1.72 (1.56-1.9)*	33.29	1.82 (1.69-1.95)*	1.84 (1.71-1.98)*
Medicaid	23.42	10.48	1.49 (1.38-1.61)*	4.45	1.39 (1.26-1.54)*	9.33	1.45 (1.36-1.55)*	1.46 (1.37-1.56)*	11.39	1.46 (1.36-1.57)*	1.48 (1.38-1.59)*
Private Insurance	52.47	5.27	Ref	2.46	Ref	6.19	Ref		8.51	Ref	Ref
Other	10.49	6.53	1.28 (1.17-1.41)*	3.17	1.26 (1.12-1.42)*	8.20	1.24 (1.15-1.34)*	1.24 (1.15-1.34)*	9.62	1.21 (1.12-1.31)*	1.22 (1.13-1.32)*
ZIP-CODE MEDIAN INCOME QUARTILE											
1	24.55	8.20	Ref	3.63	Ref	8.71	Ref		14.38	Ref	Ref
2	25.64	7.24	0.96 (0.89-1.03)	3.05	0.94 (0.85-1.04)	8.09	0.98 (0.92-1.04)	0.98 (0.92-1.04)	12.99	0.93 (0.89-0.98)*	0.93 (0.89-0.98)*
3	25.47	6.04	0.83 (0.75-0.92)*	2.66	0.86 (0.76-0.97)*	7.30	0.92 (0.87-0.98)*	0.92 (0.86-0.98)*	11.92	0.87 (0.83-0.92)*	0.87 (0.82-0.92)*
4	24.33	4.81	0.71 (0.61-0.82)*	2.19	0.75 (0.64-0.87)*	6.52	0.87 (0.81-0.94)*	0.87 (0.81-0.94)*	11.21	0.85 (0.79-0.90)*	0.84 (0.78-0.89)*
PRIOR 7-DAY HOSPITAL USE (ANY DIAGNOSIS)											
Yes	---	---	---	---	---	11.45	1.40 (1.29-1.51)*	---	18.80	1.67 (1.56-1.78)*	---
No	---	---	---	---	---	7.38	Ref	---	12.24	Ref	---
DELAYED DIAGNOSIS (PRIOR 7-DAY HOSPITAL USE WITH APPENDICITS-RELATED DIAGNOSIS)											
Yes	---	---	---	---	---	12.35	---	1.48 (1.33-1.64)*	16.65	---	1.56 (1.45-1.69)*
No	---	---	---	---	---	7.51	---	Ref	12.56	---	Ref
LENGTH OF STAY >5 DAYS											
Yes	---	---	---	---	---	12.67	1.69 (1.60-1.78)*	1.71 (1.62-1.8)*	---	---	---
No	---	---	---	---	---	6.92	Ref	Ref	---	---	---

Footnote: Income Quartiles: 2016 (Q1 $1-$42,999; Q2 $43,000-$53,999; $Q3 54,000-$70,999; Q4 $71,000+); 2017 (Q1 $1-$43,999; Q2 $44,000-$55,999; Q3 $56,000-$73,999; Q4 $74,000+)
*p<.001
**p=.068
***p=.059
Abbreviations: aIRR=adjusted incident rate ratio, CI=confidence interval, LOS=length of stay

Table 1. Outcomes of Appendectomy Episodes of Care in 4 States, 2016-2017 (N=114,397)

Scientific Session III - Resuscitation & Emergency General Surgery

Paper #18
January 13, 2022
4:30 pm

PROSPECTIVE DERIVATION OF A NECROTIZING SOFT TISSUE INFECTION SCORE (NECROSIS): AN EAST MULTICENTER TRIAL

Dennis Y. Kim, MD, FRCSC, FACS, FCCP*, Amanda Iavasile, Amy Kaji, MD, PhD, Kaushik Mukherjee, MD, MSCI, FACS*, Liz Penaloza, MD, M. Chance Spalding, DO, PhD, FACS*, Joseph Posluszny, MD*, Charles Logan, Kelly Dinnan, DO, FACOS*, Thomas Serena, DO, Sheryl Sahr, MD, MS, FACS*, Leah Hustad, CCRC, Khaldoun Bekdache, MD*, Nathan Stoddard, William H. Marx, DO, FACS*, Asad Choudhry, MD, Darin Saltzman, MD, Reynaldo Padilla, Michael Truitt, MD*, Heather M Grossman Verner, MS, Donald E. Barker, MD*, Darren Hunt, MD, FACS*, Samuel Wade Ross, MD, MPH*, Mike M. Mallah, MD*, Linda Dultz, MD, MPH, FACS*, Kali Kuhlenschmidt, MD, Caleb J. Mentzer, DO*, Areg Grigorian, MD, Grace Chang, MD*, Jeffry Nahmias, MD, MHPE, FACS, FCCM*
Harbor-UCLA Medical Center

Presenter: Dennis Y. Kim, MD, FRCSC, FACS, FCCP

Discussant: Eileen Bulger, MD, University of Washington Harborview Medical Center

Objectives: Although a number of risk indices have been developed to aid in the diagnosis of NSTIs, these instruments suffer from varying levels of reproducibility and failure to incorporate key clinical variables in model development. The objective of this study was to derive a clinical risk index score for identifying NSTIs in emergency general surgery (EGS) patients being evaluated for severe skin and soft tissue infections.

Methods: We performed a prospective study across 16 sites in the US of adult EGS patients with suspected NSTIs over a 24-month period. Variables analyzed included demographics, admission vitals and labs, physical exam, radiographic, and operative findings. The main outcome measure was the presence of NSTI diagnosed clinically at the time of surgery. Multivariate analysis was performed to identify independent predictors for the presence of NSTI using the Hosmer-Lemeshow test and the Akaike information criteria.

Results: Of 362 patients, 297 (82%) were diagnosed with NSTI. Males comprised 55% of the population with a mean age of 52 (50-55). Overall mortality was 12.3%. After adjusting for clustering, NSTI patients were found to be older (53 vs. 46, p=0.04) with longer symptom duration (2.9 vs. 1.9 days, p=0.01). There were no differences in comorbidities. NSTI patients more commonly presented with septic shock (19% vs. 2%, p=0.003), violaceous skin changes (44% vs. 15%, p<0.001), higher white blood cell (WBC) count (18 vs. 13, p<0.0001), and gas on CT (51% vs 31 %, p=0.003). After several iterations and consideration of model-fit statistics, 3 independent predictors for NSTI were identified: SBP, violaceous skin, and WBC count. **(Table)**

Conclusions: Among EGS patients at-risk for NSTIs, we developed a highly specific and simple risk index score based on 3 readily available clinical and laboratory parameters to identify patients with NSTIs. Future validation studies are warranted.

NECROSIS Score	Sensitivity	Specificity	PPV	NPV	+LR	-LR
1	92%	57%	93%	53%	2.1	0.2
2	54%	75%	91%	26%	2.2	0.6
3	18%	100%	100%	21%	inf	0.8
1 point assigned for each variable: SBP ≤120mmHg, violaceous skin, WBC ≥15						

Table. Test Characteristics of the NECROSIS Score

Scientific Session III - Resuscitation & Emergency General Surgery

Paper #19
January 13, 2022
4:45 pm

MORTALITY AND PULMONARY COMPLICATIONS IN EMERGENCY GENERAL SURGERY PATIENTS WITH COVID-19: A LARGE INTERNATIONAL MULTICENTER STUDY

Anthony Gebran, MD, Apostolos Gaitandis, MD, Ander Dorken Gallastegi, MD,
Aneel Bhangu, MBChB, PhD, Dmitri Nepogodiev, MBChB, PhD,
Haytham Kaafarani, MD, MPH*, COVIDSurg Collaborative
Massachusetts General Hospital

Presenter: Anthony Gebran, MD

Discussant: Fariha Sheikh, MD, Rutgers, New Jersey Medical School

Objectives: The outcomes of emergency general surgery (EGS) patients with concomitant COVID-19 infection remain unclear. With a multicenter study in 361 hospitals from 52 countries, we sought to study the mortality and pulmonary complications of COVID-19 patients undergoing EGS.

Methods: All patients older than 17 years and diagnosed preoperatively with COVID-19 between February and July 2020 were included. EGS was defined as the urgent/emergent performance of appendectomy, cholecystectomy or laparotomy (e.g. bowel obstruction or perforation). The primary outcomes were 30-day mortality and pulmonary complications (acute respiratory distress syndrome, unexpected mechanical ventilation, pneumonia). Multivariable analyses were performed predicting adverse outcomes. Sensitivity analyses were performed comparing patients with and without preoperative respiratory signs and symptoms of COVID-19 (e.g. cough, hypoxia, chest X-ray or CT findings).

Results: A total of 1,145 patients were included. The mean (SD) age was 46.8 ± 21.7 and 39.6% were female; 540 (47.2%), 146 (12.8%) and 459 (40.1%) underwent appendectomy, cholecystectomy, and laparotomy, respectively. The rates of mortality and pulmonary complications were 14% and 31% overall, and 30.4% and 57.7% in the subset of laparotomy patients, respectively. Figure 1 shows the forest plot for independent predictors of mortality and pulmonary complications (e.g. age, obesity, smoking, preoperative respiratory symptoms). Sensitivity analyses showed that the risk of mortality and pulmonary complications is specifically increased in patients with preoperative respiratory signs and symptoms of COVID-19 [Figure 2].

Conclusions: COVID-19 patients undergoing EGS have significantly high rates of mortality and pulmonary complications, but the risk is most pronounced in those with preoperative COVID-19 respiratory signs and symptoms.

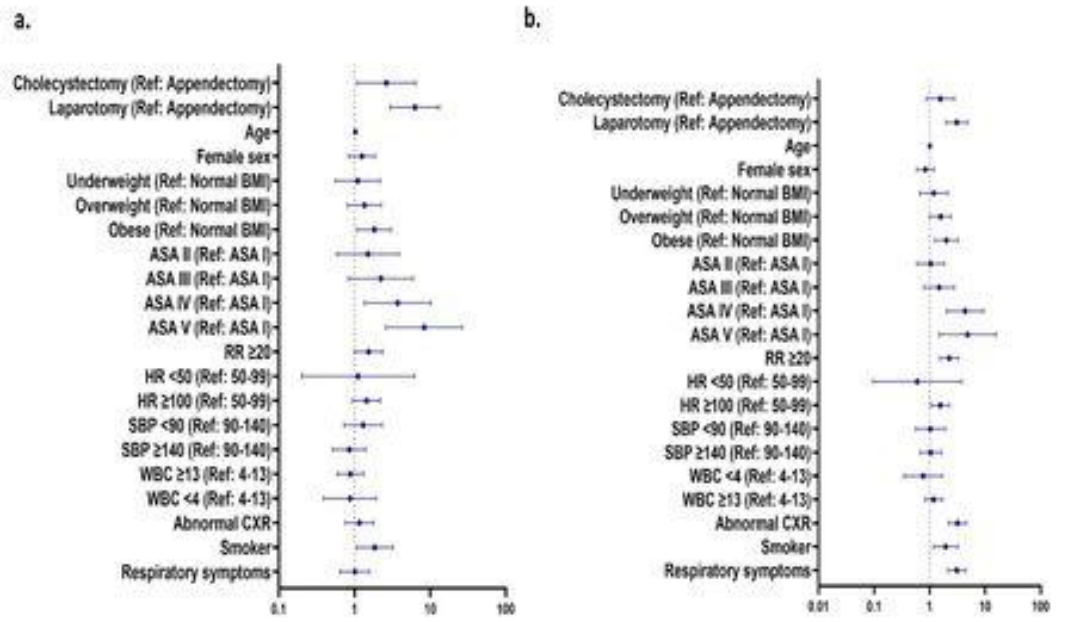


Figure 1: Forest plots depicting the adjusted relationship between predictors of **a.** mortality, **b.** respiratory complications.

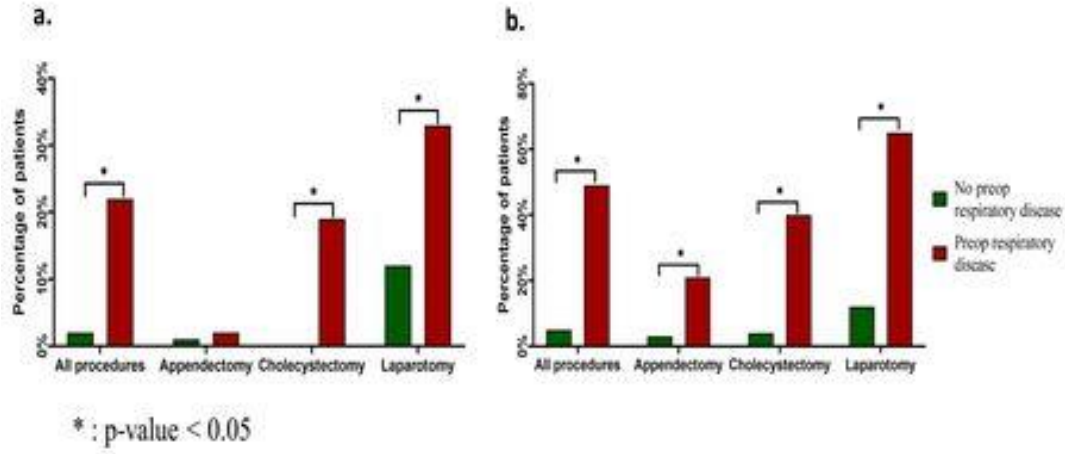


Figure 2: The **a.** mortality, **b.** pulmonary complications, in patients with and without preoperative respiratory signs and symptoms of COVID-19.

