

## Quick Shots Parallel Session I

Quick Shot Paper #1  
January 10, 2018  
4:30 pm

### EXCESS SODIUM IS DELETERIOUS TO ENDOTHELIAL AND GLYCOCALYX BARRIER FUNCTION: A MICROFLUIDIC STUDY

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**Presenter:** Jonathan Martin, MD

**Objectives:** Preclinical studies suggest a role for the administration of hypertonic saline solutions (HSS) after traumatic injury with shock. However clinical trials of HSS have failed to demonstrate significant benefits of HSS for shock resuscitation; further it may result in hypocoagulopathy and hyperfibrinolysis. The mechanism is uncertain. Excess sodium has been found to be detrimental in other clinical entities, which may be due to enhanced inflammatory signaling and damage to the endothelial cell (EC) glycocalyx. The endotheliopathy of trauma (EOT) is an important component of the acute coagulopathy of trauma. Principal drivers include tissue hypoperfusion, sympathoadrenal activation, inflammation, and hyperfibrinolysis. The effect of hypernatremia on the EOT is uncertain. Microfluidic technology has been used to study coagulation and endothelial cell biology *in vitro* and was used to compare the effects of hypernatremia on the endothelium under flow conditions.

**Methods:** Microfluidic channels lined with human umbilical vein endothelial cells (HUVEC) were exposed to hypoxia/reoxygenation (H/R) and epinephrine (EPI) for 60 minutes. HUVEC were then treated with a perfusate with sodium concentration to simulate post HSS infusion values. Microfluidic perfusate was sampled for hyaluronic acid (HA) and syndecan-1 (glycocalyx degradation), soluble thrombomodulin (TM) (EC activation/injury); tPA (tissue-plasminogen activator) and PAI-1 (plasminogen activator inhibitor-1) (coagulation phenotype).

**Results:** See table

**Conclusions:** Sodium at concentrations consistent with post HSS resuscitation result in glycocalyx degradation, endothelial injury/activation and a profibrinolytic phenotype. This was apparent in control and HUVEC cells under "shock" conditions. However the resultant effects were more profound in the "shock" HUVEC group and suggest HSS may have deleterious effects in traumatic shock resuscitation.

Mean  $\pm$  SD, N = 5

	HA (ng/ml)	Syndecan-1 (ng/ml)	TM (pg/ml)	tPA (pg/ml)	PAI-1 (pg/ml)
HUVEC control (Na <sup>+</sup> 134 mEq)	11.6 $\pm$ 1.5	26.1 $\pm$ 4.8	26.1 $\pm$ 2.5	1596 $\pm$ 45.4	5948 $\pm$ 103.8
150 mEq Na <sup>+</sup>	37.8 $\pm$ 3.8*	58.3 $\pm$ 3.9*	64.4 $\pm$ 3.4*	2740 $\pm$ 56.1*	5456 $\pm$ 47.9*
160 mEq Na <sup>+</sup>	56.0 $\pm$ 3.4*	67.4 $\pm$ 2.9*	73.4 $\pm$ 2.4*	2922 $\pm$ 56.6*	5090 $\pm$ 63.6*
HUVEC+HR+EPI	74.1 $\pm$ 2.9*	94.6 $\pm$ 7.1*	105.2 $\pm$ 5.1*	3686 $\pm$ 33.7*	4887 $\pm$ 202.7*
HR+EPI+150 mEq Na <sup>+</sup>	96.6 $\pm$ 2.9*#	105.6 $\pm$ 4.0*	168.7 $\pm$ 1.7*#	3963 $\pm$ 52.4*#	4620 $\pm$ 90.6*
HR+EPI+160 mEq Na <sup>+</sup>	120.9 $\pm$ 2.7#	114.4 $\pm$ 5.8*#	196.7 $\pm$ 5.4*#	4418 $\pm$ 184.4*#	4568 $\pm$ 196.2*

\*p < 0.01 vs. HUVEC control, #p < 0.01 vs. HUVEC + HR + EPI

## Quick Shots Parallel Session I

Quick Shot Paper #2  
January 10, 2018  
4:36 pm

### **HYPOBARIA DURING LONG RANGE FLIGHT RESULTED IN SIGNIFICANTLY INCREASED HISTOPATHOLOGICAL EVIDENCE OF LUNG AND BRAIN DAMAGE IN A SWINE MODEL**

Debra L. Malone, MD\*, Ashraful Haque, Michelle Jefferson, Lam Thuy Vi Tran Ho, Saha Biswajit, Steve Chun, MD, Kirk Blackmoore, Neda Ilieva, Charles Auker, Richard McCarron, Anke H Scultetus, MD  
Naval Medical Research Center

**Presenter:** Debra L. Malone, MD

**Objectives:** Precipitous aeromedical evacuation (AE) of combat casualties to definitive care is current practice. However, there is a dearth of knowledge about the effects of hypobaria during flight on injured patients. We investigated possible effects of hypobaria during AE on organ damage in a swine model. Data of a subgroup analysis of uninjured animals is presented here.

