## Quick Shot #1 January 13, 2016 1:00 pm

## MASSIVE TRANSFUSION IN NON-TRAUMA SURGICAL PATIENTS: HOW TO DEFINE IT AND WHAT IS THE ROLE OF BALANCED TRANSFUSION?

Stephanie F. Polites, MD, Asad Choudhry, Donald H. Jenkins, MD\*, James Stubbs, Martin D. Zielinski, MD, FACS\* Mayo Clinic

**Presenter:** Stephanie F. Polites, MD

Discussant: Amy Makely, MD, University of Cincinnati

**Objectives:** Balanced transfusion (BT) is beneficial in trauma patients who require massive transfusion (MT). It is unknown if these benefits extend to non-trauma surgical (NT) patients, however, as MT has not been clearly defined in this population. We compared NT patients receiving MT who were transfused platelet:pRBC or plasma:pRBC ratios of at least 1: 2 in 24 hours (BT) to those who were not (unbalanced transfusion; UT) using the MT definitions of  $\geq 3$  units pRBCs in 60 minutes and  $\geq 10$  units in 24 hours found in the trauma literature.

<u>Methods</u>: Review of all NT patients who were transfused  $\geq 3$  units pRBCs in 60 minutes from 2010 – 2013 was performed and ratios of platelet:pRBC and plasma:pRBC transfusion in 24 hours were calculated. Their 30 day mortality was determined and compared to the subset of patients who received  $\geq 10$  units in 24 hours. Patients who underwent cardiac surgery were excluded.

**<u>Results</u>:** We identified 1023 NT patients who received who received  $\geq 3$  units of pRBCs in 60 minutes. Overall mortality was 8.8%. The subset of patients who received  $\geq 10$  units in 24 hours (n=248) had a mortality rate of 13.3%. Mortality was similar between patients who received BT and UT regardless of MT definition (Table). The exception was BT of plasma:pRBC in patients who received  $\geq 3$  units pRBCs in 60 minutes; this had greater mortality compared to UT patients (13.2 vs 6.6%, p<.001).

**Conclusions:** Mortality of NT patients receiving MT was lower than that reported in the trauma literature regardless of MT definition. This necessitates a more conservative MT definition with higher pRBC volume requirements ifor NT patients so that ideal transfusion ratios can be further studied. Using current trauma literature definitions of MT, our data do not support a survival benefit to BT in NT patients.

Table: Mortality of Unbalanced vs Balanced Transfusion by Massive Transfusion Definition						
Massive Transfusion	plasma:pRBC platelet:pRBC					
pRBC definition	BT	UT	p value	BT	UT	p value
≥3 units in 60 minutes	13.2%	6.6%	<.001	13.3%	8.4%	.15
≥10 units in 24 hours	15.8%	11.0%	.35	8.3%	14.3%	.55

BT, balanced transfusion; UT, unbalanced transfusion

## Quick Shot #2 January 13, 2016 1:06 pm

#### POSITIVE IMPACT OF A DESIGNATED DISCHARGE TEAM

James M. Bardes, MD\*, Uzer Khan, MD, MBBS\*, Jennifer Christine Knight, MD\*, Jorge Con, MD\*, Gregory P. Schaefer, DO, FACS\*, Nicole Cornell, Alison M. Wilson, MD\* West Virginia University

Presenter: James M. Bardes, MD

Discussant: Cynthia Talley, MD, University of Kentucky

**Objectives:** Evaluate the impact on length of stay and discharge from the hospital by noon after the implementation of standardized discharge process and utilization of a separate discharge team. The discharge team was composed of faculty and a mid-level provider.

<u>Methods</u>: Retrospective review of the trauma database and hospital records at a University Level 1 trauma center. Records were reviewed for 2 years pre (2008-9), and two years post (2011-12), implementation of the discharge team. Discharge time was defined as the time the patient left the facility.

**<u>Results:</u>** 3118 patients were discharged in the pre period, and 3982 in the post. 26.1% of patients were discharged before noon in the pre period, this increased to 51.2% post implementation (p<.0001). Mean length of stay decreased from 4.6 to 3.9 days (p=.0003). When controlling for ISS (p<.0001) or patient age (p<.0001), there was still an increase in patient discharges by noon. In the pre period 25% of patients discharged to home left by noon, and 29% of patients discharge increased to 53% and those discharged to other facilities increased to 47%. This improvement was statistically significant (p<.0001) for both groups. The decrease in length of stay and discharge by noon resulted in a hospital direct cost savings of \$4 million over 2 years. Patient charges were reduced by \$14 million over the same time period.

**Conclusions:** Standardized discharge processes and utilization of a separate discharge team significantly increased the discharged by noon rate at a University Level 1 trauma center. This improvement was maintained when controlling for ISS, age and final discharge disposition. Significant savings were evident in both charges to the patient and direct costs to the facility. The utilization of a discharge team should be considered at similar facilities.

## Quick Shot #3 January 13, 2016 1:12 pm

#### POST-OPERATIVE RESUSCITATION OF ELECTIVE SURGERY PATIENTS IN THE SURGICAL INTENSIVE CARE UNIT

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Presenter: Madhu Subramanian, MD

Discussant: Scott Armen, MD, Penn State University

**Objectives:** Post-surgical fluid resuscitation requires critical analysis: over- and underresuscitation are both known to be associated with worse outcomes. We hypothesized that a goal-directed fluid resuscitation protocol would standardize fluid administration and improve outcomes for elective surgery patients in the surgical intensive care unit (SICU).

**Methods:** We prospectively applied our resuscitation algorithm to all patients admitted to SICU after elective surgery over a four-month period. The algorithm incorporates vital signs, lab values, urine output, and arterial waveform analysis to determine when to initiate resuscitation and the type of fluid and volume administered. We compared the outcomes of patients resuscitated using the algorithm to those that deviated through univariate analysis.

**<u>Results:</u>** 45 patients met study criteria: 25 patients were resuscitated according to the protocol; 20 patients were not. There were no differences in baseline demographics; intra-operative: time, intravenous fluid administration, transfusion requirements, or urine output; between the two groups. The net fluid balance at 72 hrs was lower in the patients resuscitated with the algorithm (1586mL vs. 6290mL, p<0.001). This group also had decreased diuretic use (4 vs. 9, p=0.049) and a lower but not significant rate of AKI (5 vs. 7, p=0.258) and ICU LOS (3.0 vs. 3.5, p=0.104). No differences were seen in postoperative transfusion, reintubation, hospital LOS or overall mortality. Deviations from the algorithm included inappropriate initiation of resuscitation in 10 patients (50%), failure to use waveform analysis in 6 (30%), and the incorrect choice of fluid in 3 (15%).

**<u>Conclusions</u>**: SICU patients resuscitated using a goal-directed resuscitation algorithm have a more neutral fluid balance without an apparent resultant increase in complications. Compliance with the algorithm may reduce morbidity in critically ill patients.

## Quick Shot #4 January 13, 2016 1:18 pm

## INSURANCE STATUS IS ASSOCIATED WITH COMPLEX PRESENTATION IN EMERGENCY GENERAL SURGERY PATIENTS

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Presenter: Jonathan Scott, MD - @DrJohnScott

Discussant: Joseph Sakran, MD, MPH, Medical University of South Carolina

**Objectives:** The Affordable Care Act (ACA) has the potential to significantly impact access to care for previously uninsured patients in need of emergency general surgical (EGS) care. Our objective was to determine the relationship between insurance status and disease complexity at presentation among a national sample of EGS patients.

**Methods:** Data from the 2006-2009 National Emergency Department Sample were queried for patients 18-64y admitted through the emergency department with a primary diagnosis of appendicitis, diverticulitis, inguinal hernia, or bowel obstruction. Complex presentations were defined as those presenting with generalized peritonitis, intrabdominal abscess, perforated bowel, intestinal gangrene, or other disease-specific measures of complexity (*Table 1*). Multivariable logistic regression was used to determine the independent association between insurance and complex presentation. Models accounted patient- and hospital-level covariates (*Table 1*). Counterfactual models were used to examine hypothetical outcomes assuming that all uninsured patients were insured.