Scientific Session III - Resuscitation & Emergency General Surgery

Paper #20
January 13, 2022
5:00 pm

TRAUMATIC BRAIN INJURY ATTENUATES HYPOCOAGULABILITY BY DECREASING FIBRINOLYSIS IN SEVERELY INJURED PATIENTS

Jonathan P. Meizoso, MD, MSPH*, Hunter B. Moore, M.D., Ph.D.,
Ernest Eugene Moore, MD*, Arsen Ghasabyan, M.P.H., James Chandler,
Fredric M. Pieracci, MD, MPH, Angela Sauaia, MD., PhD
Ryder Trauma Center, University of Miami Miller School of Medicine

Presenter: Jonathan P. Meizoso, MD, MSPH

Discussant: Cherisse Berry, MD, NYU Grossman School of Medicine

Objectives: Traumatic brain injury (TBI) in combination with shock has been associated with hypocoagulability. However, recent data suggest that TBI itself can promote a systemic procoagulant state via the release of brain-derived extracellular vesicles. The objective of our study was to identify if TBI was associated with differences in thrombelastography indices when controlling for other variables associated with coagulopathy following trauma. We hypothesized that TBI modifies coagulation toward a less coagulopathic state.

Methods: Prospective study including all highest-level trauma activations at an urban level 1 trauma center, from 2014-2020. TBI was defined as AIS Head>3. Blood samples were drawn at ED admission. Linear regression was used to assess the role of independent predictors on TIC. Models adjusted for ISS, shock (defined as ED SBP<70, or ED SBP<90 and ED HR>108, or base deficit >10), and prehospital GCS.

Results: Of the 1,023 patients included, 291 (28%) suffered a TBI. TBI patients more often were female (26%vs.19%, p=0.01), had blunt trauma (83%vs.43%, p<0.0001), shock (33%vs.25%, p=0.009), and higher median ISS (29vs.10, p<0.0001). Fibrinolysis shutdown (25%vs.18%) was more common in the TBI group (p<0.0001). When controlled for the confounding effects of ISS and shock, the presence of TBI independently decreases LY30 (Beta estimate: -0.16+0.06, p=0.004). This effect of TBI on LY30 persisted when controlling for sex and mechanism of injury in addition to ISS and shock (Beta estimate: -0.13+0.06, p=0.022).

Conclusions: TBI is associated with lower LY30 independent of shock, tissue injury, sex, and injury mechanism. These findings suggest a propensity toward a less coagulopathic state in patients with TBI, possibly due to fibrinolysis shutdown. Tranexamic acid has been reported to improve outcomes following TBI. Our data suggest the mechanism may be independent of changes in fibrinolysis.

Scientific Session IV - Cox-Templeton Injury Prevention Paper Competition

Paper #21
January 13, 2022
3:15 pm

FIREARM HOMICIDES: A BROADER VIEW OF OUR LANE

Dane R. Scantling, DO, MPH*, Elinore J Kaufman, MD, MSHP*, James P. Byrne, MD, PhD*, Justin Hatchimonji, MD, MBE*, Douglas Wiebe, PhD, Daniel N. Holena, MD, MSCE*, Mark J. Seamon, MD, FACS*
Boston University School of Medicine

Presenter: Dane R. Scantling, DO, MPH

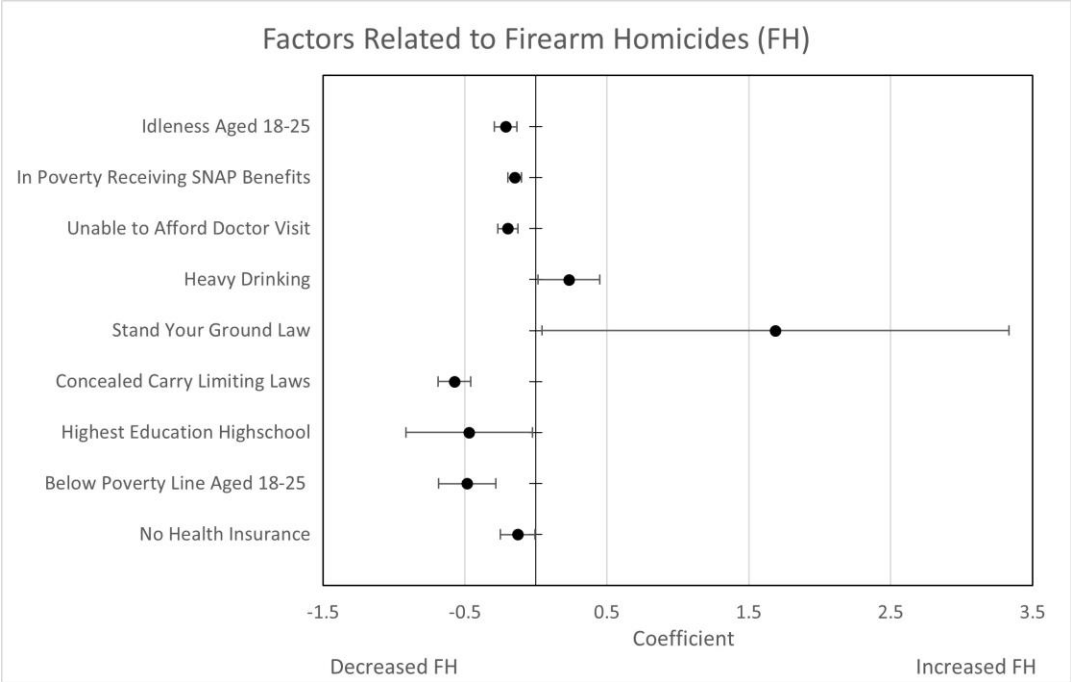
Discussant: Chad Morrison, DO, Banner Health North Colorado Medical Center

Objectives: We have previously shown that firearm restrictive legislation plays an important role in preventing firearm homicides (FH). These laws are enforced in an environment with varying socioeconomic and behavioral risk factors which also contribute to FH, yet analysis regarding the interplay of these coexisting elements is lacking. We hypothesized that both firearm laws and socioeconomic support (SS) would correlate with reduced FH.

Methods: The CDC WONDER and FBI UCR were queried for 2013-2016 state FH data. Firearm access estimates were retrieved from the RAND State-Level Firearm Ownership Database. Alcohol use, depression and access to care data were captured from the CDC BRFSS. Idleness, (SS) and poverty metrics were captured from US Census data. Firearm laws were obtained from the State Firearms Law Database. Variables with significant FH association in univariate panel linear regression were entered into a final multivariable panel regression with fixed effect for state.

Results: 49,610 firearm homicides occurred 2013-2016 (median FH rate 3.26:100,000, range 0.07-11.2). In univariate analysis, idleness ($p<0.001$), SS ($p<0.001$), poverty ($p<0.001$) and concealed carry limiting laws ($p=0.012$) correlated with decreased FH. Heavy drinking ($p=0.036$) and stand-your-ground (SYG) doctrines ($p=0.045$) were associated with increased FH. Background checks, handgun limiting laws, depression rates and weapon access were not correlated (Figure). In multivariable regression, SS (β -0.145, 95%CI -0.182 to -0.082, $p<0.001$) and laws limiting concealed carry (β -0.543, 95%CI -0.942 to -0.144, $p<0.001$) were associated with decreasing FH while SYG allowance correlated with the largest FH increase (β 1.52, 95%CI 0.069 to 2.960, $p=0.040$).

Conclusions: The causes and potential solutions to FH are complex. Our data suggests that the socioeconomic support and firearm restrictive legislation should both be a part of multidisciplinary efforts to reduce firearm deaths in America.



Forest plot of behavioral, legal and socioeconomic factors as they relate to firearm homicide rates in univariate analysis.

Scientific Session IV - Cox-Templeton Injury Prevention Paper Competition

Paper #22
January 13, 2022
3:30 pm

IMPROVING CHILHOOD SAFETY THROUGH A PEER BASED EDUCATIONAL MODEL

Amanda Teichman, MD*, David Walls, MD, Diana Starace,
Allison Mosier, MHA, Rajan Gupta, MD*, Matthew E. Lissauer, MD*
Rutgers Robert Wood Johnson Medical School

Presenter: Amanda Teichman, MD

Discussant: Stephanie Polites, MD, MPH, Mayo Clinic

Objectives: Trauma is the leading cause of childhood morbidity & mortality annually in the US. As an adult level1/pediatric level 2 trauma center, we are committed to injury prevention through outreach/education. Safety Ambassadors Program(SAP) was developed as part of this aim. Safety Ambassadors(SA) are high schoolers who teach elementary school students about safety/injury prevention. This model is impactful, relatable, and engaging when provided by participants' aspirational peers. The curriculum addresses prevalent areas of injury risk: car/pedestrian safety, wheeled sports/helmets, and fall prevention. SAP's goal is to improve safety knowledge/behaviors, and ultimately reduce childhood preventable injuries.

Methods: With IRB approval and as part of quality improvement, pre/post course exams were administered to SAP participants to assess knowledge and behavior. Results were retrospectively reviewed and pre/post training mean scores were calculated. Scores were calculated based on number of correct answers on pre/post exam. Comparisons were made using Student t-test. All tests were 2-tailed with significance set at 0.05. Statistical analysis was performed using SAS software.

Results: Pre/post training results were assessed for 2016-2018. 8,832 students participated in SAP during that time frame. 1st graders demonstrated significant improvement in safety knowledge [pre 9(8.9-9.2)vs post 9.8(9.6-9.9), $p<0.01$] and behavior modification [pre 3.2(3.1-3.2)vs post 3.6(3.5-3.6), $p<0.01$]. Similar findings were seen in 2nd graders: safety pre 9.6(9.4-9.9)vs post 10.1(9.9-10.2), $p<0.01$ and behavior pre 3.3(3.1-3.4) vs post 3.5(3.4-3.6), $p<0.01$].

Conclusions: SAP is a novel educational program. On a local level it has demonstrated improved safety knowledge and behavior in elementary school students. As trauma is the leading cause of pediatric death and disability, enhanced education may lead to life saving injury prevention in this vulnerable population.

Scientific Session IV - Cox-Templeton Injury Prevention Paper Competition

Paper #23
January 13, 2022
3:45 pm

GUN VIOLENCE IS LINKED TO FOOD INSECURITY IN A MAJOR METROPOLITAN CITY

Ayman Ali, BS, Danielle Tatum, PhD, Julia Fleckman, PhD,
Katherine Theall, PhD, M. Chaparro, PhD, Divya Dharmaraj, BS,
Juan C. Duchesne, MD, FACS, FCCP, FCCM*, Sharven Taghavi, MD, MPH, MS, FACS*
Tulane University School of Medicine

Presenter: Ayman Ali, BS

Discussant: Richard Sola Jr., MD, Morehouse School of Medicine

Objectives: Food insecurity (FI) is an important social determinant of health that is associated with intimate partner violence and child maltreatment. The influence of FI on gun violence has not been examined. We hypothesized that FI would be associated with gun violence.

Methods: We performed a cross-sectional analysis of firearm injuries from 2016-2020 at a single institution that serves as the only Level I trauma center in a major southern US city. The data was linked with Map the Meal Gap data, a publicly available dataset which estimates rates of county-level FI based on social determinates, including unemployment, poverty, disability, and other factors. FI by county of patient residence was categorized by rates less than the national average of 11.5% (Low), between the national and state average (16.5%) (Moderate), and greater than the state average (High). Out of state residents were excluded from the analysis.

Results: A total of 3,118 firearm injuries met study criterion. Of these, 138 (4.4%) patients resided in counties with low FI rates, 1048 (33.6%) in moderate FI, and 1932 (62.0%) in counties with high FI. Patients in regions of high FI were more likely to be a level 1 trauma activation, a victim of assault, and have Medicaid or be self-pay. (Table 1) Mortality was not different between groups. Linear regression analysis of firearm injury rates in 9 counties within our trauma center catchment area demonstrated that moderate and high FI were associated with firearm injury (Table 2). Being non-white was also associated with firearm injury. On logistic regression, high FI (OR: 1.88, 95% CI: 1.12-3.08, $p = 0.02$) and younger age were associated with assault by firearm.

Conclusions: Violence prevention initiatives targeting food insecure communities may help alleviate the US gun violence epidemic. Furthermore, trauma center screening for FI and in-hospital interventions addressing FI may help reduce gun violence recidivism.

