

## Quick Shots Parallel Session I

Quick Shot #1  
January 16, 2020  
9:00 am

### **BRAIN INJURY GUIDELINES - MODIFIED ADMISSION CRITERIA (BIG-MAC) IMPROVED ACCURACY IN TRIAGE FOR PATIENTS WITH TRAUMATIC BRAIN INJURY**

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University of Colorado, Aurora

**Presenter:** Laura Harmon, MD

**Objectives:** The Brain Injury Guidelines were developed to evaluate which patients with mild and moderate TBI could be safely managed without mandated neurosurgical consultation. We sought to utilize BIG to guide triage of patients for admission to observation, surgical floor and ICU levels of care with associated standardization of resource utilization for monitoring of these patients - Brain Injury Guideline - Modified Admissions Criteria (BIG-MAC). Our objective was to develop admission pathways utilizing BIG criteria to improve accuracy in triage of patients to appropriate levels of care at admission.

**Methods:** A prospective evaluation for all patients with acute TBI from 08-2017 to 04-2019. BIG-MAC was used to guide admission starting in 07-2108. Indication for admission, consultations, and level of care were guided by the BIG-MAC protocol (table 1). Each patient was graded and stratified on the BIG-MAC criteria for admission to the short-term observation unit (lowest level of care), the general surgical floor or intermediate care unit, or the intensive care unit (table 2).

**Results:** A total of 460 patients were admitted with TBI (pre-implementation n=221, post implementation n= 239) age 18-96, 68% male. Implementation of the BIG-MAC protocol decreased admissions to the observation unit from 22% to 15% (p=0.05). Unexpected admissions to the ICU from the clinical observation unit decreased from 5 patients to 1 patient (p=0.08) Post implementation, no patients required urgent or emergent operative intervention from the observation or floor unit compared to one patient in the pre-implementation time period.

**Conclusions:** Developing admission criteria using the BIG resulted in more direct admissions to the ICU and the general surgical floor or intermediate care unit with a reduction in inappropriate admissions to observation.

Table 1: Criteria for admission

	BIG-MAC* 1	BIG-MAC 2	BIG-MAC 3
Initial GCS**	13-15	13-15	Any
Focal neurologic findings	No	No	Yes
Intoxication	No	No/Yes	No/Yes
Anticoagulation/ Antiplatelet agent	No	No	Yes
Skull Fractures	No	Non-displaced	Displaced
Epidural Hematoma	No	No	Yes
Subdural Hematoma	<4mm	4-7.9mm	>8mm
Intra-paranchymal Hemorrhage	<4mm	4.7.9mm	>8mm or multiple
Subarachnoid Hemorrhage	<3sulci <1mm	Single hemisphere 1-3mm	Bi-hemispheric >3mm
Intraventricular Hemorrhage	No	No	Yes
Edema	No	Edema without sulcal or ventricular effacement, shift <1mm	Edema with sulcal or ventricular effacement, shift >1mm
Hospitalization	Emergency Department Observation Unit	Trauma/Acute Care Service	Neurosurgery or Trauma/Acute Care Service

\*Brain Injury Guideline-Modified Admission Criteria

\*\*Glasgow Coma Scale

Table 2: Treatment Algorithm

BIG-MAC 1	6 hours in EM observation unit Repeat neurologic assessment by EM physician every 2 hours Patient must have GCS of 15 and no neurologic abnormalities to meet discharge criteria
BIG-MAC 2	Admission to trauma service for observation. 2 hour neuro checks repeat CT head at 6 hours Observe 24-48 hours Neurologic assessment by trauma physician at 6-12 hours and 24 hours. GCS 15, no neurologic abnormalities at time of discharge
BIG-MAC 3	Admission to Trauma or Neurosurgery 1-2 hour neuro checks Neurologic assessment by trauma physician at 6-12 hours and 24 hours

## Quick Shots Parallel Session I

Quick Shot #2  
January 16, 2020  
9:06 am

### NATIONWIDE ANALYSIS OF WHOLE BLOOD HEMOSTATIC RESUSCITATION IN CIVILIAN TRAUMA

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Andrew L. Tang, MD\*, Bellal Joseph, MD\*  
The University of Arizona

**Presenter:** Kamil Hanna, MD

**Objectives:** Renewed interest in whole blood (WB) resuscitation in civilians has emerged following its military use. There is a paucity of data on its role in civilians where balanced component therapy (CT) is the standard of care. The aim of this study is to evaluate the outcomes of WB resuscitation in civilian trauma patients. We hypothesized that WB is associated with improved outcomes

**Methods:** We analyzed the (2015-2016) Trauma Quality Improvement Program. We included adult (age=18y) trauma patients who received CT within 4-hrs of admission. Patients were stratified: those who received WB+CT and those who received only CT. Primary outcomes were 24-hour and in-hospital mortality. Secondary outcomes were major complications, and length of stay. Multivariable logistic regression was performed adjusting for demographics, vitals, injury parameters, comorbidities, and trauma center level

**Results:** A total of 8,494 patients were identified of which 280 received WB +CT (WB 1[1-1], PRBC 12[7-19], FFP 7[4-14], Platelets 2[1-3]) and 8,214 received CT only (PRBC 7[4-15], FFP 4[2-9], Platelets 1[0-2]). Mean age was 36+/-18y, 74% were male, ISS was 24[14-34], and 18% had penetrating injuries. Patients who received WB+CT had a lower 24-hour mortality (17% vs. 25%; p=0.02), in-hospital mortality (29% vs. 40%; p=0.01) **Figure 1**, major complications (29% vs. 41%; p=0.01) and a shorter length of stay (9[7-12] vs. 15[10-21]; p=0.01). On regression analysis, WB was independently associated with reduced 24-hour (OR 0.65[0.47-0.87];p=0.01), in-hospital mortality (OR 0.82[0.76-0.89];p=0.01), and major complications (OR 0.91[0.80-0.97];p=0.01)

**Conclusions:** The use of WB as an adjunct to CT is associated with improved survival compared to CT alone in resuscitation of severely injured civilian trauma patients. Further studies are required to evaluate the role of adding WB to massive transfusion protocols.

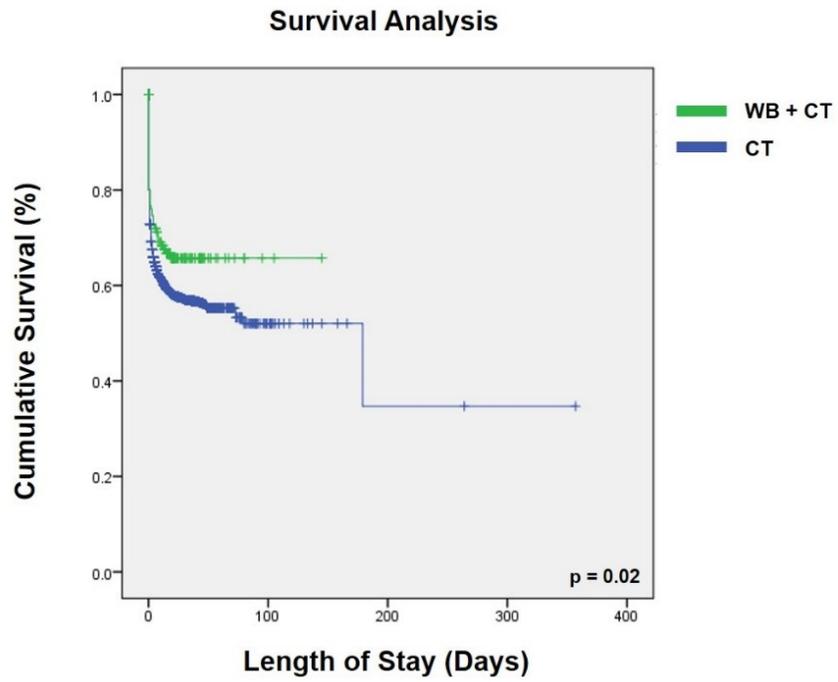


Figure 1: Kaplan Meier Survival Analysis

## Quick Shots Parallel Session I

Quick Shot #3  
January 16, 2020  
9:12 am

### GETTING BETTER WITH TIME? A TEMPORAL ANALYSIS OF THE AORTA REGISTRY

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Thomas M. Scalea, MD, FACS, FCCM\*, Laura J. Moore, MD\*,  
Jeanette Podbielski, RN, CCRP, Kenji Inaba, MD, David Kauvar, MD,  
Jeremy W. Cannon, MD, SM, FACS\*, Mark J. Seamon, MD, FACS\*,  
M. Chance Spalding, DO, PhD\*, Charles Fox, MD, Joseph J. DuBose, MD\*  
Bellevue Hospital Center

**Presenter:** Marko Bukur, MD, FACS

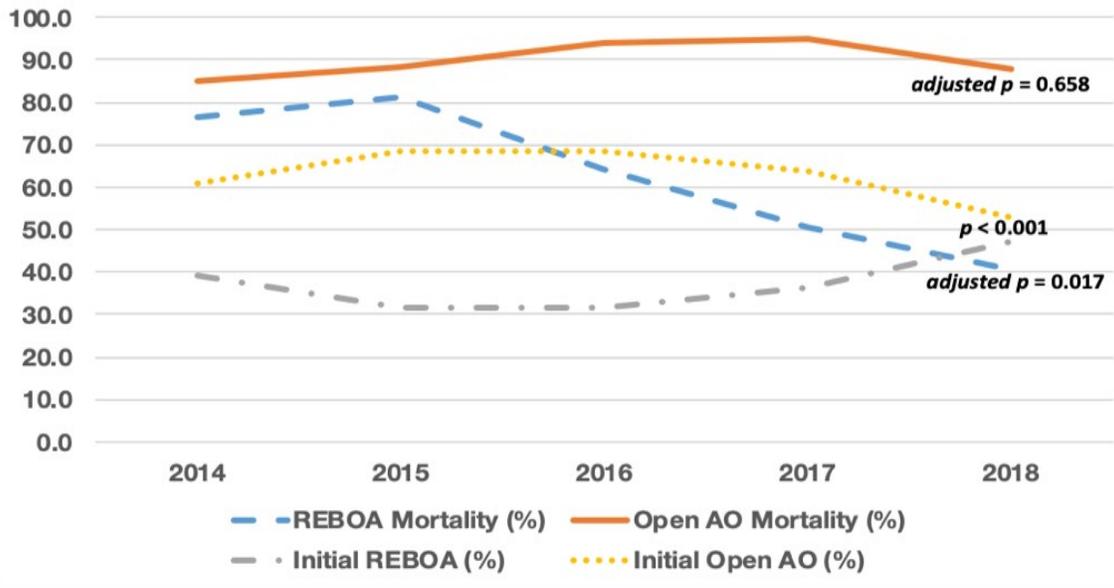
**Objectives:** Aortic occlusion (AO) is utilized for patients in extremis, with resuscitative endovascular balloon occlusion of the aorta (REBOA) use increasing. Our objective was to examine changes in AO practices and outcomes over time. The primary outcome was the temporal and procedural variation in AO mortality, while secondary outcomes included changes in technique, utilization, and complications.

**Methods:** This study examined the AORTA registry over a 5-year period (2014-2018). AO outcomes and utilization were analyzed using year of procedure as an independent variable. A multivariable model adjusting for year of procedure, type of AO, signs of life (SOL), SBP at AO initiation, operator level, timing of AO, and hemodynamic response to AO was created to analyze AO mortality.

**Results:** 1458 AO were included. Mean age (39.1±16.7) and Median ISS (34[25,49]) were comparable between REBOA and Open AO. Open AO patients were more likely: male (84% vs. 77%, p=0.001), s/p penetrating trauma (61% vs. 19%, p<0.001), and arrived without SOL (60% vs. 40%, p<0.001). REBOA use increased significantly and adjusted mortality decreased 23%/year while open AO survival was unchanged (Figure). REBOA was associated with reduced mortality compared to open AO (AOR 0.4, adj p <0.001). REBOA initiation SBP increased significantly over the study period (52.2 vs. 65, p=0.04). Compared with patients undergoing AO with CPR, each decile increase in SBP improved survival 14% (AOR 1.14, adj p<0.001). The use of 7F REBOA (2.9% to 54.8%) and Zone III deployment increased significantly (14.7% vs 40.6%), with Zone III placement having decreased associated mortality (AOR 0.33, adj p<0.001). Overall REBOA complication rate was 4.5% and did not increase over time (p=0.880).

**Conclusions:** REBOA survival has increased significantly over time compared to open AO. This may be related to increased operator experience and improved catheter technology leading to earlier deployment.

### Aortic Occlusion Trends Over Time



## Quick Shots Parallel Session I

Quick Shot #4  
January 16, 2020  
9:18 am

### **BLUNT CEREBROVASCULAR INJURY SCREENING CRITERIA SHOULD INCLUDE HIGH SPEED MOTOR VEHICLE CRASHES**

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**Presenter:** Ashley Farhat-Sabet, BS

**Objectives:** Motor vehicle collisions (MVCs) are the leading cause of blunt cerebrovascular injury (BCVI). Current screening criteria miss 30% of BCVI. Understanding mechanisms of BCVI formation may improve screening criteria.

**Methods:** We performed a retrospective review of the Crash Injury Research and Engineering Network (CIREN) database. We identified approximate BCVI injury screening criteria (diffuse axonal injury with Glasgow Coma Scale <6, cervical spine fracture, Lefort II/III fracture, and basilar skull fracture) as able in the CIREN database. We hypothesized MVC variables explaining mechanism of BCVI formation would be more common in BCVI without injury screening criteria.

**Results:** 93 BCVIs were included, with 37/93 (39.8%) without injury screening criteria. There was a significant difference in the mean change in velocity (51.00 km/h vs. 30.78 km/h,  $p < 0.001$ ), but not mean force direction from 12 o'clock (22.50 vs. 29.02 degrees,  $p = 0.35$ ) between BCVI without screening criteria and BCVI with screening criteria. BCVI without injury screening criteria had no increase in ejection (8.1% vs. 7.1%,  $p = 1.00$ ), submarining (5.7% vs. 3.6%,  $p = 0.64$ ), rollover (10.8% vs. 28.6%,  $p = 0.07$ ) or intrusion (32.4% vs. 48.2%,  $p = 0.14$ ). BCVI without injury screening criteria more commonly had seatbelt position snug across the hips (94.6% vs. 74.5%,  $p = 0.01$ ) and pretensioner deployment (92.6% vs. 70.2%,  $p = 0.04$ ). In drivers only, BCVI without injury screening criteria more commonly had steering wheel airbag deployment (89.7% vs. 68.9%,  $p = 0.05$ ) and airbag contact (77.3% vs. 62.8%,  $p = 0.28$ ).

**Conclusions:** BCVI without injury screening criteria occurred during higher speed collisions with similar crash types, and had more frequent and appropriate safety device use, supporting crash deceleration and subsequent neck flexion/extension as a potential cause of BCVI. BCVI screening criteria should include high-speed motor vehicle crashes.

## Quick Shots Parallel Session I

Quick Shot #5  
January 16, 2020  
9:24 am

### CONTEMPORARY MANAGEMENT OF TRAUMATIC ESOPHAGEAL INJURIES: THE RESULTS OF AN EASTERN ASSOCIATION FOR THE SURGERY OF TRAUMA MULTI-INSTITUTIONAL STUDY

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Nikolay Bugaev, MD\*, Kokila Jeyamurugan, Jose L. Pascual, MD, PhD, FRCS(C), FACS\*,  
Andrew Young, MD, FACS\*, Eric A. Schinnerer, MD\*, Eric M. Champion, MD\*,  
Lewis E. Jacobson, MD, FACS\*, Sigrid Burruss, MD, FACS,  
Syed Saquib, MD\*, Patrick L. Bosarge, MD\*  
University of North Carolina

**Presenter:** Lauren Raff, MD

**Objectives:** Traumatic esophageal perforation is rare and there is substantial variability in the way that these injuries are managed, ranging from a completely non-operative approach to aggressive operative management. The purpose of this study was to evaluate the management of traumatic esophageal injury and compare the different management strategies that are being used for this population.

**Methods:** This is an Eastern Association for the Surgery of Trauma multi-institutional retrospective study from 2011 to 2017 of all patients who sustained a traumatic esophageal injury and were admitted to one of the 11 participating centers. Demographics, mechanism, location, and management of the esophageal injury were collected. The primary outcome was esophageal leak after initial management.

**Results:** After exclusions, there were 51 patients in the cohort. Esophageal injuries were cervical in 69% and thoracic in 31%. Most patients were managed with operative repair as their initial intervention (61%), followed by no intervention (19%), esophageal stenting (10%), and wide local drainage (10%). Compared to patients who underwent direct operative repair, patients managed with esophageal stenting had an increased rate of esophageal leak (22% vs 80%,  $p = 0.0231$ ). Patients with a blunt mechanism of injury had a higher overall complication rate versus penetrating mechanisms (100% vs 27%,  $p = 0.0004$ ), however mortality was not significantly different (14% vs 9%,  $p = 0.53$ ).

**Conclusions:** Most patients with esophageal injuries undergo direct repair of the injury with lower rates of postoperative leaks. While few patients develop esophageal injury from blunt trauma, the overall complication rate is high. This study suggests that patients who have esophageal injury may be best managed by direct operative repair and not esophageal stenting.

## Quick Shots Parallel Session I

Quick Shot #6  
January 16, 2020  
9:30 am

### **DIRECT TO OPERATING ROOM TRAUMA RESUSCITATION: OPTIMIZING PATIENT SELECTION AND TIME-CRITICAL OUTCOMES WHEN MINUTES COUNT**

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Legacy Emanuel Medical Center

**Presenter:** Amelia Johnson, PA-C

**Objectives:** Although several trauma centers have developed “direct to OR” (DOR) trauma resuscitation programs, there is little published data on optimal patient selection, practices, and outcomes. We sought to analyze triage criteria and interventions associated with optimal DOR outcomes and resource utilization.

**Methods:** Retrospective review of all adult DOR resuscitations over a 6-year period. Triage criteria were analyzed individually, and grouped into categories: mechanism, physiology, anatomy/injury, or other. The best univariate and multivariate predictors of requiring lifesaving interventions (LSI) or emergent surgery (ES) were analyzed. Actual and predicted mortality (pM) were compared for all patients and for pre-defined time-sensitive subgroups.

**Results:** There were 628 DOR patients (5% of all admissions) identified; the majority were male (79%), penetrating mechanism (70%), severely injured (40% ISS>15), and 17% died. Half of patients required LSI and 23% required ES, with significantly greater need for ES and lower need for LSI after penetrating versus blunt injury ( $p<0.01$ ). Although injury mechanism criteria triggered most DOR cases and best predicted need for ES, the physiology and anatomy/injury criteria were associated with greater need for LSI, and mortality (Table). Observed mortality was significantly lower than pM with DOR for several key subgroups (Figure). Triage schemes for both ES and LSI could be simplified to 4-6 independent predictors by regression analysis.

**Conclusions:** The DOR program accurately identified severely injured trauma patients at high risk for requiring LSI and/or ES. Injury Different triage variable categories drive the need for ES versus LSI and could be simplified and optimized to a 4-6 variable triage scheme. DOR was associated with better than expected survival among specific time-sensitive sub-groups.

Triage Variable categories:	% of DOR cases*	LSI*	Emerg Surg*	Mortality*
1. Mechanism	64%	42%	24%	7%
2. Physiology/exam	21%	68%	24%	45%
3. Anatomy/injury	7%	67%	27%	16%
4. Other	8%	45%	4%	28%

\*all P<0.01; LSI = lifesaving interventions

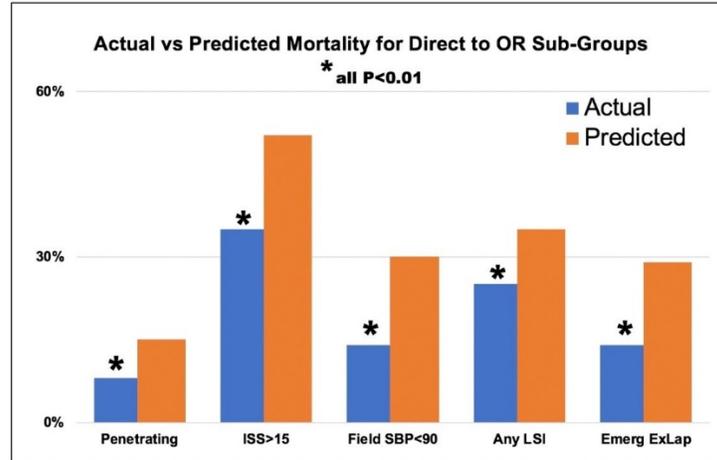


Table showing the DOR triage variable categories and association with interventions and mortality. Figure showing actual versus predicted mortality for DOR time-sensitive sub-groups.