**<u>Results:</u>** 1,533,793 patients were included, with an overall uninsured rate of 11.6% (95%CI 11.1-12.1%). Uninsured patients had significantly higher unadjusted rates of complex presentation, and uninsured payer status was independently associated with complex presentation in all four EGS diagnoses (*Table 1*). Had uninsured patients been insured, counterfactual models suggest that there would have been a 4.8-15.7% relative reduction in the total number of complicated EGS presentations nationwide (*Table 2*).

**Conclusions:** Insurance status is independently associated with severity of disease presentation among EGS conditions on a national scale. In light of recently reaffirmed ACA insurance expansion provisions, these results anticipate increased access to emergent care for newly insured patients and a corresponding decline in complex EGS presentations.

Table 1. Association of Insurance Status and Complex Emergency General Surgery Presentation

EGS Disease State	Proportion presen disease, unadju	ting with complex sted; %, 95%Cl <sup>ª</sup>	Uninsured compared to insured patients;	p-value	
	Insured <sup>b</sup>	Uninsured	AOR, <sup>c</sup> 95%CI		
A cuto Ann andicitia <sup>d</sup> ,e	24.9%	26.3%	1.29	0.001	
Acute Appendicitis	[24.4, 25.5]	[25.5, 27.1]	[1.24, 1.39]	0.001	
Acute Diverticulitied,f	18.0%	19.4%	1.12	0.002	
Acute Diverticulitis	[17.5, 18.5]	[18.4, 20.5]	[1.04, 1.20]	0.002	
In guinel Hennie <sup>d</sup> ,	78.1%	81.2%	1.25	0.012	
ingunai Hernia	[76.8, 79.4]	[80.0, 83.3]	[1.05, 1.48]	0.012	
Revuel Obstruction d,h	4.9%	6.0%	1.14	0.025	
Bower Obstruction	[4.7, 5.0]	[5.3, 6.7]	[1.01, 1.28]	0.035	

Source: Nationwide Emergency Department Sample, years 2006-2009.

EGS, emergency general surgery; CI, confidence interval; AOR, adjusted odds ratio; a, weighted for populationlevel estimates; b, insured includes private, medcare, medicaid, and other insurance; c, adjusted for year, age, gender, charlson comorbidity index, patient income, patient rural status, hospital census region, hospital metropolitan status, and hospital fixed effects; d, complicated presentation includes generalized peritonitis, intrabdominal abscess, perforated bowel, and intestinal gangrene; e, complicated presentation includes appendicitis with perforation or abscess; f, complicated presentation includes obstruction due to mural thickening; g, complicated presentation includes hernia with strangulation or obstruction; h, complicated presentation includes feculent emesis.

Table 2. Change in Complex EGS Presentation if Uninsured Patients were Insured	

EGS Disease State	Counterfactual, <sup>a</sup> weighted estimates <sup>b</sup> for uninsured patients; %, 95%Cl	Absolute reduction in complex presentation if uninsured gain coverage; %, 95%Cl	Relative reduction in complex presentation if uninsured gain coverage	p-value <sup>c</sup>
Acute Appendicitis <sup>d,e</sup>	<b>22.0%</b> [21.8, 22.2]	- <b>4.48%</b> [4.45, 4.50]	<b>-15.67%</b> [-15.60, -15.73]	< 0.001
Acute Diverticulitis <sup>d,f</sup>	<b>17.4%</b> [17.2, 17.5]	- <b>1.62%</b> [1.61, 1.63]	<b>-8.62%</b> [-8.60, -8.63]	< 0.001
Inguinal Hernia <sup>d,g</sup>	<b>77.2%</b> [76.8, 77.7]	- <b>3.57%</b> [3.53, 3.62]	<b>- 4.81%</b> [-4.77, -4.86]	< 0.001
Bowel Obstruction <sup>d,h</sup>	<b>4.9%</b> [4.9, 5.0]	- <b>0.63%</b> [0.63, 0.64]	<b>-11.37%</b> [-11.37, -11.37]	< 0.001

Source: Nationwide Emergency Department Sample, years 2006-2009.

EGS, emergency general surgery; CI, confidence interval; a, counterfactual analysis provides estimates under the assumption that all patient and facility variables are unchanged, but uninsured patients were re-coded as having insurance; b, weighted for population-level estimates; c, adjusted for year, age, gender, charlson comorbidity index, patient income, patient rural status, hospital census region, hospital metropolitan status, and hospital fixed effects; d, complicated presentation includes generalized peritonitis, intrabdominal abscess, perforated bowel, and intestinal gangrene; e, complicated presentation includes appendicitis with perforation or abscess; f, complicated presentation includes obstruction, due to mural thickening; g, complicated presentation includes hernia with strangulation or obstruction; h, complicated presentation includes feculent emesis.

## Quick Shot #5 January 13, 2016 1:24 pm

# SURGEON LED IN SITU TRAUMA TEAM SIMULATION - WHAT ARE THE BENEFITS, WHAT ARE THE COSTS?

William R. Leeper, MD, BSc, FRCSC, Elizabeth Hunt, Michael Kolaitis, David T. Efron, MD\*, Elliott R. Haut, MD, PhD, FACS\* London Health Sciences Centre

Presenter: William R. Leeper, MD, BSc, FRCSC

Discussant: Richard Falcone, Jr., MD, MPH, Cincinnati Children's Hosptial

**Objectives:** In situ simulation has been used as both a diagnostic tool for the identification of latent threats to patient safety (PS) and as an interprofessional (IP) educational tool. Trauma is an interprofessional discipline with the surgeon at the center of the process of care. We developed and instituted a surgeon led in situ trauma team simulation program at a level one inner city trauma center and utilized post simulation video analysis to identify obstacles to optimum performance and opportunities for improved team functioning.

**Methods:** We performed a pilot, mixed-methods (quantitative and qualitative) study of trauma teams managing an *in situ* simulated trauma activation. Main outcome measures included: (1) identification of latent PS concerns within the trauma bay, (2) identification of high leverage IP behaviors, and (3) human resource commitment required of lead trauma surgeon. Two reviewers analyzed video data from simulations in order to identify and quantify outcomes. Detailed post event summaries enhanced with video vignettes were created to facilitate ongoing reflection by the participants, deepen learning, and promote retention.

**<u>Results:</u>** During the 2014-2015 academic year, eleven in situ simulations have been conducted involving 101 participants including attending, fellow, and resident level physicians, registered nurses, nursing technicians, respiratory therapists, and critical care pharmacists. Simulations are conducted *in situ* within actual adult and pediatric trauma bays. Each simulation identified a mean of 2.1 latent PS concerns and highlighted 1.1 demonstrable examples of high quality IP behaviors. Each simulation consumed a mean of 15.2 hours of direct effort on the behalf of the lead surgeon (preparation = 6.1 hours, conduct = 3.1 hours, analysis = 5.8 hours). Focus groups conducted with key stakeholders (emergency department nursing staff, technical staff, trauma committee) have identified a strong positive impact of trauma surgeon involvement and a strong preference to expand and to continue the simulation curriculum.

**Conclusions:** Implementation of a surgeon led *in situ* trauma simulation was associated with identification of multiple PS and IP performance items and has reached a large number of trauma

providers with qualitatively positive impact. Measurable effort for this monthly program requires approximately 10% of a full-time equivalent attending level surgeon.



Figure 1. Example of detailed post simulation summary enhanced by narrated video vignettes. Post simulation summaries are provided to participants in order to facilitate reflection, deepen learning, and promote retention.

## Quick Shot #6 January 13, 2016 1:30 pm

#### STRUCTURED BRIEFING IMPROVES TRAUMA RESUSCITATION TEAMWORK

Susan Steinemann, Alexander Wei, Nina Ho, Gene Kurosawa, Gregory Suares, Eunjung Lim, Benjamin Berg University of Hawaii, John A. Burns School of Medicine

Presenter: Susan Steinemann

Discussant: Julie Nash, MSN, RN, Barnes-Jewish Hospital

**Objectives:** Briefing is a key aspect of teamwork. Yet, in many centers briefing of the accepting trauma team prior to patient arrival is unstructured, and is underemphasized in ATLS. We evaluated the impact of a structured, physician-led briefing on teamwork and concordance in simulated trauma resuscitations.