		Food Poverty Levels			
		Less than 11.5%	Between 11.5% and 16.1%	Greater than 16.1%	P-Value
Demographics					
Median Age (IQR)		28.0 (17.0)	26.0 (14.0)	26.0 (15.0)	0.188
Sex					
	Male	120 (87.0)	906 (86.5)	1684 (87.2)	0.859
	Female	18 (13.0)	142 (13.5)	248 (12.8)	
Race					
	Non-white	87 (63.0)	856 (81.7)	1836 (95.0)	<0.001
	White	51 (37.0)	192 (18.3)	96 (5.0)	
Ethnicity					
	Hispanic or Latino	0 (0.0)	30 (2.9)	26 (1.3)	0.003
	Not Hispanic of Latino	138 (100.0)	1017 (97.0)	1900 (98.3)	
	Unknown	0 (0.0)	1 (0.1)	6 (0.3)	
Payment					
	Medicare/Medicaid/Government Insurance[1]	83 (60.1)	703 (67.1)	1341 (69.4)	0.008
	Self-pay	21 (15.2)	172 (16.4)	332 (17.2)	
	Private/ Commercial Insurance	27 (19.6)	147 (14.0)	222 (11.5)	
	Other	7 (5.1)	26 (2.5)	37 (1.9)	
Transferred from Other Hospital					
	Yes	40 (29.0)	196 (18.7)	196 (10.0)	<0.001
	No	98 (71.0)	1761 (90.0)	853 (81.3)	
Mode of Transport					
	Air	29 (21.0)	128 (12.2)	36 (1.8)	<0.001
	Ambulance	102 (73.9)	827 (78.8)	1508 (77.1)	
	Private	4 (2.9)	93 (8.9)	406 (20.7)	
	Police	1 (0.7)	1 (0.1)	7 (0.4)	
	Unknown	2 (1.4)	0 (0.0)	0 (0.0	
Drug Use					
	Smoking	21 (15.2)	207 (19.8)	363 (18.8)	0.423
	Alcohol/ Other	10 (7.2)	38 (3.6)	69 (3.6)	0.087
Other Comorbidities					
	Hypertension	17 (12.3)	77 (7.3)	124 (6.4)	0.027
	Diabetes	2 (1.4)	25 (2.4)	47 (2.4)	0.764
	Obesity	5 (3.6)	20 (1.9)	33 (1.7)	0.271
	Psychiatric/ Neurologic	10 (7.2)	72 (6.9)	111 (5.7)	0.415
Injury Categorizations					
Trauma Activation					
	Tier 1	99 (71.7)	841 (80.2)	1626 (83.1)	0.021
	Tier 2	27 (19.6)	145 (13.8)	243 (12.4)	
	Unknown	12 (8.7)	63 (6.0)	88 (4.5)	
CDC Intent					
	Assault	107 (77.5)	892 (85.1)	1813 (93.8)	<0.001
	Self-Inflicted	15 (10.9)	69 (6.6)	28 (1.4)	
	Unintentional	15 (10.9)	69 (6.6)	71 (3.7)	
	Undetermined	0 (0.0)	5 (0.5)	9 (0.5)	
	Other	1 (0.7)	13 (1.2)	11 (0.6)	
Severity					
	Median Injury Severity Score (IQR)	9.0 (7.8)	9.0 (13.0)	9.0 (13.0)	0.204
	Median Glasgow Coma Score (IQR)	15.0 (0.0)	15.0 (0.0)	15.0 (0.0)	0.715

Table 1: Description of Study Population by Levels of Regional Food Insecurity
[1]State payment includes: Medicare, Medicaid, payments from jail, or free care.

Logistic Regression Results: Predicting Gun Violence-Related Assaults[1]

	Assault	Other	Odds Ratio (CI) – univariable model	P-value	Odds Ratio (CI) – multivariable model	P-value
Mean Age (SD)	28.9 (12.0)	34.9 (17.7)	0.97 (0.96 -0.98)	<0.001	0.98 (0.98 - 0.99)	0.001
Gender						
Male	2453 (90.5)	257 (9.5)	1.30 (0.93 - 1.79)	0.111	1.04 (0.72 - 1.47)	0.848
Female	359 (88.0)	49 (12.0)	-	-	-	-
Race						
Non-white	2614 (94.1)	165 (5.9)	11.28 (8.64 - 14.75)	<0.001	8.14 (6.08 - 10.91)	<0.001
White	198 (58.4)	141 (41.6)	-	-	-	-
Food Insecurity Levels						
Greater than 16.1%	1813 (93.8)	119 (6.2)	4.41 (2.81 - 6.79)	<0.001	1.88 (1.12 - 3.08)	0.014
Between 16.1% and 11.5%	892 (85.1)	156 (14.9)	1.66 (1.06 - 2.53)	0.023	1.05 (0.64 - 1.70)	0.832
Less than 11.5%	107 (77.5)	31 (22.5)	-	-	-	-

Linear Regression Results: Predicting Rate of Firearm Trauma Admissions[2]

	Mean Rate (SD)	Coefficient (CI) – univariable model	P-value	Coefficient (CI) – multivariable model	P-value
Gender					
Male	423.9 (124.5)	4.40 (-11.16 - 19.96)	0.579	1.88 (-2.93 - 6.68)	0.443
Female	419.5 (130.1)	-	-	-	-
Race					
Non-white	432.9 (113.7)	135.43 (115.76 - 155.09)	<0.001	27.05 (20.55 - 33.55)	<0.001
White	297.4 (188.0)	-	-	-	-
Food Insecurity Levels					
Greater than 16.1%	474.0 (33.3)	390.66 (378.94 - 402.37)	<0.001	385.65 (374.04 - 397.26)	<0.001
Between 16.1% and 11.5%	155.2 (66.8)	71.86 (59.46 - 84.27)	<0.001	71.28 (59.06 - 83.51)	<0.001
Less than 11.5%	83.4 (0.0)	-	-	-	-

Table 2: Relationships of Food Insecurity and Firearm Trauma: Results of Regression Analyses
[1]Probability of assault, given gun-related trauma admission.

[2]Calculated rate of all gun-related trauma admissions per 100,000 persons from 2016-2020. Analysis restricted to patients within the single-center trauma catchment area.

Scientific Session IV - Cox-Templeton Injury Prevention Paper Competition

Paper #24
January 13, 2022
4:00 pm

UNPLANNED READMISSIONS FOR INJURED ADOLESCENTS AT ADULT AND PEDIATRIC TRAUMA CENTERS

Whitney Orji, MD, MSHP, Justin Hatchimonji, MD, MBE*,
Saurabh Saluja, MD, MPP, Michael L. Nance, MD*, Ruth Abaya, MD, MPH,
Daniel N. Holena, MD, MSCE*, Elinore J. Kaufman, MD, MSHP*
Department of Surgery, Perelman School of Medicine, University of Pennsylvania

Presenter: Whitney Orji, MD, MSHP

Discussant: Maria McMahon, RN, MSN, PNP-AC

Objectives: Little is known about patient-centered outcomes for injured adolescents. Readmission rates are associated with health outcomes, healthcare costs, and quality of care coordination. Here, we compared readmission rates for adolescent trauma patients treated at pediatric or adult trauma centers (PTC or ATC), hypothesizing that patients treated at PTCs were less likely to be readmitted.

Methods: The National Readmissions Database (NRD) for 2016 was used to identify patients 15-19 years old admitted for an injury. Non-elective readmissions within 30 days were compared between patients treated at PTCs, ATCs, and non-trauma centers (NTCs). The NRD does not identify trauma centers, so we used a novel, validated machine learning algorithm to identify trauma centers. Multivariable logistic regression incorporating patient and injury characteristics was used to identify the association of center type with 30-d readmissions. NRD survey weights provided nationally representative estimates.

Results: Of 51816 injured adolescents, 12861 (24.8%) were treated at PTCs, 28281 (54.6%) at ATCs, and 10674 (20.6%) at NTCs. 493 (3.8%) patients were readmitted within 30 days for PTCs, 1192 (4.2%) for ATCs, and 505 (4.7%) for NTCs ($p = 0.40$). In multivariable analysis, the odds of readmission were not statistically different between ATC and NTC: 0.96 (95% CI: 0.75, 1.22) or PTC and NTC: 1.01 (0.73, 1.38). Odds of readmissions were greater for severely injured patients (ISS ≥ 16) at PTCs. Re-injury with ISS ≥ 9 accounted for 7.5% of readmissions.

Conclusions: Readmissions were rare among injured adolescents regardless of center type, indicating that injured adolescent patients may receive similar care at both adult and pediatric trauma centers. Nearly 8% of patients readmitted within 30 days return with new, serious injuries, indicating a need for enhanced injury prevention efforts in this group.

Scientific Session IV - Cox-Templeton Injury Prevention Paper Competition

Paper #25
January 13, 2022
4:15 pm

THE ASSOCIATION BETWEEN STRINGENT STATE FIREARM LAWS AND FIREARM HOMICIDES AMONG RACIAL GROUPS IN THE UNITED STATES

Khaled Abdul Jawad, MD, Majid Chammas, MD, Marie L. Crandall, MD, MPH, FACS*, Alessia Cioci, MD, Eva M Urrechaga, MD, Gerd Daniel Pust, MD*, Rishi Rattan, MD*, Nicholas Namias, MBA, MD*, D. Dante Yeh, MD, MHPE, FACS, FCCM, FASPEN*
Ryder Trauma Center, University of Miami Miller School of Medicine

Presenter: Khaled Abdul Jawad, MD

Discussant: Tanya Egodage, MD, Cooper University Hospital

Objectives: States have varying degrees of firearm restrictions. We sought to study the association between state laws and firearm deaths among racial groups in the United States over the past two decades.

Methods: The Web-based Injury Statistics Query and Reporting System (WISQARS) was queried for adult firearm homicide rates among all 50 states between 2001 and 2019. States were divided into five cohorts based on the Giffords Law Center Annual Gun Law Scorecard (A, B, C, D, and F), and two groups were constructed: *Strict* (A, B, and C) and *Lenient* (D and F). Stratification by race was performed, with only data of the black and white subgroups analyzed due to limited reporting for other races in the database. Mean and 95% [CI] crude death rates for all races, white population, and black population were plotted over time for the *Strict* and *Lenient* groups, and Wilcoxon rank-sum test was performed to compare the rates among the two groups. P-values ≤ .05 were considered statistically significant.

Results: 24 states were included in the *Strict* group, and 26 states were included in the *Lenient* group. Mean crude death rates were higher in the *Lenient* group for all races and the white population from 2001 to 2019 (p<.001), but the difference in rates between the two groups among the black population was not statistically significant (p=0.9) **(Figure)**.

Conclusions: Although stricter gun laws were associated with lower firearm homicides in the overall US population, this association seems to be restricted to the white race. Research is needed to identify socioeconomic factors that contribute to this disparity as well as recognize legislation that would benefit racial groups equitably.

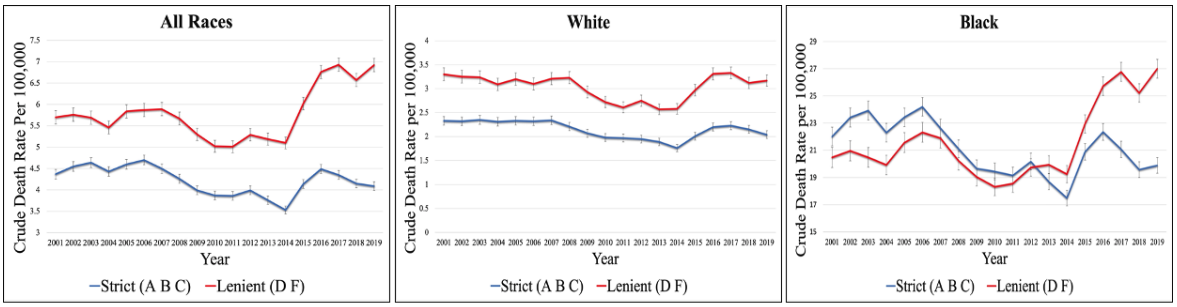


Figure. Firearm Homicide Rates in the *Strict* and *Lenient* Groups Among All Races, White, and Black Over the Past Two Decades

Scientific Session IV - Cox-Templeton Injury Prevention Paper Competition

Paper #26
January 13, 2022
4:30 pm

NOT JUST ONE 'TEACHABLE MOMENT': SUCCESS OF REFERRALS TO A HOSPITAL-BASED VIOLENCE INTERVENTION PROGRAM DURING NON-INJURY ADMISSIONS

Catherine G. Velopulos, MD, MHS, FACS*, Heather E Carmichael, MD,
Anna Cleveland, MSW, Joshua Abolarin, BA, BS*, W. Quintin Myers, PhD,
Benjamin Li, MD, Michelle McDaniel, Katherine Bakes, MD
University of Colorado, Aurora

Presenter: Catherine G. Velopulos, MD, MHS, FACS

Discussant: Andrea Long, MD, UCSF-Fresno

Objectives: Hospital-based violence intervention programs (HVIPs) decrease recidivism and healthcare costs through wraparound services. In our Level 1 urban trauma center, injury intervention specialists respond to trauma activations and alerts, as well as referrals from other inpatient areas, following them into the outpatient setting. We used our HVIP database to determine if patients referred from other inpatient areas were as likely to engage in HVIP services as those engaged after a trauma response.

Methods: Patients aged 14-28 years in our HVIP database from 2019 were linked to the electronic medical record and the local trauma registry to categorize primary complaint for the hospital visit and referral source, and to assess for subsequent ED visits.

Results: 203 patients aged 14-28 years had HVIP bedside interventions; of these, 202 were in the EMR. Referred patients were mostly male (68%) and identified as Hispanic/Latinx (48%) or Black (25%). Most were referred after an intentional violent injury: blunt assault (35%), gunshot wound (20%) and stab wound (8%). However, many patients (n=74, 37%) were referred during admission for another reason (Table). 61% of patients were on our ED trauma list and only 21% were in the trauma registry. Overall, 23% of referred patients engaged with the HVIP after initial intake, with no difference in participation between those who were presenting for intentional violent injury and those who were not (n= 31/128, 24% vs. n=15/74, 20%, p=0.64).