**Methods:** Anesthetized swine were instrumented for invasive neurological and physiological monitoring. A 4 hour AE flight was simulated in a hypobaric chamber with atmospheric pressure equivalent to an altitude of 8,000 ft. (HYPO, n=6). Control animals were kept at normobaric conditions (NORMO, n=6). Animals were then euthanized and histopathological analysis of lung, kidney and brain tissues stained with H&E was performed.

**Results:** There were no significant differences in physiological and neurological parameters between the groups over time. Organ damage was assessed by combined scores for hemorrhage, inflammation, edema, necrosis and microatelectasis (lungs only), and was significantly worse in HYPO animals compared to NORMO in lungs ( $p < 0.0001$ ) and brain ( $p = 0.0439$ ). There were no differences between groups in the kidneys.

**Conclusions:** This swine model of 4 hour simulated AE resulted in significant increase in histopathological damage to lungs and brain compared to normobaric controls. This suggests that hypobaria has an adverse effect on tissues specifically lung and brain, and therefore may complicate transport of combat casualties. The findings also indicate that healthy passengers may be affected by prolonged hypobaria. Further studies are indicated to elucidate these effects, simulate other AE scenarios and assess the effects of hypobaria on injured animals.

## Quick Shots Parallel Session I

Quick Shot Paper #3  
January 10, 2018  
4:42 pm

### LOCATION IS EVERYTHING: THE HEMODYNAMIC EFFECTS OF REBOA IN ZONE 1 VERSUS ZONE 3 OF THE AORTA

Emily M. Tibbits, MD, Guillaume Hoareau, Meryl Simon, Anders J. Davidson, MD, Erik DeSoucy, Robert Faulconer, MBChB MRCS, Joseph J. DuBose, MD\*, J. Kevin Grayson, Timothy Williams, M. Austin Johnson, MD  
David Grant Medical Center

**Presenter:** Emily M. Tibbits, MD

**Objectives:** Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) assists in augmenting proximal blood pressure during resuscitation of patients with non-compressible torso hemorrhage. The choice of aortic placement, zone 1 versus zone 3, depends upon injury patterns, but remains highly debated. We sought to compare proximal hemodynamic support provided by Zone 1 versus Zone 3 REBOA placement, and degree of hemodynamic instability upon reperfusion following it.

**Methods:** Eighteen anesthetized swine underwent controlled hemorrhage of 25% blood volume, followed by 45 minutes of Zone 1 REBOA, Zone 3 REBOA, or no intervention (control). They were then resuscitated with shed blood, balloons were deflated, and 5 hours of critical care ensued prior to euthanasia. Physiologic parameters were recorded continuously, and blood was drawn for analysis at specified intervals. Significance was defined as  $p < 0.05$ .

**Results:** There were no differences in physiologic data at baseline or during the initial 30 minutes of hemorrhage. During the intervention, average proximal MAP was significantly higher in Zone 1 animals when compared to Zone 3 animals ( $127.9 \pm 1.3$  mmHg versus  $53.4 \pm 1.1$  mmHg), and both were higher than control animals ( $42.9 \pm 0.9$  mmHg). In the hour after reperfusion, average pMAP was lower in Zone 1 animals than Zone 3 animals ( $57.3 \pm 1.9$  mmHg vs.  $69.1 \pm 0.3$  mmHg). Both were lower than control ( $72.1 \pm 0.4$  mmHg). Peak lactate was higher in Zone 1 animals ( $9.6 \pm 0.4$  mmol/L) when compared to Zone 3 animals ( $5.1 \pm 0.3$  mmol/L) and control animals ( $4.2 \pm 0.8$  mmol/L).

**Conclusions:** In our model of hemorrhagic shock, Zone 3 REBOA provided hemodynamic support, but to a lesser degree than Zone 1, with less ischemic burden and instability on reperfusion. In cases of impending hemodynamic collapse, Zone 1 REBOA may be more efficacious regardless of injury pattern, while Zone 3 should be reserved for relatively stable patients with distal hemorrhage.

