

January 14, 2015

Paper 1

8:50 am

**ADVERSE CARDIAC EVENTS IN TRAUMA IS ASSOCIATED WITH EARLY ELEVATIONS IN PLASMA CATECHOLAMINES**

Sriveena Naganathar, BMedSci MBBS, Henry De'Ath, Simon Glasgow, Sirat Khan, Claire Rourke, Johanna Wall, Imran Raza, Zane Perkins, Karim Brohi  
Queen Mary University of London

**Presenter:** Sriveena Naganathar, BMedSci MBBS

**Discussant:** Steven E. Wolf, MD, University of Texas – Southwestern Medical Center

**Objectives:** Trauma patients are at risk of trauma induced secondary cardiac injury (TISCI). TISCI was demonstrated through adverse cardiac events (ACEs) and rises in cardiac biomarkers. In sepsis, cardiac dysfunction is associated with elevated circulating catecholamines and overstimulation of the myocardium. This study aims to establish the relationship between catecholamines and TISCI.

**Methods:** Injured patients who met study criteria were prospectively enrolled from 2010 to 2012 at a major British trauma centre. Serum catecholamines (adrenaline(AD), noradrenaline(NA), dopamine(DOPA)) and cardiac biomarkers (heart-related fatty acid binding protein(HFABP), brain natriuretic peptide(BNP), troponin I(TnI)) were assayed on admission. Patients were assessed daily for ACEs. Length of stay (LOS) and 28-day mortality were measured.

**Results:** 38(13%) of 300 patients recruited had an ACE. Mortality (18% vs. 6%,  $p=0.002$ ) and ICU LOS (12.5days,  $p<0.0001$ ) were higher in the ACE cohort. HFABP (median: 10.3 vs 64.9 ng/ml,  $p<0.001$ ) was raised in the ACE group, however, there was no difference noted in BNP and TnI levels. ACEs were associated with higher AD and NA levels (AD 859.0 vs. 191.7 ng/ml  $p=0.0005$ , NA 2026 vs 678.6 ng/ml  $p<0.0001$ , respectively). This was not associated with traumatic brain injuries. Patients with high catecholamine levels had elevated serum but not BNP or TnI. Increased levels of AD was related to higher mortality rates ( AD: 11% >200pg/ml group, 0% in 100-200 pg/ml, 7% in <100 pg/ml). There was no clear link between NA and DOPA levels and mortality.

**Conclusions:** On admission, serum catecholamine levels are higher in patients who develop ACEs. Patients with higher catecholamine levels have raised serum HFABP. Increased dopamine and adrenaline levels were associated with higher mortality.

## Notes

January 14, 2015  
Paper 2  
9:10 am

**PORTABLE MECHANICAL VENTILATION WITH CLOSED-LOOP CONTROL OF INSPIRED FRACTION OF OXYGEN MAINTAINS OXYGENATION IN THE SETTING OF HEMORRHAGE AND LUNG INJURY**

Peter L. Jernigan, MD, Richard Hoehn, Chris Blakeman, Judy Heyl,  
Bryce R.H. Robinson, MD\*, Timothy A. Pritts, MD, PhD\*, Richard Branson, MSc RRT  
University of Cincinnati

**Presenter:** Peter L. Jernigan, MD

**Discussant:** Stacy A. Shackelford, MD, University of Maryland

**Objectives:** Closed-loop controllers (CLC) embedded within portable mechanical ventilators may allow for autonomous weaning. The ability of CLCs to maintain adequate oxygenation in the setting of hemorrhage and lung injury is unknown. We hypothesized that a portable ventilator with a CLC for inspired fraction of oxygen (FiO<sub>2</sub>) could provide oxygenation in a porcine model of hemorrhage and lung injury.

**Methods:** Female pigs randomized to the study group (n=6) underwent a pressure-controlled bleed (mean arterial pressure [MAP]=40 mmHg for 30 minutes). Acute lung injury was induced by saline lung lavage followed by intentional infliction of volutrauma/atelectrauma. Sham pigs (n=6) underwent placement of monitoring devices without hemorrhage or lung injury. All pigs were then placed on a portable ventilator modified with a CLC algorithm which uses feedback from pulse oximetry (SpO<sub>2</sub>) and FiO<sub>2</sub> trends to adjust FiO<sub>2</sub> and maintain a target SpO<sub>2</sub> of 94% +/- 2%. The initial FiO<sub>2</sub> was set at 0.60. Tidal volume, PEEP, rate, and I/E time were constant unless changes were required clinically.

**Results:** Study pigs had lower MAPs than shams at all time points except baseline (Fig 1). PaO<sub>2</sub>/FiO<sub>2</sub> ratios were <300 and significantly lower than both baseline values and corresponding sham values at all time points. The CLC weaned the FiO<sub>2</sub> at a reduced rate in study pigs relative to shams with a final mean FiO<sub>2</sub> of 0.54 and 0.29 in study and sham pigs, respectively (p<0.05). There was a significant divergence in the study and sham FiO<sub>2</sub> curves but no significant difference in oxygen saturation or hypoxemia (Fig. 2).

**Conclusions:** Adequate oxygenation can be maintained in the setting of hemorrhage and lung injury using a portable ventilator embedded with a CLC of FiO<sub>2</sub> based on pulse oximetry. These devices may be valuable for providing advanced medical care in resource-limited environments.

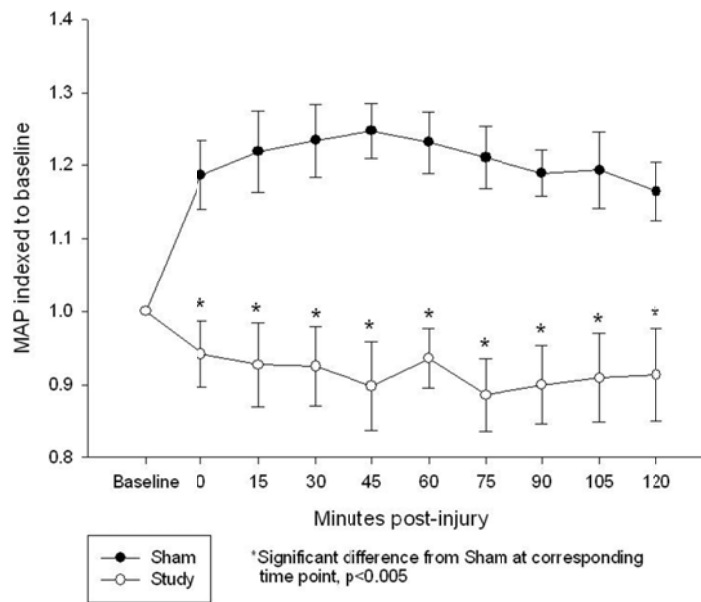


Figure 1. Mean arterial pressure [MAP] is shown (indexed to baseline) for sham and study animals during the observation period of the study. MAPs were significantly reduced in study animals at all time points after undergoing pressure-controlled hemorrhage and saline lavage lung injury.

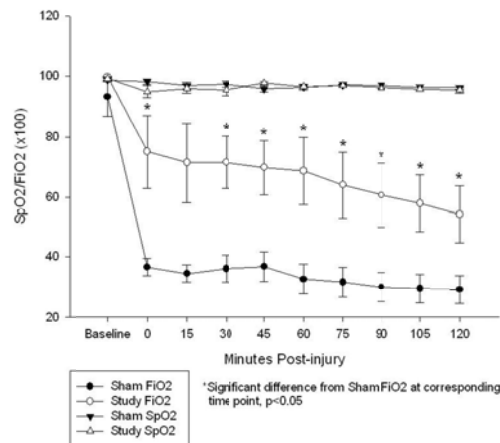


Figure 2. SpO2 and FiO2 (x100) are shown for sham and study pigs at baseline and during the weaning period, after study animals underwent hemorrhage and lung injury. The CLC weaned the study pigs at a significantly reduced rate relative to shams, but there was no significant difference between groups in oxygen saturation or hypoxemia.