Conclusions: In our HVIP, many referrals occur during hospital visits that are not for intentional violent injury; these patients are just as likely to participate in the HVIP as those who are seen during the ‘teachable moment’ after violent trauma. Patients willing to engage with HVIP services may be missed by traditional HVIP models that focus only on recruitment of patients after violent injuries.

Referrals and Engagement with HVIP		Overall (N=202)
Age in years, median [IQR]		19 [17, 23]
Criminal justice involvement		31 (15.3)
Gang involvement documented		21 (10.4)
Domestic or family violence documented		30 (14.9)
Initial referral during admission/visit for an intentional violent/traumatic injury (%)		128 (63.4)
Physical assault		71 (35.1)
Gunshot wound (assault)		40 (19.8)
Stab wound (assault)		17 (8.4)
Initial referral during admission/visit for another reason (%)		74 (36.6)
Referral Source:	ED trauma	151 (74.8)
	ED (not trauma)	40 (19.8)
	Psych unit or ED	10 (5.0)
	Other	1 (0.5)
Patient is on ED trauma list – assault code for chief complaint (%)		123 (60.9)
Patient is in the trauma registry data (%)		43 (21.3)
Participated in the HVIP after discharge		46 (22.8)
Declined (no explanation)		74 (36.6)
Declined (incarcerated)		14 (6.9)
Declined (not interested in services)		33 (16.3)
Unable to locate (expressed interest in participation but unable to f/u)		35 (17.3)
Engaged after discharge		30 (14.9)
Engaged in services (group therapy, individual meetings, etc.)		16 (7.9)
Visited any ED post referral (%)		93 (46.0)
For medical issue		74 (36.6)
For an intentional violent injury		21 (10.4)
For any injury		31 (15.3)
For substance use related problem		20 (9.9)
For mental health related problem		17 (8.4)

Scientific Session IV - Cox-Templeton Injury Prevention Paper Competition

Paper #27
January 13, 2022
4:45 pm

FIREARM INJURY SURVEILLANCE DISCREPENCIES: A CALL FOR A NATIONAL FIREARM INJURY REGISTRY

Fatima Elgammal, MD, Bianca Dearing, PhD, Ariana Gobaud, Ann Tufariello, MPH, Leonardo Antelo, BA, Salina M. Wydo, MD, FACS*, David H. Livingston, MD*, Marian Passannante, PhD, Bernadette Hohl, PhD
Rutgers-New Jersey Medical School

Presenter: Fatima Elgammal, MD

Discussant: Hillary Prince, MD, MS, University of Texas Southwestern Medical Center

Objectives: The public health approach to gun violence prevention suffers from a lack of our ability to accurately quantify nonfatal injury. The Centers for Disease Control and Prevention's estimates of both fatal and nonfatal firearm injury continue to be unacceptably unreliable as sampling methods and administrative data barriers persist. The purpose of this study is to identify sources of inaccuracy in firearm injury surveillance.

Methods: For a single state, the firearm injury mortality data was queried from 2003-2017 from the CDC WISQARS data, the National Violent Death Reporting System (NVDRS) and the state health assessment dataset (SHAD). To further identify discrepancies, queries of the state trauma databank (STDB), Discharge Data Collection System (DDCS) and VDRS were compared. Finally, individual chart review of the 2 highest volume state trauma centers was done, abstracting circumstantial firearm data from the chart and comparing to the listed external cause code.

Results: Data discrepancies exist in the surveillance of firearm death with the NVDRS undercounting firearm death at an average error of 3.5% compared to WISQARS. 544 individual charts were reviewed. Narrative support of the external cause codes in the chart was very poor, with only 4.5% of cases reporting a weapon, and 22% reporting an activity code. 14.6% of firearm injuries had no assigned e code for firearm injury and 48% of the remaining cases had inaccurate e codes assigned, with overrepresentation of assault and handgun injury without supporting documentation.

Conclusions: In a single state, nearly 15% of the firearm injuries at the two highest volume centers are not reported to any public health system. Furthermore, death counts are even inaccurate up to 4%. On a national scale, that could account for up to 1,600 gun violence deaths unaccounted for annually. A national firearm injury registry is needed for accurate firearm injury surveillance.

	Medical Chart Review E codes				
Billing E codes	W3/Y2	X7	X9	Y3	Total
W3/Y2 Unintentional/undetermined	**56**	0	23	0	79
X7 Self-harm	0	**3**	0	0	3
X9 Assault	116	0	**123**	0	239
Y3 Legal Intervention	0	0	0	**2**	2
Total	172	3	146	2	**323**
% Agreement	32.6%	100.0%	84.2%	100.0%	82.6%

Figure 1: External cause code agreement between billed chart and abstracted chart data

Scientific Session V - Clinical Trauma

Paper #28
January 14, 2022
7:45 am

THE LONG-TERM RISKS OF VENOUS THROMBOEMBOLISM AFTER NON-OPERATIVELY MANAGED SPINAL FRACTURE

Letitia Bible, MD*, Omar Obaid, MD, Adam C Nelson, MD*, Raul Reina, MD, Tanya Anand, MD, MPH*, Michael Ditillo, DO, FACS*, Molly J. Douglas, MD*, Lourdes Castanon, MD*, Bellal Joseph, MD, FACS*
The University of Arizona

Presenter: Letitia Bible, MD

Discussant: Tejal Brahmbhatt, MD, Boston University Medical Center

Objectives: The need for post-discharge prophylaxis following non-operative management of spinal fractures is not well defined. The aim of our study was to evaluate the 1-month and 6-month DVT and PE readmission rates of traumatic spinal fracture patients who were managed non-operatively.

Methods: A retrospective analysis of the 2017 NRD. Patients ≥18yrs with spinal fracture managed non-operatively were included. Patients who died on index admission, those on pre-injury anticoagulants, or had spinal cord injury were excluded. Outcome measures were rates of VTE, DVT, and PE during index admission, and at 1-mo and 6-mo after discharge. Multivariate regression was performed to identify factors independently associated with 6-mo VTE readmissions.

Results: A total of 41,337 adult traumatic spinal fracture patients who underwent non-operative management were identified. Mean age was 61yrs. Level of vertebral fractures was: 11% sacrococcygeal; 29% lumbar; 19% thoracic; 20% cervical; and 21% multiple levels. During the index admission, 601(1.5%) patients developed VTE, among whom 392(0.9%) developed DVT and 281(0.7%) developed PE. Within 1 mo of discharge, 268(0.6%) patients were readmitted with VTE, 177(0.4%) with DVT and 142(0.3%) with PE. Within 6 months of discharge, 513(1.2%) patients were readmitted with VTE, 352(0.9%) with DVT and 250(0.6%) with PE. Among those patients who were readmitted within 6 mo for VTE, mortality was 6.7%. On multivariate analysis, older age (OR 1.01) and discharge to skilled nursing facility, rehabilitation center, or care facility (OR 1.45) were independently associated with 6-mo VTE readmissions.

Conclusions: Risk for DVT, PE, and associated mortality remains high for up to 6 mo after non-operatively managed traumatic spinal fracture. Further studies regarding the optimal duration and choice of thromboprophylactic agent use among this vulnerable subset of trauma patients are warranted.

Scientific Session V - Clinical Trauma

Paper #29
January 14, 2022
8:00 am

COMPARISON OF SURGICAL STABILIZATION OF RIB FRACTURES VS EPIDURAL ANALGESIA ON EARLY CLINICAL OUTCOMES

Thomas J. Martin*, Jessica Cao, BS, Elizabeth Tindal, MD, MPH*, Charles Adams, MD*, Stephanie N. Lueckel, MD ScM FACS, Tareq Kheirbek, MD, ScM, FACS*
Brown University - Alpert Medical School

Presenter: Thomas J. Martin

Discussant: Gregory Semon, DO, Wright State University

Objectives: Surgical stabilization of rib fractures (SSRF) improves functional outcomes compared to controls, partly due to reduction in pain. We investigated the impact of early SSRF on hospital length of stay (LOS) and pulmonary complications when compared to maximal non-operative analgesia with thoracic epidural analgesia (TEA).

Methods: We queried Trauma Quality Improvement Program (TQIP) 2017 dataset for adult patients with rib fractures, excluding those with traumatic brain injury or death within 24 hours. Early SSRF and TEA were defined to occur within 72 hours, and we excluded those with both or neither intervention. Outcomes included pulmonary complications, hospital and ICU length of stay (LOS), and mortality. Multiple logistic and multiple linear regressions were controlled for age, sex, injury severity score (ISS), and presence of flail chest (FC).

Results: Our cohort included 1,024 and 1,109 patients undergoing early SSRF and TEA, respectively. Patients with SSRF had higher rates of FC (42.8 vs 13.3%, $p<0.001$) and increased ISS (17 vs 14, $p<0.001$). On multiple regression, early SSRF was associated with an additional 1.45 days (95%CI: 0.77, 2.13) in the hospital and decreased risk of unplanned intubation (OR:0.54, 95%CI: 0.35, 0.84) compared to early TEA alone. There were no differences in rate of respiratory failure (OR:1.70, 95%CI: 0.70, 4.17), ventilator-associated pneumonia (OR:1.80, 95%CI: 0.71, 4.55), or mortality between groups (OR:1.12, 95%CI: 0.61, 2.06).

Conclusions: Early SSRF was associated with longer hospital stay yet decreased risk of unplanned intubation compared to TEA alone. We observed no difference in mortality or risk of other respiratory complications. When feasible, patients should receive early referral to chest wall injury centers where both interventions are available and appropriate surgical candidates may receive timely intervention.

Scientific Session V - Clinical Trauma

Paper #30
January 14, 2022
8:15 am

FLUOXETINE REDUCES ORGAN INJURY AND IMPROVES MOTOR FUNCTION AFTER TRAUMATIC BRAIN INJURY

Jessica L. Weaver, MD, PhD*, Brian Eliceiri, PhD, Todd Costantini, MD
University of California San Diego

Presenter: Jessica L. Weaver, MD, PhD

Discussant: Brett Tracy, MD, The Ohio State University Wexner Medical Center

Objectives: Traumatic brain injury (TBI) is a leading cause of morbidity and mortality in trauma patients worldwide. Brain injury is associated with significant inflammation, both within the brain and in the peripheral organs. This inflammatory response in TBI leads to a secondary injury, worsening the effects of the original brain injury. Serotonin is linked to inflammation in the intestine and inflammatory bowel disease, and is dysregulated in the brain after TBI, but its role in systemic inflammation after TBI is not known. We hypothesized that using fluoxetine to block serotonin reuptake would reduce lung inflammation and improve motor coordination after TBI.

Methods: C57/B6 mice were given a severe TBI using a controlled cortical impact (CCI). Sham animals were anesthetized but did not undergo craniotomy or CCI. To measure lung permeability, 70kDa FITC-Dextran is injected retro-orbitally. Thirty minutes post-injection the heart is perfused with heparinized saline. The lung was removed, the tissue homogenized and centrifuged, and the fluorescence of the supernatant was measured. To measure motor coordination, mice were placed on the spinning rod (Rotarod) and the time to fall off was measured. This was performed daily until 7 days after injury.

Results: Fluoxetine significantly reduced lung permeability after TBI (Figure 1A) and improved performance on the Rotarod 7 days after injury (Figure 1B).

Conclusions: Use of fluoxetine has the potential to reduce lung injury and improve motor coordination in severe TBI patients. Further study will be needed to elucidate the mechanism behind this effect.

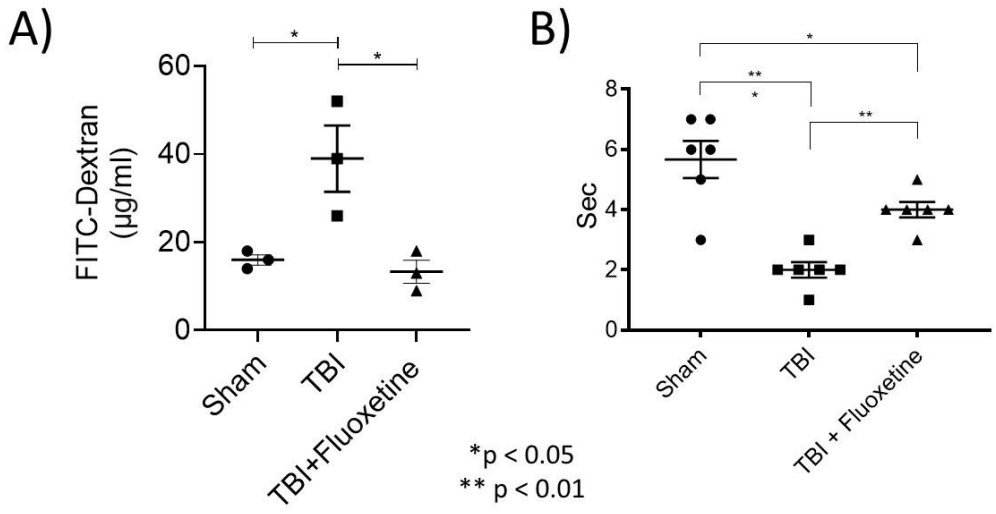


Figure 1: A) Lung permeability at 4 hours after injury in sham, TBI, and TBI + 5 mg/kg fluoxetine mice. B) Time able to stay on rotarod in sham, TBI, and TBI + 5 mg/kg fluoxetine mice seven days after injury.