**Methods:** Trauma nurses (RNs) were surveyed about briefing at our Level II center; then completed 4, random ordered, SimMan-based resuscitation scenarios. Teams had 3-4 RNs (subjects) + 2-4 confederates (physicians, respiratory therapists). Scenarios were randomized as briefed(B) or non-briefed(NB), each team served as their own control group to examine the impact of briefing. In the 2 NB (control) scenarios, RNs independently reviewed a triage sheet with written information relayed to the emergency physician by pre-hospital medics. In the 2 B scenarios, a structured, 4-minute, physician-led briefing reviewed the same pre-hospital information. Confederates were blinded as to the whether or not the RNs had been briefed. Immediately before, and at the midpoint of each scenario, RNs ranked the top 3 (of 16) immediate care priorities. RNs responses were compared for concordance using intra-class correlation coefficient (ICC), and to Trauma/Crit Care MD answers using Fisher's exact test. Teamwork was rated by a teamwork expert using T-NOTECHS (Am J Surg), t-test compared B vs NB.

**<u>Results:</u>** 39 RNs participated. 95% "agreed/strongly agreed" briefing is important, but only 46% agreed briefing is done well at our center. Comparing B vs NB scenarios, RNs ranklists exhibited higher concordance with each other (ICC 0.64 vs 0.59) and significantly more agreement with MD answers (p<0.001) in B scenarios. T-NOTECHS Leadership ratings were significantly higher in the B scenarios (3.70 ű0.83 vs 3.39 ű1.01, p<.01).

**Conclusions:** Structured, physician-led briefing improves trauma team concordance and facilitates better leadership in simulated trauma resuscitations.

## Quick Shot #7 January 13, 2016 1:36 pm

#### EPIDEMIOLOGIC AND SPATIAL ANALYSIS OF TRAUMA TRANSFERS IN MONTREAL: A CALL FOR THE IMPLEMENTATION OF TRIAGE CRITERIA TO BYPASS SECONDARY TRAUMA CENTERS FOR DEFINITIVE TRAUMA CARE

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Presenter: Fadi T. Hamadani, BMedSc, MD, MSc

Discussant: Nathan Mowery, MD, Wake Forest School of Medicine

**Objectives:** 1) To assess how regionalization of trauma services on the Island of Montreal has impacted transfer patterns & access to care of severely injured patients. 2) Use advanced spatial analysis to describe the sequence of trauma patient transfers & identify areas with longest delays & transfer times. 3) Infer the effect of delayed transfer times on patient outcomes & health system costs.

<u>Methods:</u> We analyzed transport & emergency department (ED) door-to-door times (D2D) of injured patients from 2005-2014 as a function of demographics, injury mechanism & location, vital signs, & injury severity score (ISS). CDC-ASCOT triage criteria were used to identify the proportion of patients who should have bypassed the non-level-1 trauma center stratified by location. We used geographically-weighted multivariate regression to assess transport times and D2D as predictors of hospital & ICU length of stay (LOS) and the need for rehabilitation.

**<u>Results:</u>** 2420 patients were transported to a non-level-1 trauma center before requiring definitive transfer to the level-1 facility. ISS  $\geq$  15, penetrating injuries, high-velocity MVCs, & GCS  $\leq$  13 predicted shorter ED D2D & total transport times. Based on CDC-ASCOT, 53% of these patients should have bypassed the non-level-1 trauma center (Fig1). Regression showed that for each CDC-ASCOT criteria failed there was an increased ICU LOS of 2.2 days (p<0.001) at costs of \$4200-\$7200 per day. Spatial interpolation identified a 10km radius around the level-1 center with the longest delays.

<u>Conclusions</u>: Delayed transport of critically injured patients to definitive care led to longer hospital & ICU LOS & a higher need for rehabilitation. While the results argue for an inclusive trauma system that supports the capacity of non-level-1 centers, there is a need for the institution of bypass criteria in the field.



Figure-1. Spatial Analysis of trauma transfers on the island of Montreal. Based on CDC-ASCOT triage criteria, 53% of injured patients should have bypassed the non-level-1 trauma center. Spatial interpolation identifies a 10km radius around the level-1 center with the highest failures to by pass the non-level-1 trauma center.

## Quick Shot #8 January 13, 2016 1:42 pm

#### POLICE TRANSPORT VS. GROUND EMS: A TRAUMA SYSTEM LEVEL EVALUATION OF PRE-HOSPITAL CARE POLICIES AND THEIR EFFECT ON CLINICAL OUTCOMES

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Presenter: Michael Wandling, MD

Discussant: Paul Chestovich, MD, University of Nevada

**Objectives:** Rapid transport to definitive care ("scoop and run") versus field stabilization in trauma remains a topic of debate and has resulted in variability in pre-hospital policy. We aimed to identify trauma systems frequently using a true "scoop and run" police transport approach and to compare mortality rates between police and ground emergency medical services (EMS) transport.

<u>Methods</u>: Using the National Trauma Databank (NTDB), we identified adult (age $\geq$ 16) gunshot and stab wound patients presenting to level 1 or 2 trauma centers from 2010-2012. Hospitals were grouped into their respective cities and regional trauma systems. We included patients directly transported by police or ground EMS to trauma centers in the 100 most populous US metropolitan areas. Frequency of police transport was evaluated, identifying trauma systems with high utilization. Unadjusted mortality rates and the risk-adjusted odds ratio for mortality for police vs. EMS transport were derived.

**<u>Results:</u>** Of 88,564 total patients, 86,097 (97.2%) were transported by EMS and 2,467 (2.8%) by police. 87.8% of police transports occurred in three locations (Philadelphia, Sacramento, and Detroit). Within these three trauma systems, unadjusted mortality was 19.9% for police transport and 13.5% for EMS. After adjusting for age, gender, race, injury severity, systolic blood pressure, heart rate, Glasgow Coma Scale, and insurance, patients transported by police were no more likely to die than those transported by EMS (OR=0.98, 95% CI: 0.65-1.48).

<u>**Conclusions:**</u> Using trauma system level analyses, we found that the majority of pre-hospital police transport in penetrating trauma occurs in three trauma systems. In these cities, police and EMS transport have similar survival outcomes. These three cities represent ideal sites for additional system-level evaluation of the role of "scoop and run" policies in urban trauma care.

	All Patients	Ground EMS	Police	P Value
Population Size	88,564	86,097	2,467	-
Age	32.6 +/- 13.4	32.7 +/- 13.4	30.4 +/- 11.3	< 0.001
Heart Rate <sup>1</sup>	90.5 +/- 31.3	90.6 +/- 31.1	88.1 +/- 37.2	< 0.001
Systolic Blood Pressure <sup>1</sup>	123.3 +/- 41.5	123.6 +/- 41.2	113.1 +/- 48.8	< 0.001
GCS Motor Score <sup>1</sup>	5.4 +/- 1.6	5.4 +/- 1.6	5.1 +/- 1.9	< 0.001
Injury Severity Score	10.2 +/- 12.6	10.1 +/- 12.5	14.2 +/- 16.0	< 0.001
Injury Mechanism				< 0.001
Gunshot Wounds	47,224	45,582	1,642	
Stab Wounds	41,340	40,515	825	

<sup>1</sup>First documented value after arrival to the hospital.