## Quick Shots Parallel Session I

Quick Shot Paper #4  
January 10, 2018  
4:48 pm

### INCREASE IN NEUTROPHIL/LYMPHOCYTE RATIO IS ASSOCIATED WITH EVOLUTION OF HEMORRHAGE AFTER TBI

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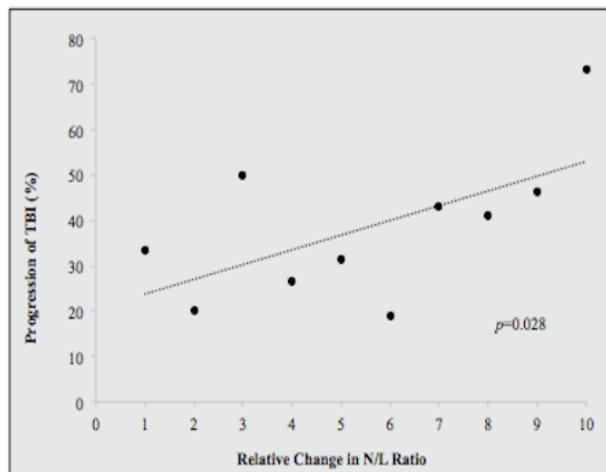
**Presenter:** Margo N. Carlin, DO

**Objectives:** The Neutrophil/Lymphocyte Ratio (NLR) is a marker of inflammation associated with adverse outcomes in the critically ill. Its impact in Traumatic Brain Injury (TBI) is unknown. We hypothesized increased NLR would predict progression of TBI on serial imaging. Secondary outcomes were effect of NLR on need for craniotomy and in-hospital mortality.

**Methods:** A retrospective study included isolated TBI patients admitted to a Level I Trauma Center from 2014-16 with sequential CT Head (CTH) imaging and blood work upon admission and day 1. Those with Head AIS of 6 or withdrawal of care within 24 hours were excluded. Worsening of TBI was determined by official radiology report. Patients were dichotomized by change in NLR; demographic, physiologic, intervention, and outcomes abstracted from the registry. Logistic regression determined effect of NLR on outcomes.

**Results:** 154 patients met inclusion criteria. 65.6% were Caucasian males over 65 injured by ground level falls. 53.9% had increased NLR with mean N/L increase of 6.5 (SD 7.9) compared to patients exhibiting decreased or no change (Mean -4.9, SD 6.1;  $p < 0.001$ ) in NLR. Patients with increased NLR had a higher ISS (Median 18 IQR [9,25] vs. 16 IQR [9,25],  $p = 0.027$ ) and more subdural hematomas (80.7% vs. 66.2%,  $p = 0.04$ ). Progression on CTH was noted in 44.6% with increased NLR (vs. 31.4% without positive change,  $p = 0.09$ ), and decreased GCS in 48.2%. Adjusting for ISS, TBI, and GCS change, NLR was associated with a 5% increased risk for TBI progression per point increase in NLR (30% overall increased risk,  $p = 0.028$ ). Craniotomy (42.2% vs. 29.6%,  $p = 0.105$ ) and in-hospital mortality (26.5% vs. 16.9%,  $p = 0.152$ ) were not different regardless of change in NLR.

**Conclusions:** Increased NLR is associated with TBI progression on sequential imaging. This ratio derived from routine labs may permit risk stratification of TBI patients and should be examined prospectively.



Relative Change in N/L Ratio vs Percent Progression of TBI

## Quick Shots Parallel Session I

Quick Shot Paper #5  
January 10, 2018  
4:54 pm

### **FRAILITY SCREENING AND A FRAILTY PATHWAY DECREASE LENGTH OF STAY, LOSS OF INDEPENDENCE, AND 30-DAY READMISSION RATES IN FRAIL TRAUMA AND EMERGENCY GENERAL SURGERY PATIENTS**

Kathryn E. Engelhardt, MD, Quentin Reuter, Jonathan Frederick Bean, M.D.\*, Joliette Barnum, Michael B. Shapiro, MD\*, Allison Ambre, Amanda Dunbar, Mara Markzon, Tara Reddy, Christing Schilling, Joseph Posluszny  
Northwestern University

**Presenter:** Kathryn E. Engelhardt, MD

**Objectives:** Frail geriatric trauma and emergency general surgery (TEGS) patients have higher rates of complications, longer lengths of stay (LOS) and less frequent discharges to home when compared to non-frail geriatric patients. Despite this, there have been no studies reported that improve outcomes for frail TEGS patients. The objective of this quality improvement (QI) project was to develop a screening program, using the TEGS-Specific Frailty Index and implement a novel frailty pathway to reduce LOS, LOI and 30-day readmission rates.