Scientific Session V - Clinical Trauma

Paper #31
January 14, 2022
8:30 am

ROUTINE REPEAT BRAIN CT SCANNING IS UNNECESSARY IN OLDER PATIENTS WITH GCS 14-15 AND A NORMAL INITIAL BRAIN CT SCAN REGARDLESS OF PREINJURY ANTITHROMBOTIC USE: A MULTICENTER STUDY OF 3033 PATIENTS

Saptarshi Biswas, MD, Stephen F. Flaherty, MD*, Dorraine D. Watts, PhD*, Nina Wilson, MSN, RN, Yan Shen, PhD, Darrell Hunt, MD, Kenneth Helmer, MD, FACS*, Gary J. Curcio, MD, Randy Gauny, MBA, BSN, RN, Dallas A. Taylor, MSN*, Ralph Barker, MD, PhD*, Charles Miller, MD, Matthew M. Carrick, MD*, Mark J. Lieser, MD*, Samir M. Fakhry, MD, FACS*, Delayed Brain Hemorrhage Research Group
Center for Trauma and Acute Care Surgery Research,
HCA Healthcare, Nashville TN & the HCA Trauma System

Presenter: Saptarshi Biswas, MD

Discussant: Molly Deane, MD, Harbor UCLA Medical Center

Objectives: There is no evidence-based consensus on the need for repeat brain CT scan in older patients with head trauma, initial GCS 14-15, negative first brain CT, and pre-injury antithrombotic (AT) therapy. The study objective was to determine if use of an AT agent is associated with the rate of delayed intracranial hemorrhage (dICH), need for surgery and mortality to determine the utility of repeat scanning in this population.

Methods: Centers from a large community hospital network were trained and provided data collection instruments per IRB-approved protocols. Data were from chart review and EMR download. Adults > 55 yrs presenting to Level I/II Trauma Centers between 2017-19 with suspected head trauma, GCS of 14-15, negative initial brain CT and no other AIS injuries >2 were identified and grouped by pre-injury AT therapy as AT- or AT+. Groups were compared on dICH rate, need for operative neurosurgical intervention and attributable mortality using univariate analysis (α=.05).

Results: 3033 patients from 24 centers were enrolled; 292 (9.6%) had repeat brain CT scan. In those rescanned, dICH rate was 14/134 (10.4%) for AT- and 10/158 (6.3%) in AT+, *P*=.202. Assuming non-rescanned patients did not suffer clinically significant dICH, the rate of dICH would be 14/2062 (0.7%) for AT- and 10/971 (1.0%) for AT+, *P*=.309. All-cause mortality was 9/3033 (0.3%) and attributable mortality was 1/3033 (0.03%). The single attributable death was an AT+ dICH patient whose family declined interventions. No surgical interventions were done for dICH.

Conclusions: In older patients with an initial GCS of 14-15 and a negative initial brain CT scan, the rate of dICH is small and of minimal clinical consequence regardless of AT use. No patient had operative neurosurgical intervention. Routine re-scanning of these patients is not supported.

Scientific Session V - Clinical Trauma

Paper #32
January 14, 2022
8:45 am

POTENTIAL INFLUENCE OF A RANDOMIZED CONTROLLED TRIAL ON PRACTICE PATTERNS AND OUTCOMES IN PATIENTS WITH SEVERE TRAUMATIC BRAIN INJURY

Tyler Johnston, BS, Ian Hulsebos, BS, Makoto Aoki, MD, PhD, Cameron Ghafil, MD, Kenji Inaba, MD, Kazuhide Matsushima, MD*
LAC+USC Medical Center

Presenter: Kazuhide Matsushima, MD

Discussant: Mayur Patel, MD, MPH, Vanderbilt University Medical Center

Objectives: In 2016, the results of the RESCUEicp trial showed that the use of decompressive craniectomy (DC) for refractory intracranial hypertension from traumatic brain injury (TBI) was associated with lower mortality, but higher rate of vegetative states compared to medical therapy. The objectives of this study were to compare practice patterns and patient outcomes before and after the RESCUEicp trial was published. We hypothesized that there would be a trend towards decreased use of DC and increased mortality in the post-RESCUEicp period.

Methods: This is a retrospective cohort study using the ACS-TQIP database 2013-2018. We included patients (age≥18 years) with isolated severe TBI (AIS 4/5). The patients were divided into pre-RESCUE (2013-2014) and post-RESCUE (2017-2018) groups by the year of admission. The primary outcome was the rate of DC, and secondary outcomes included in-hospital mortality, rate of withdrawal of care, and discharge disposition.

Results: A total of 143,675 patients (70,563 in the pre-RESCUE and 73,112 in the post-RESCUE) were included for analysis. The median age was 64 years and the most common mechanism was fall. (65.7%). DC was performed less frequently in the post-RESCUE group (1.9% vs. 1.6%, $p<0.001$). The mean time to DC was not significantly different (29.1 hours vs. 29.0 hours, $p=0.98$). While in-hospital mortality was significantly higher in the post-RESCUE group (10.4% vs. 16.0%, $p<0.001$), withdrawal of care occurred more frequently in this group (6.1% vs. 12.1%, $p<0.001$).

Conclusions: Our results suggest that the use of DC has decreased following the RESCUEicp trial. Although further studies are warranted, it appears withdrawal of care has become more common in patients with severe TBI.

Scientific Session V - Clinical Trauma

Paper #33
January 14, 2022
9:00 am

ROLE OF ICP MONITORING IN GERIATRIC TRAUMA PATIENTS

Bardiya Zangbar Sabegh, MD, Joshua Klein, DO, Ilya Shnaydman, MD,
Matthew Bronstein, MD, Jorge Con, MD*, Anthony Policastro, MD*, Rifat Latifi, MD,
Kartik Prabhakaran, MD*, Peter Rhee, MD, MPH, FACS, FCCM*
Westchester Medical Center

Presenter: Bardiya Zangbar Sabegh, MD

Discussant: Bruce Chung, MD, Maine Medical Center

Objectives: Intracranial pressure (ICP) monitoring is currently recommended by Brain Trauma Foundation guidelines for severe traumatic brain injury (TBI). The clinical value and the effect of ICP monitoring in geriatric patient population is unknown. We hypothesized that ICP monitoring does not change mortality in geriatric patient population.

Methods: Trauma Quality Improvement Program (TQIP) database (2013–2016), was quarried to identify intubated geriatric patients (≥65 years of age) with isolated blunt TBI (non-Head Abbreviated Injury Scale (AIS) score < 3) with admission Glasgow Coma Scale (GCS) scores of 3–8. Patients with hospital length of stay <24 hours were excluded. Demographic data, status of ICP monitor placement, Head-AIS, Injury Severity Score, GCS, and outcome measures were collected. After performing multiple imputation to account for missing values, propensity score (PS) matching was performed between ICP monitor and non-ICP monitor patients and outcomes were compared.

Results: A total of 264, 285 patients were identified with TBI of which 4,433 were included based on our criteria. 733 patients were treated with an ICP monitor. After PS matching, there was no difference in mortality between the two groups (48.8% vs 49%, p=0.9), however patients treated with ICP monitor had significantly longer hospital length of stay (p=0.001), ICU length of stay (p=0.001) and ventilator days (p=0.001).

Conclusions: In geriatric trauma patients who are intubated with a severe blunt TBI, ICP monitoring leads to increased hospital and ICU length of stay, however it does not appear to impact the mortality rate. Increasing number of geriatric trauma patients demands an improvement of current guidelines and resource allocation.

Scientific Session V - Clinical Trauma

Paper #34
January 14, 2022
9:15 am

BLUNT CEREBROVASCULAR INJURIES: TIMING OF CHANGES TO INJURY GRADE AND STROKE FORMATION ON SERIAL IMAGING FROM AN EAST MULTI-INSTITUTIONAL TRIAL

Kristin Sonderman, MD, MPH*, Emily Esposito, DO, Timothy W Wolff, DO,
M. Chance Spalding, DO, PhD, FACS*, Joshua Simpson, MD*,
Julie A. Dunn, MS, MD*, Linda Zier, RN, Sigrid Burruss, MD FACS, Paul Kim, BS,
Lewis E. Jacobson, MD, FACS*, Jamie Williams, MSML, BSN, RN, CCRP,
Jeffry Nahmias, MD, MHPE, FACS, FCCM*, Areg Grigorian, MD, Laura Harmon, MD*,
Anna Gergen, MD, Matthew Chatoor, MBBS*, Rishi Rattan, MD*,
Andrew J. Young, MD, FACS*, Jose L. Pascual, MD, PhD, FRCS(C), FACS, FCCM*,
Jason Murry, MD*, Adrian W. Ong, MD*, Alison Muller, MLS, MSPH,
Rovinder S. Sandhu, MD*, Rachel Appelbaum, MD*, Nikolay Bugaev, MD*,
Antony Tatar, Khaled Zreik, MD, MS, FACS*, Leah Hustad, CCRC,
Mark J. Lieser, MD*, Shenequa Deas, MPH, Deborah M. Stein, MD, MPH, FACS, FCCM*,
Thomas M. Scalea, MD, FACS, FCCM*, Margaret H. Lauerman, MD*
R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine

Presenter: Kristin Sonderman, MD, MPH

Discussant: Eric Shurtleff, DO, Main Medical Center

Objectives: Patients with blunt cerebrovascular injuries (BCVI) often undergo follow-up imaging to facilitate stroke prevention strategies through detection of BCVI morphology changes. The objective of this study was to determine the timing of change in injury grade or stroke formation after BCVI.

Methods: A sub-analysis of a multi-institutional (16 hospitals), observational trial including BCVIs from 2018 to 2020 was undertaken. BCVI imaging characteristics were collected from all imaging obtained during index admission. We performed descriptive statistics, time series analysis, and time to event analysis.

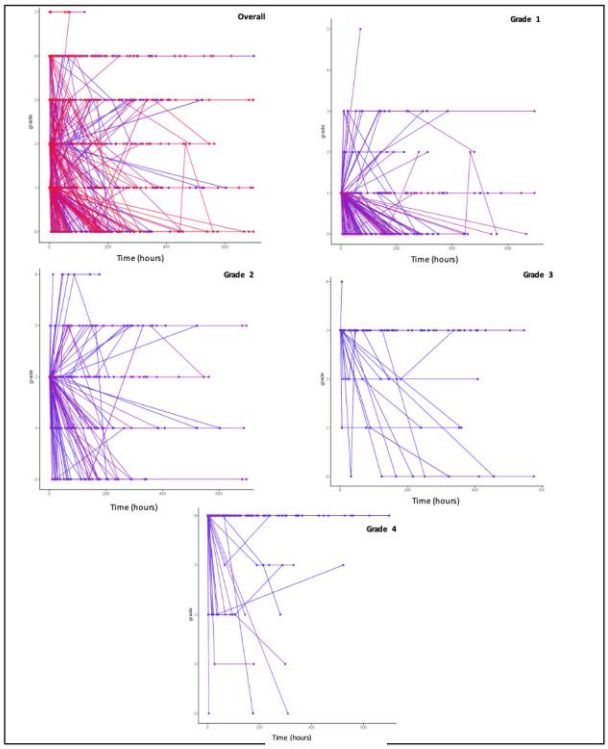
Results: 739 BCVIs were included. BCVIs underwent a median of 2 [IQR 1, 3] imaging studies, with a range of 1-9 images. 266 patients (36%) did not receive any further imaging. BCVIs were most commonly grade 1 (n=310, 42%) followed by grade 2 (n=221, 30%), grade 4 (n=130, 18%), grade 3 (n=74, 10%), and grade 5 injuries (n=4, <1%). A total of 221 BCVIs (30%) had a change in grade over time; 7% (n=51) increased in grade, 24% (n=178) decreased in grade, and 18% (n=133) resolved *(table and figure).* A total of 68 BCVIs (9%) were associated with a BCVI-related stroke. The median time from admission to change in grade was 7.4 days [IQR 3.6, 14] and median time to stroke formation was 1 day [IQR 0.42, 2.9]. Median time to stroke formation for all BCVI grades was shorter than median time to BCVI grade change *(table)*.

Conclusions: The timing and number of serial imaging obtained following BCVI for stroke prevention vary widely. Stroke development in BCVIs most often occurs within the first 1-3 days from initial injury while changes to grade/morphology occur later within the hospital course. The utility therefore of serial BCVI imaging over an extended period of time for stroke prevention remains uncertain and warrants further investigation.