## Quick Shots Parallel Session I

Quick Shot #7  
January 16, 2020  
9:36 am

### THERAPEUTIC ANTICOAGULATION IN PATIENTS WITH TRAUMATIC BRAIN INJURIES AND PULMONARY EMBOLI

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Gary Schwartzbauer, MD, Ronald B. Tesoriero, MD\*,  
Deborah M. Stein, MD, MPH, FACS, FCCM\*

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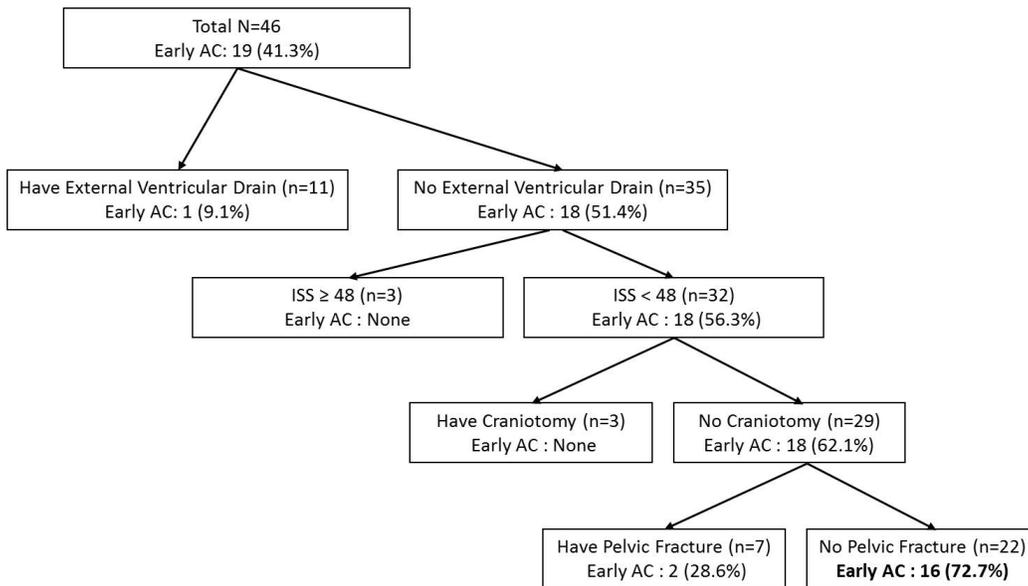
**Presenter:** Amanda M. Chipman, MD

**Objectives:** Patients with traumatic intracranial hemorrhage (ICH) and concomitant pulmonary embolus (PE) have competing care needs and demand a careful balance of anticoagulation (AC) versus potential worsening of their ICH. The goal of this study is to determine the safety of AC for PE in patients with ICH.

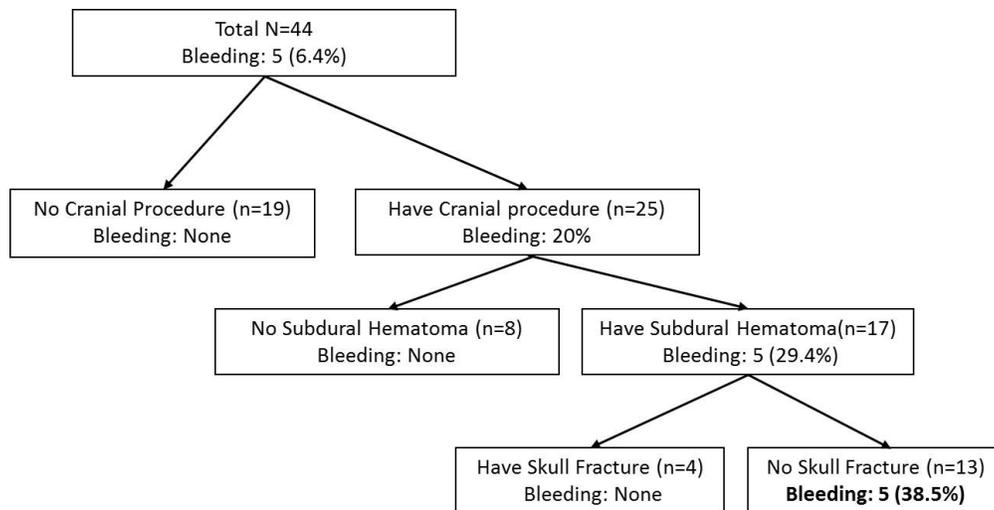
**Methods:** This is a retrospective single center study of patients >16 years old with concomitant ICH and PE occurring between June 2013 and December 2017. Early AC was defined as within =7 days of injury; late was defined as after 7 days. Primary outcomes included death, interventions for worsening ICH following AC, and pulmonary complications. Multivariate logistic regression was used to evaluate for clinical and demographic factors associated with worsening traumatic brain injury (TBI), and recursive partitioning was used to differentiate risk in groups.

**Results:** Fifty patients met criteria. Four did not receive any AC and were excluded. Nineteen (41.3%) received AC early (median 4.1, IQR 3.1-6.0) and 27 (58.7%) received AC late (median 14.0, IQR 9.7-19.5). There were 4 deaths in the early group, and none in the late cohort (21.1% vs. 0%,  $p=0.02$ ). Two deaths were due to PE and the others were from multi-system organ failure or unrecoverable underlying TBI. Three patients in the early group, and 2 in the late, had increased ICH on CT (17.6% vs. 7.4%,  $p=0.3$ ). None required intervention.

**Conclusions:** This retrospective study failed to find instances of clinically significant progression of TBI in 46 patients with CT-proven ICH after undergoing AC for PE. AC is not associated with worse outcomes in patients with TBI, even if initiated early. However, 2 patients died from PE despite AC, underlining the severity of the disease. ICH should not preclude AC treatment for PE, even early after injury.



Classification and Regression Tree (CART) Model for Early AC. Patients without an external ventricular drain (EVD), Injury Severity Score (ISS) <48, no craniotomy, and no pelvic fracture had a 72.7% chance of early AC.



CART Model for Bleeding. The highest risk of bleeding (increased ICH on CT scan) was in patients with cranial procedures, subdural hematomas and no skull fracture (38.5%).

## Quick Shots Parallel Session I

Quick Shot #8  
January 16, 2020  
9:42 am

### MASSIVE TRANSFUSION WITH WHOLE BLOOD IS SAFE COMPARED TO COMPONENT THERAPY

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Andrew Goodman, BA, Chris Freeman, MD, Martin A. Schreiber, MD, FACS\*  
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**Presenter:** Jared Gallaher, MD, MPH

**Objectives:** Transfusion with uncrossmatched cold-stored low-titer group O positive or negative whole blood in civilian trauma has been investigated as an alternative to component therapy but only in limited volumes. To our knowledge, this is the first analysis of the safety and efficacy of massive transfusion of trauma patients with whole blood.

**Methods:** This is a retrospective cohort analysis comparing trauma patients resuscitated with component therapy (COMP) versus component therapy plus whole blood (WB). The COMP group was comprised of patients who presented from 01/2017 through 06/2018 and the WB group from patients who presented from 07/2018 through 01/2019 after WB became available. 20 units of whole blood were available weekly and stored up to 2 weeks. We included patients if they received 1 unit of WB or red blood cells (RBCs) within 24 hours of admission and had a MTP activated. We used bivariate analysis to compare groups. For analysis, one unit of whole blood equaled 1 unit of RBCs, 1 unit of fresh frozen plasma, and 1/6 of a unit of apheresis platelets.

**Results:** 42 patients received WB and 83 patients received COMP with similar baseline characteristics. Patients had a median age of 41 years (IQR 28, 61) and 73% were male. 30% had penetrating injuries with a median ISS of 29 (IQR 17, 38). The WB group received a median of 6.5 units (IQR 3, 11) of WB along with component units listed in Table 1. The WB group received significantly more component-equivalent units but with a plasma:RBC ratio of 0.94:1 compared to 0.8:1 ( $p < 0.001$ ). There were no differences in 24-hour mortality (COMP 22% vs WB 26%,  $p = 0.6$ ) or 30-day mortality (COMP 43% vs WB 52%  $p = 0.3$ ). There were no transfusion reactions.

**Conclusions:** Massive transfusion utilizing primarily whole blood in civilian trauma is feasible. It appears to be a safe and effective addition to component therapy and may lead to a more balanced resuscitation but with more overall product used.

Units of Blood Products Administered Median (IQR)	Component Therapy (COMP)	Whole Blood (WB)	<i>p</i> value
Whole Blood Units	-	6.5 (3, 11)	-
Red Blood Cells (RBCs)	6 (3, 12)	4 (1, 8)	0.003
Fresh Frozen Plasma (FFP)	5 (2, 10)	4 (0,6)	0.01
Platelets	0 (0, 2)	1 (0, 2)	0.2
Cryoprecipitate	0 (0, 0)	0 (0,0)	0.9
Total Component-Equivalent Units of Product Administered	12 (5, 24)	27 (13, 41)	<0.001
Plasma:RBC Ratio	0.8:1	0.94:1	<0.001

Units of blood products administered within 24 hours of presentation by cohort

## Quick Shots Parallel Session I

Quick Shot #9  
January 16, 2020  
9:48 am

### THE IMPACT OF ANTIPLATELET (AP) AND ANTICOAGULANT(AC) AGENTS ON OUTCOMES IN GERIATRIC PATIENTS WITH TRAUMATIC BRAIN INJURY (TBI)

Jennifer Albrecht, PhD, Mira Ghneim, MD\*, Karen Brasel, MD, Anna Liveris, MD\*, Jill Watras, MD\*, James M. Haan, MD\*, Robert D. Winfield, MD, FACS\*, Sasha D. Adams, MD\*, Scott B. Armen, MD, FACS, FCCM\*, Fady Nasrallah, MD\*, Julie A. Dunn, MS, MD\*, Thomas J. Schroepfel, MD\*, Zara Cooper, MD, MSc\*, Jason Murry, MD, Matthew E. Lissauer, MD\*, Kaveh Najafi, DO, Niels D. Martin, MD\*, Deborah M. Stein, MD, MPH, FACS, FCCM\*  
R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine

**Presenter:** Mira Ghneim, MD

**Objectives:** AP and AC use is common among trauma patients, but the impact of these agents on outcomes in patients with TBI has not been clearly defined. The aim of the study was to assess the association between AC and AP medication use and clinical outcomes in geriatric patients with TBI.

**Methods:** We conducted an AAST prospective MITC of geriatric patients with TBI across 43 trauma centers. Inclusion criteria were age  $\geq 40$ , and CT-verified TBI. Patients with any non-head Abbreviated Injury Scale (AIS) score  $>2$  and presentation  $>24$  hours after injury were excluded. Patients were stratified by AP (Aspirin or Clopidogrel), AC (Warfarin, Direct Oral Anticoagulants, or Enoxaparin), or both. The primary outcomes were length of hospital stay (LOS), ICU LOS, receipt of palliative interventions, mortality and discharge disposition. We compared outcomes between those with and without AC/AP use using Chi-square Goodness of fit and the Wilcoxon rank-sum test.

**Results:** Among the 85% with home medication history available (2,624/3,081), 1,256 (48%) were on AC or AP and 14% were receiving both. Platelet transfusions were given in 18% of patients on AP. For AC reversal, 57% received Vitamin K, 20% were transfused plasma and 8% received prothrombin complex concentrate. AC/AP patients were older, with more severe injury (defined by head AIS  $>4$ ) and were more likely to receive palliative interventions.(Table 1) There were trends toward increased lesion progression on repeat CT in patients on AC/AP and a lower rate of return to pre-injury residence upon discharge. Neurosurgical intervention and mortality rates were similar, as were LOS and ICU LOS.(Table 1)

**Conclusions:** A large proportion of geriatric patients with TBI present with a history of AP/AC use. Although these patients had more severe TBI, and a higher risk of intracranial injury progression, AP/AC use was not associated with increased mortality.

+

<b>Table 1. Characteristics and Outcomes of Adults aged 64 and Older with TBI by Anticoagulant and Antiplatelet use, n= 1,868</b>			
	AP/AC, n=1,256	No AP/AC, n=612	P value
<b>Age</b>	79.9± 7.3	77.8±7.3	<0.001
<b>Antiplatelet (Aspirin, Clopidogrel)</b>	80%	0	
<b>Anticoagulants (Warfarin, Direct Oral Anticoagulants, Enoxaparin)</b>	34%	0	
<b>Both Antiplatelet and Anticoagulants</b>	14%	0	
<b>Cardiac history</b>	94%	76%	0.001
<b>Head AIS &gt; 4</b>	19%	14%	0.04
<b>GCS 13-15</b>	83%	81%	0.34
<b># CT scans</b>	1.7± 1.3	1.7±1.2	0.21
<b>Received platelet transfusion</b>	18%	-	<0.001
<b>Received Prothrombin Complex Concentrate</b>	8%	-	
<b>Received Plasma</b>	20%	-	
<b>Received Vitamin K</b>	57%	-	
<b>CT scan worsening</b>	25%	21%	0.085
<b>Hospital LOS</b>	5.6±6.4	5.6±6.4	0.84
<b>ICU LOS</b>	3.9±4.9	3.9±6.9	0.99
<b>Neurosurgical intervention</b>	8.8%	8.5%	0.85
<b>Palliative interventions</b>	16%	13%	0.05
<b>Mortality</b>	10%	9%	0.43
<b>Discharged to pre injury residence</b>	53%	56%	0.37

## Quick Shots Parallel Session I

Quick Shot #10  
January 16, 2020  
9:54 am

### INTO THE WILD AND ONTO THE TABLE - A MULTICENTER ANALYSIS OF WILDERNESS FALLS

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Muhammad Zeeshan, MD, David S. Morris, MD, FACS\*, Kevin N. Harrell, MD\*,  
Robert A. Maxwell, MD\*, Allison E. Berndtson, MD, FACS\*, Terry Curry, RN,  
Michael Rott, PA-C, Krista L. Kaups, MD, FACS\*, Rachel Dirks, PhD, CCRP,  
Clay Cothren, MD, Caitlin Robinson, Zachary D. Warriner, MD\*, Kenji Inaba, MD,  
Alison M. Wilson, MD, FACS\*, Thomas J. Schroepel, MD\*, Zachary Stillman, MD,  
Julie A. Dunn, MS, MD\*, Trinetta Chapin, RN, Ryan Phillips, MD, Niti Shahi, MD,  
Catherine Velopulos, MD, MHS, FACS\*, Shane Urban, RN, William R.C. Shillinglaw, DO\*,  
Michael J. Schurr, MD\*, Terrie Smith, RN, CCRN, Sabino Lara, MD,  
Carlos V.R. Brown, MD\*, Andrew C. Bernard, MD, FACS\*  
University of Kentucky

**Presenter:** Matthew D. Bernard

**Objectives:** Wilderness activities expose outdoor enthusiasts to austere environments with injury potential, including falls from height. The majority of published data on falls from height have been in urban environments, with little data on epidemiology/outcomes in wilderness locations. We sought to more accurately describe the injury pattern of wilderness falls, and to further distinguish rock climbers as a unique demographic and pattern of injury.

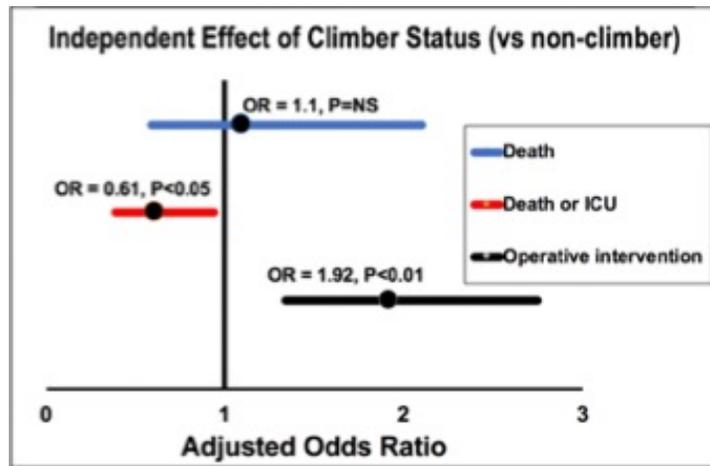
**Methods:** Data were collected from 17 centers on all wilderness falls (fall from cliff: ICD-9 e884.1, ICD-10 w15.xx) from 2007-2016 as a Multicenter Investigation. Demographics, injury characteristics, and care delivery were analyzed. Additional comparative analysis was performed for climbing (participating in rock climbing when injured) vs non-climbing mechanisms.

**Results:** Over the 10 year study period, 831 wilderness fall victims were analyzed (216 climbers, 615 non-climbers) 69% of patients were men with a median ISS of 10 (IQR=12). Average fall height was 50 feet and average rescue/transport time was 4.8h. 19% were intoxicated. The most common injury regions were soft tissue (63%, median AIS>0=1 IQR=0), lower extremity (53%, median AIS>0=2 IQR=1), and head (43%, median AIS>0=2 IQR=1). Non-climbers had a higher incidence of severe head and facial injuries despite having equivalent overall ISS (Table). On multivariate analysis, climbing remained independently associated with increased need for surgery but lower odds of ICU admission or death (Figure).

**Conclusions:** Wilderness falls represent a unique population with distinct patterns of predominantly soft tissue, head, and extremity injury. Climbers are younger, usually male, more often discharged home, and require more surgery but less critical care.

	Climber	Non-Climber	P-Value
Intoxication	9%	23%	.001
Night time	0.6%	25%	.001
Severe Injury (AIS>2)			
Head	11%	17%	.02
Chest	22%	21%	.92
Abdomen	3%	6%	.14
ISS > 15	32%	32%	.93
Facial Injury	15%	24%	.009
Extremity Injury	78%	65%	.006
Operative injuries	43%	30%	.001
Died	8%	8%	.98
D/C Disposition	Home 90% Rehab 9%	Home 83% Rehab 15%	.05

Statistical Comparison of Injury Patterns in Climbers and Non-Climbers



Analysis of the effect of climber status on odds of death, transfer to ICU, and necessity of operative intervention.

## Quick Shots Parallel Session II

Quick Shot #11  
January 16, 2020  
9:00 am

### **PULL BACK THE CURTAIN: EXTERNAL DATA VALIDATION IS AN ESSENTIAL ELEMENT OF QUALITY IMPROVEMENT BENCHMARK REPORTING**

Jill L. Jakubus, PA-C, Shauna Di Pasquo, RN, BSN, Judy N. Mikhail, PhD, MBA, RN\*,  
Anne Cain-Nielsen, MS, Peter Jenkins, MD\*, Mark R. Hemmila, MD\*  
University of Michigan

**Presenter:** Jill L. Jakubus, PA-C

**Objectives:** Accurate and reliable data is pivotal to credible risk-adjusted modeling and hospital benchmarking. Evidence assessing the reliability and accuracy of data elements considered as variables in risk-adjustment modeling and measurement of outcomes is lacking. This deficiency holds the potential to compromise benchmarking integrity. We detail the findings of a longitudinal program to evaluate the impact of external data validation on data validity and reliability for variables utilized in benchmarking of trauma centers.

**Methods:** A collaborative quality initiative-based study was conducted of 29 trauma centers from March 2010 through December 2018. Case selection criteria were applied to identify high-yield cases that were likely to challenge data abstractors. 127,238 total variables were re-abstracted and reported to trauma centers. Study endpoints included data accuracy (agreement between registry data and contemporaneous documentation) and reliability (consistency of accuracy within and between hospitals). Data accuracy was assessed by mean error rate and type (under capture, inaccurate capture, or over capture). Cohen's Kappa estimates were calculated to evaluate reliability.

**Results:** 185,120 patients met the collaborative inclusion criteria. 1,243 submissions were re-abstracted. The initial validation visit demonstrated the highest mean (+/- SD) error rate at 6.2% (+/- 4.7), and subsequent validation visits demonstrated a statistically significant decrease in error rate compared to the first visit (Figure 1). The mean hospital error rate steadily improved over time (Figure 2). Reliability of substantial or higher ( $\kappa > 0.61$ ) was demonstrated in 90% of the 20 co-morbid conditions considered in the benchmark risk-adjustment modeling, 39% of these variables exhibited a statistically significant ( $p < 0.05$ ) interval decrease in error rate from the initial visit.

**Conclusions:** Implementation of an external data validation program is correlated with increased data accuracy and reliability. Improved data reliability both within and between trauma centers improved risk-adjustment model validity and quality improvement program feedback.

Validation Visit	Error Type 1 <sup>a</sup>	Error Type 2 <sup>b</sup>	Error Type 3 <sup>c</sup>	All Error Types	p Value <sup>d</sup>
1	3.5 ± 3.6	2.1 ± 2.1	0.6 ± 0.9	6.2 ± 4.7	reference
2	2.2 ± 2.4	1.7 ± 1.8	0.6 ± 1.1	4.5 ± 3.8	<0.001
3	2.1 ± 2.1	1.4 ± 1.6	0.5 ± 0.9	3.9 ± 3.0	<0.001
4	2.3 ± 3.2	1.3 ± 1.6	0.6 ± 1.1	4.1 ± 3.9	<0.001
5	1.7 ± 2.3	1.5 ± 1.8	0.6 ± 1.3	3.9 ± 3.4	<0.001
6	2.0 ± 2.3	1.3 ± 1.4	0.4 ± 1.0	3.7 ± 3.1	<0.001
7	1.5 ± 2.4	1.2 ± 1.6	0.4 ± 0.8	3.1 ± 3.5	<0.001
8	2.6 ± 3.9	0.8 ± 0.8	0.3 ± 0.5	3.6 ± 4.3	<0.001
All Visits	2.3 ± 2.8	1.5 ± 1.8	0.5 ± 1.0	4.4 ± 3.9	

Data represented as % (± SD) unless otherwise noted.

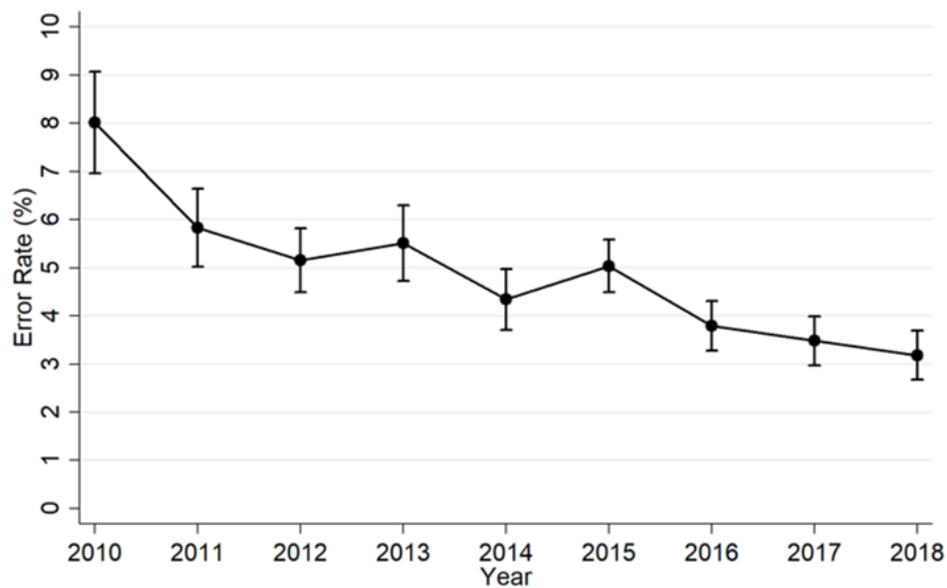
<sup>a</sup> Error type 1 indicates the validator identified the variable, but the center did not.