**Table 1:** Baseline characteristics of sample population by mode of pre-hospital transportation.

	All Patients % (n)	Ground EMS % (n)	Police % (n)	P Value
All Penetrating Wounds	11.8% (10,422)	11.6% (9,986)	17.7% (436)	< 0.001
Gunshot Wounds Only	19.5% (9,221)	19.3% (8,807)	25.2% (414)	< 0.001
Stab Wounds Only	2.9% (1,201)	2.9% (1,179)	2.7% (22)	0.680

**Table 2:** Unadjusted mortality rates by mode of pre-hospital transportation.

## Quick Shot #9 January 13, 2016 1:48 pm

#### PERFORMANCE OF REGIONAL TRAUMA NETWORK: A STATE-WIDE ANALYSIS

Jack C. He, MD, Laura Kreiner, MD\*, Nitin Sajankila, Debra Allen, BSN, RN, Jeffrey A. Claridge, MD, MS\* MetroHealth Medical Center

Presenter: Jack C. He, MD

**Discussant:** Adam Fox, DO, Rutgers-NJMS

**Objectives:** Regional Trauma Network (RTN), composed of one level I and several lower level trauma centers (TCs) across multiple hospital systems, was established in 2010. Mortality between counties in RTN and other counties in the state were compared to assess RTN's performance.

<u>Methods</u>: Patients in the state trauma registry age  $\geq 15$  from 2006-2012 were analyzed. First, change in mortality over time was assessed by comparing all counties before and after RTN establishment. Then, two analyses were done for the post-RTN period: 1). a county-level analysis, comparing County C, the county containing RTN's level I TC (L1TC), to other counties containing L1TCs; 2). a regional analysis, comparing County C and its adjacent counties (i.e. RTN region) to other L1TC containing counties and their respective neighboring counties. The following patient subgroups were included *a priori* for both comparisons: Injury Severity Score (ISS)  $\geq 15$ , age  $\geq 65$ , and mechanisms.

**<u>Results:</u>** 178,143 patients were analyzed. Mean age was 57; 91% had blunt injuries. Overall patient mortality was 4.7%. County C was the only county that had a decrease in mortality for both the overall group (relative reduction of 24%) and all patient subgroups over time (all p <0.05). Both the county-level and regional analyses showed that RTN patients were 1-4 years older (p <0.05), had similar or higher ISS (p <0.05), and were treated more often at lower level TCs (p <0.001). Mortality for the county-level and regional analyses are shown in Tables 1 and 2, respectively.

**Conclusions:** County C was the only county in the state that had significant mortality reduction for all patient groups over time. Trauma system regionalization was associated with greater utilization of lower level TCs and lower patient mortality. An amplified survival benefit was seen when County C or RTN region was compared to counties or regions with multiple L1TCs, suggesting that having one L1TC in a county or region may be superior.

COUNTY C VS. COU	NTIES WIT	TH ANY NUM	IBER OF I	1TC LOCAT	ED WITHIN
	Cou	County C Non-RTN Countie			
Patient Group	Total (n)	Morality (%)	Total (n)	Morality (%)	p-value*
All Patients	9235	5.0%	27398	5.0%	0.958
$ISS \ge 15$	1258	20.6%	4237	21.6%	0.457
Age ≥ 65	4546	4.1%	11867	4.9%	0.039
Blunt Injury	8098	3.6%	24379	3.9%	0.239
Penetrating					
Injury	983	14.9%	2482	14.3%	0.668
COUNTY C VS.	COUNTIES	S WITH ONL	Y 1 L1TC	LOCATED W	VITHIN
All Patients	9235	5.0%	10274	4.8%	0.466
$ISS \ge 15$	1258	20.6%	1635	21.2%	0.712
Age ≥ 65	4546	4.1%	4769	4.1%	0.958
Blunt Injury	8098	3.6%	9127	3.6%	0.838
Penetrating					
Injury	983	14.9%	1043	13.5%	0.408
COUNTY C V	S. COUNTI	ES WITH >	1 L1TC LC	DCATED WI	THIN
All Patients	9235	5.0%	17124	5.2%	0.702
$ISS \ge 15$	1258	20.6%	2602	21.9%	0.380
Age ≥ 65	4546	4.1%	7098	5.3%	0.002
Blunt Injury	8098	3.6%	15252	4.1%	0.063
Penetrating					
Injury	983	14.9%	1439	14.8%	1.000

\* p-value ≤ 0.05 is considered significant

## Table 1: County-Level Mortality Comparison

	RTN	Region	Non-R'	<b>FN Regions</b>	
Patient Group	Total (n)	Mortality (%)	Total (n)	Mortality (%)	p-value
All Patients	14178	4.3%	40293	5.0%	< 0.001
$ISS \ge 15$	1721	20.1%	6466	21.2%	0.3
Age ≥ 65	6921	3.8%	17759	5.2%	< 0.001
Blunt Injury	12733	3.3%	36481	4.1%	< 0.00
Penetrating Injury	1215	13.1%	3012	14.3%	0.33
RTN REGIO	VS. REG	IONS WITH	ONLY 1	L1TC COVER	AGE
All Patients	14178	4.3%	14847	4.5%	0.39
$ISS \ge 15$	1721	20.1%	2393	20.4%	0.81
Age ≥ 65	6921	3.8%	6959	4.2%	0.24
Blunt Injury	12733	3.3%	13476	3.6%	0.28
Penetrating Injury	1215	13.1%	1240	13.2%	1
RTN REG	ON VS. RI	GIONS WIT	H >1 L1	TC COVERA	GE
All Patients	14178	4.3%	25446	5.3%	< 0.00
$ISS \ge 15$	1721	20.1%	4073	21.7%	0.16
Age ≥ 65	6921	3.8%	10800	5.9%	< 0.00
Blunt Injury	12733	3.3%	23005	4.5%	< 0.00
Penetrating Injury	1215	13.1%	1772	15.1%	0.14

Table 2: Regional Mortality Comparison

## Quick Shot #10 January 13, 2016 1:54 pm

## WHO SHOULD MANAGE THE ADOLESCENT SEVERE HEAD-INJURED PATIENT? A STATEWIDE ANALYSIS OF PEDIATRIC VERSUS ADULT TRAUMA CENTERS

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Presenter: Daniel Wu, DO, FACOS, FACS

Discussant: Nicole Fox, MD, Cooper University Hospital

**Objectives:** Non-pediatric trauma centers must often decide whether adolescent trauma patients (aged 15-17) presenting with severe head injuries (SHI) can be effectively managed at their facility or should be transferred to a pediatric center. We sought to determine whether mortality differences existed between pediatric and non-pediatric trauma centers while adjusting for injury severity and demographic covariates. It was hypothesized pediatric trauma centers would provide a survival advantage in SHI patients.

**Methods:** All trauma admissions aged 15-17 presenting with severe traumatic brain injury (TBI) (head Abbreviated Injury Scale [AIS] 4-5) to the 29 level I-II accredited trauma centers in Pennsylvania from 2003-2013 were extracted from the Pennsylvania Trauma Systems Foundation state registry. Patients transferred from adult to pediatric trauma centers were excluded from analysis. Trauma centers with no pediatric affiliation were considered non-PED (n=20), while standalone pediatric hospitals and centers with pediatric affiliation were considered PED (n=9). A multivariate logistic regression model controlling for injury severity and demographic covariates assessed the effect of pediatric affiliation on mortality.

**<u>Results:</u>** A total of 724 SHI patients aged 15-17 presented over the 11-year study period (non-PED: 347; PED: 377). In a multivariate logistic regression model controlling for admission systolic blood pressure, Glasgow-coma score (GCS), and head AIS, PED centers were found to have a 37% reduction in mortality compared to non-PED counterparts (AOR: 0.631, 0.426-0.934; p=0.022) (Figure 1).

**<u>Conclusions</u>**: There is a trend that favors the care of SHI adolescent patients at pediatric trauma centers rather than adult trauma centers.