**Methods:** This was a before-after study of a prospective cohort of all geriatric patients admitted to the TEGS service from 10/2016-5/2017. After 3 months of screening to obtain baseline outcome measures (pre-intervention), both frailty screening and implementation of the frailty pathway were implemented (*Fig 1*). Non-parametric statistical tests were used to assess significant differences in continuous variables; chi-squared and Fisher's exact were used for categorical variables, where appropriate.

**Results:** Of 153 geriatric TEGS patients screened, 47 (31%) were frail. All TEGS geriatric patients were screened within 24 hours of admission. Following frailty pathway implementation, median length of stay decreased from 8.5 to 6 days ( $p=0.67$ ), readmissions decreased from 36.4% to 14.7% ( $p=0.19$ ), and loss of independence decreased by 37%, (100% vs 63.6%;  $p=0.02$ ; *Fig 2*). Outcomes for non-frail geriatric patients did not differ between cohorts.

**Conclusions:** Screening for frailty and a frailty pathway decreased LOS, LOI and 30 day readmission rates for frail TEGS patients. This pathway shifted available resources toward frail patients, without negatively affecting outcomes in other geriatric TEGS patients. Implementation of this pathway with larger patient cohorts and in varied settings is needed to confirm our findings.

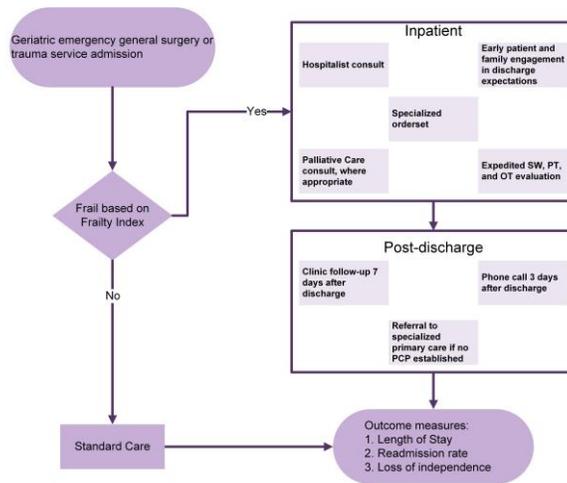


Figure 1: Novel, multidisciplinary clinical pathway for frail patients admitted to the emergency general surgery and trauma service

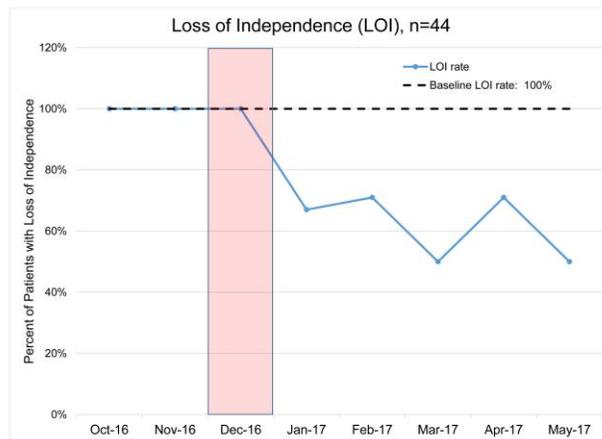


Figure 2: Run chart showing trend in loss of independence by month. The intervention was implemented mid-December, 2016

## Quick Shots Parallel Session I

Quick Shot Paper #6  
January 10, 2018  
5:00 pm

### **PIC SCORE: AN EFFECTIVE TOOL TO GUIDE MANAGEMENT OF BLUNT CHEST WALL INJURY (ANALYSIS OF THE FIRST TWO YEARS OF APPLICATION AT A LEVEL I TRAUMA CENTER)**

Shawn M. Terry, MD, FACS\*, Kimberly A. Shoff, BSN, RN, CCRN  
WellSpan -- York Hospital

**Presenter:** Shawn M. Terry, MD, FACS

**Objectives:** Blunt chest wall injury patient outcomes were identified to be unsatisfactory based on trauma program process improvement review. A novel, comprehensive treatment plan involving a power plan protocol (PIC Protocol) and rating scale (PIC Score) was developed and deployed as a strategic intervention. We hypothesize that application of this protocol will improve outcomes from blunt chest wall injury at our institution.