<sup>b</sup> Error type 2 indicates the validator and center identified the variable but disagreed with the answer.

<sup>c</sup> Error type 3 indicates the center identified the variable, but the validator was unable to confirm documentation consistent with the definition.

<sup>d</sup> Comparisons were performed for all error types by validation visit (visit 1 vs. subsequent visits 2-8).

Mean Hospital Error Rate by Validation Visit and Error Type



Mean Hospital Error Rate by Year

## Quick Shots Parallel Session II

Quick Shot #12  
January 16, 2020  
9:06 am

### **DISPARITIES IN RURAL VS URBAN FIELD TRIAGE: RISK AND MITIGATING FACTORS FOR UNDERTRIAGE**

Andrew-Paul Deeb, MD, Heather Phelos, MPH, Andrew B. Peitzman, MD\*,  
Timothy Billiar, MD, Jason L. Sperry, MD, MPH\*, Joshua B. Brown, MD, MSc\*  
University of Pittsburgh Medical Center

**Presenter:** Andrew-Paul Deeb, MD

**Objectives:** There are known outcome disparities among patients injured in rural vs urban settings. Many cite access to care; however, causal mechanisms are not well defined. One potential factor is field triage. Thus, our objective was to evaluate differences in prehospital undertriage (UT) in rural vs urban settings.

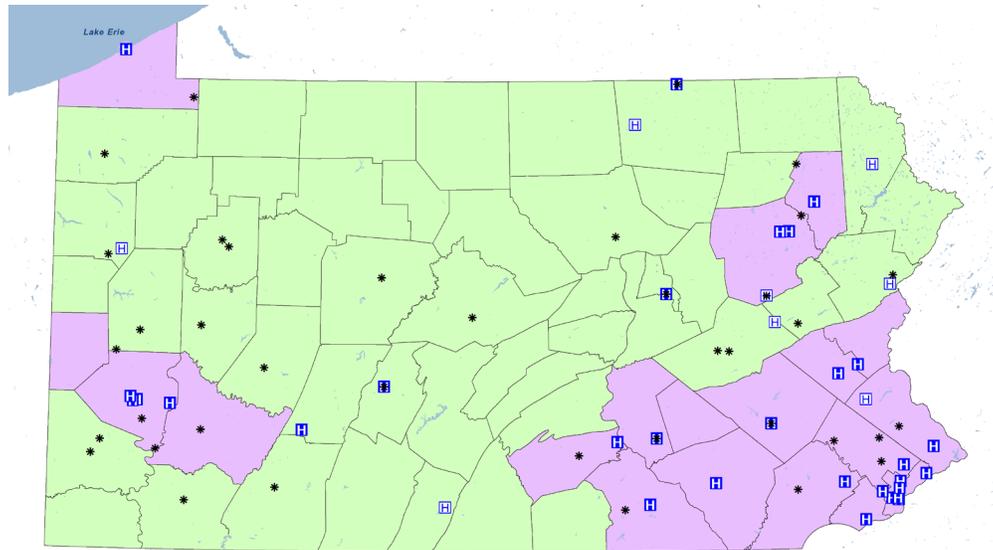
**Methods:** Adult patients in PTOS 2000-2017 were included. Rural/urban setting was defined by county (FIG). UT was defined as patients with physiologic or anatomic triage criteria who were not initially transported to a level 1 or 2 trauma center (TC). Logistic regression determined the association between UT and patient rural/urban setting while adjusting for transport distance and prehospital time. Models were expanded to evaluate the effect of individual triage criteria, TC rural/urban setting, and transport mode on UT.

**Results:** 453,112 patients were included (26% rural). UT was higher in rural vs urban patients (8.6% vs 3.4%,  $p<0.01$ ). UT was associated with increased mortality (OR 1.17; 95%CI 1.09-1.25,  $p<0.01$ ). Rural setting was associated with UT after adjusting for distance and prehospital time (OR 3.52; 95%CI 1.82-6.78,  $p<0.01$ ). Different triage criteria were associated with UT in rural vs urban settings (TABLE). Rural setting was associated with UT for patients transferred to an urban TC (OR 3.32; 95%CI 1.75-6.25,  $p<0.01$ ), but not a rural TC (OR 0.68; 95%CI 0.08-5.53,  $p=0.72$ ). Rural setting was associated with UT for ground (OR 5.01; 95% 2.65-9.46,  $p<0.01$ ) but not air transport (OR 1.18; 95%CI 0.54-2.55,  $p=0.68$ ).

**Conclusions:** UT is more common in rural settings. Specific triage criteria are associated with UT in rural and urban settings. Lack of a rural TC requiring transfer to an urban TC is a risk factor for UT of rural patients. Air transport mitigated the risk of UT in rural patients. Poor TC access resulting in UT plays a role in rural disparity, and system interventions may reduce UT in rural areas.

**TABLE. Association of national field triage guideline criteria with undertriage in rural and urban settings**

Criterion	Rural		Criterion	Urban	
	Odds ratio (95% CI)	p value		Odd ratio (95% CI)	p value
Crush injury	6.81 (3.59-12.92)	<0.01	Paralysis	6.42 (3.53-11.70)	<0.01
GCS≤13	6.12 (4.88-7.66)	<0.01	Amputation	6.00 (3.51-10.27)	<0.01
Penetrating injury	5.79 (4.06-8.25)	<0.01	Pelvic fracture	3.94 (2.94-5.27)	<0.01
Pelvic fracture	5.13 (3.77-6.99)	<0.01	GCS≤13	3.29 (2.49-4.35)	<0.01
≥2 proximal long bone fractures	3.11 (2.16-4.46)	<0.01	≥2 proximal long bone fractures	2.13 (1.66-2.74)	<0.01
Flail chest	2.12 (1.57-2.89)	<0.01	Penetrating injury	1.91 (1.19-3.05)	0.01
Paralysis	1.97 (1.15-3.38)	0.01	SBP<90	1.40 (1.12-1.74)	<0.01
SBP<90	1.96 (1.51-2.55)	<0.01	Flail chest	1.39 (0.85-2.29)	0.19
Amputation	0.44 (0.16-1.20)	0.11	Crush injury	1.32 (0.55-3.17)	0.53
Open skull fracture	0.51 (0.36-0.73)	<0.01	Open skull fracture	1.09 (0.77-1.56)	0.60
RR <10 or >29	0.42 (0.26-0.68)	<0.01	RR <10 or >29	0.75 (0.57-0.98)	0.03



Map of Pennsylvania depicting urban counties (purple) and rural counties (green) as classified by the Pennsylvania Trauma System Foundation. Blue background hospital symbols represent level 1 or level 2 trauma centers; White background hospital symbols represent level 3 or level 4 trauma centers. Black stars represent air medical helicopter bases.

## Quick Shots Parallel Session II

Quick Shot #13  
January 16, 2020  
9:12 am

### **ELECTRONIC TRAUMA RESUSCITATION DOCUMENTATION AND DECISION SUPPORT USING T6 HEALTH SYSTEMS MOBILE APPLICATION: A COMBAT TRAUMA CENTER PILOT PROGRAM**

Lisa Angotti, MD, MS\*, Remealle A. How, MD\*, Dominick Vitale, MD\*, Jared Folwell, MD,  
Katie Barnack, RN, Jason Neel, RN, Charlie Srivilasa, MD, Valerie Sams, MD\*  
San Antonio Military Medical Center

**Presenter:** Lisa Angotti, MD, MS

**Objectives:** The care of trauma patients in combat operations is handwritten on a 5-page flow sheet. The process requires the manual scanning and uploading of paper documents to bridge the gap between electronic and paper record management. There is an urgent operational need for an information technology solution that will enable medics to better capture patient treatment information which will improve long term healthcare without impacting short term care responsibilities.

**Methods:** We conducted a PI project to assess T6 Health Systems Mobile Application to explore feasibility and improve patient data collection at a deployed trauma hospital. We conducted a head-to-head comparison of electronic records versus handwritten records to include completeness and accuracy of data capture to assess non-inferiority.

**Results:** Over the 90-day pilot there were 131 trauma evaluations of which 53 patient resuscitations (40%) were also documented in the electronic application. We compared completeness and accuracy of admit, prehospital, primary survey, secondary survey, interventions, and trends data. (Figure 1) We found an overall 13% increase in data capture at 96% accuracy compared to the written record suggesting the electronic record was superior. We also had the medical evacuation teams document prehospital and en route care then synchronize the record in the trauma bay, allowing the trauma teams there to continue documenting on the same patient record, likely contributing to superiority since teams did not have to re-document based on an oral report. (Figure2)

**Conclusions:** Our pilot program in the deployed environment not only demonstrated a mobile technology that enhanced the completeness and accuracy of pen and paper trauma documentation but also proved capable of providing patient-specific decision support and real-time data analysis.

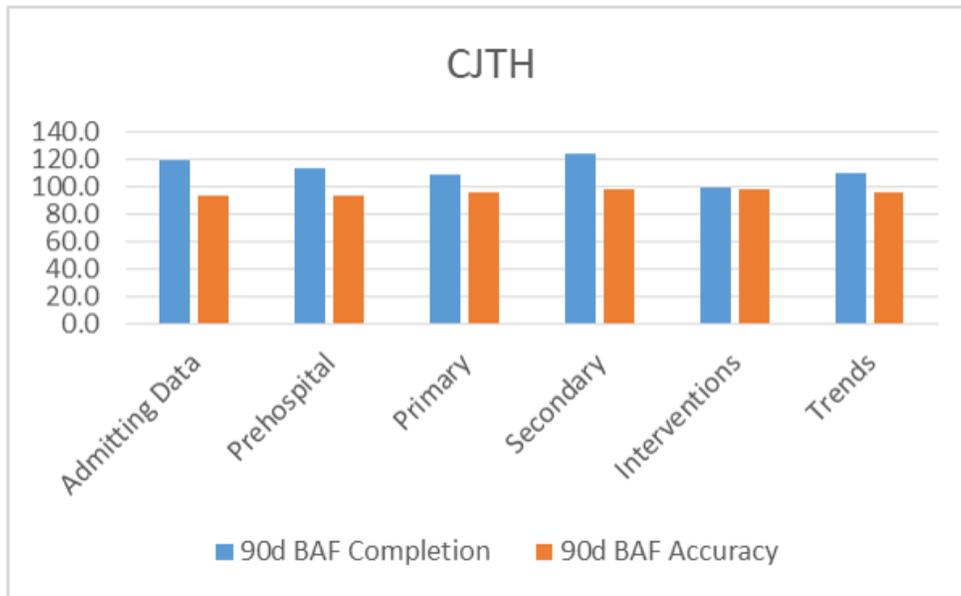


Figure 1 Comparison of Data Capture



Figure 2 Prehospital Medic Synchronization

## Quick Shots Parallel Session II

Quick Shot #14  
January 16, 2020  
9:18 am

### **RISK ASSESSMENT FOR INTRA-ABDOMINAL INJURY FOLLOWING BLUNT TRAUMA IN CHILDREN: DERIVATION AND VALIDATION OF A MACHINE LEARNING MODEL**

Christopher Pennell, MD, Conner Polet, MD, L. Grier Arthur, MD,  
Harsh Grewal, MD\*, Stephen Aronoff, MD, MBA  
St. Christopher's Hospital for Children

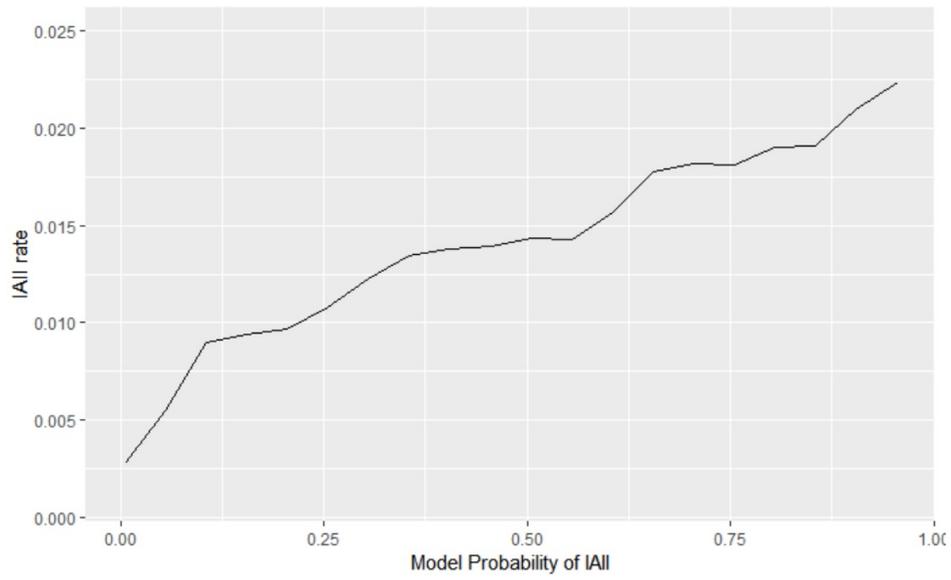
**Presenter:** Christopher Pennell, MD

**Objectives:** Computed tomography (CT) is the gold standard for diagnosing intra-abdominal injury (IAI) but has costs financially and in radiation exposure. The Pediatric Emergency Care Applied Research Network (PECARN) uses a linear decision tree to provide group estimates of risk and identify those at low risk of IAI requiring intervention (IAI-I) in whom CT may be omitted. While useful, the model cannot provide an individualized risk assessment. We hypothesized that machine learning algorithms could provide a more individualized assessment to better predict children at low risk of IAI-I.

**Methods:** The PECARN dataset was used to derive a model for identifying IAI-I (one causing death, requiring surgical or angiographic intervention, blood transfusion, or hospitalization  $\geq 2$  nights). The dataset was divided into training (n=7940) and validation (n=4089) subsets. A model was created using 19 clinical variables including emesis, dyspnea, GCS $<15$ , visible thoracic or abdominal trauma, seat belt sign, abdominal distension, tenderness or rectal bleeding, peritoneal signs, absent bowel sounds, flank pain, pelvic pain or instability, gender, age, HR, and RR. Five algorithms were optimized and predicted IAI-I rates were compared to actual rates. The model was validated using the validation subset.

**Results:** Of 12,029 included children, 274 (2.27%) experienced IAI-I. Of the 5 models, GBM (generalized boosted) and RF (random forest) produced the highest correlations with IAI-I rates ( $R^2 = .99$  and  $.96$ , respectively); RF had the widest range of predicted values and accurately predicted children with a risk of IAI-I as low as 0.28%.

**Conclusions:** We developed a machine learning model that accurately identifies children with the lowest risk of IAI-I after blunt trauma through individualized risk stratification. Application of this model to clinical practice can help to inform clinical decision making.



Receiver Operator Curve (ROC) for predicting IAI-I in children plotting the actual rate of IAI-I (y-axis) against the model's predicted probability of IAI-I.  $R^2 = 0.99$ .

## Quick Shots Parallel Session II

Quick Shot #15  
January 16, 2020  
9:24 am

### THE ELUSIVE TRAUMA DENOMINATOR: FEASIBILITY OF COMBINING DATASETS TO QUANTIFY THE TRUE BURDEN OF FIREARM INJURY

Heather E. Carmichael, MD, Jason Samuels, MD, Ethan Jamison, MHS, Kirk Bol, MSPH,  
Jamie J. Coleman, MD, FACS\*, Eric M. Campion, MD\*,  
Catherine Velopulos, MD, MHS, FACS\*  
University of Colorado, Aurora

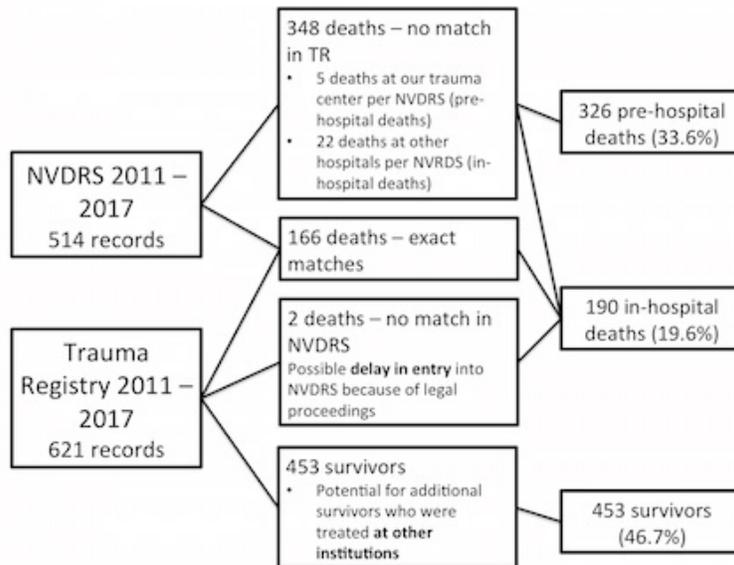
**Presenter:** Heather E. Carmichael, MD

**Objectives:** Evidence guiding firearm injury prevention is limited by current data collection infrastructure. Trauma registries (TR) omit pre-hospital deaths and underestimate the burden of injury. In contrast, the National Violent Death Reporting System (NVDRS) tracks all firearm deaths including pre-hospital fatalities, excluding survivors. This is a feasibility study to link these datasets through collaboration with our state Public Health Department (PHD), aiming to better estimate the burden of firearm injury and assess comparability of data.

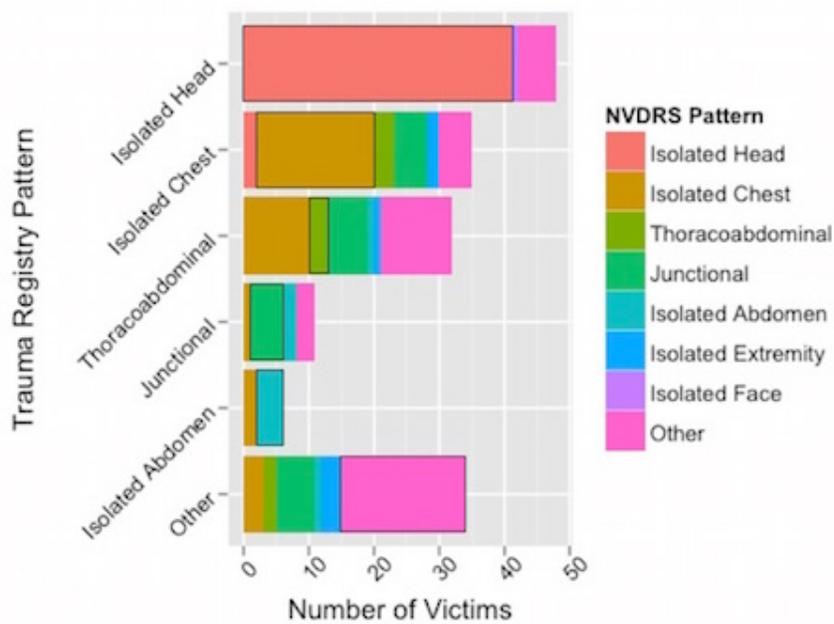
**Methods:** We reviewed all firearm injuries in our Level I TR from 2011–2017. We provided the PHD with in-hospital deaths, which they linked to NVDRS using patient identifiers and time of injury/death. The NVDRS collates information about circumstances, incident type, and wounding patterns from multiple sources (i.e. death certificates, medical examiner, law enforcement). We considered only subjects with injury location in a single county to best estimate in-hospital and pre-hospital mortality.

**Results:** Of 168 TR deaths, 166 (99%) matched to NVDRS records (Fig 1). Based on data linkages, we estimate 326 pre-hospital deaths, 190 in-hospital deaths and 453 survivors, for a total of 969 firearm injuries. For the matched patients, there was near-complete agreement regarding simple demographic variables (e.g. age and sex), and good concordance between incident types (suicide, homicide, etc). However, agreement in wounding patterns between NVDRS and TR varied (Fig 2).

**Conclusions:** We demonstrate feasibility of linkage of TR and NVDRS with good concordance for many variables, allowing for good estimation of the trauma denominator. Standardized data collection methods in one dataset could improve methods used by the other, e.g. training NVDRS abstractors to utilize AIS for injury patterns. Such data integration holds immediate promise for guiding prevention strategies.



Flow diagram describing linkage of the two datasets to estimate pre-hospital and in-hospital mortality, as well as survivorship after firearm injury.



Comparison of wounding patterns according to NVDRS and TR classifications. Agreement between the two datasets varied, ranging from just 9% agreement among thoracoabdominal injuries to 85% in isolated head injuries (cases with agreement are highlighted in black boxes).

## Quick Shots Parallel Session II

Quick Shot #16  
January 16, 2020  
9:30 am

### **PUTTING A HALT TO UNNECESSARY TRANSFERS: DO PATIENTS WITH ISOLATED SUBARACHNOID HEMORRHAGE NEED A TRAUMA CENTER?**

Danielle L. DeFoe, DO, Jyoti Sharma, MD MPH\*, Jenna Gillen, DO, YenHong Kuo, PhD, Saraswati Dayal, MD\*, Kelly A. Rippey, MD\*, Setu Dalal, DO, Elizabeth Kiselak, MD\*, Sanjeev Kaul, MD\*, Javier Martin Perez, MD, Stephen Cohn, MD\*  
Hackensack University Medical Center

**Presenter:** Danielle L. DeFoe, DO

**Objectives:** Trauma patients with isolated subarachnoid hemorrhage (iSAH) presenting to non-trauma centers are typically transferred to an institution with neurosurgical availability. However, recent studies suggest that iSAH is a benign clinical entity with an excellent prognosis. This investigation aims to evaluate the neurosurgical outcomes of traumatic iSAH with GCS 13-15 who were transferred to a higher level of care.