Variable	Adjusted Odds Ratio	p-value
	(95% CI)	-
Pediatric	0.631 (0.426-0.934)	0.022
Systolic BP	0.985 (0.979-0.991)	< 0.001
GCS	0.674 (0.570-0.796)	< 0.001
Head AIS	3.081 (1.953-4.860)	< 0.001
Constant	0.052 (0.005-0.506)	0.011
N = 724		
AUROC: 0.76		

Adjust odds of mortality controlling for admitting systolic blood pressure, GCS, and head AIS

## Quick Shot #11 January 13, 2016 1:00 pm

# PLATELET DYSFUNCTION CORRELATES WITH PROGRESSION OF INTRACRANIAL HEMORRHAGE IN TRAUMATIC BRAIN INJURY

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Presenter: Bradley Putty, MD

Discussant: Alison Wilson, MD, West Virginia University

**Objectives:** Patients presenting with traumatic brain injury (TBI) frequently develop a TBIassociated coagulopathy that traditionally has been described using international normalized ratio elevation and thrombocytopenia, and more recently studied using thromboelastography (TEG). The mechanism of this coagulopathy is not well defined, nor has it been correlated with progression of intracranial hemorrhage (ICH). The purpose of this study is to identify TEG parameters that are associated with ICH and its progression in TBI.

<u>Methods</u>: In 2012, the resuscitation protocols at two urban level 1 trauma center hospitals were amended to include admission TEG with platelet mapping (PM) for TBI patients, and follow up CT imaging for those with ICH. Adult subjects presenting with a TBI (head abbreviated injury score (AIS) 1-5 with or without ICH) from December 2012 to December 2014 were identified, and demographic and clinical variables to include age, gender, Glasgow Coma Scale (GCS), Injury Severity Score (ISS), AIS by body area, and type of ICH were collected. TEG and PM values were evaluated based on presence of ICH, severity (AIS>3) and progression of ICH.

**<u>Results:</u>** The predominant mechanism was blunt (Table 1). The median age, head AIS, and ISS were 48.4(18-94), 4, and 21. There were no significant differences in TEG or PM values except for arachidonic acid receptor site inhibition (%AA). Median values were significantly higher in subjects with ICH compared to those without ICH (33.2 vs 16.8, p=.006). For those with a primary diagnosis of TBI (n=559, defined as all other AIS < 3), severity of TBI (head AIS>3 vs <3) demonstrated similar correlation with %AA (35 vs 25, p=.04). AA inhibition >30% was associated with progression in volume of ICH on subsequent CT imaging (Table 2).

<u>**Conclusions:**</u> AA inhibition is significantly elevated in those presenting with ICH, and correlates with severity of injury. Furthermore, AA inhibition >30% is predictive of progression of ICH on repeat imaging. This may serve as a target for intervention to reduce progression of ICH and improve outcome.

Total	n=643
Age 18-94y	47.0 (30, 62)
Male (%)	479 (74.8)
Mechanism; Blunt (%)	604 (94.5)
Head AIS	4 (3, 4)
ISS	21 (16, 29)
Mortality	123 (19.2%)

Table 1: Study Population

Data reported as median with interquartile range AIS, Abbreviated Injury Scale; ISS, Injury Severity Score

Table 2: Correlation of Arachidonic Acid Greater than 30% with Progression of Bleed

	Odds Ratio	p
All Progression	2.00 (1.22-3.31)	0.01
Minimal Progression	1.65 (0.91-2.97)	0.1
Significant Progression*	2.32 (1.17-4.60)	0.02

\*Defined as large volume progression and/or craniotomy

## Quick Shot #12 January 13, 2016 1:06 pm

#### SAFETY OF THERAPEUTIC ANTICOAGULATION IN PATIENTS WITH TRAUMATIC BRAIN INJURY

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Presenter: Kazuhide Matsushima

Discussant: Herb A. Phelan, III, MD, UT Southwestern Medical Center

**Objectives:** Anticoagulant therapy (ACT) is often required in trauma patients for various indications; however, it remains unknown whether ACT can be safely initiated in the post-injury period for the patients with traumatic brain injury (TBI). The purpose of this study was to evaluate the safety of ACT in acute TBI patients.

**Methods:** We conducted a 7-year (2008-2014) retrospective study at a high-volume Level 1 trauma center. All TBI patients who received ACT within 60 days post-injury were included. In addition to patient and injury characteristics, detail information regarding ACT (e.g. indication, type and timing of initiation) was collected. Primary outcome was progression of hemorrhagic TBIs on repeat head computed tomography (HCT) or neurological deterioration after the initiation of ACT. All HCTs were retrospectively reviewed by radiologists for initial Rotterdam score and volumetric analysis of hemorrhagic TBI. Univariable and multivariable analyses were used to identify the factors significantly associated with the progression of TBI after ACT.

**<u>Results:</u>** A total of 3,355 TBI patients were identified. Of those, 72 patients (2.1%) received ACT. Median age: 58.5, 76.4% male, median ISS: 19, median Rotterdam score on the initial HCT: 3. While atrial fibrillation was the most common pre-injury indication for ACT, venous thromboembolism was the most common post-injury indication for ACT. ACT was initiated on the median 9 days post- injury (IQR: 4-18). Intravenous heparin infusion was the most commonly used for ACT (63.9%), followed by low-molecular weight heparin. None of our study patients had any signs of neurological deterioration due to ACT. Progression of hemorrhagic TBI on the repeat CT was observed in 6/25 patients. Five of these 6 patients were age  $\geq$ 65 years (83.3% vs. 21.1% in NO worsening group, p=0.012). In a logistic regression model, age  $\geq$ 65 years was significantly associated with the progression of TBI after ACT (OR: 15.2, 95% CI: 1.1-212.7, p=0.043).

**Conclusions:** This study showed preliminary results regarding the safety of ACT in patients with TBI. It appeared to be safe to initiate ACT in carefully selected cases. Further prospective study will be warranted to determine the risk and benefit of ACT in this specific group of patients.

## Quick Shot #13 January 13, 2016 1:12 pm

#### COST-EFFECTIVENESS OF CERVICAL SPINE COLLAR CLEARANCE INTERVENTIONS IN OBTUNDED ADULT TRAUMA PATIENTS

Audrey E. Ertel, MD, MS, Bryce R.H. Robinson, MD, MS, FACS, FCCM\*, Mark Eckman University of Cincinnati

Presenter: Audrey E. Ertel, MD, MS

Discussant: Therese Duane, MD, JPS Health Network

**Objectives:** Recent guidelines from EAST conditionally recommend cervical collar removal after a negative cervical CT in obtunded adult blunt trauma patients. Though the rates of missed injury are extremely low, the impact of chronic care costs and litigation upon decision-making remains unclear. We hypothesize that the cost-effectiveness of strategies that include additional imaging may contradict current guidelines.

**Methods:** A cost-effectiveness analysis was performed for a base-case 40 year-old, obtunded, male with a negative CT. Strategies compared included: adjunct imaging with cervical MRI, collar maintenance for 6 weeks, or removal. The probability for collar pressure ulcer formation, spine injury, imaging costs, acute and chronic care, and litigation were obtained from published and Medicare data. Outcomes were expressed as 2014 US dollars and quality-adjusted life-years (QALYs).

**<u>Results:</u>** MRI was more effective and less costly than collar use or removal (20.00 vs. 19.99 vs. 19.98 QALYs; \$361,168 vs. \$361,345 vs. \$361,828) in the base case analysis. When the probability of missed injury on CT is reduced to <0.00001, collar removal becomes more cost-effective. MRI remains more effective than other strategies above that threshold, however cost is prohibitively high until the probability of 0.00053 for missed injury on CT, cost per QALY for MRI drops below \$100K. Above a probability of 0.00053 for missed injury on CT, cost per QALY gained drops below \$50K. Adjunctive imaging with MRI dominates all strategies until cost of MRI exceeds \$450. When the cost of MRI exceeds \$1,050, the cost per QALY for adjunctive MRI exceeds \$50K (figure).

**Conclusions:** Adjunctive MRI for obtunded adult blunt trauma patients appears to be the most effective and least costly strategy for cervical clearance. Future cervical care strategies must be analyzed in the context of cost-effectiveness and may contradict current guidelines.



**Figure**: The marginal cost-effectiveness ratio (mCER; dollars per quality-adjusted life year) of adjunct MRI vs. application of collar based on cost of imaging.