	Total n=739	Grade I n=310 (42%)	Grade II n=221 (30%)	Grade III n=74 (10%)	Grade IV n=130 (18%)	Grade V n=4 (<1%)
Change in grade over time	221 (30%)	105 (34%)	80 (36%)	19 (26%)	17 (13%)	0
Increase in grade	51 (7%)	23 (7%)	27 (12%)	1 (1%)	0	0
Decrease in grade	178 (24%)	85 (27%)	58 (26%)	18 (24%)	17 (13%)	0
*Resolution of BCVI	133 (18%)	85 (27%)	34 (15%)	9 (12%)	5 (4%)	0
Time to change in grade median, [IQR] days	7.4 [3.6, 14]	7.2 [3.6, 11]	7.2 [3.5, 14]	13 [7.2, 18]	11.7 [3.6, 13.8]	--
CVA occurrence	68 (9%)	11 (3%)	30 (14%)	10 (14%)	15 (12%)	2 (50%)
Time to CVA median, [IQR] days	1.0 [.42, 2.9]	4 [2.8, 5.7]	.58 [.23, 1.0]	1.2 [.56, 4.1]	1.0 [.42, 1.6]	1.4 [.80, 1.9]

*subset of patients who had a decrease in grade

Changes in BCVI grade by repeat imaging and timing of change in grade and stroke formation



Change in BCVI grade over time (hours), overall and by initial BCVI grade

Scientific Session V - Clinical Trauma

Paper #35
January 14, 2022
9:30 am

ROUTINE CT SCREENING FOR BLUNT CEREBROVASCULAR INJURY IDENTIFIES INJURIES MISSED BY CLINICAL RISK FACTORS

Paul R. Harper, Lewis E. Jacobson, MD, FACS*, Zachary Sheff, MPH,
Jamie Williams, MSML, BSN, RN, CCRP, Richard Rodgers, MD
Ascension St. Vincent Hospital

Presenter: Paul R. Harper

Discussant: Nina Glass, MD, Rutgers New Jersey Medical School

Objectives: Current guidelines for screening for Blunt Cerebrovascular Injury (BCVI) are commonly based on the Denver Criteria, a set of risk factors that identifies patients who require CT-angiographic (CTA) evaluation for these injuries. Based on previously published data from our center, we have used more liberal screening guidelines than outlined in the Denver Criteria. This entails routine CTA of the neck for all blunt trauma patients already undergoing CT of the cervical spine or CTA of the chest. The aim of this study was to investigate the incidence of BCVI in patients with blunt trauma who did not meet any of the risk factors included in the Denver Criteria.

Methods: A retrospective review of all patients diagnosed with BCVI between June 2014 and December 2019 at a Level I Trauma Center were identified from the trauma registry. Medical records were reviewed for the presence or absence of risk factors as outlined in the expanded Denver Criteria. Demographic data, time to CTA and treatment, BCVI grade, GCS and ISS were collected.

Results: During the study period 17,054 blunt trauma patients were evaluated, and 29% (4923) underwent CTA of the neck to screen for BCVI. 167 BCVIs were identified in 160 patients (0.94% of all blunt trauma patients, 3.25% of patients screened with CTA). 16% (25/160) of patients with BCVI had none of the risk factors outlined in the Denver Criteria. Mechanism of injury is outlined in Table 1. Clinical characteristics are outlined in Table 2.

Conclusions: Our findings indicate that reliance on the Denver Criteria alone for BCVI screening will result in missed injuries. Liberal use of CTA screening in all patients with blunt trauma undergoing CT of the cervical spine or CTA of the chest should be considered to minimize this risk.

	Denver Criteria Present?		
	Yes	**No**	Total
MVC/MCC	93 (84.5%)	17 (15.5%)	110 (68.7%)
Fall	18 (81.8%)	4 (18.2%)	22 (13.7%)
Ped struck	5 (71.4%)	2 (28.6%)	7 (4.4%)
Assault	3 (75.0%)	1 (25.0%)	4 (2.5%)
ATV/Other	6 (85.7%)	1 (14.3%)	7 (4.4%)
Bicycle	4 (100%)	0	4 (2.5%)
Hanging	2 (100%)	0	2 (1.3%)
Other	4(100%)	0	4(2.5%)
Total	135 (84.4%)	25 (15.6%)	160 (100%)

Table 1: BCVI by mechanism of injury and presence or absence of Denver Criteria

	Denver Criteria Present?		
	Yes	No	p-Value*
Age	51.28	47.21	0.278
GCS	11.6	13.6	**0.018**
ISS	22.1	14.7	**0.004**
Avg. time to CTA (hours)	5.8	1.9	0.119
Avg. time to treat (hours)	42.7	20	**0.001**
BCVI Grade I, II	74 (80.4%)	18 (19.6%)	n/a
BCVI Grade III, IV, V	61 (89.7%)	7 (10.3%)	n/a

Table 2: Clinical characteristics in patients with BCVI in the presence or absence of Denver Criteria.

*Significance indicates a p-value < 0.05 for two-tailed t-test (continuous variables), z-score test of two proportions (count variables), or Fisher's exact test (count variables, n < 5) as appropriate.

Scientific Session VI - Trauma Systems & Education

Paper #36
January 14, 2022
7:45 am

ASSOCIATION BETWEEN CHILD ACCESS PREVENTION (CAP) AND STRINGENT STATE FIREARM LAWS WITH ALL-INTENT PEDIATRIC FIREARM-RELATED DEATHS

Majid Chammas, MD, Saskya E. Byerly, MD*, Jennifer Lynde, DO*,
Alejandro Mantero, PhD, Rebecca A. Saberi, MD, Gareth P. Gilna, MD,
Gerd Daniel Pust, MD*, Rishi Rattan, MD*, Nicholas Namias, MBA, MD*,
Marie L. Crandall, MD, MPH, FACS*, D. Dante Yeh, MD, MHPE, FACS, FCCM, FASPEN*
University of Miami Miller School of Medicine

Presenter: Majid Chammas, MD

Discussant: Regan Williams, MD, MSE, University of Tennessee Health Science Center

Objectives: We aim to study the association between state CAP and stringent overall firearm laws with pediatric firearm-related mortality.

Methods: The Centers for Disease Control and Prevention Web-based Injury Statistics Query and Reporting System (WISQARS) was queried for pediatric (<18 y) all-intent (accidental, suicide, and homicide) firearm-related crude death rates (CDR) among 50 states and the District of Columbia from 1999 to 2019. We divided states into 3 groups based on CAP law status: Always CAP (for the 20-yr period), Never CAP, and New CAP (enacted new CAP during the study period). We used the Giffords Law Center Annual Gun Law Scorecard (A, B, C, D, F) to group states into strict (A, B) and lenient (C, D, F) firearm laws. A scatter plot was constructed to display state CDR based on CAP laws by year. The top 10 states by CDR per year were tabulated based on CAP law status. Wilcoxon-rank sum was used to compare CDR between strict and lenient scorecard states in 2019. P-values <0.05 are statistically significant.

Results: There were 12 Always CAP, 22 Never CAP, and 17 New CAP states from 1999 to 2019. No states changed from CAP laws to no CAP laws. Never CAP and New CAP states dominated the high outliers in CDR compared to Always CAP (**Figure 1**). The top 10 states with the highest CDR per year were most commonly Never CAP (**Table 1**). Strict firearm laws states had lower median CDR in 2019 than lenient states (0.79 [0-1.67] vs 2.59 [1.66-3.53], p=.007).

Conclusions: Stricter overall gun laws are associated with three-fold lower all-intent pediatric firearm-related deaths. For two decades, the 10 states with the highest CDR were almost universally those without CAP laws. Our findings support the RAND Gun Policy in America initiativeâ€™s claims on the importance of CAP laws in reducing suicide, unintentional deaths, and violent crime among children, but more research is needed.

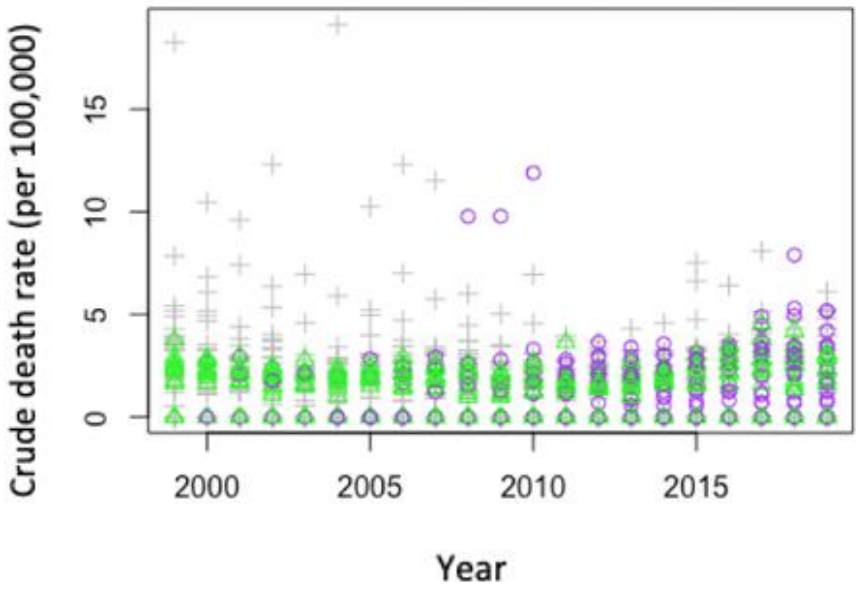


Figure 1. Crude death rates by CAP law status during 1999-2019
CAP = Child Access Prevention
Legend: Always CAP: green triangle; Never CAP: gray cross; New CAP: purple circle

	Always CAP	New CAP	Never CAP
1999	0	0	10
2000	0	0	10
2001	1	0	9
2002	0	0	10
2003	2	0	8
2004	0	0	10
2005	0	1	9
2006	1	0	9
2007	0	0	10
2008	0	1	9
2009	0	2	8
2010	1	3	6
2011	1	2	7
2011	0	3	7
2012	1	3	6
2013	1	3	6
2014	0	4	6
2015	1	2	7
2016	1	3	6
2017	2	2	6
2018	2	4	4
2019	0	3	7
All Years (sum)	**14**	**36**	**170**

Table 1. Number of top 10 states by CDR based on CAP law status
CAP = Child Access Prevention; CDR = crude death rate

Scientific Session VI - Trauma Systems & Education

Paper #37
January 14, 2022
8:00 am

FAILURE TO RESCUE IN TRAUMA: EARLY AND LATE MORTALITY IN LOW AND HIGH PERFORMING TRAUMA CENTERS

Naveen Sangji, MD, MPH, Laura Gerhardinger, Bryant W. Oliphant, MD, MBA, MSc, Anne Cain-Nielsen, MS, John W Scott, MD, MPH*, Mark R. Hemmila, MD*
University of Michigan

Presenter: Naveen Sangji, MD, MPH

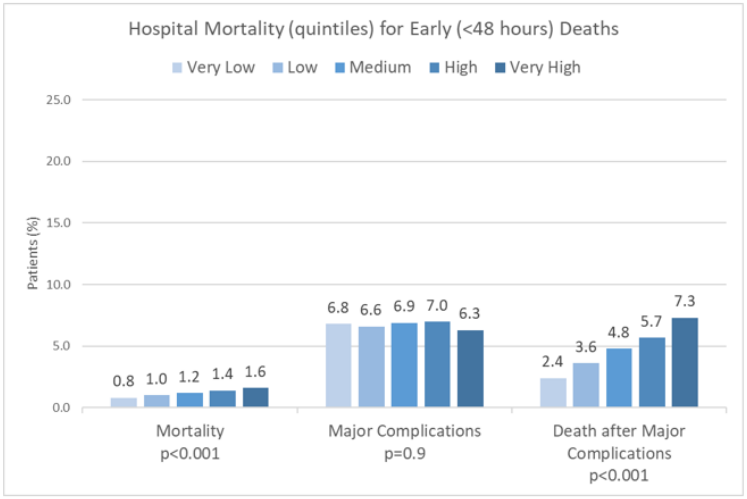
Discussant: Brittany K. Bankhead, MD, MS, Texas Tech University Health Sciences Ctr

Objectives: Failure to Rescue (FTR) is defined as mortality following a complication. FTR has had mixed results in the literature and has come under scrutiny as a quality metric to compare trauma centers. In contrast to elective surgery, trauma has an early period of high expected mortality due to injury sequelae rather than a complication. Here, we report FTR in early and late mortality using an externally validated trauma patient database.

Methods: The study included 114,220 patients at 34 Level I and II trauma centers in a statewide quality collaborative (2016-2020) with ISS ≥5. Emergency room deaths were excluded. Multivariate regression models were used to produce center-level adjusted rates for mortality and major complications. Centers were ranked on adjusted mortality rate and divided into quintiles. Early deaths (within 48 hours of presentation) and late deaths (after 48 hours) were analyzed.

Results: Overall, 7.8% of patients had a major complication and 3.1% died. There was no difference in the mean risk-adjusted complication rate amongst the centers (Figures 1 and 2). FTR was significantly different across quintiles. For early deaths the FTR rate was 7.3% in the highest vs. 2.4% in the lowest mortality quintiles, $p<0.001$ (ANOVA). For late deaths, the overall FTR rate was 14.0% vs. 4.7% for early deaths, and there was a twofold increase in the FTR rate between the lowest and highest performing centers, $p<0.001$.

Conclusions: Similar to elective surgery, low-performing trauma centers have higher mortality rates due to lower rates of rescue following complications. Expected deaths may contribute more to early mortality than late mortality at low and high performing centers. A better understanding of the complications and their role in mortality after 48 hours is an area of interest for quality improvement efforts.



*Major complications include: Deep venous thrombosis, ICU readmission, pneumonia, decubitus ulcer, catheter related blood stream infection, C. difficile infection, unplanned return to the OR, enterocutaneous fistula, pulmonary embolism, cardiac arrest requiring cpr, acute renal failure, unplanned intubation, systemic sepsis, ARDS, myocardial infarction, stroke/CVA, renal insufficiency, VAP.