January 14, 2015  
Paper 3  
9:30 am

**FUNCTIONAL AND LONG-TERM OUTCOMES IN SEVERE TRAUMATIC BRAIN INJURY  
FOLLOWING REGIONALIZATION OF A TRAUMA SYSTEM**

Michael L. Kelly, MD, Mary Roach, Aman Banerjee, MD, Michael Steinmetz, MD  
MetroHealth Medical Center

**Presenter:** Michael L. Kelly, MD

**Discussant:** Jeffrey Coughenour, MD, University of Missouri Health Care

**Objectives:** We previously demonstrated that regionalization of trauma (RT) significantly reduced in-hospital mortality from 19% to 14% in patients with severe traumatic brain injury (sTBI). However, functional and long-term outcomes had not been assessed. We hypothesized that RT would be associated with improved functional and long-term outcomes in sTBI patients.

**Methods:** All TBI patients >14 years with a Head Abbreviated Injury Scale  $\geq 3$  were identified from the RT database and matched to the state death index and the regional TBI rehabilitation (TBIR) database. Data from 2008 through 2012 were analyzed before and after RT in 2010. For patients discharged to the TBIR unit, overall Functional Independence Measure (FIM) scores and FIM score gains were compared pre- and post-RT.

**Results:** 3,496 patients with sTBI were identified in the RT database; 1,359 pre-RT and 2,137 post-RT. Table 1 shows decreased post-RT mortality at 30-days and 6-months. Multivariable logistic regression demonstrated RT to be an independent predictor against mortality at 30-days (OR: 0.74; 95% CI: 0.60-0.91, C-stat=0.84) and 6-months (OR: 0.82; 95% CI: 0.67-0.99, C-stat=0.82). Discharges to the TBIR unit increased from 117 (9%) pre- to 297 (14%) post-RT ( $p<0.0001$ ), while discharges to home and non-TBIR units remained similar. Injury Severity Scale (ISS) and Glasgow Coma Scale (GCS) scores for all discharged patients remained similar. FIM admission scores were similar pre- (median: 54; interquartile range: 30,65) and post-RT (48;31,61) ( $p=0.2$ ) and remained similar at discharge pre- (92;75,102) and post-RT (89;73,100) ( $p=0.1$ ). TBIR patients showed similar FIM score gains pre- (37;26,46) and post-RT (36;24,49) ( $p=0.6$ ).

**Conclusions:** Regionalization of trauma was associated with reduced long-term mortality, increased TBIR admissions, and similar FIM score improvements for patients with sTBI.

**Table 1. Mortality for severe TBI patients**

	<b>Pre-RT (n=1359)</b>	<b>Post-RT (n=2137)</b>	<b>P value</b>
In-hospital	262 (19%)	302 (14%)	<0.0001*
30-day	285 (21%)	343 (16%)	<0.0001*
6-month	320 (24%)	417 (20%)	0.004*

RT = Regionalization of trauma; TBI = Traumatic brain injury

\*Statistically significant

January 14, 2015

Paper 4

9:50 am

**EFFECT OF ASCORBIC ACID CONCENTRATIONS ON HEMODYNAMICS AND  
INFLAMMATION FOLLOWING LYOPHILIZED PLASMA TRANSFUSION**

Sean P. McCully, MD, MS, David T. Martin, Mackenzie R. Cook, Nicole T. Gordon,  
Belinda H. McCully, PhD, Tim H. Lee, MD MS, Rondi Dean, BS, CVT,  
Elizabeth A. Rick, Alexis M. Moren, Kelly A. Fair, Vicente JU Perl,  
Kate Watson, Martin A. Schreiber, MD, FACS\*  
Oregon Health and Science University

**Presenter:** Sean P. McCully, MD, MS

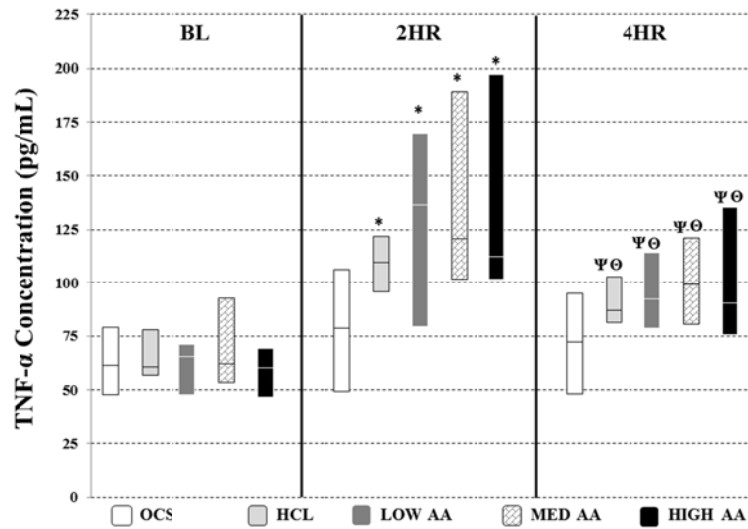
**Discussant:** Bryce RH Robinson, MD, FACS, University of Cincinnati

**Objectives:** Determine the range of ascorbic acid (AA) concentrations that are safe and maintain hemodynamic function, pro-coagulant activity and attenuation of systemic inflammation after transfusion of lyophilized plasma (LP) following polytraumatic injury.

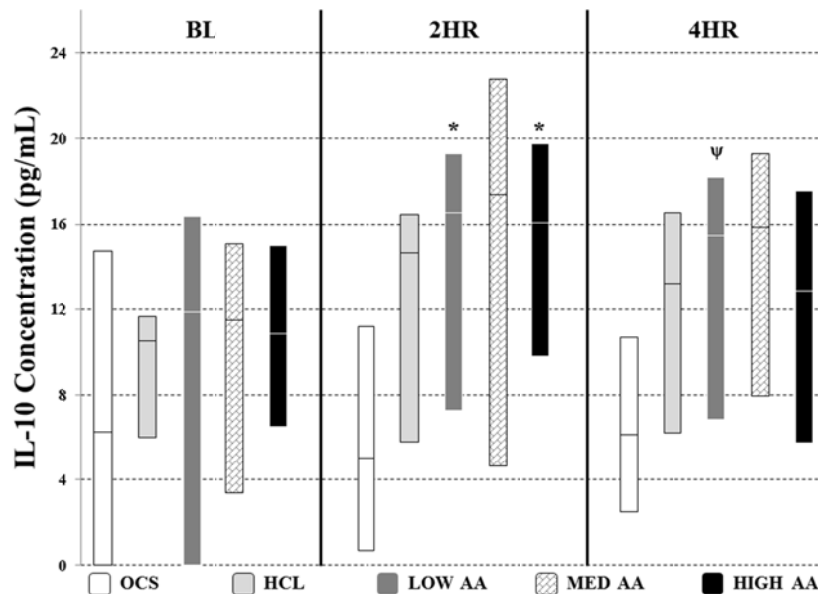
**Methods:** This was a prospective, randomized, blinded animal study. Forty-six female swine were subjected to a validated polytrauma model and resuscitated with LP. Five groups: operative control sham (n=6), high AA (n=10), medium AA (n=10), low AA (n=10) and a hydrochloric acid control (HCL: n=10) were randomized. Hemodynamic monitoring, thrombelastography (TEG), blood chemistries and blood loss were assessed. Inflammatory cytokines (TNF- $\alpha$ , IL-6, C-reactive protein, IL-10) and a biomarker of DNA damage (8-Hydroxy-2-Deoxyguanosine) were measured by ELISA at baseline, 2- and 4-hours post liver injury. Significance was  $p < 0.05$  with a Bonferroni correction for multiple comparisons.

**Results:** Hemodynamics, shock and blood loss were similar between groups. All animals had robust pro-coagulant activity 2-hours following liver injury. Inflammatory markers were similar between groups at baseline, and treatment groups remained similar to HCL following liver injury. IL-6 and TNF- $\alpha$  were increased at 2- and 4-hours compared to baseline within all groups ( $p < 0.02$ ). DNA damage increased at 2-hours compared to baseline in all groups ( $p < 0.02$ ) and further increased at 4-hours compared to baseline in HCL, low and high AA groups ( $p < 0.02$ ). CRP was not different between or within groups. IL-10 increased at 2-hours compared to baseline in both low and high AA groups and remained elevated at 4-hours compared to baseline only in the low AA group (all,  $p < 0.02$ ).