## Quick Shot #14 January 13, 2016 1:18 pm

## EMBEDDING A HOSPITALIST ON THE TRAUMA SERVICE REDUCES MORTALITY AND READMISSIONS

Mark D. Cipolle, MD, PhD\*, Joan M. Pirrung, RN, MSN, ACNS-BS\*, Erin Meyer, Bailey Ingraham Lopresto, Seema Sonnad, Glen H. Tinkoff, MD\* Christiana Care Health System

Presenter: Mark D. Cipolle, MD, PhD

Discussant: Natasha Becker, MD, Baylor College of Medicine

**Objectives:** Recognizing the increasing age and comorbid conditions of patients admitted to our trauma service, we embedded a hospitalist on the trauma service at our level 1 trauma center. This program was initiated in January of 2013. This study was designed to investigate any differences in outcomes before and after the implementation of the trauma hospitalist (T-Hosp) program.

**Methods:** There were 566 patients co-managed with the T-Hosp between Dec 2013-Nov 2014. These patients were matched (1:2) with propensity scores to a pre T-Hosp control group based on age, ISS, and comorbid conditions. Outcomes examined included: mortality, trauma-related readmissions, upgrades to the ICU, hospital length of stay (LOS), the development of in-hospital complications, and the frequency of obtaining medical subspecialist consultation. Differences in outcomes were compared with Mann-Whitney or Chi-Square tests as appropriate.

**<u>Results:</u>** High quality matching resulted in the loss of 97 T-Hosp patients for the final analysis. Table 1 shows the balance between the two groups after matching. While there was a one day increase in hospital LOS, and an increase in upgrades to the ICU, there was a reduction in mortality, trauma-related readmissions, and the development of renal failure after implementation of the T-Hosp program (Table 2). Implementation of this program made no significant difference in the frequency of cardiology, nephrology, neurology, or endocrinology consultations. There was also no difference in the development of the complications of venous thromboembolism, pneumonia, stroke, urinary tract infection, bacteremia, or alcohol withdrawal.

**Conclusions:** Our study provides evidence that embedding a hospitalist on the trauma service reduces mortality and trauma-related readmissions. A reason for these improved outcomes may be related to T-Hosp "vigilance" as reflected by the increase in upgrades to the ICU.

	Pre-T-Hosp (n=938)	Post T-Hosp (n=469)	P-value
Years of Age, mean(SD)	71.9 (16.1)	71.6 (15.9)	0.77
ISS, mean(SD)	9.5 (8.3)	9.9 (6.3)	0.27
Diabetes, n (%)	234 (25.0%)	121 (28.5%)	0.73
Hypertension, n (%)	697 (74.3%)	337 (71.9%)	0.33
CHF, n (%)	97 (10.3%)	54 (11.5%)	0.50
CVA, n (%)	70 (7.5%)	39 (8.3%)	0.57
≥ 1 comorbidity, n (%)	759 (80.9%)	385 (82.1%)	0.59

Table 1. Results of propensity score matching

1

## Table 2. Outcomes before and after implementation of T-Hosp program

	Pre-T-Hosp (n=938)	Post T-Hosp (n=469)	P-value*
Mortality, n (%)	27 (2.9%)	2 (0.4%)	0.002
Trauma-related readmission, n (%)	22 (2.3%)	3 (0.6%)	0.02
Hospital LOS (days), mean(SD)	5.7 (13.3)	6.9 (8.3)	0.048
Upgrade to ICU, n (%)	20 (2.1%)	20 (4.3%)	0.02
Renal failure, n (%)	11 (1.2%)	0 (0%)	0.02

\*\*Fisher Exact Tests were used where the expected count of a subgroup's outcome was below a count of 5 patients

## Quick Shot #15 January 13, 2016 1:24 pm

### OPEN CHEST CARDIAC MASSAGE OFFERS NO BENEFIT OVER CLOSED CHEST COMPRESSIONS IN PATIENTS WITH TRAUMATIC CARDIAC ARREST

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Presenter: Matthew J. Bradley, MD

Discussant: Joseph J. DuBose, MD, University of California-Davis

**Objectives:** Open chest cardiac massage (OCCM) is a commonly performed procedure after traumatic cardiac arrest (TCA). OCCM has been reported to be superior to closed chest compressions (CCC) in animal models and in non-traumatic cardiac arrest. The purpose of this study is to prospectively compare OCCM versus CCC in traumatic cardiac arrest using end-tidal carbon dioxide (ETCO2), the gold standard for determining the effectiveness of chest compressions and detection of return of spontaneous circulation (ROSC), as the surrogate for cardiac output and marker for adequacy of resuscitation.

<u>Methods</u>: This prospective observational study enrolled patients over a nine-month period directly presenting to a Level 1 trauma center after TCA. Continuous high-resolution ETCO2 measurements were collected every six seconds for periods of CCC and OCCM, respectively. Patients receiving CCC-only were compared to patients receiving CCC followed by OCCM. Student t-tests were used to compare ETCO2 within and between groups.

**<u>Results:</u>** Thirty-five patients were enrolled (17 OCCM, 18 CCC-only). Mean time of CCC prior to OCCM was sixty-six seconds. Within the OCCM group, both peak and mean ETCO2 levels significantly increased when comparing the initial CCC period to the OCCM interval. Using a time-matched comparison, similar significant increases were observed when comparing the first minute of CCC to the remaining time in the CCC-only group. However, when periods of OCCM were compared to equivalent periods of CCC-only, there were no differences in the initial, final, peak, or mean ETCO2 values (Table 1). Correspondingly, no difference in rates of ROSC was observed between groups (OCCM 23.5% vs CCC 38.9%, p=0.53).

<u>**Conclusions:**</u> We found no significant improvement in ETCO2 or ROSC with OCCM. With newer endovascular techniques for aortic occlusion, thoracotomy solely for performing OCCM provides no benefit over CCC.

Table 1. ETCO2 Values for CCC-only and OCCM grou
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CCC Only* (n=18)				OCCM	CCC vs. OCCM		
	First Minute	Remaining Time	p-value	CCC <sup>†</sup>	OCCM	p-value	p-value
Initial $\pm$ SD	$6.1 \pm 9.4$	$8.2 \pm 10.6$	0.53	$3.4 \pm 3.4$	$8.5 \pm 5.7$	0.007	0.92
$Final \pm SD$	$6.4 \pm 6.9$	$16.2 \pm 12.1$	0.01	$7.2 \pm 6.9$	$14.8\pm12.1$	0.03	0.73
$Peak \pm SD$	$9.0 \pm 9.7$	$27.4\pm16.5$	0.003	$10.4\pm10.4$	$28.8 \pm 22.2$	0.004	0.83
$Mean \pm SD$	$6.8 \pm 7.4$	$12.4 \pm 6.1$	0.02	$6.8 \pm 6.4$	$13.1\pm8.7$	0.02	0.78

\*CCC-only data separated into first minute and the remainder of CCC period for comparison to OCCM <sup>†</sup>Mean CCC period duration prior to OCCM =  $66.3 \pm 33.1$  seconds

ETCO2=end-tidal carbon dioxide; CCC=closed chest compressions; OCCM=open chest cardiac massage; SD=standard deviation

## Quick Shot #16 January 13, 2016 1:30 pm

### THE TEMPORAL RESPONSE WITH TRANEXAMIC ACID ON GUT BARRIER PROPERTIES IN AN IN VITRO MODEL OF TRAUMA-HEMORRHAGIC SHOCK

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Presenter: Mark E. Diebel, MD

Discussant: David J. Ciesla, MD, MA, UMA-Tampa General Hospital

**Objectives:** Intestinal hypoperfusion associated with trauma-hemorrhagic shock (T/HS) leads to impaired gut barrier function due to uptake of luminal factors including pancreatic digestive enzymes. Studies have shown that tranexamic acid (TXA) administered luminally or systemically protects gut barrier function when administered prior to or "early" after the insult. However the therapeutic window for TXA administration is unknown and served as the basis for the current study.