**Methods:** The American College of Surgeon (ACS) Trauma Quality Improvement Program was retrospectively analyzed from 2010-2015 for transferred patients  $\geq 16$  yo with blunt trauma, iSAH, and GCS  $\geq 13$ . Those with any other body region abbreviated injury score (AIS)  $\geq 3$ , positive or unknown alcohol/drug status, and requiring mechanical ventilation were excluded. The primary outcome was need for neurosurgical intervention (i.e. intracranial monitor or craniotomy/craniectomy).

**Results:** A total of 11,380 patients with blunt trauma, iSAH, and GCS 13-15 were transferred to an ACS Level I/II from 2010-2015. These patients were  $\geq 65$  yo [Median: 72 (IQR 59-81)], white (83%), and had one or more comorbidities (72%). 18% reported a bleeding diathesis/chronic anticoagulation on admission. Most patients had fallen (80%), had a GCS of 15 (84%), and were mildly injured [Median Injury Severity Score (ISS): 9 (IQR 5-14)]. Only 1.7% required neurosurgical intervention with 55% of patients being admitted to the ICU for a median of 2 days (IQR 1-3). 2.2% of the patients died. The median hospital LOS was only 3 days (IQR 2-5) and the most common discharge location was home with self-care (62%).

**Conclusions:** Trauma patients transferred for isolated subarachnoid hemorrhage with GCS 13-15 are at very low risk for requiring neurosurgical intervention.

## Quick Shots Parallel Session II

Quick Shot #17  
January 16, 2020  
9:36 am

### PREHOSPITAL END TIDAL CARBON DIOXIDE PREDICTS MASSIVE TRANSFUSION AND DEATH FROM TRAUMA

Eric M. Champion, MD\*, Alexis Cralley, MD, Caitlin Robinson, Angela Sauaia, MD, PhD,  
Fredric Pieracci, MD, MPH, Ryan A. Lawless, MD\*, Barry Platnick, MD\*, James Robinson,  
David Edwards, Kevin McVaney, MD, Ernest Eugene Moore, MD\*,  
Mitchell J. Cohen, MD, FACS, Jamie J. Coleman, MD, FACS\*,  
Charles Fox, MD, Clay Cothren, MD  
Denver Health Medical Center

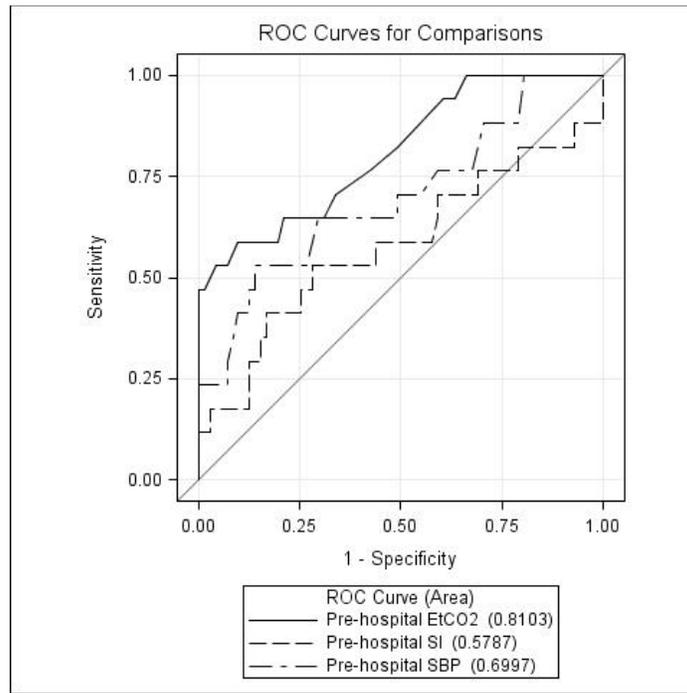
**Presenter:** Eric M. Champion, MD

**Objectives:** End tidal carbon dioxide (ETCO<sub>2</sub>) levels are easily measured in the prehospital setting. Prior work has suggested that ETCO<sub>2</sub> may be predictive of mortality in trauma, presumably by identifying hypoperfusion. However, the cause of death in prior studies or association of ETCO<sub>2</sub> levels with bleeding is unknown. We hypothesized that ETCO<sub>2</sub> would be predictive of mortality and need for transfusion.

**Methods:** All trauma patient with prehospital ETCO<sub>2</sub> values from 4/2016-8/2018, who did not require prehospital CPR were included. Receiver operating characteristics (ROC) curves were constructed. We compared the predictive performance (area under the ROC, AUROC) for death and massive transfusion (MT: >10 RBC units or death/24hrs) of prehospital ETCO<sub>2</sub>, shock index (SI) and systolic blood pressure (SBP). The Youden index was used to determine optimal cutoffs and positive/negative predictive values (PPV, NPV) were calculated. Numerical variables are reported as median (interquartile range).

**Results:** 96 patients, age 40 (24-55) years, ISS 26(13-35); 85% suffered blunt trauma. MT rate was 33% and mortality was 23%. Prehospital ETCO<sub>2</sub>'s AUROC for death was 0.72(95%CI: 0.59-0.86) compared with AUROC=0.51(0.34-0.67) for SI and 0.64(0.49-0.79) for SBP. Prediction of OR requirement within 6 hours showed ETCO<sub>2</sub> AUROC= 0.69(0.55-0.83) vs SI AUROC=0.62(0.46-0.77) vs SBP AUROC=0.65(0.52-0.79). Similarly, the predictive performance of ETCO<sub>2</sub> for MT was better than SI and SBP (AUROCs: 0.81 vs 0.58 and 0.70, respectively) (Figure). The ETCO<sub>2</sub> Youden Index for death was 23mmHg (PPV=64%; NPV=84%); for MT the Youden Index was 28mmHg (PPV=44%; NPV=91%). These values outperformed the PPV and NPV of SI and SBP for all outcomes.

**Conclusions:** Prehospital ETCO<sub>2</sub> is a novel predictor that outperformed SI and SBP in prediction of mortality, MT and OR requirement within 6 hours. Consideration should be given to including ETCO<sub>2</sub> to triage and study enrollment criteria.



Predictive performance of prehospital end tidal carbon dioxide, shock index, and systolic blood pressure for massive transfusion or death.

## Quick Shots Parallel Session II

Quick Shot #18  
January 16, 2020  
9:42 am

### MISSION GROUND TIME AND ITS IMPACT ON THE COVERAGE OF FATAL MOTOR VEHICLE INCIDENTS IN ALABAMA

Weston A. Smedley, BSc, Russell Griffin, PhD, John Killian, MD,  
Jeffrey D. Kerby, MD, PhD\*, Jan Jansen, MBBS PhD\*  
University of Alabama, Birmingham

**Presenter:** Weston A. Smedley, BSc

**Objectives:** The development of a trauma system has been shown to decrease mortality and improve outcomes for the severely injured. A critical element of the trauma system is air prehospital transport. Helicopter emergency services (HEMS) require mission ground time (time for launch, landing, and loading of casualties) to transport patients. In this study, our aim was to evaluate how mission ground time (MGT) affects HEMS ability to reach fatal motor vehicle collisions (MVCs) within a one hour access time threshold.

**Methods:** Fatal MVCs in Alabama, 2015-2017 (n=2584), were extracted from the Fatality Analysis Reporting System. Elliptical isochrones were created using helicopter bases (n=15) and Level-I and II trauma centers (n=5) accounting for air speed and MGTs (30, 25, 20, 15 minutes). The ellipses and MVC data were analyzed in ArcGIS to determine if the collision would have been reached by air. For each MGT ellipse, count and percent of total MVCs covered were calculated and stratified by state trauma region (Table 1).

**Results:** Coverage increased by ~15% for each 5-min increment of MGT excluding 15-min MGT (6%). With a MGT of 30, a majority of fatal MVCs were covered in regions with Level-I centers. Regions with high coverage with 30-min MGT did not have meaningful increases in fatal MVCs covered beyond a 25-min MGT. Regions with limited coverage at 30-min MGT needed a MGT of 20 in order to have a majority of fatal MVCs covered.

**Conclusions:** A decrease in MGT from 30 to 20-min would result in a 30% increase in the number of fatal MVCs covered. A change of MGT by 5-min resulted in HEMS coverage of nearly all fatal MVCs in regions with sufficient trauma center coverage. Decreases of MGT beyond 20 would provide limited returns and still fail to cover all incidents. Attention to MGT may benefit patients involved in fatal MCVs by increasing the number that could potentially reach a trauma center within one flight hour.

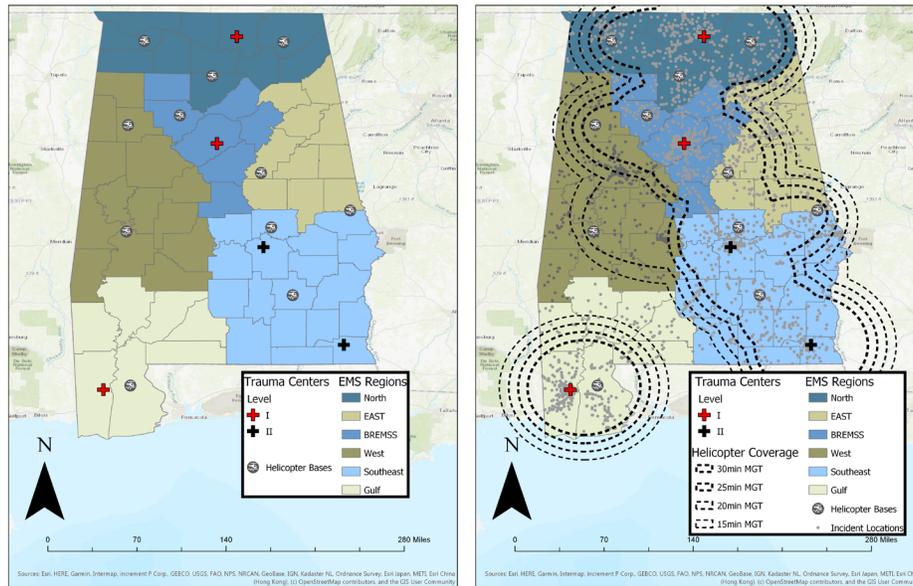


Figure 1: Alabama Trauma Centers, Helicopter Coverage, and Fatal MCVs

**Table 1. Comparison of counts of fatal collisions that could access a level I or II trauma center, by helicopter, by mission ground time**

	Mission Ground Time			
	30 minutes	25 minutes	20 minutes	15 minutes
<b>ALL REGIONS</b>				
# Collisions covered by rotary (%)	1782 (68.9)	2038 (78.9)	2311 (89.4)	2445 (94.6)
# Collisions not covered by rotary	802	546	273	139
Sum additional collisions covered (% increase)	--	256 (14.4)	529 (13.3)	663(5.8)
Count ratio	2.22	3.73	8.46	17.59
<b>REGION 1 – NORTH</b>				
# Collisions covered by rotary (%)	461 (87.5)	508 (96.3)	519 (98.5)	522 (99.1)
# Collisions not covered by rotary	66	19	8	5
Sum additional collisions covered (% increase)	--	47 (10.1)	58 (2.2)	61 (0.6)
Count ratio	6.98	26.74	64.88	104.40
<b>REGION 2 – EAST</b>				
# Collisions covered by rotary (%)	110 (35.5)	156 (50.5)	229 (74.1)	285 (92.2)
# Collisions not covered by rotary	199	153	80	24
Sum additional collisions covered (% increase)	--	46 (41.8)	119 (46.8)	175 (24.5)
Count ratio	0.55	1.02	2.86	11.88
<b>REGION 3 – BREMSS</b>				
# Collisions covered by rotary (%)	471 (93.1)	496 (98.0)	505 (99.8)	505 (99.8)
# Collisions not covered by rotary	35	10	1	1
Sum additional collisions covered (% increase)	--	25 (5.3)	34 (1.8)	34 (0.0)
Count ratio	13.46	49.60	505.00	505.00
<b>REGION 4 – WEST</b>				
# Collisions covered by rotary (%)	40 (12.5)	121 (37.8)	236 (73.4)	269 (84.1)
# Collisions not covered by rotary	280	199	84	51
Sum additional collisions covered (% increase)	--	81 (302.5)	196 (95.0)	229 (14.0)
Count ratio	0.14	0.61	2.81	5.27
<b>REGION 5 – SOUTHEAST</b>				
# Collisions covered by rotary (%)	409 (75.6)	455 (84.1)	508 (93.9)	536 (99.1)
# Collisions not covered by rotary	132	86	33	5
Sum additional collisions covered (% increase)	--	46 (11.2)	99 (11.6)	127 (5.5)
Count ratio	3.10	5.29	15.39	107.20
<b>REGION 6 – GULF</b>				
# Collisions covered by rotary (%)	291 (76.4)	302 (79.3)	314 (82.4)	328 (86.1)
# Collisions not covered by rotary	90	79	67	53
Sum additional collisions covered (% increase)	--	11 (3.8)	23 (4.0)	37 (4.5)
Count ratio	3.23	3.82	4.69	6.19

## Quick Shots Parallel Session II

Quick Shot #19  
January 16, 2020  
9:48 am

### **THE GERIATRIC TRAUMA PATIENT: A NEGLECTED INDIVIDUAL IN A MATURE TRAUMA SYSTEM**

Frederick Rogers, MD, MS, FACS\*, Michael Horst, PhD, Tawnya Vernon, BA,  
Tamer Shtayyeh, DO, Alan D Cook, MD\*, Eric H. Bradburn, DO, MS, FACS\*  
Penn Medicine Lancaster General Health

**Presenter:** Eric H. Bradburn, DO, MS, FACS

**Objectives:** Those aged >65 represent the fastest growing demographic in the U.S. As such, their care has been emphasized by trauma entities such as the ACSCOT. Unfortunately much of that focus has been on their care once they reach the hospital with little attention on the access of geriatric trauma patients (GTPs) to trauma centers (TCs). We sought to determine the rate of geriatric undertriage (UT) to TCs within a mature trauma system. We hypothesized that the GTP would have a higher UT rate (UTR) compared to their younger counterpart.

**Methods:** From 2003-2015, all geriatric (age>65) admissions with an Injury Severity Score (ISS) >9 from the PTSF registry and those meeting trauma criteria (ICD-9: 800-959) from the Pennsylvania Health Care Cost Containment Council (PHC4) database were included. UTR was defined as patients not admitted to accredited TCs (n=35) divided by the total number of patients as from the PHC4 database. PHC4 contains inpatient admissions within PA while PTSF reports admissions to PA TCs. ArcGIS Desktop and GeoDa were used for geospatial mapping of UT with a spatial empirical Bayesian smoothed UTR and Stata for statistical analyses.

**Results:** PTSF had 58,336 cases while PHC4 had 111,626 that met inclusion criteria, suggesting a geriatric UTR of 47.7% across PA (Figure 1). Geospatial mapping reveals significant clusters of UT regions with high UTR in some of the rural regions with limited access to a TC. High UTR appears to be mostly centered around non-TCs. UTR for patients with an ISS>15 was 48.4% (Figure 2).

**Conclusions:** There is a significant number of moderate to severely injured GTPs that do not get admitted to a TC within a mature trauma system. Increased emphasis needs to focus prehospital on identifying the severely-injured geriatric patient including specific geriatric triage protocols.

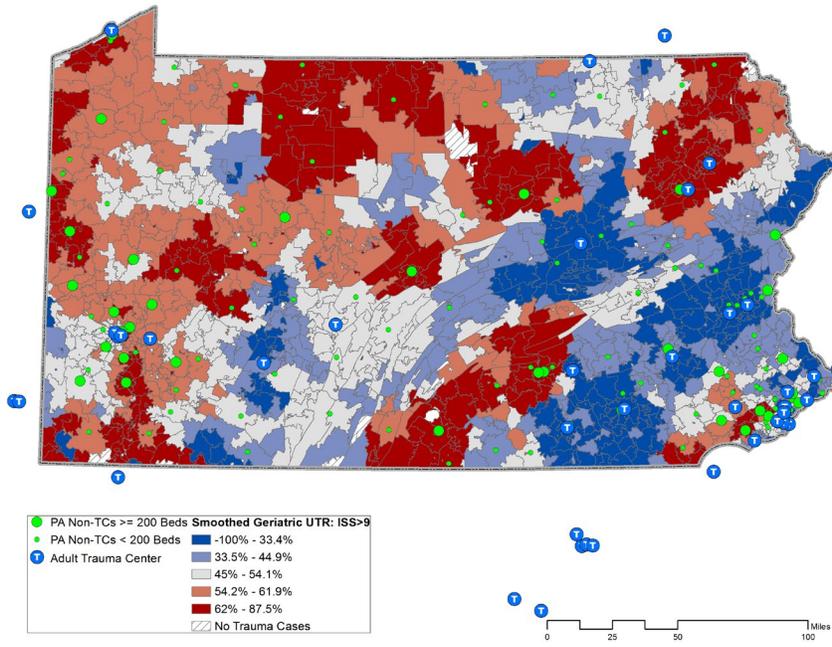


Figure 1. Geriatric Undertriage in a Mature Trauma System (ISS>9)

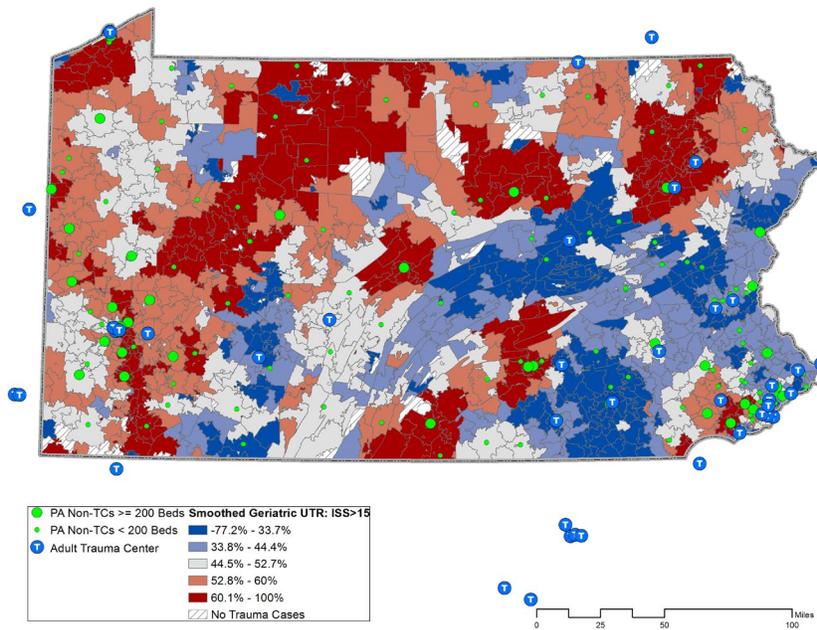


Figure 1. Geriatric Undertriage in a Mature Trauma System (ISS>15)

## Quick Shots Parallel Session II

Quick Shot #20  
January 16, 2020  
9:54 am

### CAUSES OF DEATH FOLLOWING DISCHARGE AFTER TRAUMA IN NORTH CAROLINA

Mary K. Bryant, BS, MD, Staci T. Aubry, MD, Sharon Schiro, PhD,  
Arielle Perez, MD, MPH, Lauren Raff, MD\*, Rebecca Maine, MD, MPH\*  
University of North Carolina

**Presenter:** Mary K. Bryant, BS, MD

**Objectives:** While a “fourth peak” of delayed trauma mortality has been described, limited data describes the causes of death (COD) for patients in the years following an injury. This study investigates the difference in COD statewide for patients with and without a recent trauma admission.

**Methods:** This retrospective cohort study compared COD for trauma and non-trauma patients in North Carolina. Death certificates in NC’s death registry were matched with the NC trauma registry between 2013–2018 using probabilistic matching on name and date of birth. Patients who died during the index trauma admission were excluded. Bivariate analysis of COD and patient factors were determined with  $\chi^2$  tests and regression models. Multiple COD recorded on the death certificates were included.

**Results:** Of 481554 death records, 18971 (3.9%) were linked to an alive discharge within the trauma registry during the study period. Prior trauma patients (PTP) had a higher incidence of mental illness (27.6% vs 24.2%), heart conditions (42.5% vs 41.5%), and opioid-related (1.8% vs 1.6%) COD compared to non-trauma patients,  $p < 0.05$  (Table 1). Overall, suicide was higher in the non-trauma cohort (1.5% vs 1.1%), however, PTP had higher incidences of death by MVC (2.5% versus 1.2%), fall (8.1% vs 0.9%), and homicide (0.9% vs 0.6%),  $p < 0.001$ . PTP had 1.16 increased odds of an opioid-related death ( $p = 0.009$ , 95% CI 1.04, 1.29) compared to those without prior trauma. For PTP, mental illness related COD was the second leading COD for all age subgroups (16-40y, 41-64y, >65y). Younger PTP had a much higher rate of death from suicide (11.8%) compared to those 41-64y (2.9%) and >65y (0.3%),  $p < 0.001$ .

**Conclusions:** After hospital discharge, PTP remain at risk of dying from future trauma and mental health conditions. Prevention strategies for PTP should address the increased risk of death from a subsequent traumatic injury, opioid-related death, and suicide, especially in younger adults.