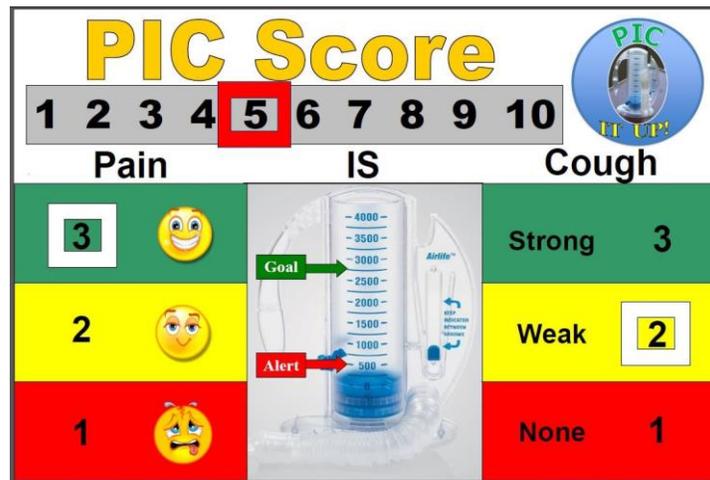
**Methods:** Retrospective trauma registry and electronic medical record queries at a Level I Trauma Center for 2 years following protocol initiation (2014-2015) for non-intubated chest wall injury patients were conducted and compared to outcomes recorded from 2 years prior to protocol development (2012-2013). Independent-sample t tests were performed to assess differences between groups for measurement variables. Chi Squares tests were performed to assess relationships between categorical variables of interest.

**Results:** Compliance with protocol was 100% (533/533 pts). Unanticipated transfer to higher level of care for respiratory decline was significantly reduced from 4% to 0.37% ( $p=0.0022$ ). Patients requiring transfer to higher level of care were successfully predicted by an acute fall in PIC score of 2 points. No unpredicted patient care escalations related to declining pulmonary function occurred post PIC protocol (0/533) compared to prior study period (24/501). No significant increase in ICU or hospital length of stay was incurred.

**Conclusions:** Application of institution-developed PIC Protocol Chest Wall Injury Initiative improved patient outcomes for non-intubated chest wall injury patients without increasing time in the ICU or the hospital. The PIC Protocol Assessment Tool Score was demonstrated to have predictive value in assessment of declining respiratory function and need for patient transfer to higher level of care.

	PIC		P value
	No PIC Control Group	PIC Group	
	Mean	Mean	
Age	58.5	58	0.709
ISS	12.8	13.2	0.491
Time in ED	171.4	189.2	0.819
ICU LOS	1.2	1.4	0.365
Vent Days	0.8	0.8	0.958
LOS	5.2	5.2	0.803

Comparison data derived from pre- and post- PIC Protocol initiation for blunt chest wall injury patients.



Magnetized patient scoring, education, and communication tool board created for bedside use. Composite **PIC** score (range 3-10) derived from total for each column score: **Pain**, **Incentive Spirometer Volume** achieved, **Cough**.

## Quick Shots Parallel Session I

Quick Shot Paper #7  
January 10, 2018  
5:06 pm

### HEALTH LITERACY AND QUALITY OF PHYSICIAN-TRAUMA PATIENT COMMUNICATION: OPPORTUNITY FOR IMPROVEMENT

Jonathan Dameworth, MD, Jordan V Jacobs, MD, Pamela Goslar, Terrell Thompson,  
Dana Stout, Thomas Gillespie, Scott Petersen,  
St. Joseph's Hospital and Medical Center

**Presenter:** Jonathan Dameworth, MD

**Objectives:** Although physician-patient communication and health literacy (HL) have been studied in diverse patient groups, little research has focused on trauma patients. The purpose of this study was to evaluate trauma patient ratings of the quality of physician-patient communication during hospitalization and how this varies by HL.

**Methods:** Level 1 trauma center patients were interviewed during hospitalization (Aug 2016-Jan2017). Short Assessment of Health Literacy (SAHL) tool was used to stratify subjects by deficient vs. adequate HL. Interpersonal Processes of Care (IPC) survey was administered to assess perception of physician-patient communication. This survey allowed patients to rate physician-patient interaction across 6 domains: "clarity," "elicited concerns," "explained results," "worked together (on decision making)," "compassion and respect," and "lack of discrimination by race/ethnicity." Each is scored on a 5-point scale. Frequencies of "top-box" (5/5) scores were compared for significance ( $p < 0.05$ ) between HL-deficient and HL-adequate patients.