**Conclusions:** Concentrations of AA were well tolerated physiologically and did not diminish the pro-coagulant activity of LP. Within our tested range of concentrations, AA can safely be used to buffer LP.



Median plasma TNF- $\alpha$  concentration at baseline (BL), 2- and 4-hours post liver injury. Operative control sham (OCS) provided for reference. Significant difference between baseline-2 hours (\*), baseline-4 hours ( $\Psi$ ) and 2- to 4- hours ( $\Theta$ ); all  $p < 0.02$ . Ascorbic acid (AA) groups were similar to hydrochloric acid control (HCL) at all-time points ( $p > 0.05$ ).



Median plasma IL-10 concentration at baseline (BL), 2- and 4-hours post liver injury. Operative control sham (OCS) provided for reference. Significant difference between baseline-2 hours (\*) and baseline-4 hours ( $\Psi$ ). Ascorbic acid (AA) groups were similar to hydrochloric acid control (HCL) at all-time points ( $p > 0.05$ ).



January 14, 2015  
Paper 5  
10:10 am

**CERTIFIED ACUTE CARE SURGERY PROGRAMS IMPROVE OUTCOMES IN PATIENTS  
UNDERGOING EMERGENCY SURGERY: A NATIONWIDE ANALYSIS**

Mazhar Khalil, MD, Peter Rhee, MD, MPH\*, Viraj Pandit, MD, Narong Kulvatunyou, MD\*,  
Bardiya Zangbar, MD, Terence O'Keeffe, MD, MSPH\*, Andrew L. Tang, MD\*,  
Gary A. Vercruysse, MD\*, Rifat Latifi, MD\*, Randall S. Fries, MD\*, Bellal Joseph, MD\*  
The University of Arizona

**Presenter:** Mazhar Khalil, MD

**Discussant:** Jose J. Diaz, Jr., MD, CNS, University of Maryland School of Medicine

**Objectives:** Differences in outcomes among trauma centers (TC) and non-trauma centers (NTC) in patients undergoing emergency general surgery (EGS) are well established. However, the impact of development of certified acute care surgery (ACS) program on patient outcomes remains unknown. The aim of this study was to evaluate outcomes in patients undergoing EGS across TC, NTC, and trauma center with ACS (ACS-TC).

**Methods:** National estimates for EGS procedures were abstracted from the National Inpatient Sample (NIS) database. Patients undergoing emergent procedures (appendectomy, cholecystectomy, hernia repair, small and large bowel resections) were included. TCs were identified based on American College of Surgeons verification. ACS-TC programs were recorded from the American Association for the Surgery of Trauma. Outcome measures were: hospital length of stay (LOS), complications, and mortality. Regression analysis was performed after adjusting for age, gender, race, Charlson co-morbidity index, and type of procedure.

**Results:** 131,410 patients undergoing EGS were analyzed. Patients managed in ACS-TC had shorter hospital LOS ( $p=0.045$ ) and lower complication rate ( $p=0.041$ ) compared to patients managed in both TC and NTC. There was no difference in mortality in patients managed across the groups, however there was a trend towards lower mortality in patients managed in ACS-TC in comparison to TC ( $p=0.064$ ) and NTC ( $p=0.089$ ). The overall hospital costs were lower for patients managed in ACS-TC compared to TC ( $p=0.036$ ).

**Conclusions:** Trauma centers with ACS program have improved outcomes in emergency general surgery procedures compared to both trauma centers and non-trauma centers. ACS training with the associated infrastructure standards may contribute to these improved outcomes.

**Table 1.** Outcomes

	NTC * (n=75,930)	TC (n=47,753)	ACS-TC (n=7,727)
Hospital LOS	RF	<b>1.18 [1.11-1.82]</b>	<b>0.91 [0.82-0.97]</b>
Complications	RF	<b>1.1 [1.02-1.9]</b>	<b>0.95 [0.89-0.98]</b>
Mortality	RF	1.07 [0.8-1.2]	0.98 [0.92-1.5]

\*RF: Reference

January 14, 2015

Paper 6

10:50 am

**MESENCHYMAL STEM CELLS INCREASE T-REGULATORY CELLS AND IMPROVE HEALING  
SEVEN DAYS FOLLOWING TRAUMA AND HEMORRHAGIC SHOCK**

Amy V. Gore, MD, Letitia E. Bible, MD, Walter Alzate, MS, Alicia M. Mohr, MD\*,  
David H. Livingston, MD\*, Ziad C. Sifri, MD\*  
Rutgers-New Jersey Medical School

**Presenter:** Amy V. Gore, MD

**Discussant:** Robert Southard, MD, Baylor College of Medicine

**Objectives:** Rat lungs undergo full histologic recovery within one week following unilateral lung contusion (LC), however, when LC is followed by hemorrhagic shock (HS) wound healing is impaired. We hypothesize that the addition of mesenchymal stem cells (MSC) to animals undergoing combined LCHS will improve wound healing.

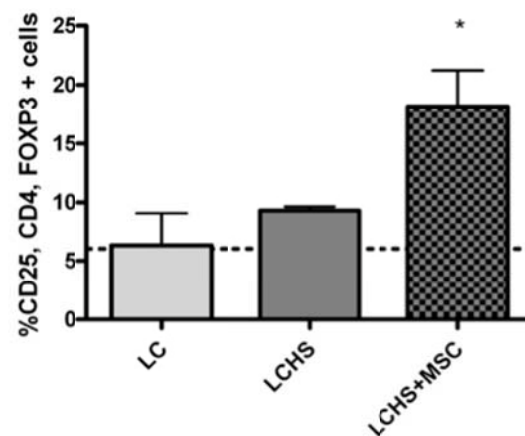
**Methods:** Male Sprague-Dawley rats (n=5-6/group) were subjected to LCHS with or without the injection of a single iv dose of  $5 \times 10^6$  MSCs following return of shed blood after HS. Rats were sacrificed seven days following injury. Flow cytometry was used to determine the T regulatory (Treg) cell population in peripheral blood (PB). Lung histology was graded using a well-established lung injury score (LIS). Components of the LIS include average inflammatory cells/high power field (hpf) over 30 fields, interstitial edema, pulmonary edema, and alveolar integrity with total scores ranging from 0-11. Data analyzed by ANOVA followed by Tukey's multiple comparison test, expressed as mean  $\pm$  SD.  $p < 0.05$  considered significant.

**Results:** Seven days following isolated LC, as previously shown, LIS is  $0.8 \pm 0.4$ , unchanged from naïve. The addition of HS results in a persistently elevated LIS score, whereas addition of MSC to LCHS decreased the LIS score to naïve. The change in LIS was driven by a significant decrease in edema scores. In rats undergoing LC alone,  $6.0 \pm 1.5\%$  of CD4+ cells were Tregs. The addition of HS caused no significant change in Treg population at  $9.3 \pm 0.7\%$ , whereas LCHS+MSC increased the population to  $18.2 \pm 6.8\%$  in PB ( $p < 0.05$  vs LCHS).

**Conclusions:** Impaired wound healing following trauma and hemorrhagic shock is improved by a single dose of MSCs given at the time of injury. This enhanced healing is associated with an increase in the T regulatory cell population and a decrease in lung edema score. Further study into the role of Tregs in MSC-mediated wound healing is warranted.