Cause of death*	Prior trauma** N=18971 n (%)	No prior trauma N=462583 n (%)	p value
Suicide	211 (1.1)	6792 (1.5)	<0.001
Mental illness	5246 (27.6)	112146 (24.2)	<0.001
Septicemia	1489 (7.8)	35512 (7.7)	0.384
Cirrhosis	494 (2.6)	10994 (2.4)	0.044
Other gastrointestinal disorders	1006 (5.3)	27999 (6.1)	<0.001
Kidney disease	1466 (7.7)	35857 (7.8)	0.904
Musculoskeletal disorders	471 (2.5)	8847 (1.9)	<0.001
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	3385 (17.8)	72540 (15.7)	<0.001
Homicide	169 (0.9)	2691 (0.6)	<0.001
Ischemia	2984 (15.7)	85476 (18.5)	<0.001
Other heart disorders	8055 (42.5)	192100 (41.5)	0.011
Endocrine disorders	2645 (13.9)	75206 (16.3)	<0.001
Cancer	2517 (13.2)	115986 (25.1)	<0.001
Alzheimer's disease	1417 (7.4)	22863 (4.9)	<0.001
Nervous system disorders	2641 (13.9)	51707 (11.2)	<0.001
Motor vehicle accident	478 (2.5)	5771 (1.2)	<0.001
Fall	1541 (8.1)	4127 (0.9)	<0.001
Other injury	662 (3.5)	14087 (3.0)	0.001
Opioid-related	346 (1.8)	7319 (1.6)	0.009

\* Most common causes listed, not inclusive of all less common causes

\*\*Eligible for entry into NC State Trauma Registry

Table 1. Most common causes of death for all deaths (N=481554) in North Carolina January 1, 2013, through December 31, 2018, stratified by prior recent trauma admission or not

### Quick Shots Parallel Session III

Quick Shot #21  
January 16, 2020  
11:15 am

#### RELATIONSHIP OF BODY MASS INDEX, SERUM CREATINE KINASE, AND ACUTE KIDNEY INJURY AFTER SEVERE TRAUMA

Charles R. Vasquez, MD, Thomas DiSanto, BS, John Reilly, MD, MSCE, Caitlin Forker, BA, Daniel N. Holena, MD, MSCE\*, Qufei Wu, MS, Paul Lanken, MD, MSCE, Jason Christie, MD, MSCE, Michael Shashaty, MD, MSCE  
University of Pennsylvania

**Presenter:** Charles R. Vasquez, MD

**Objectives:** Body mass index (BMI) is associated with acute kidney injury (AKI) after trauma, but underlying mechanisms are unclear. Higher BMI correlates with increased muscle mass even in patients with excess adiposity. We hypothesized that BMI would correlate with higher creatine kinase (CK) release after injury, and that adjustment for serum CK would attenuate the BMI-AKI association.

**Methods:** Prospective cohort study of 463 critically ill patients at a Level I trauma center with injury severity score (ISS)>15 and serum CK measured in the first 7 days. We defined AKI by AKI Network creatinine criteria. We used Spearman's rho and Wilcoxon rank-sum tests for unadjusted associations, and multivariable logistic regression to adjust the BMI-AKI association for peak CK and confounders.

**Results:** Median age was 43 years, 350 (76%) were male, 366 (79%) had blunt mechanism, and median ISS was 24. BMI correlated with peak CK ( $\rho$  0.20,  $p < 0.001$ ). Patients with AKI ( $n=148$ , 32%) had higher median peak CK than those without AKI (3650 U/l, IQR 1328-9322 v. 1850 U/l, IQR 583-5139, respectively,  $p < 0.001$ ). BMI was significantly associated with AKI in multivariable models adjusted for age, race, sex, diabetes, injury mechanism and severity, and red blood cell transfusions (OR 1.31 per 5 kg/m<sup>2</sup>, 95% CI 1.09-1.58,  $p=0.004$ ). Adding peak CK to the model partially attenuated the effect of BMI (OR 1.26 per 5 kg/m<sup>2</sup>, 95% CI 1.04-1.52,  $p=0.018$ ), and peak CK remained associated with AKI (OR 1.19 per natural log, 95% CI 1.00-1.41,  $p=0.049$ ). In addition, serum CK in the first 24h was significantly associated with AKI, even among those with CK<5000 U/l (OR 1.38, 95% CI 1.04-1.83,  $p=0.026$ ;  $n=286$ ).

**Conclusions:** Serum CK correlated with BMI and partially attenuated the association of BMI with AKI after major trauma, suggesting that excess muscle injury may contribute to the association of BMI with AKI.

### Quick Shots Parallel Session III

Quick Shot 22  
January 16, 2020  
11:21 am

#### CAN EDUCATIONAL VIDEOS REDUCE OPIOID CONSUMPTION IN TRAUMA INPATIENTS? A CLUSTER-RANDOMIZED PILOT STUDY

Esther S. Tseng, MD\*, Brian T Young, MD, Samuel Zolin, MD, Eric Curfman,  
Nicole Wise, Vetrica Lemaitre, Jeffrey A. Claridge, MD, MS, FACS\*,  
Kristen Conrad-Schnetzer, DO\*, Vanessa P. Ho, MD, MPH\*  
MetroHealth Medical Center

**Presenter:** Esther S. Tseng, MD

**Objectives:** To determine effect and feasibility of video-based education on trauma inpatient opioid use. We hypothesized that morphine equivalent doses (MEDs) taken by trauma floor patients on the day before discharge would be reduced by 30% and that  $\geq 80\%$  of patients assigned to receive the intervention would view the videos.

**Methods:** We performed a prospective cluster randomized pilot study of opioid education videos for trauma floor patients. Videos on pain expectations and opioid safety were created. One of two equivalent trauma-credentialed regular nursing floors (RNF) was selected to show the video as the intervention. Patients were equally likely to be admitted to either RNF. Nursing staff were to show videos to English speaking or Spanish-literate patients within one day of RNF arrival, excluding patients with GCS  $< 15$ . Clinical characteristics, MEDs taken on the day before discharge, discharge prescriptions, and 30-day pain-related follow-up events were compared. Intention to treat (intervention vs. control) and per-protocol groups (viewed video vs. no video) were compared,  $\alpha=0.05$ . Protocol compliance was also assessed.

**Results:** In intention-to-treat analysis (Table 1), there was no difference in MEDs taken on the day before discharge, discharge opioid prescriptions, or 30-day pain-related follow-up. Per-protocol analysis (Table 2) also showed no significant difference in outcomes. Protocol compliance was poor; only 45.6% of the intervention group saw the videos. Among patients using opioids on the day before discharge, those who saw the videos took fewer MEDs than those who did not ( $p=0.038$ ).

**Conclusions:** Video-based education did not reduce inpatient opioid consumption, although there may be benefits in specific subgroups. We must work towards establishing effective methods to educate patients about safe pain management and integrate them into standard workflow.

	Control	Intervention	p
Number of Patients	84	90	
Age (Median [IQR])	67.5 [41.5, 81]	59 [37, 72]	0.049
Male (%)	56 (66.7)	56 (62.2)	0.635
Penetrating Mechanism (%)	5 (6.0)	15 (16.7)	0.033
ISS (Median [IQR])	10 [9, 16]	13 [9, 17]	0.369
ICU Length of Stay (Median [IQR])	0 [0, 2]	0 [0, 2]	0.499
Total Length of Stay (Median [IQR])	5.50 [4, 8.25]	5 [4, 8]	0.69
MEDS Consumed Day Before Discharge (Median [IQR])	15 [0, 41.25]	17.5 [0, 47.25]	0.446
Opioids Prescription Given at Discharge (%)	48 (57.1)	54 (60.0)	0.759
MEDs Prescribed at Discharge (Median [IQR])	210 [135, 210]	210 [150, 210]	0.264

Table 1 – Intention-to-Treat Analysis

	Did Not See Videos	Saw Videos	p
Number of Patients	133	41	
Age (Median [IQR])	60 [37, 78]	63 [53, 72]	0.56
Male (%)	86 (64.7)	26 (63.4)	1
Penetrating Mechanism (%)	12 (9.1)	8 (19.5)	0.091
ISS (Median [IQR])	13 [9, 17]	10 [5, 14]	0.025
ICU Length of Stay (Median [IQR])	0 [0, 2]	0 [0, 1]	0.355
Total Length of Stay (Median [IQR])	6 [4, 9]	5 [3, 8]	0.265
MEDS Consumed Day Before Discharge (Median [IQR])	20 [0, 60]	15 [0, 32.5]	0.166
Opioids Prescription Given at Discharge (%)	75 (56.4)	27 (65.9)	0.365
MEDs Prescribed at Discharge (Median [IQR])	180 [127.5, 210]	210 [195, 217.5]	0.066

Table 2 – Per-Protocol Analysis

### Quick Shots Parallel Session III

Quick Shot #23  
January 16, 2020  
11:27 am

#### THE SCALES OF RECOVERY: BALANCING POSTTRAUMATIC STRESS WITH RESILIENCE IN THE VIOLENTLY INJURED

Andrew Wheeler, LCSW, Leah C. Tatebe, MD FACS\*, Eleanor Clifford, BS,  
Saclarides Constantine, MD, Emily Deyo, MSW, Annie Guedikian, BS,  
Erik Liesen, MA, Sydney Pekarek, BS, Nandini Rajaram Siva, MBBS,  
Caroline Butler, MD\*, Matthew Kaminsky, MD\*, Thomas A. Messer, MD\*,  
Victoria Schlanser, DO\*, Frederic L. Starr, MD\*, Carol Reese,  
Faran Bokhari, MD, MBA, FACS, FACP\*, Andrew J. Dennis, DO, FACS, FACOS\*  
Stroger Cook County Hospital

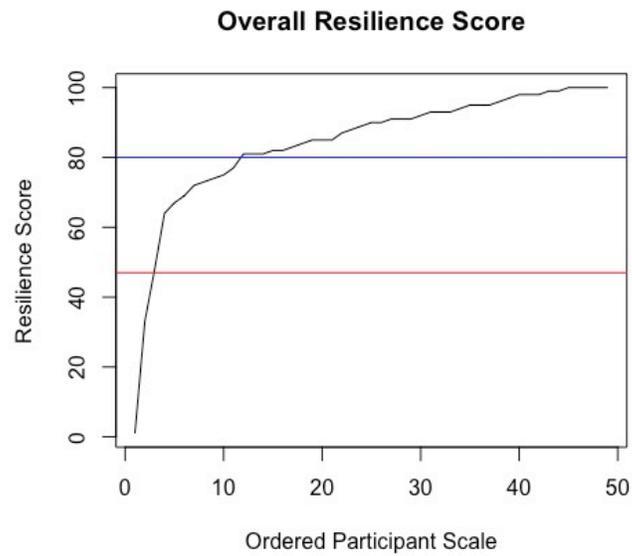
**Presenter:** Andrew Wheeler, LCSW

**Objectives:** In order to improve services that promote the emotional healing process of violently injured patients, we sought to assess resilience and contributory factors among adult victims of penetrating trauma caused by interpersonal violence.

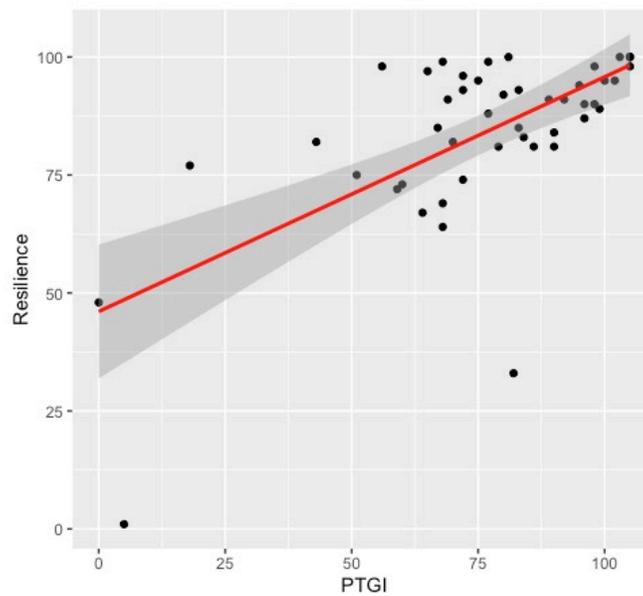
**Methods:** Adults who presented with non-accidental penetrating trauma to an urban Level 1 trauma center and were at least one month but no more than 12 months from their injury were eligible. Participants completed the Connor-Davidson Resiliency Scale, Post-Traumatic Growth Inventory (PTGI), Primary Care Post-Traumatic Stress Disorder (PC-PTSD) Screen, and a community violence exposure screen. Possible contributing factors were collected including age, injury severity score (ISS), length of stay (LOS), number of surgeries, and time from injury.

**Results:** 55 participants have been enrolled thus far with a mean resiliency score of 84.1 (SD 18.2). 77.5% of respondents scored higher than what has been reported in the general population, and 95.9% scored higher than reports among those with PTSD (Figure 1). The mean PTGI score was 78.7 (SD 20.8), with 94% scoring above 45 which represents significant growth. 54% screened positive on the PC-PTSD and report high levels of exposure to community violence with 94.3% having had a close friend or family member killed. Resiliency did correlate with PTGI ( $p < 0.001$ , Figure 2). Resiliency did not correlate with PTSD score, exposure to violence, or any other evaluated factor.

**Conclusions:** Victims of violent injury experience a myriad of traumatic events yet are highly resilient and exhibit traits of growth across multiple domains. Assessing for resilience provides useful results to inform treatment options that may be otherwise missed. Considering the lack of correlation found with known variables, further investigation is needed to determine other contributing factors that positively reinforce resiliency among violently-injured patients and could be generalizable to other patient populations.



Ordered resiliency scores of study participants compared to general population (top, blue line) and treatment seeking patients with PTSD (bottom, red line).



Positive correlation between scores on Connor Davidson Resiliency Scale and Post-Traumatic Growth Inventory (PTGI) with a linear regression fit ( $p < 0.001$ ).

### Quick Shots Parallel Session III

Quick Shot #24  
January 16, 2020  
11:33 am

#### RACIAL INEQUALITY IN THE TRAUMA OF WOMEN: A DISPROPORTIONATE DECADE

Shawn Izadi, BS, Niral Patel, BBA, Julie Whitis, MD,  
Demba Fofana, PhD, Samuel Snyder, MD, Jeffrey J. Skubic, DO\*  
The University of Texas Rio Grande Valley School of Medicine

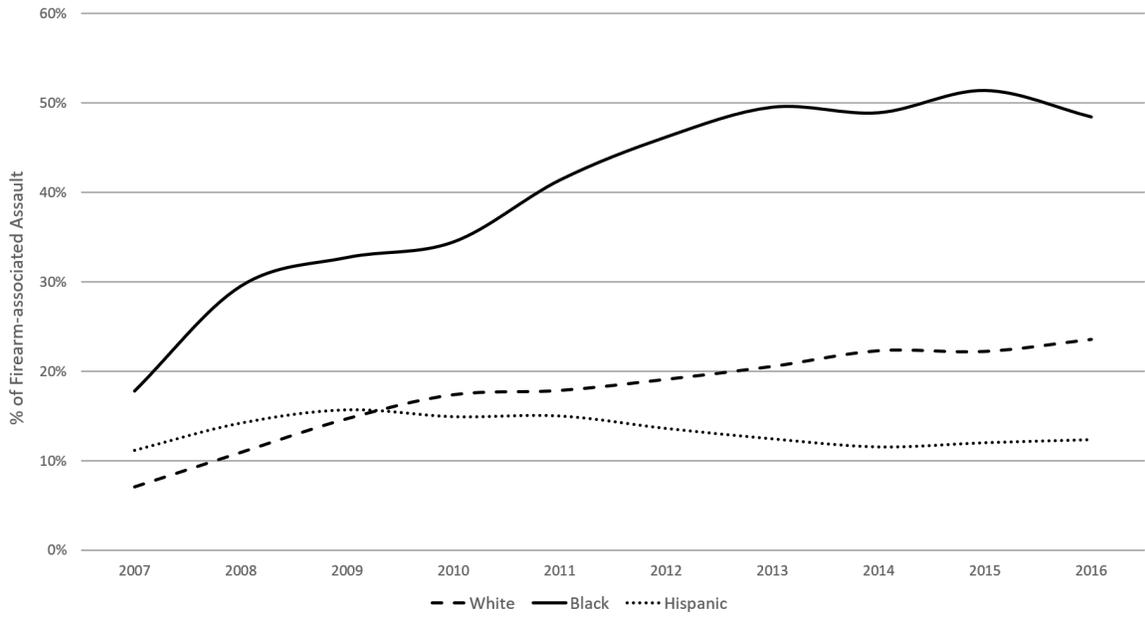
**Presenter:** Shawn Izadi, BS

**Objectives:** We sought to: (1) evaluate the most common mechanisms of injury experienced by women; and (2) characterize ethno-demographic trends in regard to intent of injury over a 10-year period.

**Methods:** A 10-year review (2007-2016) of the National Trauma Data Bank (NTDB) was conducted to identify common mechanisms of injuries among women. Pearson Chi Square tests were performed to identify differences in temporal trends amongst racial groups. Data was analyzed corresponding to demographics and intent of injury.

**Results:** Between 2007 and 2016, 1,650,496 women presented secondary to a trauma. Most presented due to an unintentional mechanism (93%) while fewer presented secondary to an assault (6%), self-inflicted injury (1%), or other mechanism (<1%). Among this population, White women incurred 56% of related traumas while Black and Hispanic women each represented 6%. Although racial/ethnic minority women represented a small percentage of total traumas, they accounted for roughly 1 in 2 assault-related traumas ( $p < 0.05$ ). Compared to White women, firearm-associated assault was 2.3 times more prevalent among Black women ( $p < 0.001$ ). Though assaults decreased by 43% during this study period, Black women saw a 40% increase in total assaults. Specifically, Black women saw a 172% increase in firearm-associated assaults.

**Conclusions:** Compelling data highlights a paradoxical trend in respect to the decrease in total assault-related traumas in women compared to its increase in Black women. Further studies are essential to help understand and subsequently provide social and preventative services for the diverse population of women in the United States.



Trends of firearm-associated assault stratified by race.

### Quick Shots Parallel Session III

Quick Shot #25  
January 16, 2020  
11:39 am

#### DOWNSTREAM EFFECTS OF A COMPREHENSIVE TRAUMA RECOVERY SERVICES PROGRAM

Vanessa P. Ho, MD, MPH\*, Mark Kalina Jr., BA, Belinda DeMario, BA, Evelyn Truong, BS, Sarah Hendrickson, MEd, Christina Ragone, MPH, BSN, RN, CCRN, Esther S Tseng, MD\*, Jeffrey A. Claridge, MD, MS, FACS\*, Heather Vallier, MD  
MetroHealth Medical Center

**Presenter:** Vanessa P. Ho, MD, MPH

**Objectives:** To ascertain whether participation in a comprehensive Trauma Recovery Services (TRS) program can reduce trauma survivor emergency department (ED) recidivism and facilitate in-network follow-up after injury. We hypothesized TRS participants would have with greater downstream non-emergent use of our hospital system, manifested by lower ED charges and higher non-ED charges in the year following admission.

**Methods:** Our Level 1 Trauma Center's TRS program connects patients and families with resources including education, peer mentors, and a support network. We retrospectively studied trauma inpatients (3/2017-3/2018) offered TRS who survived their index admission. Injury characteristics, TRS registry data and hospital system charges were compared between TRS participants and non-participants. The main outcome of interest was cumulative ED and non-ED charges for the 1 year following index admission. Non-ED charges encompassed outpatient and subsequent admission charges. Charges were assessed using multivariable regression.

**Results:** 587 patients were identified: 70% male, 26% penetrating. Aggregate charges for this cohort were \$81 million, of which \$32 million occurred after the index admission. 399 (68%) patients participated in TRS; all but one received education and 362 (91%) had peer mentoring. TRS participants were older, more severely injured, had fewer penetrating injuries, and had longer index LOS (Table 1). 510 (87%) had at least 1 subsequent encounter; 175 (29%) returned to the ED. Non-ED charges were associated with ISS and index LOS, but not TRS. ED charges were significantly lower for TRS participants (Table 2).

**Conclusions:** A comprehensive TRS program including education, peer mentors, and a support network may provide value to the patient and the healthcare system by reducing subsequent care provided by the ED in the year after a trauma without affecting non-emergent care.

Table 1. Trauma Recovery Services (TRS) Participants vs. Non-Participants

Factor	Bivariate Comparison		
	No TRS n=188	TRS n=399	p-value
Age	31 (24-48)	46 (27-59)	<0.0001
Female	43 (23%)	133 (33%)	0.01
Penetrating	82 (44%)	70 (17.5%)	<0.0001
Injury Severity Score	10 (9-14)	14 (10-21)	<0.0001
Hospital LOS	3 (2-6)	7 (4-11)	<0.0001
Any ED Visit	70 (37%)	105 (26%)	0.007
Charges, \$			
Index Admission	43,602 (24,777-68,218)	71,473 (44,380-116,686)	<0.0001
Subsequent ED	0 (0-3,062)	0 (0-867)	0.006
Subsequent Non-ED	0 (0-1,911)	0 (0-131)	0.07

Median (IQR) or N (%); p-values determined by Wilcoxon Rank Sum or Chi-Square. LOS=Length of Stay, ED=Emergency Department

Table 2. Linear Regression of Charges

Factor	ED Charges, \$			Non-ED Charges, \$		
	$\beta$	95% CI	p-value	$\beta$	95% CI	p-value
Age	-26	-58 – 4	0.09	-118	-530 – 294	0.57
Penetrating	501	-821 – 1,822	0.46	8,648	-9,038 – 26,334	0.34
Female	-778	-1,958 – 401	0.20	2,061	-13,724 – 17,848	0.80
TRS	-1,472	-2,701 – -244	0.02*	-4,113	- 20,554 – 12,328	0.62
ISS	1	-65 – 67	0.98	1,426	546 – 2,305	0.001*
LOS	6	-63 – 74	0.87	1,685	766 – 2,605	<0.001*

TRS=Trauma Recovery Services, ISS=Injury Severity Score, LOS=Length of Stay, ED=Emergency Department

### Quick Shots Parallel Session III

Quick Shot #26  
January 16, 2020  
11:45 am

#### FEASIBILITY OF A TRAUMA QUALITY OF LIFE FOLLOW UP CLINIC

Colleen M. Trevino, NP, PhD\*, Timothy Geier, PhD, Sydney Timmer-Murillo, PhD,  
Matthew Shawlin, MSW, David J. Milia, MD\*, Panna Codner, MD, Terri deRoos-Cassini, PhD  
Medical College of Wisconsin

**Presenter:** Colleen M. Trevino, NP, PhD

**Objectives:** Little effort has been made to address long-term quality of life (QOL), chronic pain (CP), post-traumatic stress disorder (PTSD), and functional disability in trauma survivors. This quality initiative was developed to determine feasibility of a coordinated, comprehensive, patient-centered follow up clinic for those at risk for poor long-term outcomes.