**Results:** 199 patients participated. Average age was 42, 33% female, and median ISS 10. 49 patients (25%) had deficient HL. Comparison of patients with deficient vs. adequate HL with respect to IPC top-box scores is demonstrated in Figure 1. The majority of patients in both groups rated communication below 5/5 across most domains. HL-deficient patients were consistently less likely to give physicians top-box scores, most notably in the "elicited concerns" domain.

**Conclusions:** HL-deficient patients appear relatively less satisfied with physician communication, particularly with respect to perceiving that their concerns are being heard. Overall, however, the majority of patients in both groups were unlikely to score physician communication in the "top box." Efforts to improve physician-trauma patient communication are warranted, with attention directed toward meeting the needs of HL-deficient patients.

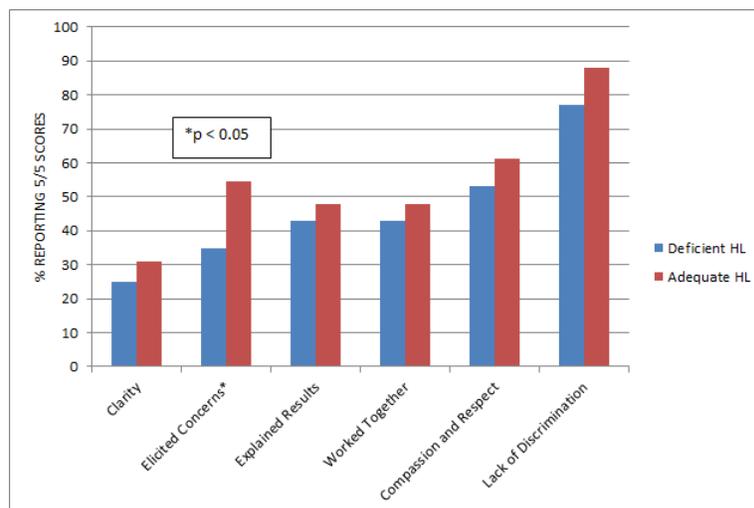


Figure 1. Proportion of "top box" scores across IPC survey domains, stratified by HL group.

## Quick Shots Parallel Session I

Quick Shot Paper #8  
January 10, 2018  
5:12 pm

### INCREASED TRAUMA ACTIVATION IS NOT EQUALLY BENEFICIAL FOR ALL ELDERLY TRAUMA PATIENTS

Bryan Carr, MD, Peter M Hammer, MD\*, Grace S. Rozycki, MD, MBA, FACS\*,  
David V. Feliciano, MD, FACS\*, Jamie J. Coleman, MD, FACS\*  
Indiana University

**Presenter:** Bryan Carr, MD

**Objectives:** Physiologic changes in the elderly lead to higher morbidity and mortality after injury. Increasing the level of trauma activation for has been proposed to improve geriatric outcomes; but, the increased cost to the patient and stress to the hospital system are significant downsides. The purpose of this study was to identify the age at which an increase in activation status is beneficial.

**Methods:** A retrospective review of trauma patients = 70 years old from October 1, 2011, to October 1, 2016 was performed. On October 1, 2013, a policy change increased the activation criteria to the highest level for patients = 70 years of age with a significant mechanism of injury. Patients who presented prior to (PRE) were compared to those after the change (POST). Data collected included age, injury severity score (ISS), length of stay (LOS), complications and mortality. Primary outcome was mortality and secondary outcome was LOS. Multivariable regressions controlled for age, ISS, injury mechanism, and number of complications.

**Results:** 4363 patients were included in the study, 1921 in PRE (mean age 80.4, mean ISS 11.6) and 2442 in POST (mean age 81, mean ISS 12.5). After adjusting for injury mechanism, LOS and number of complications, there was no significant difference in age ( $p=0.053$ ) or ISS ( $p=0.820$ ) between PRE and POST. POST had more level 1 activations (712 vs. 221,  $p<0.001$ ). After multivariable logistic regression analysis, a significant reduction in mortality occurred in the POST group = 77 of age (OR 0.53, 95% CI: 0.3-0.87), figure 1. LOS started to decrease significantly in the POST group at age 78 (regression coefficient -0.55, 95% CI: -1.09-0.01), figure 2.