LIS Total and Subgroup Score Seven Days Following Injury					
Group	Inflammatory cells/hpf	Interstitial Edema	Pulmonary Edema	Alveolar Integrity	Total LIS
LC	0 ± 0	0.75 ± 0.5	0 ± 0	0 ± 0	0.8 ± 0.4
LCHS	0.4 ± 0.5*	2.0 ± 0*	1.0 ± 0.7*	0.4 ± 0.5	3.7 ± 0.81*
LCHS +MSC	1.0 ± 0 **	0.4 ± 0.5**	0 ± 0**	0.2 ± 0.4	1.6 ± 0.6**

**Table 1: LIS Total and Subgroup Score Seven Days Following Injury.** LC= lung contusion, LCHS= lung contusion hemorrhagic shock, MSC= mesenchymal stem cells. Data presented as mean score ± standard deviation; \* p<0.05 vs LC \*\*p<0.05 vs LCHS



**Figure 1: T-Regulatory Cell Population Seven Days Following Injury.** Dotted line represents naïve. LC= lung contusion, LCHS= lung contusion hemorrhagic shock, MSC= mesenchymal stem cells. Data presented as mean score ± standard deviation; \*p<0.05 vs LCHS.

January 14, 2015  
Paper 7  
11:10 am

**QUANTIFYING THE EFFECT OF CRYSTALLOID RESUSCITATION ON LACTATE AND BASE DEFICIT IN A HUMAN MODEL FOR CLASS I HEMORRHAGE**

Samuel Wade Ross, MD, MPH, A. Britton Christmas, MD, FACS\*, Peter E. Fischer, MD, MS\*, Haley Holway, Rachel Seymour, Michael Gibbs, MD\*, B. Todd Heniford, Ronald F. Sing, DO\*  
Carolinas Medical Center

**Presenter:** Samuel Wade Ross, MD, MPH

**Discussant:** Jeffrey A. Clardige, MD, MS, MetroHealth Medical Center

**Objectives:** Resuscitation after hemorrhage with crystalloid solutions can lead to marked acidosis and iatrogenically worsen the lethal triad. The effect of differing solutions on base deficit and lactate has been sparsely prospectively studied in humans. We sought to quantify the effect of normal saline (NS) and lactated ringers(LR) resuscitation in voluntary blood donors as a model for Class I hemorrhage.

**Methods:** A prospective randomized control trial was conducted in conjunction with blood drives. Donors were randomized to receive no IV fluid (noIVF), 2L NS or 2L LR after blood donation of 500 ml. Lactate and base deficit were measured before and after fluid administration using an iSTAT. Donor height and weight were collected and total blood volume (TBV) was calculated using Nadler's formula. The mean lab values were compared between groups using the Wilcoxon Rank Sum and Kruskal Wallis tests.

**Results:** 157 patients completed the study. Average age was  $39.2 \pm 12.7$  and 65.0% were female. Average TBV, lactate and base deficit values are reported in the Table. Patients in each group lost similar amounts of TBV, and a similar amount was replaced in the crystalloid group ( $p>0.05$ ). Donors had similar increases in lactate and base deficit after donation regardless of the group ( $p>0.05$ ). After resuscitation with 2L crystalloid, the lactate level increased higher in the LR group than in the NS or the noIVF group ( $p<0.001$ ). Additionally, the resuscitation base deficit was more negative in the NS group than in the LR or noIVF group ( $p<0.001$ ).

**Conclusions:** This study is one of the first to prospectively demonstrate quantifiable differences in base deficit and lactate by type of crystalloid resuscitation. LR resuscitation elevated lactate levels, and NS increased the base deficit. These findings are critical to interpretation of trauma patient resuscitation with crystalloid solutions.

Table. Results by Crystalloid Group

Average†	No Fluid	Normal Saline*	Lactated Ringers*	P Value
	n= 52	n= 51	n= 54	
TBV (L)	4.8	4.7	4.9	NS
% TBV Loss	10.9	11.0	10.6	NS
% TBV Replacement	0	44.1	42.6	<0.0001
Post-Donation Lactate	1.10	1.12	1.05	NS
Post-Resuscitation Lactate	1.36	1.00	1.54	<0.001
Post-Donation Base Deficit	0.04	-0.24	0.33	NS
Post-Resuscitation Base Deficit	-0.65	-3.06	-0.34	<0.001

\* 2 L IV fluid; TBV: Total Blood Volume

January 14, 2015

Paper 8

11:30 am

**CHRONIC RESTRAINT STRESS AFTER INJURY AND SHOCK IS ASSOCIATED WITH PERSISTENT ANEMIA DESPITE PROLONGED ELEVATION IN ERYTHROPOIETIN LEVELS**

Letitia E. Bible, MD, Latha Pasupuleti, MD, Amy V. Gore, MD, Ziad C. Sifri, MD\*,  
Kolenkode Kannan, Alicia M. Mohr, MD\*  
Rutgers-New Jersey Medical School

**Presenter:** Letitia E. Bible, MD

**Discussant:** Jason J. Sperry, MD, MPH, University of Pittsburgh

**Objectives:** After severe traumatic injury, critically ill patients have prolonged catecholamine elevation associated with bone marrow (BM) dysfunction and persistent anemia. However, anemia in current animal models of injury and shock is transient. Daily restraint stress (CS) increases catecholamines. We hypothesize that adding CS after injury or injury and shock in rats will prolong the hypercatecholaminemia and anemia, despite elevated erythropoietin (EPO) levels.

**Methods:** Male Sprague-Dawley rats (N=6-9/group) were randomly allocated into 1 of 5 groups: naïve, lung contusion (LC), LC+CS, LC with hemorrhagic shock (LCHS), or LCHS+CS. CS consisted of a daily 2hr restraint period interrupted by repositioning and alarms every 30min to prevent habituation. At 7days, urine was assessed for norepinephrine (NE), blood for EPO and hemoglobin (Hgb), and BM for erythroid progenitor growth.

**Results:** LC or LCHS animals predictably recovered by day 7; NE, EPO, and Hgb levels were normal. LC animals exposed to CS had significant elevation of NE on day 6 (Figure). LC+CS had significantly lower Hgb levels, suppressed BM erythroid progenitor cell growth despite elevated EPO (Table). Adding CS to LCHS led to significant, persistent NE elevation (Figure). LCHS+CS had persistent anemia despite significantly elevated EPO which was associated with suppressed BM erythroid progenitor cell growth (Table).

**Conclusions:** Injured animals exposed to CS results in prolonged elevation of norepinephrine and erythropoietin associated with worsening BM erythroid function and persistent anemia. Chronic restraint stress after injury and shock provides a clinically relevant model to further evaluate persistent injury-associated anemia seen in critically ill trauma patients. Moreover, alleviating chronic stress after severe injury is a potential therapeutic target to improve BM dysfunction and anemia.

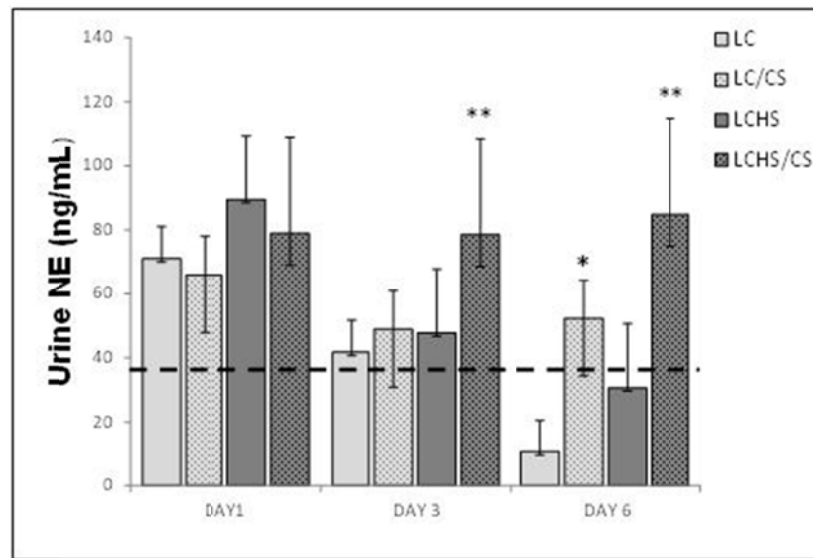


Figure 1: Urinary Norepinephrine levels increase with chronic restraint stress. LC- lung contusion LC/CS- lung contusion and chronic restraint stress, LCHS- lung contusion with hemorrhagic shock, LCHS/CS lung contusion with hemorrhagic shock and chronic restraint stress. \* $p<0.05$  vs. LC and \*\* $p<0.05$  vs. LCHS by ANOVA and Tukey Kramer