<u>Methods</u>: Caco-2 (intestinal cells)+HT29-MTX (mucus cells) intestinal epithelial cell (IEC) co cultures were established in a two-chamber cell culture system. IEC co cultures were then exposed to hypoxia-reoxygenation (HR) challenge ± trypsin added to the apical media. TXA was added after 90 minute hypoxia challenge at time 0, 60 and 120 minutes after reoxygenation. IEC barrier function was indexed by permeability (FITC-dextran), apoptosis, transepithelial electrical resistance (TEER) and mucus thickness and viscosity. Mucin 2 and 13 content of the mucus layer was determined by western blot and quantified by relative density calculation.

**Results:** Please see Table.

<u>**Conclusions:**</u> TXA administration protected IEC barrier function when administered "early" after the hypoxic event. No effect was noted when TXA was given >60 minutes after the hypoxic event. Our study correlates the clinical data that to be effective, TXA should be administered early in patients with T/HS. Protection of gut barrier function with "early" TXA administration following T/HS may be important for the anti-inflammatory effects noted with TXA in clinical studies.

Mean  $\pm$  SD, N = 4 for each group

	Perm. (nmol/cm²/hr)	% Apop	TEER	Mucus thickness (µm)	Viscosity (dyne/cm²)
IEC baseline	0.30 ± 0.02	4.9 ± 0.7	197± 5	150 ± 10	26,200 ± 200
IEC + H/R + trypsin	1.63 ± 0.06*	39.8 ± 2.3*	166± 5*	50 ± 5*	4,100 ±125*
IEC + H/R+ trypsin + TA (Time 0)	0.46 ± 0.03*#	6.2±1.5*#	185±10#	125 ± 10*#	23,900 ± 150*#
IEC + H/R + trypsin + TA (Time 60min)	1.24 ± 0.04*#	25.8 ± 2.5*#	172±7*	75 ± 5*#	7,400 ±100*#
IEC + H/R + trypsin + TA (Time 120min)	1.58 ± 0.06*	28.1 ± 3.0*#	170± 6*	50 ± 5*	5,800 ±125*#

\*p<0.001 vs. IEC baseline , #p<0.001 vs. IEC + HR + trypsin

Mucin 2 and 13 content remained near control values only with TXA administration immediately after hypoxic event.

## Quick Shot #17 January 13, 2016 1:36 pm

## QUANTIFICATION OF THE HEMODILUTIONAL EFFECT OF CRYSTALLOID RESUSCITATION IN A CLASS III HEMORRHAGE MODEL

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Presenter: Ciara R. Huntington, MD

Discussant: Christopher Dente, MD, Emory University

**Objectives:** A previous randomized controlled trial quantified the hemodilutional effect of crystalloid resuscitation in a Class I hemorrhage model of human blood donors. This study tests the resulting equation's ability to predict hemoglobin(Hb) levels after hemodilution in a Class III hemorrhage model in rats.

**Methods:** Sprague-Dawley rats underwent controlled Class III hemorrhage(35% blood volume by weight) via carotid arterial cannula. A "sham" control group underwent anesthesia without hemorrhage or resuscitation. One hour following hemorrhage, 1:1 resuscitation with normal saline, lactated Ringers, or Normosol<sup>TM</sup> solution was performed; a hemorrhage-only control group did not receive crystalloid resuscitation. Measured and formula-calculated Hb were compared immediately and 3hours post-resuscitation, and correlation coefficients(CC) were determined.

**<u>Results:</u>** 25 rats were included in analysis. Mean Hb decreased 3.4 grams/deciliter after hemorrhage. Median Hb were similar in hemorrhage-only control group(HO) vs. resuscitation group(RG) prior to hemorrhage(13.3vs.12.8,p>0.05) and at the end of hemorrhage (9.5HOvs.9.2RG,p>0.05), but immediately after resuscitation, median Hb were significantly lower in the RG(9.2HOvs.7.5RG,p=0.018). This difference persisted at 3 hours post-resuscitation (7.5HOvs.6.7RG,p=0.03). CC of actual and formula-predicted Hb was significant immediately following resuscitation (0.94,p<0.0001) and at 3 hours post-resuscitation (0.73,p=0.0001).

**Conclusions:** Hemodilution exists after crystalloid resuscitation for hemorrhage, and the previously defined mathematic relationship remains accurate in a Class III hemorrhage model in rats. This finding has significance for interpretation of initial lab values in severe hemorrhage and merits validation in large mammalian models.



Hemodilution Formula: A previously derived formula to predict hemoglobin levels from a given blood loss and crystalloid volume replacement.

## Quick Shot #18 January 13, 2016 1:42 pm

## THROMBIN GENERATION PROFILE AS PREDICTOR OF VENOUS THROMBOEMBOLISM (VTE) AFTER TRAUMA: A PROSPECTIVE CASE-COHORT STUDY

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Presenter: Myung Park, MD

Discussant: Erik Streib, MD, Eskenazi Health, IUHP

**Objectives:** The Surgeon General recommends assessment of the risk of VTE for every hospitalized patient. We hypothesize that injured patients(pts) with accelerated thrombin generation early after injury are at increased risk of development of VTE within 3 months after trauma.

<u>Methods</u>: Trauma pts were enrolled from Feb 2011 to June 2014. Blood was collected by venipuncture into 3.2% trisodium citrate at 0, 6, 12, 24 and 72 hours after injury, and discharge. Platelet poor plasma was harvested and stored at -80°C until analysis. Thrombin generation was determined using the calibrated automated thrombogram (CAT) using 5 pM tissue factor (TF)/4 uM phospholipid (PS; strong coagulation activator), reported peak height (nM thrombin) and time to peak height (ttPeak [minutes]). Data are presented as median [IQR] or hazard ratio(HR) with (95% CI).

**<u>Results:</u>** Among 443 trauma pts (ISS=13.0 [6.0, 22.0], hospital LOS=4.0 [2.0, 10.0] days, age=48 [28, 65] years, 70.7% male, 95% with blunt mechanism, mortality 3.2%). Fifty four pts developed symptomatic VTE within 92 days after injury, 27 (55%) after hospital discharge. Some of the predictors of VTE are outlined in the TABLE. In a multivariate Cox model that included clinical characteristics available at 24 hours of admission, increased pt age (1.21 [1.02,1.43], P=0.025), body mass index (BMI  $\ge$  25) (3.14[1.23,8.02], P=0.017), lack of mechanical prophylaxis(2.30[1.25, 4.23], P=0.007) and most hypercoagulable (shortest) ttPeak value reached during initial 24 hours (1.24[1.10, 1.44], p=0.007) were independent predictors of incident VTE within 92 days after trauma with C-statistic=0.74.

**Conclusions:** Plasma coagulome (as reflected by thrombin generation via CAT) is important for stratifying VTE risk. Combination of clinical characteristics and ttPeak can be used to stratify acute trauma pts into high and low risk for VTE. This multivariable model needs to be validated.

Variables	HR (95% CI)	P-value	
Age (per 10 year increase)	1.18 [1.02, 1.37]	0.029	
$BMI \ge 25$	3.95 [1.56, 10.03]	0.004	
ISS (per 5 point increase)	1.19[1.05, 1.35]	0.008	
Any Transfusion	2.17[1.19, 3.95]	0.012	
No Mechanical Prophylaxis	2.08[1.15, 3.74]	0.015	
Total Bedrest	2.10[1.06, 4.17]	0.034	
No Chemoprophylaxis	0.76[0.41, 1.38]	0.360	
Time to Peak (per .5 minute decrease)	1.25[1.06, 1.48]	0.008	
Peak Height (per 25 µM increase)	1.27[1.11, 1.44]	<0.001	

 Table: Univariable Cox Proportional Hazard of Variables Available at 24-Hours of Injury:

 Independent Predictors of VTE after Trauma

## Quick Shot #19 January 13, 2016 1:48 pm

#### HYPERTONIC SALINE AFTER DAMAGE CONTROL LAPAROTOMY AND PRIMARY FASCIAL CLOSURE: PILOT STUDY

Michelle Buehner, MD, Valerie Sams, MD\*, Brian Hernandez, Joel Michalek, Xiaoming Shi, Christopher E. White, MD, FACS\* San Antonio Military Medical Center

Presenter: Michelle Buehner, MD

Discussant: Jason Smith, MD, PhD, University of Louisville

**Objectives:** The inability to close the abdominal wall following an initial damage control laparotomy (DCL) has led to new challenges. Hypertonic saline (HTS) use after DCL may reduce bowel edema and resuscitation volume, leading to successful and faster PFC. Our primary objective is to determine if there is a higher rate of PFC in patients who undergo DCL when using HTS versus normal saline resuscitation.