**Conclusions:** This study suggests that geriatric trauma patients = 77 years benefit from the highest level of trauma activation with a shorter LOS and lower mortality. A focused approach to increasing activation level for elderly patients may decrease patient cost.

Figure 1:

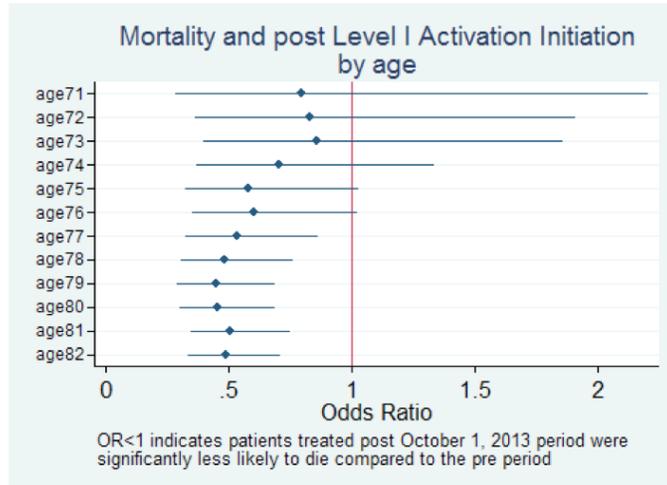
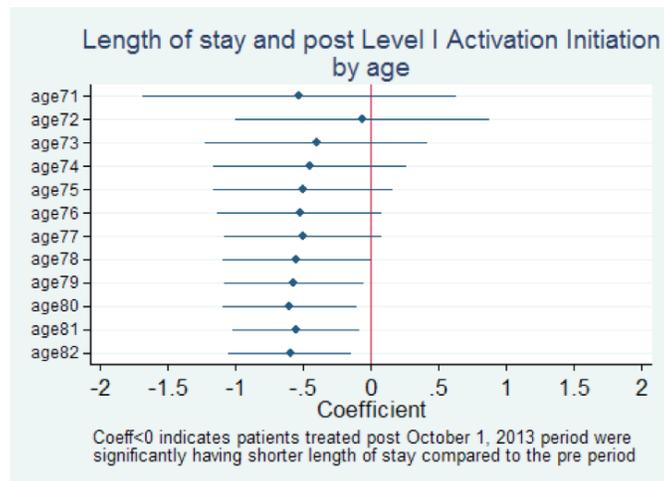


Figure 2:



## Quick Shots Parallel Session I

Quick Shot Paper #9  
January 10, 2018  
5:18 pm

### THE UTILITY OF ADDITIONAL IMAGING IN TRAUMA CONSULTS WITH MILD TO MODERATE INJURY AFTER INITIAL ED WORKUP

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Virginia Tech Carilion School of Medicine

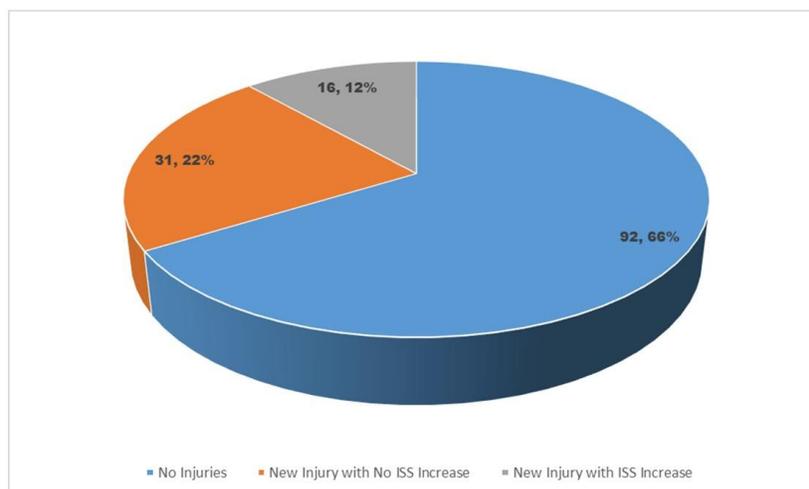
**Presenter:** Andrew L. Plaster, BS

**Objectives:** Limiting CT imaging in the ED has gained interest recently. However, following trauma consultation in the ED, additional CT imaging is frequently ordered. We sought to determine the benefits of additional imaging after initial workup by the ED. Hypothesis: Additional imaging in trauma patients results in the diagnosis of new significant injuries that will change the treatment plan and raise the Injury Severity Score (ISS).