**Methods:** A convenience sample from 649 hospitalized trauma patients at a Midwestern level 1 trauma center between 2/2018 and 8/2018 was screened for risk of PTSD and CP. 36 patients were randomized into a standard follow up clinic (SOC) (2-week post-discharge surgical clinic) or a new trauma quality of life clinic (TQOL). The TQOL was developed to provide comprehensive care to patients at high risk for PTSD (Injured Trauma Survivor Score  $\geq 2$ ) and/or CP (discharge pain score  $\geq 4$ ). TQOL included a nurse practitioner or surgeon (NP/MD), psychologist, social worker, and physical therapist at one-week post discharge. All providers saw the patient independently, developed a care plan collaboratively, and communicated the plan to the patient. The SOC involved a visit only with an NP/MD. Measures of pain, PTSD, depression, QOL, physical functioning, and life satisfaction were completed at time of the TQOL/SOC or over the phone.

**Results:** There were no differences in demographics, readmissions, or emergency department visits after discharge between groups (Fig.1). However, no show rates were almost twice as high in SOC (40%) compared to TQOL (22%) and those in TQOL completed 23 additional psychology visits versus one psychology visit in SOC (Fig. 2). This clinic structure is feasible for high risk patients and TQOL patients demonstrated improved engagement in their care.

**Conclusions:** A comprehensive multidisciplinary TQOL addressing issues affecting convalescence for trauma patients at high risk for developing PTSD and CP can improve follow up rates to ensure patients are recovering successfully.

Figure 1: Demographics, readmissions, or emergency department visits after discharge

	TQOLc (N=18)	SOC (N=18)	P (*significant)
Injury Severity Score	12.13 (SD=6.5)	12.11 (SD= 8.3)	0.99
Discharge Pain	6.6 (SD=2.2)	5.89 (SD=1.4)	0.26
Age	38	35.7	0.23
Injured Trauma Survivor Score Total	228	374	0.35
Readmission	3	4	0.39
Emergency Department visits	7	6	0.97

\*p<0.5

Figure 2: Post-Discharge Clinic Follow-up Visits

	TQOL	SOC
Total number of trauma visits	22	9
Total number of additional Psychology visits	23	1

### Quick Shots Parallel Session III

Quick Shot #27  
January 16, 2020  
11:51 am

#### MAKING THE NEWS: VICTIM CHARACTERISTICS ASSOCIATED WITH MEDIA REPORTING ON FIREARM VIOLENCE

Elinore J. Kaufman, MD\*, Jesse Passman, MD, MPH, Sara Jacoby, PhD,  
Daniel N. Holena, MD, MSCE\*, Mark J. Seamon, MD, FACS\*,  
Jim MacMillan, BS, Jessica H. Beard, MD, MPH\*  
Lewis Katz School of Medicine at Temple University

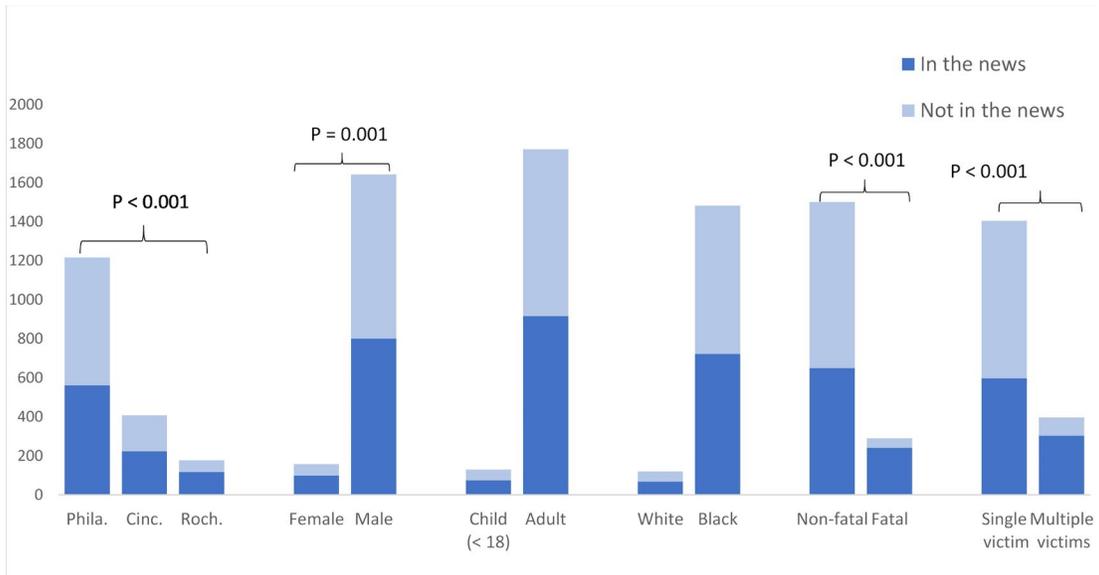
**Presenter:** Elinore J. Kaufman, MD

**Objectives:** Firearm violence is increasingly seen as a public health crisis in the United States, but the public may not have a comprehensive understanding of this epidemic. Limited media coverage may contribute to limited public understanding. We analyzed media coverage of firearm assaults (FAs) in 3 U.S. cities. We hypothesized that multiple shootings and fatal shootings would be more likely to make the news, as would shootings affecting children, women, and white individuals.

**Methods:** The Gun Violence Archive (GVA) is an online repository of FAs collected from local, regional, and national media sources in the US. We compared GVA to police department (PD) FA data for 2017 in 3 cities with detailed, publicly available PD data: Philadelphia, PA, Rochester, NY, and Cincinnati, OH. We assumed that PD data included all FAs for each jurisdiction and that GVA data included all FAs reported in the media. GVA data were matched to PD data by date, location, victim age, and sex. Matched victims were compared to unmatched victims using  $\chi^2$  tests for categorical variables and Kruskal-Wallis tests for nonparametric continuous variables.

**Results:** Philadelphia PD reported 1,216 FA victims in 2017; Cincinnati PD reported 407; and Rochester PD reported 178. Media covered 562 (46.2%), 222 (54.6%), and 116 (65.2%), respectively ( $p < 0.001$ ). Fatal shootings were significantly more often reported as were shootings with multiple victims or women (Figure). Of 120 total white victims, 56.7% made the news compared to 48.7% of 1,482 Black victims,  $p = 0.09$ .

**Conclusions:** A large proportion of shootings never make the news, which may limit public understanding of the true burden of gun violence. Lack of awareness in turn may hinder support for and implementation of evidence-based approaches to reducing gun violence. Researchers and policy makers should collaborate with journalists and editors to improve public awareness of firearm violence.



Number of firearm assaults reported in the media by victim characteristics, 2017

### Quick Shots Parallel Session III

Quick Shot #28  
January 16, 2020  
11:57 am

#### **FLAIM: A DEEP NEURAL NETWORK (DNN) BASED APPROACH TO EARLY PREDICT MORTALITY IN TRAUMA PATIENTS ADMITTED TO THE ICU**

Fahad S. Ahmed, MD, Liaqat Ali, PhD Student, Bellal Joseph, MD\*, Ahmed Chan, PhD  
Yale School of Medicine

**Presenter:** Fahad S. Ahmed, MD

**Objectives:** Trauma patients admitted to critical care are at high risk of mortality because of their injuries. We integrated a machine learning based framework (FLAIM) to both validate and predict risk factors through a deep neural network. We hypothesized machine learning could be applied to critically ill trauma patients.

**Methods:** The FLAIM works in two phases. In the first phase, we statistically analyzed the publicly available MIMIC III v1.4 dataset which is developed by MIT Lab for health data in critically ill patients. We applied univariate and multivariate analyses to generate hazard ratios and to rank the trauma associated risk factors. In the second phase, we applied deep neural network models to predict mortality. Additionally, we compared the performance of our proposed system by using popular machine learning models such as Linear Discriminant Analysis, Gaussian Naive Baye, etc.

**Results:** There were 3022 trauma patients with an average age > 18 years. We observed a number of significant parameters which were: Serum anion gap (HR 2.46, CI 1.94-3.11), sodium (HR 2.11, CI 1.61-2.77) and chloride (HR 2.11, CI 1.69-2.64) abnormalities on labs. After calculating clinical parameters we included the Diagnosis of sepsis (HR 2.03, 95%CI 1.23-3.37), qSOFA score (HR 1.52, CI 1.32-3.76) and SIRS criteria (HR 1.41, CI 1.24-1.26) presented in Table 1. We then applied multiple machine learning models to these significant data and we found that the proposed Deep Neural Network (DNN) outperformed all the other methods with test set accuracy of 92.25%, the sensitivity of 79.13% and specificity 94.16% all the rest of the algorithms TABLE 2.

**Conclusions:** The applicability of machine learning can lead to immediate processing of clinical data to potentially drive clinical practice. FLAIM model based on deep learning is superior to other predictive models and can be applied to trauma data to predict outcomes.

Risk factors	Reference ranges	Units	n (abnormal levels)	%	p-value	Univariate		Multivariate			
						HR	95%CI	p-value	HR	95%CI	
Chemistry	Sodium	135-145	mEq/L	299	9.8	*<0.001	2.475	1.89-3.24	*<0.001	2.114	1.61-2.77
	Potassium	3.5-5.5	mmol/L	275	9.0	*<0.05	1.444	1.03-2.02	0.053	1.399	1.00-1.97
	Chloride	97-107	mEq/L			*<0.001	2.055	1.65-2.56	*<0.001	2.110	1.69-2.64
	Bicarbonate	23-29	mEq/L	1177	38.7	*<0.001	2.215	1.70-2.66	*<0.001	2.085	1.67-2.61
	Blood urea nitrogen	7-20	mg/dL	792	26.0	*<0.001	1.818	1.46-2.27	0.001	1.488	1.18-1.88
	Creatinine	0.6-1.2	mg/dL	663	21.8	*<0.001	1.769	1.41-2.22	*<0.001	1.665	1.32-2.10
	Glucose	72-99	mg/dL	2272	89.4	*<0.01	2.142	1.17-3.91	*<0.05	2.067	1.13-3.78
	Anion Gap	8-16	mEq/L	494	16.2	*<0.001	2.602	2.06-3.29	*<0.001	2.460	1.94-3.11
	Lactate	0.5-1.0	mmol/L	2300	75.6	*<0.001	1.951	1.41-2.70	*<0.001	2.101	1.51-2.93
	Bilirubin	0.1-1.2	mg/dL	137	4.5	*<0.05	1.627	1.11-2.39	0.05	1.474	1.00-2.17
	Hematological	Hematocrit	37-52	%	2007	66.0	0.203	1.178	0.92-1.52	-	-
Hemoglobin		13.5-15.5	g/dL	2425	79.7	*<0.05	1.489	1.06-2.10	0.112	1.328	0.94-1.89
WBC		4.5-11	1000 cells/mL	1855	61.0	0.922	0.999	0.80-1.25	-	-	-
Bleeding profile	Plateletes	150-350	1000 cells/mL	690	22.7	*<0.001	1.646	1.31-2.07	*0.001	1.478	1.18-1.86
	PTT	25-35	Seconds	1375	45.2	*<0.05	1.304	1.05-1.62	*0.005	1.366	1.10-1.70
	PT	11-13.5	Seconds	1216	40.0	*<0.001	2.156	1.72-2.70	*<0.001	2.081	1.66-2.61
Albumin	0.8-1.1		1619	53.2	*<0.001	1.881	1.48-2.40	*<0.001	1.925	1.51-2.46	
Clinical Scores	INR	3.5-5.5	g/dL	381	12.5	*<0.005	1.528	1.17-1.99	*<0.05	1.428	1.09-1.87
	Explicit sepsis using ICD-9 codes					*0.002	2.491	1.51-4.11	*0.006	2.032	1.23-3.37
	Angus criteria of sepsis					*0.003	0.671	0.51-0.88	*<0.001	0.617	0.47-0.81
	Acute Physiology Score III					*<0.001	1.040	1.04-1.04	*<0.001	1.038	1.03-1.04
	Logistic Organ Dysfunction System					*<0.001	1.336	1.30-1.37	*<0.001	1.315	1.28-1.35
	Sepsis diagnosis using Martin Sepsis et al					0.817	0.952	0.63-1.45	-	-	-
	Oxford Acute Severity of Illness Score (OASIS)					*<0.001	1.128	1.11-1.14	*<0.001	1.119	1.10-1.13
	Quick Sequential Organ Failure Assessment (qSOFA)					*<0.001	1.648	1.43-1.90	*<0.001	1.521	1.32-1.76
	Simplified Acute Physiology Score (SAPS)					*<0.001	1.223	1.20-1.25	*<0.001	1.205	1.18-1.23
	Simplified Acute Physiology Score II (SAPS II)					*<0.001	1.066	1.06-1.07	*<0.001	1.063	1.06-1.07
	Systemic inflammatory response syndrome (SIRS) criteria					*<0.001	1.380	1.22-1.56	*<0.001	1.414	1.24-1.61
	Sequential Organ Failure Assessment (SOFA)					*<0.001	1.242	1.21-1.28	*<0.001	1.218	1.18-1.26

Table 1. Clinical parameters and their respective Hazard ratios, Confidence intervals and *p*-values.

Method	Training Accuracy (%)	Testing Accuracy (%)	Sensitivity	Specificity
Deep Neural Network (Layer 1 Nodes = 7 & Layer 2 Nodes = 5)	93.84	92.25	79.13	94.16
LDA Model	82.61	81.84	72.17	83.25
GNB Model	81.47	80.07	67.83	81.85
Decision Tree Model (CART)	89.59	100	63.48	93.40
KNN Model	93.30	84.94	66.96	87.56

Table 2. Different Machine learning methods and their respective Training Accuracies, Test set accuracies, Sensitivities and Specificities.

## Quick Shots Parallel Session III

Quick Shot #29  
January 16, 2020  
12:03 pm

### DEATHS FOLLOWING WITHDRAWAL OF LIFE SUSTAINING THERAPY REPRESENT OPPORTUNITIES FOR QUALITY IMPROVEMENT

Matthew P. Guttman, MD, Bourke W. Tillmann, MD,  
Barbara Haas, MD, PhD\*, Avery B. Nathens, MD, PhD, MPH\*  
University of Toronto

**Presenter:** Matthew P. Guttman, MD

**Objectives:** Risk-adjusted performance benchmarking is useful for identifying quality improvement (QI) opportunities. There is controversy as to whether patients who die following withdrawal of life sustaining therapy (WLST) should be included as deaths, given that they may have survived if patient preferences were different. However, it is possible that some deaths following WLST may be preventable with better care. We explored whether outcomes among those with WLST might be modifiable by evaluating the proportion who died as a result of failure to rescue (FTR).

**Methods:** Data were derived from the ACS TQIP 2016 cohort. FTR was defined as death following a major complication. To identify potential for QI, we calculated the proportion of deaths following WLST that represented FTR. Risk adjustment models were used to rank hospital performance by quartile. Three different decedent cohorts were used for ranking: 1) all deaths, 2) excluding WLST deaths, and 3) excluding WLST deaths where there was no FTR.

**Results:** There were 13,607 (5.2%) deaths among 260,159 patients in 447 centers. For all deaths, mean age was 59 years, 69% were male, and median ISS was 25 (Table). Of the 13,607 deaths, 42% occurred after WLST, of which 23% represented FTR. After excluding patients who died following WLST, 32% of centers in the lowest mortality quartile moved to a higher quartile. When excluding those with WLST not classified as FTR, 29% of centers moved to a higher quartile.

**Conclusions:** Many deaths following WLST represent FTR and are thus potentially preventable. The inclusion of these deaths in benchmarking had an impact on hospital rankings and excluding them would be inappropriate. Deaths following WLST should be evaluated as part of a trauma center's QI program to determine whether FTR was contributory. ACS TQIP should consider highlighting these patients in benchmarking reports.

	<b>All Deaths n=13,607</b>	<b>Excluding WLST n=7,880</b>	<b>Excluding only WLST without FTR n=9,191</b>
<b>Age in years, mean (SD)</b>	58.7 (22.5)	54.8 (23.4)	56.0 (23.0)
<b>Male gender, n (%)</b>	9399 (69.1%)	5538 (70.3%)	6461 (70.3%)
<b>Race</b>			
<b>White</b>	9734 (71.5%)	5201 (66.0%)	6210 (67.6%)
<b>Black</b>	1993 (14.6%)	1491 (18.9%)	1658 (18.0%)
<b>Other</b>	1424 (10.5%)	908 (11.5%)	1011 (11.0%)
<b>Insurance status, n (%)</b>			
<b>Commercial</b>	3543 (26.0%)	1998 (25.4%)	2405 (26.2%)
<b>Non-commercial</b>	7142 (52.5%)	3738 (47.4%)	4459 (48.5%)
<b>Self-pay</b>	2070 (15.2%)	1555 (19.7%)	1673 (18.2%)
<b>Any comorbidity, n (%)</b>	8640 (63.5%)	4328 (54.9%)	5344 (58.2%)
<b>Mechanism of injury, n (%)</b>			
<b>Fall</b>	6088 (44.7%)	2923 (37.1%)	3517 (38.3%)
<b>MVC</b>	3006 (22.1%)	1859 (23.6%)	2234 (24.3%)
<b>Other blunt</b>	2263 (16.6%)	1401 (17.8%)	1644 (17.9%)
<b>Firearm</b>	2063 (15.2%)	1541 (19.6%)	1627 (17.7%)
<b>Other penetrating</b>	187 (1.4%)	156 (2.0%)	169 (1.8%)
<b>ISS, median (IQR)</b>	25 (16)	25 (17)	25 (17)
<b>AIS ≥ 3, n (%)</b>			
<b>Head</b>	8870 (65.2%)	4617 (58.6%)	5318 (57.9%)
<b>Chest</b>	4742 (34.8%)	3053 (38.7%)	3632 (39.5%)
<b>Abdomen</b>	1824 (13.4%)	1310 (16.6%)	1522 (16.6%)
<b>Level I trauma center</b>	8763 (64.4%)	4952 (62.8%)	5853 (63.7%)

**Table:** Characteristics of all mortalities, all mortalities excluding WLST, and all mortalities excluding those WLST that did not follow a major complication (FTR).

### Quick Shots Parallel Session III

Quick Shot #30  
January 16, 2020  
12:09 pm

#### NO NEWS IS GOOD NEWS? THE 3-YEAR MORTALITY RATES OF OCTOGENARIAN AND NONAGENARIAN PATIENTS FOLLOWING EMERGENCY GENERAL SURGERY

John Hwabejire, MD, MPH, Natawat Narueponjirakul, MD, Manasnun Kongwibulwut, MD, Jae Moo Lee, BA, Napaporn Kongkaewpaisan, M.D., George Velmahos, MD, PhD, MSED, Peter Fagenholz, MD, David King, MD\*, Noelle Saillant, MD\*, April E. Mendoza, MD, MPH\*, Martin Rosenthal, MD, Haytham Kaafarani, MD, MPH\*  
Massachusetts General Hospital

**Presenter:** John Hwabejire, MD, MPH

**Objectives:** Outcome data on the very elderly patients undergoing emergency general surgery (EGS) are sparse. We sought to examine short and long-term mortality in the 80+ population following EGS.

**Methods:** Using our institutional 2008-2018 EGS Database, all the 80+ patients undergoing EGS were identified. The data were linked to the Social Security Death Index to determine cumulative mortality rates up to 3 years after discharge. Univariate and multivariable logistic regression analyses were used to determine predictors of in-hospital and 1-year cumulative mortality.

**Results:** A total of 385 patients were included with a mean age of 84; 54% were female. The 2 most common comorbidities were hypertension (76.1%), and cardiovascular disease (40.5%). The most common procedures performed were colectomy (20.0%), small bowel resection (18.2%), and exploratory laparotomy for other procedures (15.3%; e.g. internal hernia, perforated peptic ulcer). The overall in-hospital mortality was 18.7%. Cumulative mortality rates at 1, 2, and 3 years after discharge were 34.3%, 40.5%, & 43.4%, respectively [Fig. 1]. The EGS procedure associated with the highest 1-year mortality was colectomy (49.4%). Although hypertension, renal failure, hypoalbuminemia, and elevated liver enzymes predicted in-hospital mortality, the only independent predictors of cumulative 1-year mortality were hypoalbuminemia (OR 2.17, 95%CI 1.10-4.27; p= 0.025), and elevated serum SGOT level (OR 2.56, 95%CI 1.09-4.70; p=0.029) at initial presentation. Patients with both factors had a cumulative 1-year mortality rate of 75.0%.

**Conclusions:** More than half of the very elderly patients undergoing major EGS were still alive at 3 years post-discharge. The combination of hypoalbuminemia and elevated liver enzymes predicted the highest 1-year mortality. Such information can prove useful for patient and family counseling preoperatively.