	Seven Days After Initial Injury				
	Erythropoietin (pg/mL)	Hgb (g/dL)	CFU-GEMM (colonies/plate)	BFU-E (colonies/plate)	CFU-E (colonies/plate)
Naive	16±6	13.6 ± 1	35±0.6	65±2	75±2
LC	19±10	14.1±0.2	34±0.5	66±1	75±4
<b>LC/CS</b>	<b>46±55</b>	<b>12.9±0.3*</b>	<b>22±5*</b>	<b>49±3*</b>	<b>57±5*</b>
LCHS	34±22	13.1±1	28±2	50±3	58±1
<b>LCHS/CS</b>	<b>72±66**</b>	<b>10.8±1**</b>	<b>16±1**</b>	<b>36±1**</b>	<b>47±1**</b>

Table 1: Chronic stress following injury increases epo but worsens bone marrow erythroid progenitor growth and prolongs anemia. LC- lung contusion LC/CS- lung contusion and chronic restraint stress, LCHS- lung contusion with hemorrhagic shock, LCHS/CS lung contusion with hemorrhagic shock and chronic restraint stress. \* $p<0.05$  vs. LC and \*\* $p<0.05$  vs. LCHS ANOVA and Tukey Kramer



January 14, 2015  
Paper 9  
11:50 am

**PREDICTING SECONDARY INSULTS AFTER SEVERE TRAUMATIC BRAIN INJURY**

Brandon Bonds, MD, Shiming Yang, PhD, Peter Hu, PhD, Kostas Kalpakis, Lynn Stansbury, Thomas M. Scalea, MD, FACS, FCCM\*, Deborah M. Stein, MD, MPH, FACS, FCCM\*  
R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine

**Presenter:** Brandon Bonds, MD

**Discussant:** John J. Como, MD, MPH, MetroHealth Medical Center

**Objectives:** Secondary insults such as hypotension, hypoxia, cerebral hypoperfusion, and intracranial hypertension (ICH) are associated with poor outcome following severe traumatic brain injury (TBI). Preventing and minimizing the effect of secondary insults are essential in management of severe TBI. At present, clinicians have no way to predict the development of these events, limiting their ability to plan appropriate timing of interventions. We hypothesized that processing continuous vital signs (VS) data using machine learning methods could predict the development of future ICH.

**Methods:** Continuous VS including intracranial pressure (ICP), heart rate, systolic blood pressure, and mean arterial pressure data were collected from adult patients admitted to a level one trauma center requiring an ICP monitor. We tested the ability of Nearest Neighbor Regression (NNR) to predict changes in ICP changes in advance of the observed rise in ICP by algorithmically learning from the patients' past physiology.

**Results:** Continuous VS were collected on 50 adult patients over a minimum of 10 hours per patient (904 hours total; 10,853 data points). The ability to predict ICP changes using this methodology is depicted in the FIGURE. Bland-Altman plots show that NNR provides good agreement in predicting actual ICP with a bias of 0.02 ( $\pm 2$  standard deviations [SD]=4mmHg) for the subsequent 5 minutes and -0.02 ( $\pm 2$ SD=10mmHg) for the subsequent 2 hours.

**Conclusions:**

We have demonstrated that using physiological data, it is possible to predict with reasonable accuracy impending secondary insults following severe TBI. NNR predicts ICP changes in clinically useful timeframes. This ability to predict events may allow clinicians to make better decisions about the timing of necessary interventions and this method could support the future development of minimally-invasive ICP monitoring systems which may lead to better overall clinical outcomes after severe TBI.

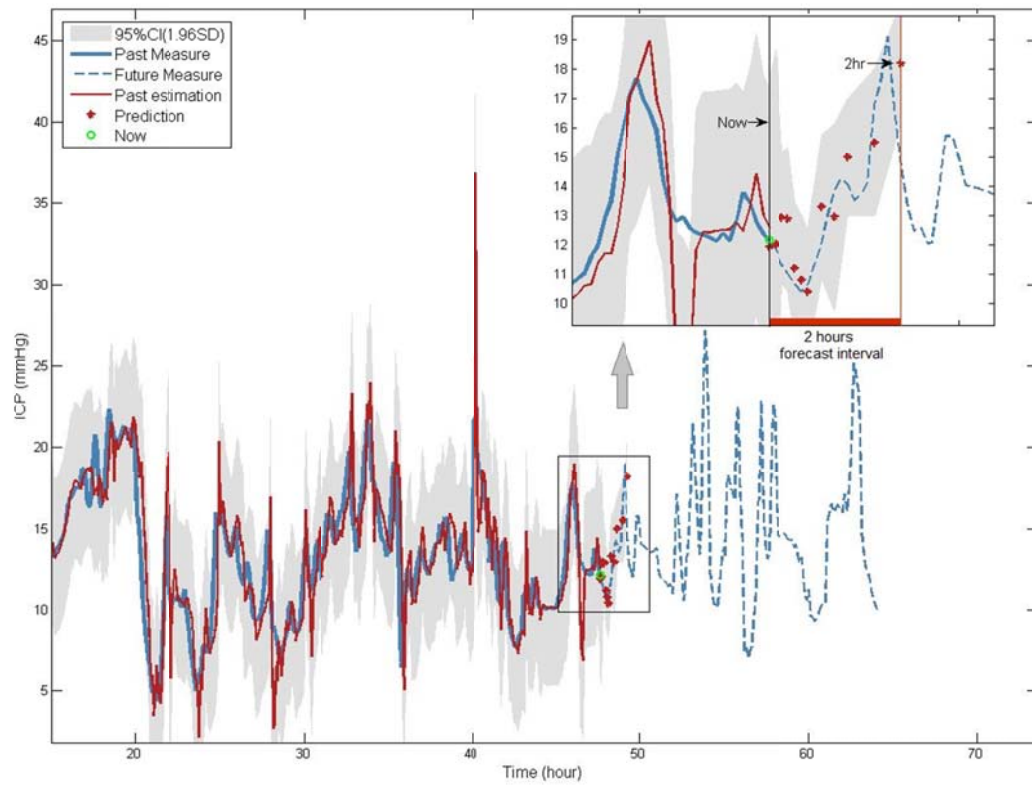


Illustration of using the NNR method to dynamically build regression models by ‘borrowing’ data (especially the ICP) from other patients. A 2-hour prediction window on the top-right corner displays a trend for ICP, under the assumption that if this patient will receive standard treatment

January 14, 2015

Paper 10

12:10 pm

**CELL IMPERMEANTS IMPROVE OUTCOMES IN LOW VOLUME RESUSCITATION FOR  
HEMORRHAGIC SHOCK**

Dan W. Parrish, MD, Susanne Lindell, Heather Muir, Martin J. Mangino, PhD\*  
Virginia Commonwealth University

**Presenter:** Dan W. Parrish, MD

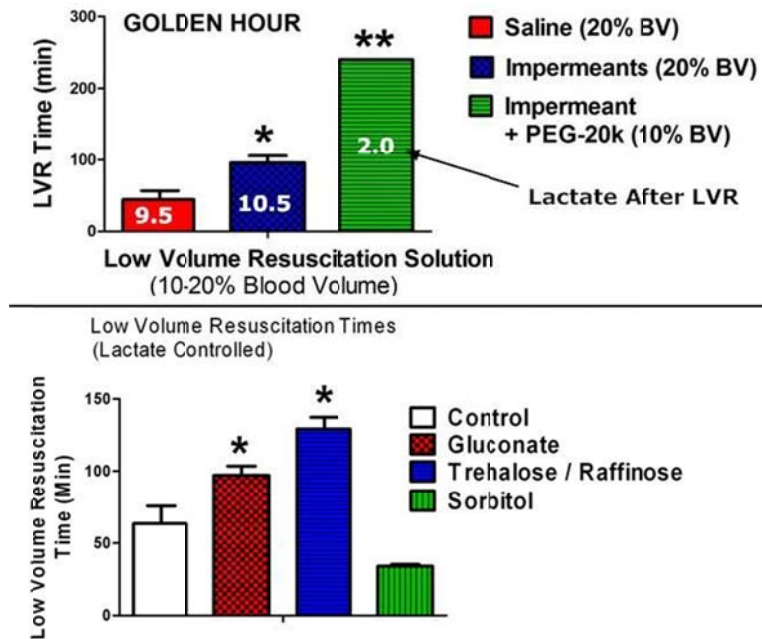
**Discussant:** Jason W. Smith, MD, PhD, University of Louisville

**Objectives:** Lethal cell swelling associated with altered cellular energetics during shock leads to loss of organ function, systems failure, and death. Preventing cell swelling with cell impermeant infusion could significantly improve outcomes at resuscitation. Our objective was to determine if the use of simple cell impermeants in low volume resuscitation (LVR) solutions would prevent lethal cell swelling and improve resuscitation outcomes.