**Methods:** The trauma registry at our level 1 trauma center was queried from November 2015 to November 2016 for trauma consults initially evaluated by ED physicians. Patients with mild to moderate injuries were included. Injury findings before and after additional imaging were determined by chart review and a pre and post imaging ISS was calculated for patients with new injuries. Blinded trauma surgeons reviewed the findings to assess for clinical significance and changes in treatment.

**Results:** 421 patients were evaluated, with 140 (33%) undergoing additional CT imaging. 47 (34%) had additional injuries found, with 16 (12%) increasing their ISS with a mean change of 0.536 (SD 1.658) - significant by Wilcoxon test (N=16, W=136.0). After physician review, 93% of cases resulted in at least one physician finding the new injuries clinically significant; however, agreement between the reviewers was low ( $\kappa = 0.0948$ ). For 70%, at least one physician felt the findings resulted in a change in treatment plan ( $\kappa = 0.4047$ ).

**Conclusions:** Attempts to minimize imaging for trauma consultations resulted in additional imaging for one third of our patient sample resulting in identification of a considerable number of new injuries. This suggests that current efforts to limit the use of CT imaging in trauma patients may result in significant injuries going undiscovered and under-treated. Further research is needed to determine the risk versus benefit of attempts to limit imaging in this population.



Frequency of new injuries and ISS increase after additional imaging

## Quick Shots Parallel Session I

Quick Shot Paper #10  
January 10, 2018  
5:24 pm

### BENCHMARKING EMERGENCY DEPARTMENT THORACOTOMY: USING TRAUMA VIDEO REVIEW TO GENERATE PROCEDURAL NORMS

Ryan P. Dumas, MD Kristen Chreiman, BSN, Matthew Goldshore, Mark J. Seamon, MD\*,  
Jeremy W. Cannon, MD, SM, FACS\*, Patrick M. Reilly, MD\*, Jason Christie, Daniel N. Holena, MD MSCE\*  
University of Pennsylvania

**Presenter:** Ryan P. Dumas, MD

**Objectives:** Emergency department thoracotomy (EDT) must be rapid and well-executed. Currently there are no defined benchmarks for EDT procedural milestones. We hypothesized that trauma video review (TVR) can be used to define the “normative EDT” and generate procedural benchmarks. As a secondary aim, we used these benchmarks to classify EDTs performed at our center.

**Methods:** We used high-definition, continuously recording video to review all EDTs from 4/2016-2/2017. Using skin incision as procedure start time, we defined four procedural milestones for EDT: 1.) time to chest entry (defined as completion of retractor deployment) 2.) time to right chest decompression 3.) time to pericardiotomy and 4.) time to aortic cross-clamp. A benchmark was defined as the 75<sup>th</sup> percentile of time from skin incision to each milestone. EDTs with any milestone time exceeding the 75th percentile were identified as outliers.

**Results:** 30 EDTs were performed during the study period. Patients had a median age of 31(IQR 29-49) and were predominantly African-American (96%) males (93%) with penetrating trauma (93%). From skin incision median times in seconds to milestones were as follows: left chest entry 66.5(IQR 58-105), right chest decompression 129(IQR 38-170), pericardiotomy 142.5(IQR 113-204.5), aortic cross-clamp 242.5(IQR 170-340). Procedural milestones can be seen in Figure 1. In total, 19/30 (63%) of EDTs were high outliers for one or more benchmarks.

**Conclusions:** Video review can be used to define normative times for the procedural milestones of EDT. Steps exceeding the 75th percentile of time were common, with over half of EDTs having at least one milestone as an outlier. Future work should seek to determine if minimizing procedural technical outliers improves patient outcomes.

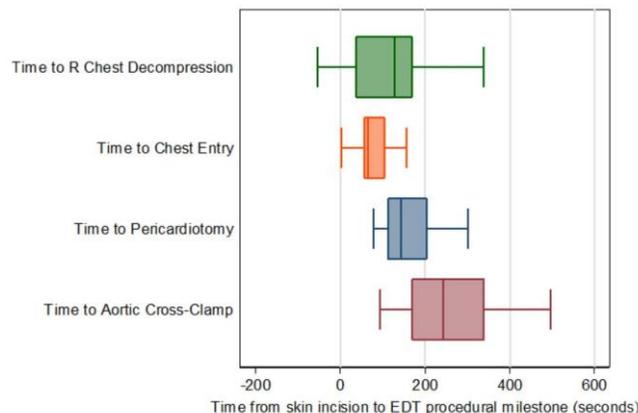


Figure 1