<u>Methods</u>: All trauma patients requiring a DCL were randomized to receive a standard rate of either HTS or normal saline solution in this double blinded prospective study. Demographics, vital signs, laboratory values, surgical procedures, blood transfusions, PFC, and outcomes were compared.

**<u>Results:</u>** We randomized 20 patients to determine the validity of our methodology and value of continuing this research. Treatment groups (HTS, normal saline) did not differ significantly with regard to mean age (p>0.05), BMI (p>0.05), or gender (p>0.05). The normal saline group had a higher mean injury severity score and higher rate of blunt trauma (p<0.05). Both groups had similar mean trauma injury severity score (TRISS) and revised trauma score (RTS). Mean heart rate, systolic blood pressure, initial hemoglobin, INR, base deficit, and lactate were not significantly different between the two groups (p>0.05). No significant differences were identified between either group in regards to the peak creatinine, delta sodium, hospital days, intensive care unit and ventilator free days (p>0.05). The HTS and normal saline groups did not differ significantly with regard to the rate of closure.

<u>Conclusions</u>: There have been no prospective studies to date that compare HTS with standard crystalloid resuscitation in terms of overall volume requirements and ability to achieve PFC closure after DCL. Efforts to minimize postoperative complications are paramount for good functional outcomes. Our pilot data demonstrates HTS use is safe and feasible in DCL.

#### Table 1. Demographics

	Hypertonic Saline	Normal Saline	Total	P-value
	(N = 9)	(N = 11)	(N = 20)	
Gender	50 - C.S.S.			$0.09^{1}$
Female	0(0)	4 (36.36)	4 (20)	
Male	9 (100)	7 (63.64)	16 (80)	
Total	9	11	20	
BMI				$0.07^{2}$
N	9	11	20	
Mean±SD	$27.79 \pm 6.1$	$35.21 \pm 9.71$	$31.87 \pm 8.93$	
Madian [O1 O3]	26.9 [25.4,	33.5 [27.8,	27.85 [25.85,	
Median [Q1, Q5]	27.3]	40.25]	38.2]	
Age				$0.97^{3}$
N	9	11	20	
Mean±SD	35.67±15.65	35.36±15.56	35.5±15.18	
Median [Q1, Q3]	31 [24, 41]	30 [22, 50.5]	30.5 [22.75, 48.75]	
ISS				0.043*
N	9	11	20	
Mean±SD	$21.33 \pm 12.72$	32.82±9.02	$27.65 \pm 12.05$	
Median [Q1, Q3]	22 [16, 34]	34 [30, 37.5]	34 [18.75, 34]	
RTS				0.862
N	9	11	20	
Mean±SD	6.84±1.59	$6.9 \pm 1.51$	$6.88 \pm 1.51$	
Madian [O1 O3]	7 94 [7 1 7 94]	7.84 [6.44,	7.84 [6.67,	
Median [Q1, Q5]	/.04[/.1, /.04]	7.84]	7.84]	
Mechanism				$0.02^{1} *$
BLUNT	3 (33.33)	10 (90.91)	13 (65)	
PENETRATING	6 (66.67)	1 (9.09)	7 (35)	
Total	9	11	20	
TRISS				$0.59^{2}$
N	9	11	20	
Mean±SD	$0.79 \pm 0.28$	$0.83 \pm 0.19$	0.81±0.23	
Median [Q1, Q3]	0.95 [0.74, 0.98]	0.92 [0.8, 0.96]	0.93 [0.76, 0.96]	

## Table 1. Demographics

Outcome	Hypertonic Saline (A)	Normal Saline (B)	Total	<b>D</b>	
Outcome	(N = 9)	(N = 11)	(N = 20)	P-value	
Peak Creatinine				0.852	
N	9	11	20		
Mean±SD	$1.45 \pm 0.88$	1.25±0.48	1.34±0.68		
Median [Q1, Q3]	1.29 [0.88, 1.62]	1.12 [1.02, 1.44]	1.12 [0.9, 1.6]		
PFC				11	
No	1 (11.11)	1 (9.09)	2 (10)		
Yes	8 (88.89)	10 (90.91)	18 (90)		
Total	9	11	20		
Hours to PFC				0.332	
N	8	10	18		
Mean±SD	37.88±33.77	$37.9 \pm 14.39$	37.89±24.07		
Median [Q1, Q3]	30 [23.5, 34.25]	35.5 [27.25, 47.5]	33 [25.25, 40.75]		
Hospital days				0.94	
N	9	11	20		
Mean±SD	28.5±21.45	24±10.81	25.8±16.1		
Median [Q1, Q3]	25 [8, 35]	25 [16, 28]	25 [14.75, 29.75]		
Delta Na				0.723	
N	9	11	20		
Mean±SD	4±7.48	3±3.66	3.45±5.56		
Median [Q1, Q3]	3 [1, 10]	3 [0.5, 4]	3 [0.75, 6.5]		
ICU free days				0.753	
N	9	11	20		
Mean±SD	9.67±7.02	8.64±7.3	9.1±7		
Median [Q1, Q3]	13 [3, 15]	7 [3, 14]	9.5 [2.75, 15]		
Vent free days				0.673	
N	9	11	20		
Mean±SD	$11.33 \pm 8.49$	$13\pm 8.64$	$12.25\pm8.38$		
Median [O1_O3]	11 [4, 19]	14 [7.5, 20.5]	12 [5.5, 19.75]		

Table 2. Outcome by Fluid Type

## Quick Shot #20 January 13, 2016 1:54 pm

# IT IS STILL OKAY TO THROW IN THE TOWEL: AN INSTITUTION'S OPEN ABDOMINAL EXPERIENCE WITH 1533 VACUUM PACK WOUND CLOSURES

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Presenter: Nicholas Drahush, MD

Discussant: Jose Diaz, MD, MPH, University of Maryland Medical Center

**Objectives:** The Barker "Vacuum Pack" (VP) technique for temporary abdominal wound closure has been used at our institution since 1992. This review examines our overall experience before and after implementation of a massive transfusion protocol (MTP) in May 2005.

<u>Methods</u>: Retrospective data review of all adult patients undergoing open abdomen management with VP closure at a single institution from January 1999-October 2013 was completed.

**Results:** 623 adult patients treated with 1533 VPs (244 Trauma and 379 general/vascular surgery) were included. Primary fascial closure (PFC) rate was 58.1% (60.7% general/vascular surgery, 54.1% trauma). Overall all-cause mortality rate for both groups was 28.9% and the total abdominal complication rate was 15.9%. Acute care population PFC rates and intra-abdominal complication rates remained static when compared to our previous reports; however, in the trauma population, an improvement was seen after the implementation of a MTP. Blunt trauma comprised 74.4%; penetrating 25.6%. Mean ISS was 32.2 prior to MTP; 32.6 after initiation. PFC rates for trauma patients who survived to discharge before and after MTP adoption were 58.5% and 72.1%, respectively. Average ratio of blood products for those receiving MTP was 1:0.8:0.62 (PRBC, FFP, and platelets). Overall all-cause mortality for this subset of the population was 31.8%. Average time to closure prior to and after adoption of MTP was 9.97 and 5.64 days, respectively.

**Conclusions:** Changes in technique and resuscitation strategy amongst the trauma population correlate with a beneficial impact on PFC rates. Institutional cost savings for utilizing the Barker VP over the KCI ABThera<sup>TM</sup> is \$347 per negative pressure wound dressing. The Barker VP is a cost effective and viable alternative that compares favorably to a commercially available product.