Figure 1: Rates of Death, Major Complications, and Death after Major Complications, According to Hospital Quintile of Mortality, for Early Deaths

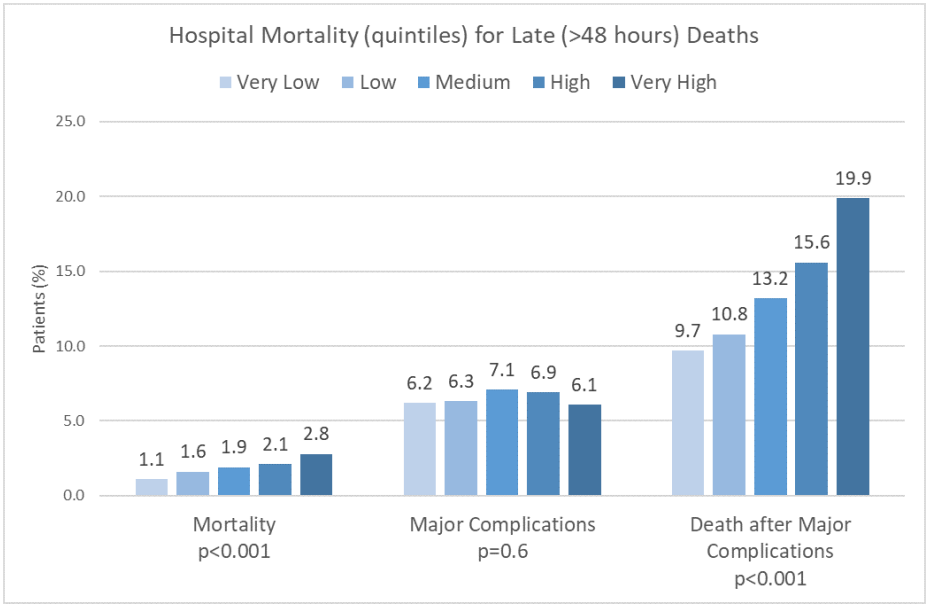


Figure 2: Rates of Death, Major Complications, and Death after Major Complications, According to Hospital Quintile of Mortality, for Late Deaths

Scientific Session VI - Trauma Systems & Education

Paper #38
January 14, 2022
8:15 am

ICD-10-BASED MACHINE LEARNING MODELS OUTPERFORM THE TRAUMA AND INJURY SEVERITY SCORE (TRISS) IN SURVIVAL PREDICTION

Zachary Tran, MD, Arjun Verma, Sigrid Burruss, MD, FACS,
Kaushik Mukherjee, MD, MSCI, FACS*, Peyman Benharash, MD, FACS
University of California, Los Angeles

Presenter: Zachary Tran, MD

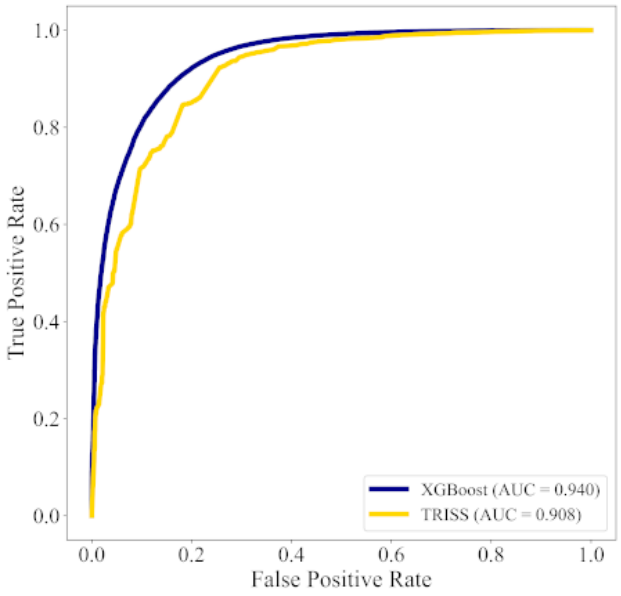
Discussant: Kyle Cunningham, MD, MPH, Atrium Health - Carolinas Medical Center

Objectives: Precise models are necessary to estimate mortality risk following traumatic injury to inform clinical decision making or quantify hospital performance. The Trauma and Injury Severity Score (TRISS) has been the gold standard in survival prediction but its limitations are well-characterized. The present study used *International Classification of Diseases 10th Revision* (ICD-10) injury codes and machine learning approaches to develop survival prediction models whose performance was compared to that of TRISS.

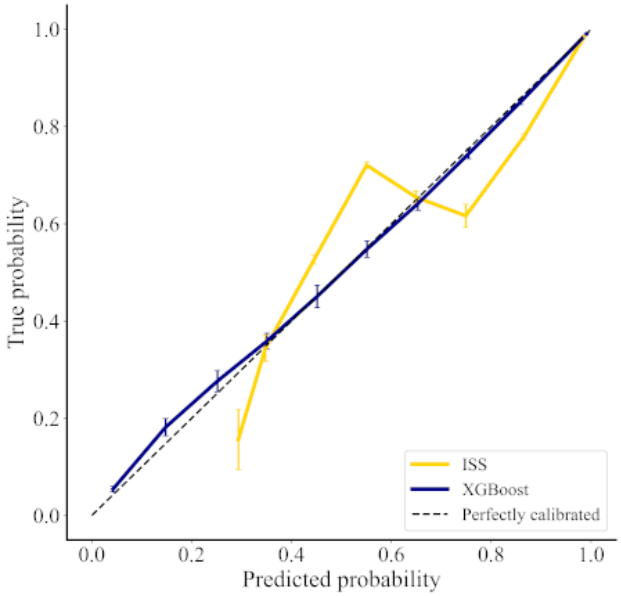
Methods: The 2015–2017 National Trauma Data Bank was used to identify patients following trauma-related admission. Injury codes from ICD-10 were grouped by clinical relevance into 1,492 variables. The TRISS score, which comprises the Injury Severity Score, age, mechanism (blunt vs penetrating) as well as highest 24-hour values for systolic blood pressure (SBP), respiratory rate (RR) and Glasgow Coma Scale (GCS) was calculated for each patient. An eXtreme gradient boosting model (XGBoost), a machine learning technique, was developed using injury variables as well as age, SBP, RR, mechanism and GCS. Prediction of In-hospital survival models were compared between both models using receiver operating characteristic (ROC) and reliability plots.

Results: Of 1,406,140 patients included, 96.95% survived. Compared to those who died, patients who survived were younger (median: 50 years (IQR:27-70) vs 61 (IQR:35-78)), had higher 24-hour SBP (136 mmHg (IQR:121-153) vs 125 (IQR:91-153)) and more commonly involved in blunt mechanisms (90.3 vs 81.8%) (all $p<0.001$). The XGBoost model exhibited a better C-statistic (ROC: 0.940±0.001 vs 0.908±0.001) and superior calibration (R^2=0.997 vs 0.814) compared to TRISS (Figure).

Conclusions: We report improved performance of machine learning models over TRISS. Our model may improve stratification of injury severity in clinical and quality improvement settings.



Receiver operating characteristics comparing XGBoost model with TRISS. AUC: area under curve



Calibration curves comparing XGBoost model with TRISS.

Scientific Session VI - Trauma Systems & Education

Paper #39
January 14, 2022
8:30 am

PREHOSPITAL SYNERGY: TRANEXAMIC ACID AND BLOOD TRANSFUSION IN PATIENTS AT RISK FOR HEMORRHAGE

Andrew-Paul Deeb, MD, Lara Hoteit, MD, Heather Phelos, MPH, Shimena Li, MD, Frank Guyette, MD, MPH, Brian J. Eastridge, MD*, Raminder Nirula, MD, MPH, Gary A. Vercruysse, MD*, Terence O'Keeffe, MD, MSPH*, Bellal Joseph, MD, FACS*, Matthew D. Neal, M.D., Jason L. Sperry, MD, MPH*, Joshua B Brown, MD, MSc*
University of Pittsburgh Medical Center

Presenter: Andrew-Paul Deeb, MD

Discussant: Zain G. Hashmi, MD, University of Alabama at Birmingham School of Medicine

Objectives: Growing evidence supports improved survival with prehospital blood products. Recent trials show a benefit of prehospital tranexamic acid (TXA) administration in select subgroups. Our objective was to determine if receiving prehospital packed red blood cells (pRBC) in addition to TXA improved survival in injured patients at risk of hemorrhage.

Methods: A secondary analysis of all scene patients from the STAAMP trial was performed. Patients were randomized to prehospital TXA or placebo. Some EMS services utilized pRBC. Four resuscitation groups resulted: TXA, pRBC, TXA+pRBC, and neither. Our primary outcome was 30d mortality and secondary outcome 24h mortality. Cox regression tested the association between resuscitation group and mortality while adjusting for confounders.

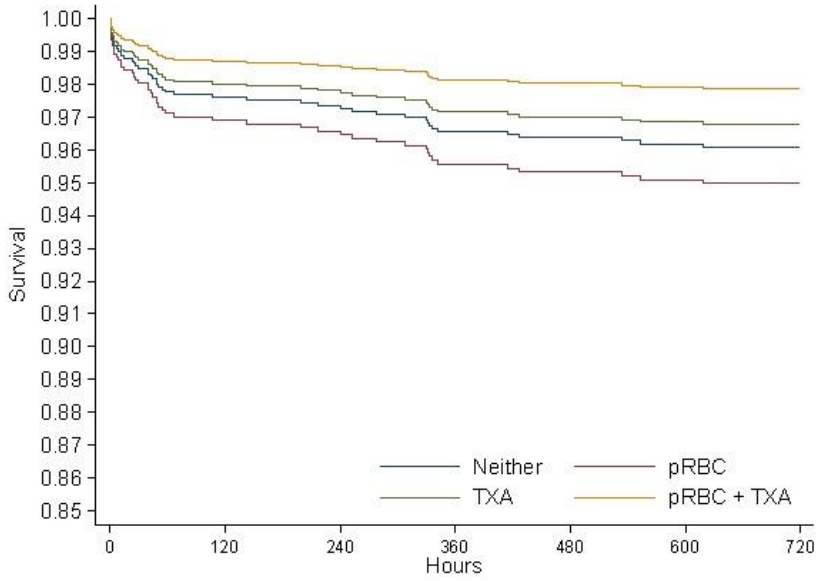
Results: 763 patients were included. Table 1 shows resuscitation group characteristics. Overall, patients receiving prehospital blood were sicker with ISS higher in the pRBC (22 [10, 34]) and combined TXA+pRBC (22 [17, 36]) groups than in TXA (12 [5, 21]) and neither (10 [4, 20]), $p<0.01$. Mortality was greatest in the TXA+pRBC and pRBC groups at 28.6% and 23.4%, respectively. TXA alone had no mortality benefit; however, resuscitation with TXA+pRBC was associated with a 46% reduction in hazards of 30d mortality vs neither (HR 0.54; 95%CI 0.34-0.86, $p=0.009$; Fig 1). No survival benefit was observed at 24h for TXA+pRBC, but pRBC alone was associated with a 47% reduction in hazards of 24h mortality (HR 0.53; 95%CI 0.45-0.65, $p<0.001$).

Conclusions: For injured patients at risk of hemorrhage, prehospital combination of TXA+pRBC is associated with reduced 30-day mortality. pRBC transfusion alone was associated with a reduction in early mortality. Potential synergy appeared only in longer term mortality and further work to investigate mechanisms of this therapeutic benefit is needed to optimize the prehospital resuscitation of trauma patients.

Table 1. Patient Characteristics by Resuscitation Groups

	TXA (n=350)	pRBC (n=35)	TXA + pRBC (n=22)	Neither (n=356)	p-value
Age, years	39 (26, 52)	53 (40, 69)	39 (31, 56)	37 (25, 55)	<0.001
Sex (male)	254 (73%)	23 (66%)	11 (50%)	262 (74%)	0.090
Blunt mechanism	305 (87%)	28 (80%)	18 (82%)	323 (91%)	0.130
PH time, min	37 (28, 46)	41 (31, 63)	41 (34, 49)	36 (30, 45)	0.068
PH SBP, mmHg	128 (90, 147)	84 (74, 95)	86 (68, 102)	128 (89, 148)	<0.001
PH HR, bpm	118 (112, 128)	112 (90, 120)	115 (99, 140)	118 (112, 125)	0.074
ISS	12 (5, 21)	22 (10, 34)	22 (17, 36)	10 (4, 20)	<0.001
MOF	24 (7%)	9 (26%)	4 (18%)	26 (7%)	<0.001
24-hour mortality	10 (3%)	5 (14%)	3 (14%)	9 (3%)	<0.001
In-hospital mortality	24 (7%)	10 (30%)	4 (19%)	24 (7%)	<0.001

Continuous variables presented as median (IQR)
Categorical variables presented as n (%)
pRBC, packed red blood cells; PH, prehospital; SBP, systolic blood pressure; HR, heart rate; ISS, injury severity score; MOF, multiple organ failure



Scientific Session VI - Trauma Systems & Education

Paper #40
January 14, 2022
8:45 am

THE EFFECTS OF TIMING OF PREHOSPITAL TRANEXAMIC ACID ON OUTCOMES AFTER TRAUMATIC BRAIN INJURY

Alexandra Brito, MD*, Martin A. Schreiber, MD, FACS*, James El Haddi, MD,
Eric Meier, MS, Susan E. Rowell, MD, MCR*
Oregon Health and Science University

Presenter: Alexandra Brito, MD

Discussant: Joshua Brown, MD, MSc, UPMC Presbyterian Hospital

Objectives: Tranexamic acid (TXA) is an antifibrinolytic that has shown some promise in improving outcomes in TBI, but only when given early after injury. We examined the association between time of TXA administration and outcomes in patients with moderate or severe TBI.