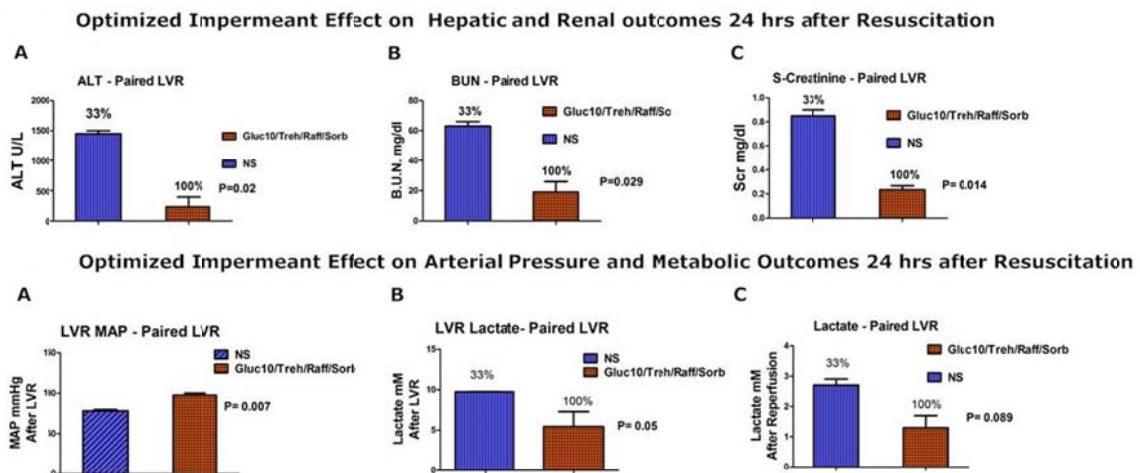
**Methods:** Rats were hemorrhaged to a mean arterial pressure of 30-35 mm Hg until arterial lactate reached 9 mg/dl. Then, LVR (10% or 20% blood volume) containing 0.9% Sodium Chloride, one of the studied cell impermeants, or polyethylene glycol (PEG-20k, a colloid) was started followed by full resuscitation when the lactate value again reached 9 mg/dl. The animals were then recovered for 24 hrs. Paired and unpaired experiments were performed. Cardiovascular, metabolic, and organ function, and survival were observed.

**Results:** Impermeants added to the LVR solution significantly increased the amount of time the animals could tolerate the low volume state and improved metabolic and organ function after full resuscitation. When PEG-20k was added to the impermeant solution, the LVR time increased 5 fold, relative to saline with significantly higher MAP and a lower resuscitation volume (10%).

**Conclusions:** Cell impermeants prevent lethal cell swelling caused by shock and increase the time that the animals can remain in the low volume state. The effect was dramatically potentiated when PEG-20k was added to the solution. These agents are deliverable in LVR solutions in the field, are stable, economical, non-toxic, and may significantly prolong the golden hour and survival.



The low volume resuscitation times are shown for saline, impermeants, and impermeant + PEG-20K in the top window. Low volume resuscitation times for individual impermeants are displayed in the bottom window.



The significant differences in metabolic and organ (liver and kidney) function were best demonstrated in the paired experiments as seen in the top row of graphs. Differences in MAP and lactate measurements following LVR and full resuscitation are shown in the second row of graphs.

January 15, 2015  
Paper 11  
8:00 am

**CENTRAL AORTIC WIRE CONFIRMATION FOR REBOA DEPLOYMENT: AS FAST AS THE FAST**

Sundeep Guliani, MD\*, Michael Amendola, Mack Hendrix, Adam McLaurin, DO,  
Gordon Morano, Brian Strife, Jeffrey Elbich, Francisco Albuquerque,  
Daniel Komorowski, Malcolm Sydnor, Mark Levy  
Virginia Commonwealth University

**Presenter:** Sundeep Guliani, MD

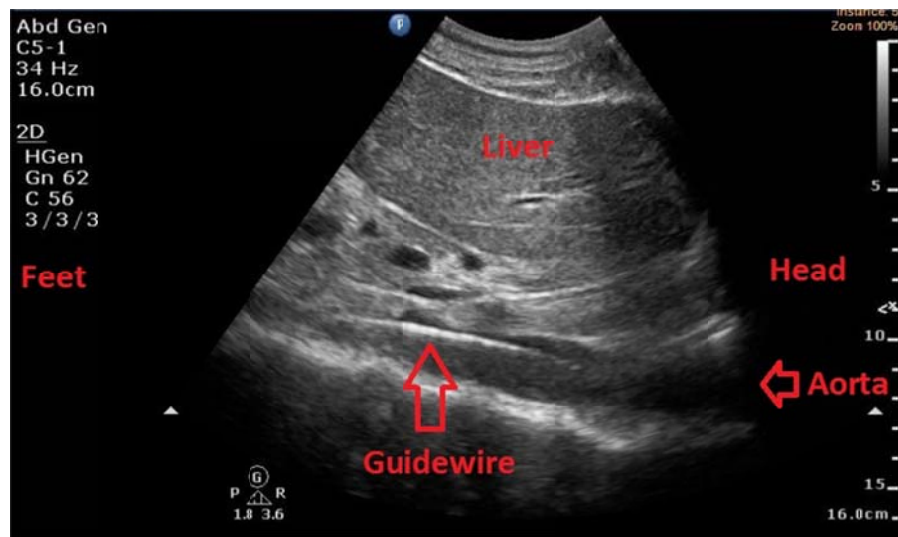
**Discussant:** Joseph D. Love, DO, University of Texas at Houston

**Objectives:** There has been recent reappraisal of aortic balloon occlusion in the setting of uncontrolled hemorrhage in trauma. Challenges currently limiting the use of Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) include safe and rapid balloon placement. Following arterial access, deployment requires fluoroscopic confirmation of an intra-aortic guidewire, atop which an occlusion balloon is advanced. We postulated that using a modified subxiphoid FAST view, both the aorta and an intra-aortic guidewire could be reliably identified.

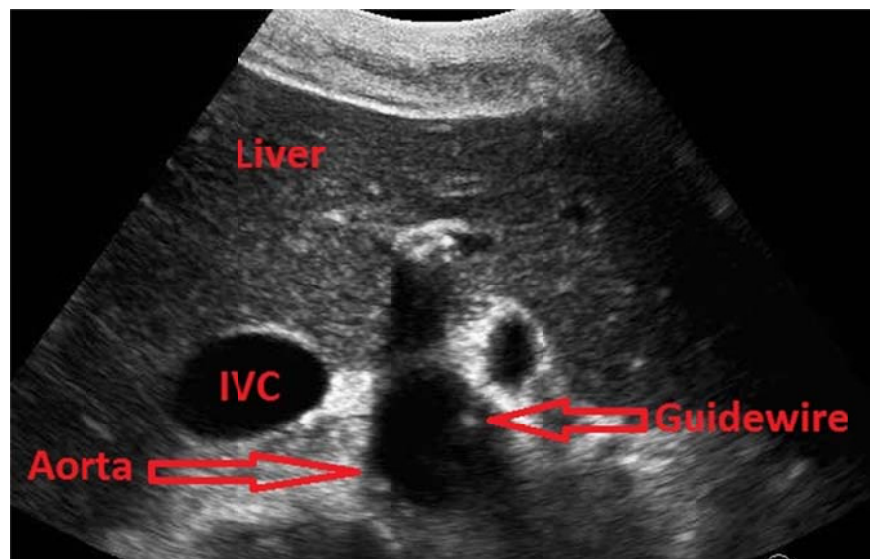
**Methods:** Thirty consecutive angiography patients underwent femoral arterial cannulation and initial guidewire advancement to the supraceliac aorta. Via a subxiphoid FAST view, the aorta was identified in both sagittal and transverse planes. Intra-aortic wire identification was subsequently recorded. The rate of central aortic wire location from unaided guidewire advancement was also observed.