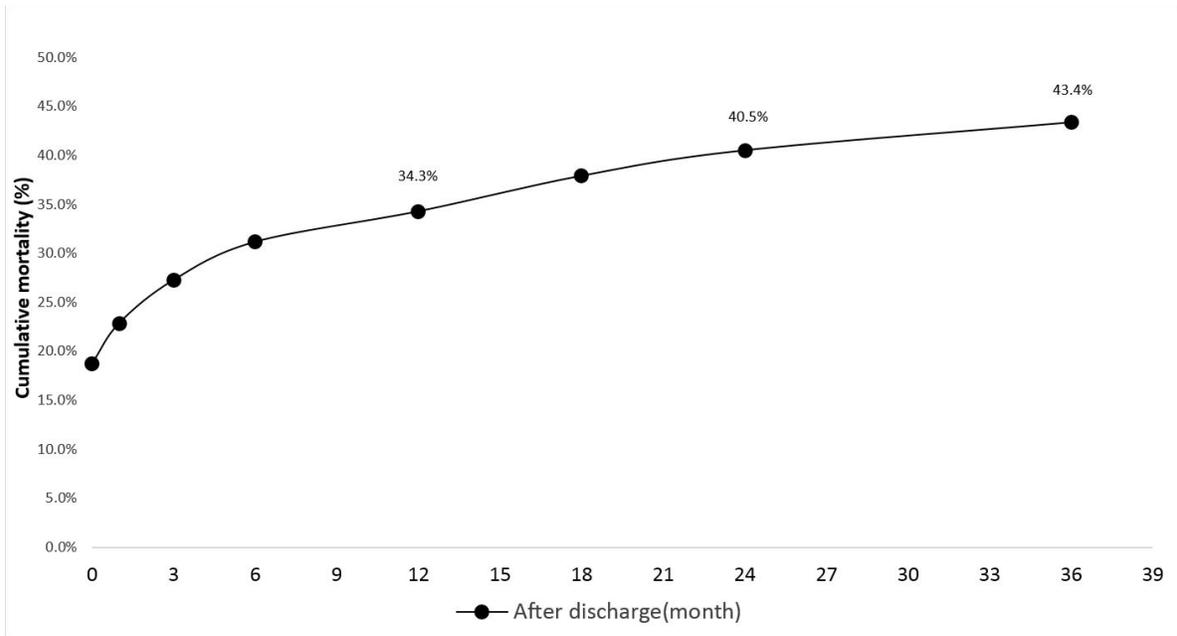


Figure 1: Cumulative Post-discharge Mortality Rates

## Quick Shots Parallel Session IV

Quick Shot #31  
January 16, 2020  
11:15 am

### IDENTIFICATION OF A NEW GENETIC VARIANT ASSOCIATED WITH CHOLECYSTITIS: A MULTICENTER GENOME-WIDE ANALYSIS

Apostolos Gaitandis, MD, Alexander Bonde, BSc, Majed el Hechi, MD, Charlie Nederpelt, BSc, Nikos Kokoroskos, MD, April E. Mendoza, MD, MPH\*, George Velmahos, MD, PhD, MEd, Martin Sillesen, MD, Maha Farhat, MD, MSc, Haytham Kaafarani, MD, MPH\*  
Massachusetts General Hospital

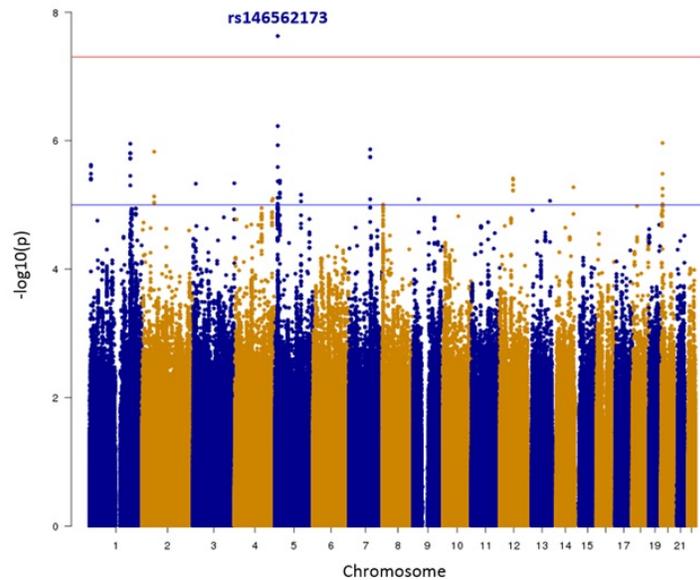
**Presenter:** Apostolos Gaitandis, MD

**Objectives:** The genomic landscape of gallbladder disease remains poorly understood. We sought to examine the association between common genetic variants and the development of cholecystitis.

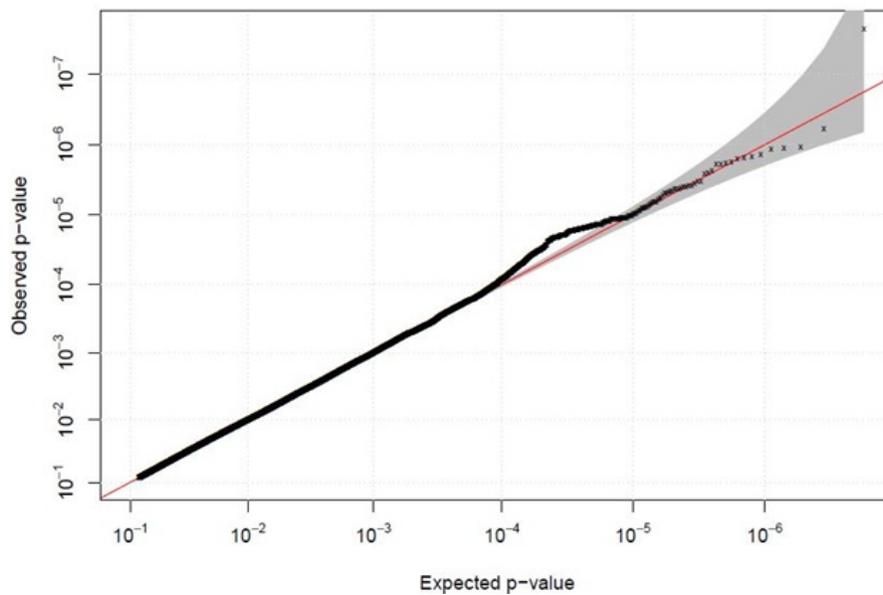
**Methods:** We used the 2015-2018 biobank of a large multi-institutional health-system. All patients with cholecystitis were identified using ICD codes and genotyped across five batches. For each batch, the single nucleotide polymorphism (SNP) data was cleaned, SNP status at additional sites was imputed, and the results were analyzed separately to avoid batch effects. The genomic ancestry of the target population was characterized by calculating multidimensional scaling components and anchoring the results in a population of known ethnic structure. To control for population stratification, we restricted data to that from individuals of Northern European genomic ancestry and delineated genomic correlation using a genetic relatedness matrix. The association between genetic variants and cholecystitis was evaluated by mixed linear models, controlling for age, sex, cholelithiasis, and obesity.

**Results:** From a total of 24,644 patients, 20,384 individuals of Northern European genomic ancestry were identified. This subpopulation consisted of 756 cases and 19,628 controls. After meta-analysis, one variant (rs146562173) on chromosome 5p12 exceeded the threshold for genome-wide significance ( $p=2.35 \times 10^{-8}$ ).

**Conclusions:** In this genome-wide association study we identified a new genetic variant on chromosome 5p12 that could serve as a predictor for the development of cholecystitis.



**Figure 1:** Each point in the Manhattan plot represents a SNP. The X-axis illustrates the chromosomal position and chromosomes are represented with alternating colors. The Y-axis shows the association with cholecystitis (presented as the  $-\log_{10}$  of the p-value). The blue line represents the suggestive threshold ( $p=5 \times 10^{-5}$ ), and the red line marks the threshold for genome-wide significance ( $p=5 \times 10^{-8}$ ).



**Figure 2:** QQ-plot

## Quick Shots Parallel Session IV

Quick Shot #32  
January 16, 2020  
11:21 am

### ASSOCIATION BETWEEN HOSPITAL LEVEL COMPUTED TOMOGRAPHY RESOURCES AND OUTCOMES FOR ACUTE ABDOMEN

Kevin Ricci, MD, MS, Amy Rushing, MD\*, Adrian Diaz, MD, MPH,  
Anghela Paredes, MD, MS, Wendelyn Oslock, Angela M. Ingraham, MD, MS\*,  
Vijaya T. Daniel, MD, MPH, Victor Heh, Holly E. Baselice, MPH,  
Scott A. Strassels, PharmD, PhD, Heena P. Santry, MD, MS, BA\*  
Ohio State University Wexner Medical Center

**Presenter:** Kevin Ricci, MD, MS

**Objectives:** Patients presenting with abdominal pain often undergo CT scan. We aimed to investigate the relationship between availability, timeliness, and results communication of CT imaging and outcomes for acute abdomen.

**Methods:** Data from a 2015 national survey of 2,811 hospitals regarding EGS structures and processes (60.1% overall response, N=1,690) were linked to 2015 Medicare inpatient claims data. We identified beneficiaries age  $\geq 65$  admitted emergently with intraabdominal diseases (e.g., perforated viscus, ischemic enteritis) undergoing operative intervention on the same calendar date. Multivariable regression adjusted for significant covariates as appropriate was performed to determine odds of complications and mortality based upon CT resources.

**Results:** We identified 9,125 acute abdomen patients treated at 1,253 hospitals of which 77.7% had  $\geq 64$  slide CT scanners and 85.1% had 24/7 CT techs. Overnight CT reads were provided at 14.1% by in-house radiologists and at 66.2% by tele-radiologists. Patients were predominantly 65-74yo (42.6%), female (60.4%), white (87.8%) and had  $\geq 3$  comorbidities (67.1%). 44.2% experienced  $\geq 1$  surgical complication, 48.0%  $\geq 1$  systemic complication, and 8.6% died. Results of the multivariable analysis can be seen in Table 1. STAT radiology reads by a board certified radiologist Rarely/Never available in 2 hours was associated with increased systemic complications and mortality (aOR 2.6 [1.3-5.4] and 2.3 [1.1-4.8], respectively).

**Conclusions:** Even with widespread availability of CT scans and radiology staff, delays in communicating results is associated with adverse outcomes. This may be attributable to delays in surgical consultation and time to source control for acute abdomen. Processes to ensure timely communication of critical CT scan results in patients with abdominal pain may improve outcomes in high risk patients.

**Table.** Odds of post-operative complications and mortality among Medicare Beneficiaries admitted to 1253 US hospitals for acute abdomen in 2015.

	Major Operative Complication*		Major Systemic Complication *		Mortality**	
	OR [95% CI]	aOR [95% CI]	OR [95% CI]	aOR [95% CI]	OR [95% CI]	aOR [95% CI]
<b>Advanced Abdominal Imaging Equipment</b>						
<b>CT scan (N = 8,888)</b>						
≥64 slice	-	-	-	-	-	-
<64 slice	1.20 [0.99,1.45]	1.20 [0.99,1.46]	0.93 [0.77,1.13]	0.92 [0.75,1.13]	0.89 [0.70,1.13]	0.90 [0.69,1.16]
None	0.65 [0.42,1.00]	0.65 [0.42,0.99]	0.89 [0.59,1.34]	0.91 [0.60,1.38]	0.76 [0.41,1.40]	0.76 [0.41,1.39]
<b>Diagnostic Radiology Staff</b>						
<b>Round the clock CT technicians</b>						
Yes	-	-	-	-	-	-
No	1.18 [0.94,1.48]	1.19 [0.95,1.49]	1.13 [0.90,1.41]	1.14 [0.89,1.45]	0.87 [0.64,1.17]	0.83 [0.61,1.13]
Unsure	1.05 [0.71,1.54]	1.05 [0.71,1.56]	<b>0.67 [0.45,0.98]</b>	<b>0.63 [0.42,0.94]</b>	0.85 [0.52,1.39]	0.88 [0.54,1.44]
<b>Overnight radiologist presence</b>						
In-house overnight radiologist	-	-	-	-	-	-
Tele-radiologist overnight	1.13 [0.98,1.31]	1.14 [0.99,1.32]	1.00 [0.87,1.16]	1.03 [0.88,1.19]	0.95 [0.80,1.14]	0.96 [0.80,1.16]
No overnight radiologist	1.26 [0.63,2.51]	1.23 [0.62,2.45]	1.61 [0.81,3.18]	1.59 [0.78,3.24]	1.29 [0.54,3.07]	1.10 [0.47,2.59]
<b>Timeliness of Diagnostic Radiology Services</b>						
<b>Stat CT scan completed ≤4hrs of being ordered</b>						
Always/Often	-	-	-	-	-	-
Sometimes	1.07 [0.79,1.44]	1.05 [0.78,1.43]	0.81 [0.60,1.09]	0.76 [0.56,1.05]	0.88 [0.59,1.34]	0.90 [0.59,1.38]
Rarely/Never	1.35 [0.66,2.78]	1.33 [0.65,2.70]	1.81 [0.87,3.75]	1.80 [0.82,3.92]	1.29 [0.53,3.12]	1.10 [0.43,2.80]
<b>Stat imaging read by board-certified/eligible radiologist ≤2hrs of completion</b>						
Always/Often	-	-	-	-	-	-
Sometimes	0.96 [0.78,1.19]	0.98 [0.79,1.20]	0.93 [0.76,1.14]	0.98 [0.79,1.20]	0.85 [0.65,1.19]	0.90 [0.68,1.20]
Rarely/Never	1.01 [0.51,2.00]	1.01 [0.51,2.01]	<b>2.29 [1.12,4.67]</b>	<b>2.59 [1.25,5.40]</b>	<b>2.33 [1.11,4.86]</b>	<b>2.25 [1.05,4.84]</b>
<b>Critical results communicated directly to surgeons</b>						
Always/Often (ref)	-	-	-	-	-	-
Sometimes	0.99 [0.84,1.17]	0.99 [0.83,1.17]	1.15 [0.98,1.35]	1.13 [0.95,1.35]	1.26 [1.03,1.53]	1.22 [0.99,1.51]
Rarely/Never	1.04 [0.78,1.40]	1.06 [0.79,1.42]	1.27 [0.95,1.70]	1.36 [1.00,1.85]	0.93 [0.65,1.33]	0.91 [0.62,1.34]

\* Adjusted for age and comorbidities.

\*\*Adjusted for any major operative complication, any major systemic complication, age, and comorbidities.

BOLD results text = significant odds ratio.

## Quick Shots Parallel Session IV

Quick Shot #33  
January 16, 2020  
11:27 am

### THE BURDEN OF ENTEROCUTANEOUS FISTULA AFTER EMERGENCY SURGERY DISCHARGE: MORTALITY AND READMISSION RATES

Justin Hatchimonji, MD, MBE\*, Jesse Passman, MD, MPH, Elinore J Kaufman, MD\*,  
Catherine Sharoky, MD, MSCE, Lucy Ma, Dane Scantling, DO, MPH,  
Aria Xiong, MS, Daniel N. Holena, MD, MSCE\*  
Hospital of the University of Pennsylvania

**Presenter:** Justin Hatchimonji, MD, MBE

**Objectives:** The burden of enterocutaneous fistula (ECF) after emergency general surgery (EGS) has not been rigorously characterized. Using a nationally representative dataset, we set out to describe 30- and 90- day readmission and mortality rates of ECF after gastrointestinal EGS. We hypothesized that ECF would be associated with higher rates of post-discharge mortality and readmissions.

**Methods:** Using the 2016 National Readmission Database, we conducted a retrospective study of adults presenting for gastrointestinal EGS, defined as non-elective admissions with ICD-10 procedure codes 75 (small bowel resection), 78 (colorectal resection), 86 (other hernia repair), 87 (laparoscopy (GI only)), 89 (exploratory laparotomy), or 90 (excision; lysis of peritoneal adhesions) occurring on hospital day 0 or 1. We used ICD-10 diagnosis code K63.2 (fistula of intestine) to define postoperative fistula. To measure readmissions, we used 30- and 90- day rates censoring discharges occurring in December or from October-December, respectively.

**Results:** 94,897 patients underwent emergency surgery during the study period, of whom 1,396 (1.5%) developed ECF. Mortality was higher in patients who developed ECF than in those who did not (11.5% vs. 6.6%; OR 1.82, 95% CI 1.54-2.16) in patients who survived the index admission. The development of ECF was associated with multiple readmissions. Readmission rates were considerably higher for patients with ECF than without at 30 days (25.2% vs. 13.6%; OR 2.13, 95% CI 1.85-2.46) and at 90 days (41.6% vs. 21.9%; OR 2.54, 95% CI 2.22-2.91).

**Conclusions:** The development of ECF after gastrointestinal EGS is associated with significantly increased odds of both mortality and readmission, rates of which continue to climb out to at least 90 days. Processes of care designed to mitigate risk in this high-risk cohort should be developed.

## Quick Shots Parallel Session IV

Quick Shot #34  
January 16, 2020  
11:33 am

### ADMISSION PREDICTORS OF MORTALITY AND LIMB LOSS FOLLOWING NECROTIZING SOFT TISSUE INFECTION

Dara L. Horn, MD, Jolie Shen, BS, Emma Roberts, BA, Theresa N. Wang, MD,  
Kevin S. Li, MS, Grant E. O'Keefe, MD, MPH, Eileen M. Bulger, MD, FACS\*,  
Bryce R.H. Robinson, MD, MS, FACS, FCCM\*  
University of Washington

**Presenter:** Dara L. Horn, MD

**Objectives:** Necrotizing soft tissue infections (NSTI) are the most severe manifestation of soft tissue infection and carry significant morbidity and mortality. While the mortality for this disease has improved over time, understanding the risk factors for death and amputation may guide expedited care and goals of care discussions. We sought to identify risk factors for death and extremity loss in a large, single-institution cohort.

**Methods:** We analyzed prospectively collected data of patients >18 years old with surgically confirmed NSTI from a registry maintained at a single Level 1 trauma center. Analyses included demographic variables, disease characteristics and microbiology, and outcomes. Factors associated with mortality and amputation were identified using multiple logistic regression.

**Results:** Between January 2013 and September 2018, 430 infections were identified. The median age was 55, 65% were male, and 77% were white, and 14% involved injection drug use. The majority (89%) were transferred from an outside facility. 50% involved an extremity, 37% the perineum, and 16% the abdomen or chest. The median number of operative debridements was 3 [IQR 2,4], and the median hospital LOS was 18 days [IQR 10,30]. 78% of patients had a positive wound culture, 79% were polymicrobial, 3% involved Clostridium, and 21% involved Group A Streptococcus. Overall mortality was 14%, and 21% of extremity NSTI required amputation. Factors that were independently associated with mortality and amputation are listed in Tables 1 and 2 respectively.

**Conclusions:** Though a heterogeneous disease state, NSTI have discrete patient and disease characteristics associated with mortality and limb loss. These variables can assist the acute care surgeon in expediting care for these high-risk patients and in goals of care discussions with next of kin. Further work is needed to define modifiable risk factors and best practices for those with NSTI.

<b>Variable</b>	<b>OR</b>	<b>95% CI</b>	<b>P value</b>
Age > 60	2.37	1.30-4.35	0.005
WBC > 30	2.23	1.11-4.48	0.025
Creatinine > 2	3.96	2.20-7.13	<0.001
Clostridium Involved	7.67	1.73-33.93	0.007
Perineum Involved	0.46	0.23-0.95	0.032

Table 1: Factors independently associated with death.

<b>Variable</b>	<b>OR</b>	<b>95% CI</b>	<b>P value</b>
Age > 60	3.68	1.38-9.78	0.009
Male Sex	4.64	1.75-12.27	0.002
Non-White Race	4.42	1.66-11.75	0.003
Sodium < 130	4.63	1.83-11.73	0.001
Diabetes Mellitus	3.30	1.35-8.06	0.007
Chronic Wound Etiology	5.40	2.01-14.48	<0.001
Leg Involved	5.01	1.37-18.28	0.014
Transferred	6.64	1.37-32.21	0.018

Table 2: Factors independently associated with amputation amongst patients with limb involvement.

## Quick Shots Parallel Session IV

Quick Shot #35  
January 16, 2020  
11:39 am

### **PLATELET DYSFUNCTION IN PATIENTS WITH TRAUMATIC INTRACRANIAL HEMORRHAGE: DO DESMOPRESSIN AND PLATELET THERAPY HELP OR HARM ?**

Nina Glass, MD\*, Nina Glass, MD\*, Julia Riccardi, Helen Horng, PharmD,  
Gregory Kacprzyński, MD, Ziad C. Sifri, MD\*  
Rutgers-New Jersey Medical School

**Presenter:** Nina Glass, MD

**Objectives:** Pre-injury anti-platelet use with aspirin and clopidogrel has been associated with increased risk of progression of traumatic intracranial hemorrhage (ICH) and possible worse outcomes. VerifyNow® assays are point of care tests that assess platelet inhibition to aspirin and clopidogrel. Desmopressin and/or platelet transfusion has been proposed to reverse this platelet inhibition. This study aims to assess the effect administration of desmopressin and platelets on progression of ICH and outcomes of trauma patients with platelet dysfunction.

**Methods:** We performed a retrospective chart review of consecutive trauma patients with mild TBI (presentation Glasgow Coma Score (GCS) 13-15) and ICH at a level 1 trauma center between 1/1/2013 and 6/1/2016. Patients with documented platelet dysfunction (VerifyNow® Aspirin <550 or P2Y12 <250) who received desmopressin and/or platelets were compared patients to those who did not. Primary outcomes were progression of intracranial hemorrhage and neurologic outcomes at discharge.

**Results:** Of 565 patients with a mild TBI and ICH, 200 patients had a positive VerifyNow® assay. These patients were mostly male and had a median age of 60 and an average ISS of 15 (Table 1). Most (159) underwent a second head CT of which 35% had progression of hemorrhage. Both patients that did and did not receive desmopressin or platelets, had similar baseline GCS, Marshall score, and rate of ICH progression, but the patients who received desmopressin and/or platelets, had worse discharge GCS and Glasgow Outcomes Score (GOS) (Table 2).

**Conclusions:** Treatment of mild TBI patients with platelet dysfunction identified by VerifyNow® assay with desmopressin and platelets has no effect on ICH progression and is associated with worse neurologic outcomes. Administration of desmopressin or platelets to patients with platelet inhibition and a mild TBI is not beneficial.