Methods: Patients enrolled in the multi-institutional, double-blind randomized Prehospital TXA for TBI Trial with blunt or penetrating injury and suspected TBI (GCS </=12, SBP >/=90) who received either a 2g TXA bolus or a 1g bolus plus 1g 8h infusion within 2 hours of injury were analyzed. Outcomes were compared between early administration (<45 minutes from injury) and late administration (> 45 minutes from injury) using a Chi Square, Fisher's Exact Test, Student's t-test, or Mann Whitney U test as indicated. Logistic regression examined time to drug as an independent variable. Results were considered significant when $p < 0.05$.

Results: 649 Patients met inclusion criteria (354 early and 259 late). 28-day and 6-month mortality, 6-month Glasgow Outcome Scale - Extended (GOSE) and disability rating scale scores were not different between early and late administration. The incidence of secondary complications was also not different between groups. Prolonged EMS transport and need for a prehospital airway was associated with late administration ($p<0.01$).

Conclusions: In patients with moderate or severe TBI who received TXA within two hours of injury, there were no differences in outcomes between patients who received early and late TXA. Late administration of TXA was associated with the need for life-saving procedures suggesting TXA can be given within 2 hours of injury without loss of benefit.

Scientific Session VI - Trauma Systems & Education

Paper #41
January 14, 2022
9:00 am

A DISTURBING TREND: AN ANALYSIS OF THE DECLINE IN SURGICAL CRITICAL CARE (SCC) FELLOWSHIP TRAINING OF BLACK AND HISPANIC SURGEONS.

Amanda Hambrecht, MD, Cherisse Berry, MD, FACS*, Charles DiMaggio, PhD, Kenji Inaba, MD, Carla Pugh, MD, PhD, Wendy Greene, MD*, Nabil Issa, MD*, Leandra Krowsoski, MD*, Spiros Frangos, MD, William C. Chiu, MD, FACS, FCCM*, Marko Bukur, MD, FACS*
NYU School of Medicine

Presenter: Amanda Hambrecht, MD

Discussant: Kimberly A. Davis, MD, MBA, Yale School of Medicine

Objectives: Underrepresented minorities in medicine (URiM) are disproportionally represented in surgery training programs. Rates of URiM applying to and completing General Surgery residency remain low. We hypothesized that the patterns of URiM disparities would persist into Surgical Critical Care (SCC) fellowship applicants, matriculants and graduates.

Methods: We performed a retrospective analysis of SCC applicants, matriculants and graduates from 2005-2020 using the Graduate Medical Education (GME) resident survey. The data were stratified by race/ethnicity and gender. Indicator variables were created for Asian, Hispanic, White and Black trainees. Yearly proportions for each race/ethnicity and gender categories completing or enrolling in a program were calculated and plotted over time with Loess smoothing lines and overlying 95% confidence bands. The yearly rate and statistical significance of change over time were tested with linear regression models with race/ethnicity and gender proportions as the dependent variables and year as the explanatory variable.

Results: From 2005-2020, Black men accounted for 5% of all graduates and there was a significant decline of 0.3% per year of the study period for those completing the fellowship ($p = 0.02$). Black women comprised 7% of all graduates and had a 0.6% decline each year ($p < 0.01$). A similar trend was seen with Hispanic men, who comprised 3% of graduates and had a 0.3% annual decline ($p = 0.02$). White men had a significant increase in both application to and graduation from SCC fellowships during the same interval (Figures 1 and 2).

Conclusions: Disparities in URiM representation remain omnipresent in surgery and extends from residency training into SCC fellowship. Efforts to enhance the recruitment and retention of URiM in SCC training are warranted.

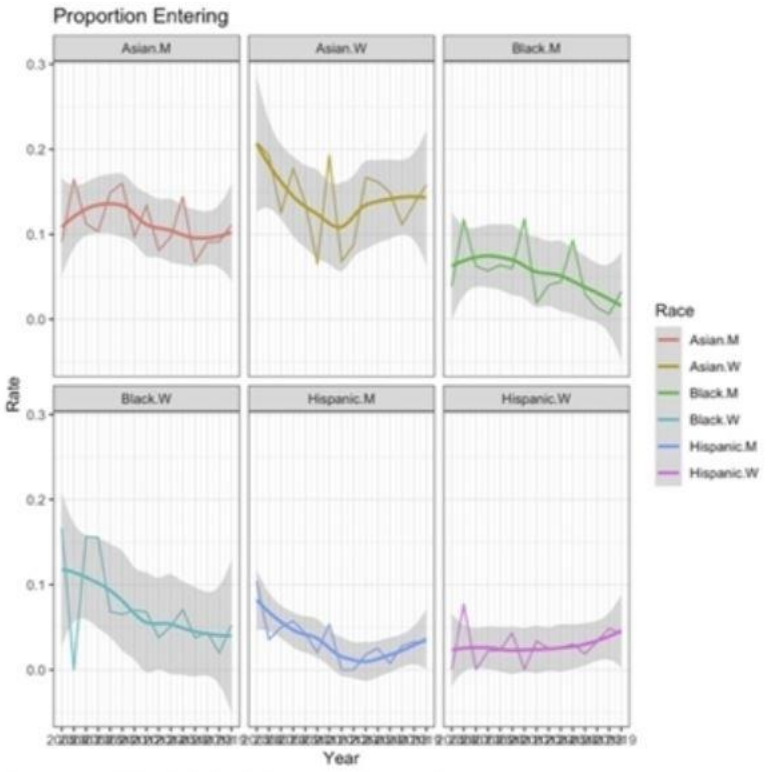


Figure 1. Proportion Entering SCC Fellowship.

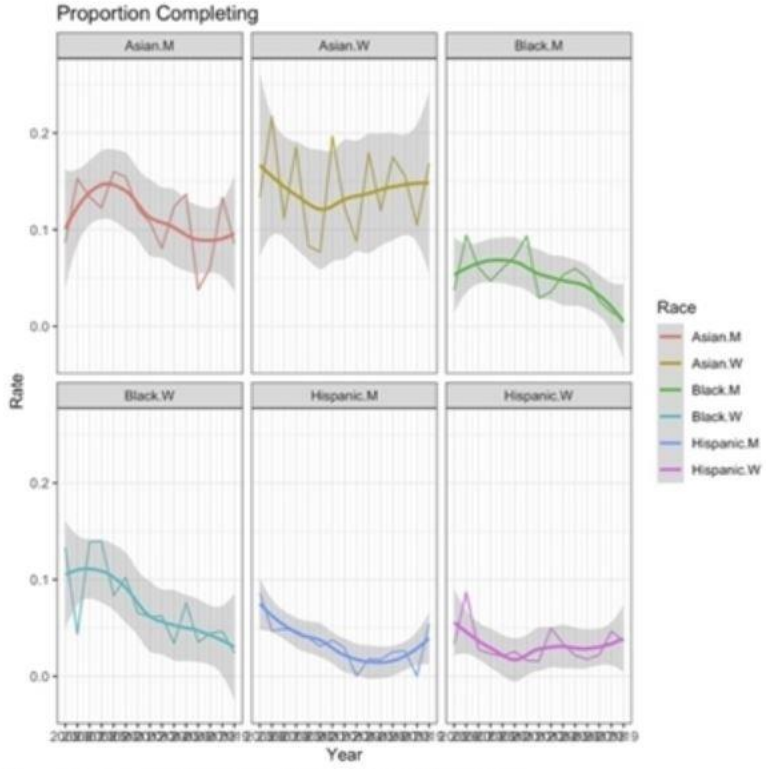


Figure 2. Proportion Completing SCC Fellowship.

Scientific Session VI - Trauma Systems & Education

Paper #42
January 14, 2022
9:15 am

GROWING THE NEXT GENERATION OF SURGEON SCIENTISTS - REFLECTIONS ON 20 YEARS OF EAST RESEARCH INVESTMENT

Rachael A. Callcut, MD, MSPH, FACS*, Jason W. Smith, MD, PhD, MBA, FACS*, Rachel Dixon, Ben L. Zarzaur, MD, MPH, FACS*
EAST Research-Scholarship Committee-Eastern Association for the Surgery of Trauma

Presenter: Rachael A. Callcut, MD, MSPH, FACS

Discussant: Andrew C. Bernard, MD, University of Kentucky College of Medicine

Objectives: There is a known deficit in human research capital in trauma. EAST's mission includes fostering research and career development opportunities. For 20 yrs, EAST has awarded a Research Scholarship and 5 yrs ago EAST started the INVEST-C Hack-a-thon. INVEST-C provides an intensive, short-term engagement to propel junior faculty toward establishing research independence. This study investigates the impact of these programs on academic productivity.

Methods: Pubmed, NIH Reporter, and SCOPUS h-index was acquired for all scholarship [SCH] awardees (2002-2021, n=20) and INVEST-C [INV] participants (2017-2020, n=19). Current practice type, total number of funding awards, and timing of first grant were ascertained. INVEST-C participants were surveyed annually. Bibliometrics are reported and compared (ANOVA; paired t-test).

Results: Median publications (PUB) of SCH awardees was 56 [IQR 33-88], h-index 16 (12-21), and 35% with >=1 NIH grant post-SCH. Amongst the last 10 awardees with a minimum of 2yrs post-SCH, 50% have received a NIH grant compared with all-comer mean NIH funding rate of 18.5% of grants over the same time. For those still in academics (90% SCH), PUB were higher for those >5yrs (66, 51-115) vs. <5yrs post-SCH (33, 22-59, p=0.05), but there was no difference in h-index (16, IQR 14-25, vs 15, 9-19, p=0.7). Comparing the most recent 5 yrs of SCH to INV, there was no difference in academic productivity as measured by total PUB (SCH 33, IQR 22-59 vs INV 34, IQR 18-44, p=0.7) or h-index (INV 9, 5-14, p=0.1). No one held research funding prior to INV, but 31.6% (6/19) acquired >=1 funding award (11 non-NIH, 1 NIH; p=0.008) in the short interval since INV.

Conclusions: Investments in research have translated to significant extramural funding. Those in the last 5 yrs have been particularly fruitful with INV participants already achieving equal median academic productivity to early SCH recipients.

Scientific Session VI - Trauma Systems & Education

Paper #43
January 14, 2022
9:30 am

Surgical Video

OLD SCHOOL TECHNIQUES IN A NEW AGE TEACHING MODEL: USING PERFUSED CADAVERS TO TEACH COMPLEX SURGICAL TECHNIQUES FOR PEPTIC ULCER DISEASE

Aaron M. Hudnall, DO, James M. Bardes, MD*, David C. Borgstrom, MD, FACS*,
Kennith Conley Coleman, DO*, Daniel J. Grabo, MD, FACS*
West Virginia University

Presenter: Aaron M .Hudnall, DO

Discussant: Shariq Raza, MD, Perelman School of Medicine, Univ of Pennsylvania

Background: Peptic ulcer disease (PUD), once a primary surgical problem, is now medically managed in the vast majority of patients. The surgical treatment of PUD is now strictly reserved for life-threatening complications. In cases of PUD that require intervention, such as bleeding and stricture, surgical treatment is often the second or third line after endoscopic or radiologic intervention.

Free perforation, refractory bleeding and gastric outlet obstruction, although rare in the age of medical management of PUD, are several of the indications for surgical intervention. The acute care surgeon taking care of patients with PUD should be facile in techniques required for bleeding control, bypass of peptic strictures, and vagotomy with resection and reconstruction. This EAST Master Class Video Presentation proposes the use of a high-fidelity perfused cadaver training model to demonstrate these infrequently encountered, but critical operations.

Content (Video Description): A combination of anatomic representations as well as videos of step-by-step instructions on perfused fresh human cadavers will demonstrate the key steps in the following critical operations. Graham patch repair of perforated peptic ulcer will be demonstrated in both open and laparoscopic fashion. The choice to perform open versus laparoscopic repair is based on individual surgeon comfort. Oversewing of a bleeding duodenal ulcer via duodenotomy and ligation of the gastroduodenal artery is infrequent in the age of advanced endoscopy and interventional radiology techniques yet can be lifesaving. Repair of giant duodenal or gastric ulcers can present a challenging operative dilemma on how to best repair or exclude the defect. Vagotomy and antrectomy, perhaps the least common of all the afore mentioned surgical interventions, may require more complex reconstruction than the other techniques making it challenging for inexperienced surgeons. A brief demonstration on reconstruction options will be shown to include traditional gastrojejunostomy and Roux-en-Y reconstruction options.

Conclusions: Surgical management of PUD is reserved today for life-threatening complications for which the acute care surgeon must be prepared. This presentation provides demonstration of key surgical principles in management of bleeding and free perforation as well as gastric resection, vagotomy and reconstruction.