**Results:** The mean patient age was 63.9 and the mean BMI was 27.2. 50% were male. 53.3% of patients had prior abdominal surgeries. 87% of studies were performed using portable point of care ultrasound machines. Identification of the aorta via the subxiphoid FAST was successful in 29 of 30 patients (97%) in sagittal and 28 of 30 patients (93%) in the transverse orientation. Among visualized aortas, an intra-aortic wire was identifiable in 28 of 29 patients (97%) in sagittal and 26 of 28 patients (93%) in transverse orientation. Unaided wire advancement achieved preferential central aortic positioning in 28 of 30 patients (93%).

**Conclusions:** The subxiphoid FAST view can rapidly and consistently identify a central aortic guidewire in both transverse and sagittal orientations. This finding obviates the need for fluoroscopy for this important initial maneuver in REBOA deployment. In addition, unaided guidewire advancement has a high likelihood of preferential central aortic positioning.



Sagittal FAST View of Aorta



Transverse FAST view of Aorta

January 15, 2015

Paper 12

8:20 am

**BOTULINUM TOXIN A INDUCED FLACCID PARALYSIS OF THE LATERAL ABDOMINAL WALL MUSCULATURE AFTER DAMAGE CONTROL LAPAROTOMY: A MULTIINSTITUTIONAL, PROSPECTIVE, RANDOMIZED, PLACEBO CONTROLLED, DOUBLE-BLINDED CLINICAL TRIAL**

Martin D. Zielinski, MD, FACS\*, Melissa Kuntz, Xiaoming Zhang, Henry J. Schiller, MD\*, Myung Park, MD\*, Mohammad A. Khasawneh, MBBS, Benjamin Zendejas, Abigail Zagar, Michael Ferrara, Stephanie F Polites, William Harmsen, MS, Karla V Ballman, PhD, David J. Dries, MD\*, Donald H. Jenkins, MD\*  
Mayo Clinic

**Presenter:** Martin D. Zielinski, MD, FACS

**Discussant:** Michael F. Rotondo, MD, FACS, University of Rochester School of Medicine

**Objectives:** Damage control laparotomy (DCL) is a life-saving operation used in critically ill patients; however, interval primary fascial closure remains a challenge. We hypothesized that flaccid paralysis of the lateral abdominal wall musculature induced by Botulinum Toxin A (BTX), would improve rates of primary fascial closure, decrease duration of hospital stay (LOS), and enhance pain control.

**Methods:** Consenting adults who had undergone a DCL at two institutions were prospectively randomized to receive ultrasound-guided injections of their external oblique, internal oblique, and transversus abdominus muscles with either BTX (150cc, 2units/cc) or placebo (150cc 0.9%NaCl). Patients were excluded if they had a BMI>50, remained unstable or coagulopathic, were home O<sub>2</sub> dependent or had an existing neuromuscular disorder. Outcomes were assessed in a double-blinded manner. Univariate and Kaplan Meier estimates of cumulative probability of abdominal closure were performed.

**Results:** We randomized 46 patients (24 BTX, 22 placebo). There were no significant differences in demographics, comorbidities, and physiological status. Injections were performed on average  $1.8 \pm 2.8$  days after DCL (range 0-14). The 10-day cumulative probability of primary fascial closure was similar between groups: 96% for BTX (95% CI 72%-99%) and 93% for placebo (95% CI 61%-99%); HR =1.0 (95% CI 0.5-1.8). No difference between BTX and placebo groups was observed for LOS (37 vs 26 days, p=0.30) or intensive care unit stay (17 vs 11 days, p=0.27). There was no difference in median morphine equivalents following DCL (**TABLE**). The overall complication rate was similar (63% vs 68%, p=0.69), with 2 deaths in the placebo group and 0 in the BTX group. No BTX or injection procedure complications were observed.

**Conclusions:** Use of BTX after DCL was safe but did not appear to affect primary fascial closure, LOS, or pain modulation after DCL.

Day	BTX (MSO4 mg)	Placebo (MSO4 mg)	P
1	120.0	81.8	.27
2	99.4	86.5	.60
3	91.3	93.0	.64
4	69.6	54.0	.61
5	57.3	49.0	.47

Morphine Equivalents (MSO4) per randomized group over the first 5 days after Damage Control Laparotomy



January 15, 2015  
Paper 13  
8:40 am

**DOES TXA MATTER? REFINING INDICATIONS FOR ITS USE IN COMBAT CASUALTIES.**

Zsolt T. Stockinger, MD, FACS\*, Kirby R. Gross, MD\*,  
Frank K. Butler, MD\*, Jeffrey Bailey, MD, US  
Army Institute of Surgical Research

**Presenter:** Kirby R. Gross, MD – *presenting on behalf of Dr. Stockinger who is deployed*

**Discussant:** Laura Kreiner, MD, MetroHealth Medical Center

**Objectives:** Because the CRASH-2 civilian trial and the MATTERs military study demonstrated that the antifibrinolytic agent tranexamic acid (TXA) reduces mortality in trauma patients, the use of TXA was embraced by the US military, to include in the prehospital setting. A performance improvement monitoring program was initiated to monitor that its use is within guidelines and that its efficacy can be verified in this patient population.

**Methods:** Retrospective PI review of the DoD Trauma Registry for all patients admitted to Role 3 hospitals in Afghanistan from January 2009 through September 2013 who received at least one unit of blood. All records were reviewed for documentation of TXA use at any point during their care (TXA vs. non-TXA.) Records were then analysed by patient demographics, Injury Severity Score (ISS), transfusion requirements, deep venous thrombosis (DVT), pulmonary embolism (PE), and mortality.

**Results:** 1413 transfused patients were identified, 454 TXA and 959 non-TXA. The TXA vs non-TXA group was more seriously injured (mean ISS 28.0 vs 22.3,  $p < .0001$ ), with no difference in mortality (8.8 vs 6.9%,  $p = .282$ ) but an increased incidence of pulmonary embolism (PE, 15.6 vs 6.7%,  $p < .0001$ .) When cohorted by need for massive transfusion (MT), TXA MT patients had similar mean ISS, mortality, and DVT/PE rates to non-TXA MT patients. Non-MT patients also had similar mean ISS, DVT rate and mortality but a higher PE rate (11.4 vs 4.7%,  $p = .0078$ ) in TXA vs. non-TXA patients. Patients sustaining traumatic amputation and/or pelvic fracture had no difference in ISS, PE, DVT or mortality between TXA and non-TXA.

**Conclusions:** In this, the largest military review to date on TXA use, no mortality benefit has yet to be demonstrated in combat casualties. Further analysis is required, but consideration is being given to refining recommendations for TXA use in combat casualties to those with identified risk factors for massive transfusion.