Characteristic	VerifyNow® positive
Age Median [IQR]	60 [46.5, 70.5]
Male sex n (%)	141 (70.5)
Blunt mechanism	199
Penetrating (GSW)	1
Blunt mechanism:	
Fall	107 (54)
Assault	44 (22)
Pedestrian	22 (11)
Stuck	
MVC	17 (9)
Other	9 (5)
Initial GCS 15	144 (72)
Initial GCS 14	42 (21)
Initial GCS 13	14 (7)
ISS Mean (SD; range)	14.7 (7.8; 4-50)
LOS Mean (SD; range)	7.8 (11.7; 1-116)
Hospital disposition	
Home	133 (66.5)
Acute rehab	48 (24)
Other	11 (5.5)
Death	8 (4)

Table 1: Demographics and Injury Characteristics of all Minor TBI patients with VerifyNow® positive  
Numbers presented as n (%) unless otherwise stated

	Got desmopressin	No desmopressin	p-Value
Initial GCS 15	51/72 (71)	94/131 (72)	0.89
Initial Marshall 1 or 2	68/72 (94)	115/122 (94)	1.0
Progression of ICH on 2 <sup>nd</sup> CT	32/69 (33)	23/80 (29)	0.03
Discharge GOS>3	67/82 (82)	124/132 (94)	0.006
Discharge GCS>13	59/71 (83)	125/132 (95)	0.01
	Got platelets	No platelets	p-Value
Initial GCS 15	24/34 (71)	7/105 (73)	0.93
Initial Marshall 1 or 2	31/34 (91)	98/102 (96)	0.37
Progression of ICH on 2 <sup>nd</sup> CT	11/29 (38)	25/79 (32)	0.64
Discharge GOS>4	24/34 (71)	97/106 (92)	0.004
Discharge GCS>13	25/33 (76)	99/106 (93)	0.004

Table 2: Outcomes for patients by receipt of desmopressin and/or platelets  
Numbers presented as n/denominator (%)

## Quick Shots Parallel Session IV

Quick Shot #36  
January 16, 2020  
11:45 am

### EARLY COGNITIVE IMPAIRMENT IS COMMON AFTER INTRACRANIAL HEMORRHAGE WITH MILD TRAUMATIC BRAIN INJURY

Patrick Delaplain, MD, Spencer Albertson, Areg Grigorian, MD,  
Barbara Williams, Megan Smith, PhD, Kenji Inaba, MD,  
Michael Lekawa, MD, Jeffrey Nahmias, MD, MHPE, FACS\*  
University of California, Irvine

**Presenter:** Areg Grigorian, MD

**Objectives:** To determine the incidence of early cognitive impairment (ECI) after traumatic brain injury (TBI) and identify risk factors for its development.

**Methods:** A single-center, retrospective review of adult trauma patients (2014-2016) with intracranial hemorrhage (ICH) and mild TBI (GCS 13-15) was performed. The primary outcome was ECI, defined as a Rancho Los Amigos Score < 8. Routine cognitive evaluation is performed on all ICH patients at our institution. Comparisons between ECI and no-ECI groups regarding demographic, cognitive, and clinical outcomes were evaluated using bivariate statistics (?2, Fischer's exact, t test). The odds of ECI were evaluated using a multivariable logistic regression.

**Results:** There were 465 patients with mild TBI, 70.3% were male and the average age was 53+/-23 years. The most common mechanism of injury was fall (41.1%) followed by motor vehicle collision (15.9%). The incidence of ECI was 51.4% (N = 239). The incidence in patients with a GCS of 15 was 42.9% and BIG 1 category was 42.7%. There were no differences in demographics (age, gender, comorbidities), mechanism of injury, or imaging when comparing those with ECI to those with no-ECI. GCS was lower in the ECI group (14.4 vs. 14.7,  $p < 0.0001$ ). Patients with ECI were also less likely to be discharged home (58% vs. 78%,  $p < 0.0001$ ). Lower GCS and BIG category 3 (vs. 1) were strong risk factors of ECI in a multiple logistic regression model adjusted for age, loss of consciousness, anticoagulants, and Rotterdam score (**Table 1**).

**Conclusions:** Half of all patients with ICH and mild TBI had ECI. Both lower initial GCS and BIG category 3 were associated with increased likelihood of ECI. Therefore, we recommend all patients with ICH and mild TBI undergo cognitive evaluation.

<b>Variable</b>	<b>OR</b>	<b>95% CI</b>	<b>P-value</b>
<i>Age*</i>	1.01	(1.00 - 1.02)	0.066
<b><i>GCS*</i></b>	<b>2.38</b>	<b>(1.49 - 3.13)</b>	<b>&lt;0.001</b>
<i>LOC</i>	1.37	(0.86 - 2.21)	0.232
<b><i>Anticoagulants*</i></b>	<b>0.42</b>	<b>(0.22 - 0.77)</b>	<b>0.005</b>
<i>Rotterdam score</i>	1.02	(0.73 - 1.43)	0.992
<i>BIG category 2</i>	1.24	(0.69 - 2.24)	0.474
<b><i>BIG category 3</i></b>	<b>2.28</b>	<b>(1.28 - 4.13)</b>	<b>0.005</b>

\*Odds of ECI with 1-unit increase/decrease of covariable

+Also includes antiplatelet medication

Abbrev: GCS (Glasgow Coma Scale), LOC (Loss of consciousness),

BIG (Brain Injury Guideline)

Table 1. Multivariable regression model for likelihood of early cognitive impairment.

## Quick Shots Parallel Session IV

Quick Shot #37  
January 16, 2020  
11:51 am

### **VENOUS THROMBOEMBOLISM FOLLOWING PENETRATING FEMORAL AND POPLITEAL ARTERY INJURIES: AN OPPORTUNITY FOR INCREASED PREVENTION**

Odessa Pulido, DO, Asanthi Ratnasekera, DO, FACOS\*, Alicia Lozano, MS,  
Danielle Sienko, Sandra Durgin, RN, MSN, Sharon Nichols, Niels D. Martin, MD\*  
Crozer Chester Medical Center

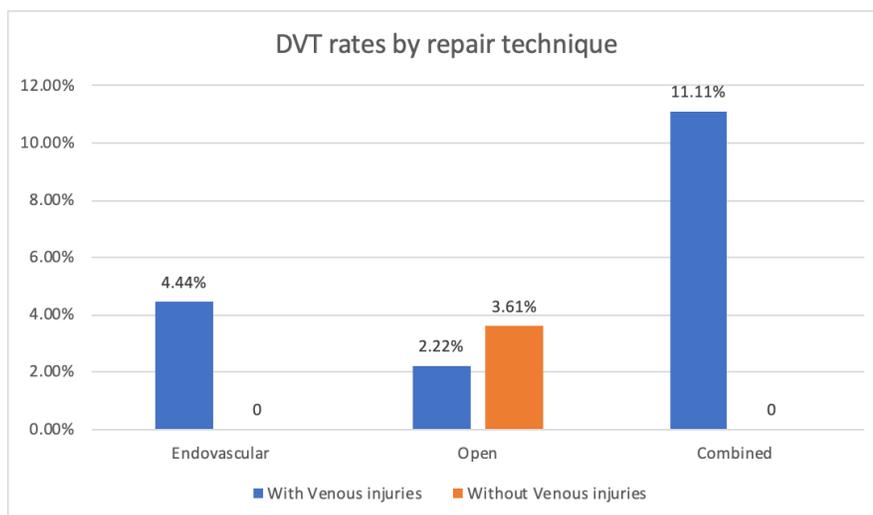
**Presenter:** Odessa Pulido, DO

**Objectives:** Due to a multitude of factors, trauma patients at baseline, have an increased risk of venous thromboembolism (VTE). This risk increases with injuries to the vascular system, especially those of a penetrating nature. The purpose of this study is to evaluate VTE rates among open vs. endovascular repair of penetrating vascular injuries to the femoral-popliteal system with specific attention to the association with concomitant venous injuries.

**Methods:** A retrospective study of the prospectively-collected Pennsylvania Trauma Outcome Study (PTOS) registry was conducted over a 5 year period (2013-2017). All adult patients with a penetrating mechanism and femoral/popliteal vascular injuries were studied. Patient demographics, injury details, and VTE outcomes were evaluated. Secondary endpoints were ICU LOS, Hospital LOS and mortality. Statistical comparisons were accomplished using Fisher's exact tests, and parametric two-sample t-tests or non-parametric Wilcoxon rank-sum tests for categorical and continuous variables, respectively.

**Results:** There were 865 patients with penetrating extremity vascular injuries. Of those, 128 patients had femoral or popliteal artery injuries. Patients with isolated arterial injuries (n=83) had a significantly lower DVT rate compared to those with concurrent venous injuries (n=45) (3.6% vs. 20%, p=0.003). The groups were divided into open, endovascular, and combined repair techniques. Among the 3 patients with isolated femoral or popliteal arterial injuries who had developed DVTs, all had an open repair. Of the 9 patients with concurrent arterial and venous injuries who developed DVTs, 2 (4.44%) had endovascular repair, 1 (2.22%) had open repair, 5 (11.11%) had combined repair and 1 did not undergo a repair (Figure 1). ICU LOS (p=0.009), hospital days (p=0.006), and ventilator days (p=0.001) were significantly longer for those with both arterial and venous injuries compared to those with only arterial injuries. ICU LOS (p=0.007), ventilator days (p=0.001), and hospital LOS (p=0.01) were significantly longer for patients with DVT (Table 1).

**Conclusions:** The DVT rates are higher with concomitant venous injuries in penetrating femoral and popliteal artery trauma. Open repair was associated with significant DVT rates, even without associated venous injury. Consideration should be given for aggressive prophylaxis or empiric full anticoagulation in this subset of patients.



DVT rates by repair technique in patients with concurrent venous injuries and in patients with isolated arterial injuries.

**Table 1. Patient Characteristics for those with femoral or popliteal artery injuries by DVT Group**

	No DVT (N = 116)	DVT (N = 12)	P-value <sup>1</sup>
ISS, Median (Q1, Q3)	10 (9, 17)	17 (9.5, 23)	0.0767
TRISS, Median (Q1, Q3)	0.990 (0.976, 0.991)	0.974 (0.889, 0.985)	0.0130
AIS, Median (Q1, Q3)	3 (3, 4)	3 (3, 4)	0.1724
ICU LOS, Median (Q1, Q3)	2 (1, 3.5)	5 (2, 7.5)	0.0075
Stepdown LOS, Median (Q1, Q3)	0 (0, 0)	0 (0, 0)	0.9482
Ventilator Days, Median (Q1, Q3)	0 (0, 1)	1.5 (1, 3.5)	0.0010
Hospital LOS, Median (Q1, Q3)	10.5 (5.5, 16)	17.5 (12.5, 26.5)	0.0119
SBP, Mean (SD)	117.63 (32.9)	106.25 (31.2)	0.2543
HR, Mean (SD)	97.52 (26.1)	113.36 (31.1)	0.0605
GCS, Median (Q1, Q3)	15 (15, 15)	15 (13, 15)	0.4656
Age, Median (Q1, Q3)	26 (21, 34)	23 (22, 48)	0.9771
Blood Unit, Median (Q1, Q3)	0 (0, 2)	1 (0, 2.5)	0.0883
MTP, n (%) (n=31)	2 (7.4%) (n=27)	4 (100%) (n=4)	0.0005]
Gender, n (%)			>.9999
Male	107 (92.2%)	11 (91.7%)	
Female	9 (7.8%)	1 (8.3%)	
Race, n (%) (n=117)			>.9999
White	25 (23.6%)	2 (18.2%)	
Black	75 (70.7%)	9 (81.8%)	
Asian	2 (1.9%)	0 (0.0%)	
Other	4 (3.8%)	0 (0.0%)	

1. The p-values are examining differences in patient characteristics between patients with DVT and those without. For continuous variables, non-parametric Wilcoxon rank-sum tests were used to examine group differences in non-normally distributed variables. Parametric two sample t-tests were used to examine group differences in normally distributed variables. To examine group differences in categorical variables, Fisher's exact tests were used.

Patient characteristics for those with penetrating femoral and popliteal artery injuries with and without DVTs.

## Quick Shots Parallel Session IV

Quick Shot #38  
January 16, 2020  
11:57 am

### TO ANGIO OR NOT TO ANGIO: AN ANALYSIS FROM THE AAST PROOVIT STUDY GROUP

Ahmed F. Khouqeer, MD, Sherene Sharath, PhD, MPH, Joseph J. DuBose, MD\*,  
Jeanette Podbielski, RN, CCRP, John B. Holcomb, MD\*, John P. Sharpe, MD, MS,  
Tiffany K. Bee, MD\*, Jonny Morrison, MD, Thomas M. Scalea, MD, FACS, FCCM\*,  
David J. Skarupa, MD, FACS\*, Richard D. Catalano, MD\*, Jennie Kim, MD,  
Kenji Inaba, MD, Nathaniel Poulin, MD\*, John Myers, MD, Michael C. Johnson, MD,  
John Bini, MD, John Matsuura, MD, Ramyar Gilani, MD  
Baylor College of Medicine

**Presenter:** Ahmed F. Khouqeer, MD

**Objectives:** The use of a completion angiogram post-traumatic extremity arterial open repair remains an area of debate. Guidelines, however, recommend routine completion angiograms with a paucity of supporting data. We hypothesize that completion angiography is not necessarily associated with improved procedural outcomes and therefore not obligatory.

**Methods:** Using data from the American Association for the Surgery of Trauma PROspective Vascular Injury Treatment (PROOVIT) registry, we included open repairs of peripheral arterial injuries (axillary, brachial, radial, ulnar, common/superficial/deep femoral, popliteal, anterior tibial, posterior tibial, peroneal arteries). Ligated injuries and immediate amputations were excluded. We divided the cohort into two groups, Completion Angiogram (CA) and No-Completion Angiogram (NCA). The outcomes of interest were: immediate revisions, reoperations, and amputations. Arterial injuries were modeled with multiple factors that could affect the repair and its outcome. Multivariable logistic and linear regressions were used to assess the influence of demographics, diagnostic factors, and pre, intra, and postoperative factors on the use of CA.

**Results:** Between February 2013 and January 2018, data on 397 patients with 429 peripheral vascular injuries were available. CA was utilized in 92 injuries (21.5%). A greater proportion of CA injuries required immediate revision (22.8% vs 7.4% NCA group,  $p < 0.001$ ). However, there was no difference between groups in need for reoperation (CA 15.2% VS NCA 11.3%,  $p = 0.30$ ) or amputation (9.0% CA vs 4.0% NCA,  $p = 0.06$ ). Among the repairs without immediate revision, there was also no difference in reoperation (CA 4.2% VS NCA 7.7%,  $p = 0.30$ ), or amputation (5.6% CA vs 3.5% NCA,  $p = 0.40$ ). The adjusted odds of reoperation increased with immediate revision (OR= 11.79, 95% CI (5.53, 25.1),  $p < 0.001$ ) among the entire cohort. Even when stratified by CA use, reoperation odds were still higher after immediate revision despite CA (OR= 5.6, 95% CI (0.98, 31.5),  $p < 0.05$ ). Furthermore, more amputations were observed in injuries with reoperation compared to those without reoperation (21.6% vs 2.7%,  $p < 0.001$ ).

**Conclusions:** CA occurred in approximately 20% of injuries. When CA was used, there was an increase in revisions. CA with revision was associated with higher rates of reoperation suggesting the influence of factors that cannot be ascertained by CA. Contrarily, repair not requiring revision is equivalent whether CA is performed or not. Performance of high quality repair at initial operation with close clinical monitoring is the bedrock of peripheral vascular trauma with CA playing a much more selective role than mandated by guidelines.

## Quick Shots Parallel Session IV

Quick Shot #39  
January 16, 2020  
12:03 pm

### VALIDATION OF HEART RATE VARIABILITY AS A MEASUREMENT OF REAL-TIME SURGEON STRESS

Johnathan R. Kent, MD, Allan Fong, MS,  
Shimae Fitzgibbons, MD, MEd., Erin Hall, MD, MPH\*, Jack Sava, MD  
MedStar Washington Hospital Center

**Presenter:** Johnathan R. Kent, MD

**Objectives:** Acute stress is a potentially modifiable risk-factor that contributes to surgeon error. Research on stress mitigation has been limited by the lack of a validated objective measure of surgeon stress. While decreased Heart Rate Variability (HRV) is a physiologic measure associated with increased stress, it has not been successfully correlated with subjective measures of surgeon stress. We sought to validate HRV against the Subjective Units of Distress Score (SUDS) in a real-world surgical setting.

**Methods:** Acute care and trauma surgeons working at an urban level one trauma center wore armbands to measure HRV between October and December of 2018. HRV was analyzed using the standard deviation of N-N intervals (SDNN) and the root mean square of successive differences (RMSSD). Subjective, perceived stress was measured with two approaches. First, participants reported SUDS scores at random intervals. Second, participants identified the moment of peak stress within each four hours of their shift. In the first approach the correlation between SUDS and HRV was evaluated using the McNemar test. In the second approach, the HRV around the period of peak stress was compared to the mean HRV of the 4-hour shift segment within which that peak stress occurred. P values less than 0.05 were considered significant.

**Results:** Twelve surgeons were monitored for 340 hours, producing 135 SUDS responses and 65 peak stress time points. Decreased SDNN was associated with an elevated SUDS ( $P=0.03$ ). The self-identified time of peak stress within four hours also correlated with decreases in both SDNN and RMSSD ( $P=0.02$ ;  $P<0.01$ ).

**Conclusions:** In this study, blunting of HRV correlated with high levels of perceived stress in a real-world, trauma care setting. These results lend validity to its use as marker of surgeon stress in trauma and other high-acuity settings. Further work must be done on refining stress metrics and developing mitigation strategies.

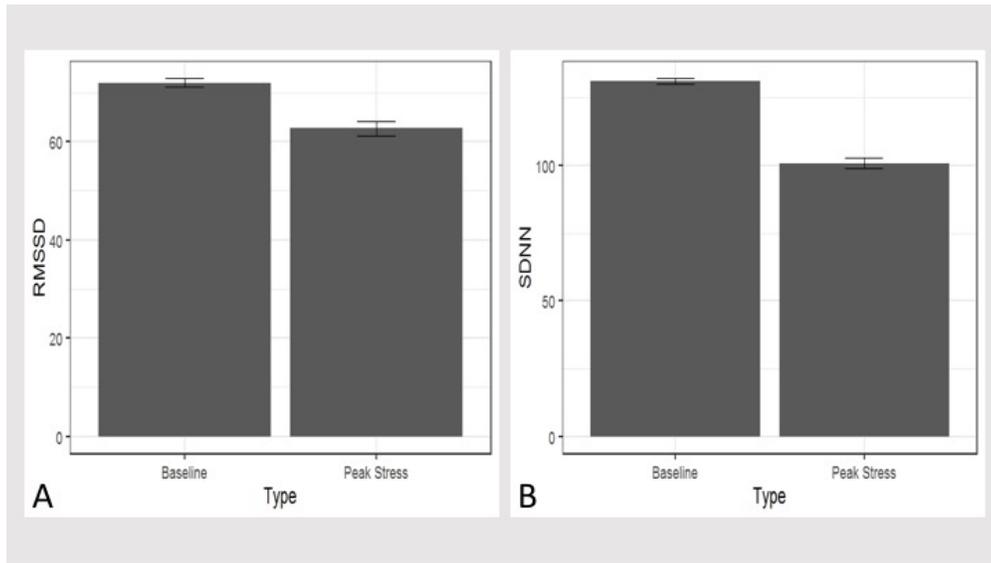


Figure 1. Bar graphs demonstrating the root mean square of successive differences (A) and the standard deviation of N-N intervals (B) during moments of self-identified peak stress compared to the baseline, mean values over the four-hour interval within which the moments of peak stress occurred. Error bars represent standard error. Both significantly lower with  $P < 0.05$ .

## Quick Shots Parallel Session IV

Quick Shot #40  
January 16, 2020  
12:09 pm

### **AUTOLOGOUS SKIN CELL SUSPENSION REDUCES LENGTH OF STAY FOR BURN INJURIES**

Blake J. Platt, MD, MHS, Jeffrey E. Carter, MD\*  
Louisiana State University School of Medicine

**Presenter:** Blake J. Platt, MD, MHS

**Objectives:** Burn injuries remain a surgical challenge with few recent innovations. Grafting with split-thickness skin grafts (STSGs) has been the standard of care for four decades. Although shown to have mortality benefits, STSGs are associated with significant morbidity in the form of pain and additional open wounds. For years, surgeons have looked for ways to decrease this associated morbidity. To that end, autologous skin cell suspension (ASCS) is a recently FDA-approved point of care regenerative medicine technology that reduces donor skin requirements while neither compromising healing outcomes and patient safety nor requiring a cell culture. We reviewed length of stay (LOS) of patients with burn injuries who were treated with ASCS to both STSGs at our institution and to the 2019 American Burn Association National Burn Repository (NBR).

**Methods:** 36 patients were treated with ASCS in combination with meshed autografts for full-thickness acute burn injuries. Concomitantly, 37 patients were treated with STSGs at our center. Age, percentage burn injury (TBSA), LOS, mortality, and number of surgeries were reviewed. Using the NBR, expected LOS was able to be calculated from TBSA and age data.

**Results:** Mean age and TBSA was 45.2 years and 6.6% for the STSG group and 46.0 years and 18.6% for the ASCS group. The LOS/TBSA for the STSG was 1.72 versus 1.19 for the ASCS patients, where the NBR predicts a LOS/TBSA of 3.38 and 3.42 for the STSG and ASCS groups, respectively. Patients in the STSG group and ASCS group had statistically similar surgeries and mortalities.

**Conclusions:** Burn injured patients treated with ASCS had a decreased LOS/TBSA when compared to both the STSGs and NBR predictions. ASCS is a novel technology allowing for point-of-care treatment that may decrease length of stay for burn injured patients and should be considered as an alternative to traditional techniques for burn patients.