## Notes

January 15, 2015  
Paper 14  
9:00 am

**MILITARY TO CIVILIAN EXPERIENCE- A PRELIMINARY MULTI-INSTITUTIONAL  
ANALYSIS OF PRE-HOSPITAL TOURNIQUET USE**

Rebecca W Schroll, MD\*, Norman E. McSwain, Jr., MD, FACS, NREMT-P\*, Alison Smith,  
John Myers, MD, Kristin Rocchi, Kenji Inaba, MD, Stefano Siboni, Gary A. Vercruysse, MD\*,  
Irada Ibrahim-zada, MD, PhD, Jason L. Sperry, MD, MPH\*, Christian Martin-Gill,  
Jeremy W. Cannon, MD, SM, FACS\*, Seth R. Holland, Martin A. Schreiber, MD, FACS\*,  
Diane Lape, Alexander L. Eastman, MD, MPH, FACS\*, Cari S. Stebbins, Paula Ferrada, MD\*,  
Jinfeng Han, RN, Williams Randy, Peter Meade, MD, MPH\*,  
Juan C. Duchesne, MD, FACS, FCCP, FCCM\*  
Tulane University School of Medicine

**Presenter:** Rebecca W. Schroll, MD

**Discussant:** Elliot M. Jessie, MD, MBA, Walter Reed National Military Medical Center

**Objectives:** Tourniquets have seen resurgence in use for extremity injuries, especially in the military. Recent military studies demonstrated an association between pre-hospital tourniquet use and increased survival. Adaptation and benefits of this pre-hospital intervention in a civilian population remains unclear. The aim of our study was to compare mortality outcomes from Military to Civilian Experience (M2CE).

**Methods:** This is a preliminary Multi-Institutional Analysis of Pre-Hospital Tourniquet use (MIA-T). Retrospective chart review of patients with pre-hospital tourniquets admitted to 9 urban Level 1 trauma centers from January 2010–December 2013 was conducted. Patient demographics and mortality from a previous military experience by Kragh et al (Ann Surg, 2009 249:1-7) were compared to our MIA-T. Patients less than 18 years of age or with non-traumatic bleeding requiring tourniquet application were excluded. Data was analyzed using a two-tailed unpaired Student's t test with  $p < 0.05$  significant.

**Results:** A total of 197 patients were included in this study. The average ISS for MIA-T vs military was  $14 \pm 10$  vs.  $11 \pm 12$  ( $p = 0.02$ ). The overall mortality rate for the MIA-T group was significantly lower than the military population 6/197 (3%) vs 22/194 (11%), ( $p = 0.0015$ ). This finding was maintained in both subsets of patients with shock (2.7% vs 83.0%,  $p = 0.0001$ ) and without shock (2.2% vs 9.0%,  $p = 0.0036$ ) (Table I). Of patients in the civilian group, there were 25 whose vitals were unknown at the time of tourniquet application; this subset had a mortality rate similar to the military patients at 12%.

**Conclusions:** Our M2CE is the first adaptation evaluation of pre-hospital tourniquet use in a civilian population. We found evidence of lower mortality than has been previously seen in the military setting. Adaptation of this pre-hospital intervention may convey a survival benefit in the civilian population.



**Table I.** Comparative outcomes for pre-hospital tourniquet use

	Military	Civilian	p
Overall Mortality	22/194(11.3%)	6/197 (3%)	0.0015
Shock	5/6 (83.3%)	1/37 (2.7%)	0.0001
No Shock	17/188(9.0%)	2/135 (2.2%)	0.0036



January 15, 2015  
Paper 15  
9:20 am

**SELF-EXPANDING FOAM FOR SEVERE ABDOMINAL HEMORRHAGE: A MULTI-CENTER DOSE TRANSLATION STUDY IN RECENTLY DECEASED HUMANS**

David King, MD\*, Adam P. Rago, MS, Tomaz Mesar, Mackenzie R. Cook,  
Andreas Larentzakis, Jeanette M. Podbielski, RN BSN, Ryan A. Lawless, MD\*,  
Samantha Underwood, MS, Martin A. Schreiber, MD, FACS\*,  
John B. Holcomb, MD\*, Upma Sharma, PhD  
Massachusetts General Hospital

**Presenter:** David King, MD

**Discussant:** Jeremy Cannon, MD, SM, San Antonio Military Medical Center

**Objectives:** Severe noncompressible abdominal bleeding results in 50% mortality in both military and civilian populations. There is an emergent need for a temporary intervention whenever surgical care is not immediately available. We previously described a self-expanding polyurethane foam for treatment of exsanguinating abdominal hemorrhage. The objective of this study was to translate a safe and effective swine dose into an appropriate human dose through foam administration in recently deceased humans with representative tissue compliance.

**Methods:** With IRB oversight and informed consent at three centers, patients imminently expected to die were identified. Within 3 hours of death, the abdomen was accessed and fluid was added to simulate hemorrhage. Foam was administered using a prototype delivery system. A foam dose of 45 mL was selected based on biostatistical models comparing swine and humans. Intraabdominal pressure (IAP) was monitored for 15 minutes, then foam was removed to assess abdominal tissue contact (0=no contact, 1=some contact, 2=full contact).

**Results:** N=5 subjects, ranging in age (29-87 yr) and body habitus (BMI 24-35 kg/m<sup>2</sup>), were enrolled at the 45 mL dose.  $\Delta$ IAP and semi-quantitative organ contact were used as surrogates to compare findings between humans and swine. 45mL foam resulted in a peak pressure of  $27 \pm 7.7$  mmHg, within the acceptable range defined by swine studies. Organ contact was variable, but less than that observed in swine at key sites (*e.g.* liver  $0.5 \pm 0.8$  vs  $1.2 \pm 0.9$  in swine). Foam material properties were consistent between models (expansion:  $37 \pm 3.9x$  vs  $36 \pm 5.8x$ ).

**Conclusions:** The use of recently deceased humans demonstrates a novel and unusual approach to device evaluation in representative human anatomy, particularly when tissue compliance is critical. Testing of other doses may identify an acceptable pressure with enhanced organ contact, and testing is ongoing at 100mL. This study is critical to the translation of promising foam findings in swine to clinical benefit.

Figure 1:  $\Delta$ IAP as a function of time following fcam deployment. Minimum and maximum acceptable IAP in swine are shown for reference. Mean  $\pm$  standard error.

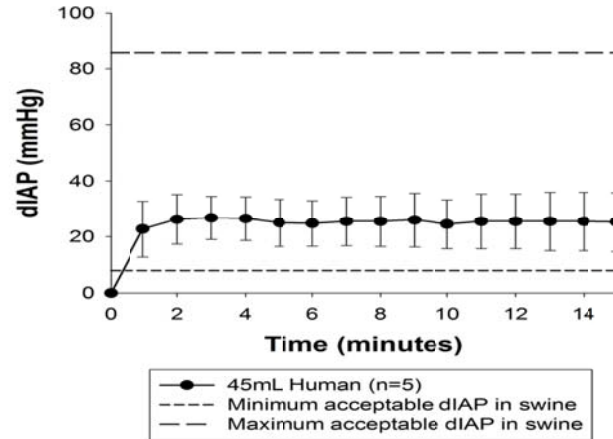


Figure 2: Semi-quantitative contact with abdominal tissues following 45mL dose administration in humans; organ contact for a 100mL dose in swine (optimal swine dose based on pre-clinical studies) shown for reference. Mean  $\pm$  standard deviation.

Tissue	45 mL dose in humans (n=5)	100mL dose in swine (n=11)
Paracolic Gutters	1.0 $\pm$ 0.9	1.2 $\pm$ 0.7
Diaphragm	0.50 $\pm$ 0.5	0.60 $\pm$ 0.7
Bladder	0.4 $\pm$ 0.9	1.3 $\pm$ 0.8
Small Bowel	1.2 $\pm$ 0.8	1.3 $\pm$ 0.8
Large Bowel	0.80 $\pm$ 0.7	1.7 $\pm$ 0.5
Liver	0.48 $\pm$ 0.8	1.2 $\pm$ 0.9
Stomach	0.53 $\pm$ 0.7	0.93 $\pm$ 0.8
Spleen	0 $\pm$ 0	1.4 $\pm$ 0.5
Omentum	1.6 $\pm$ 0.5	1.5 $\pm$ 0.5

January 15, 2015  
Paper 16  
8:00 am

**UNSTEADI: IMPLEMENTATION OF THE CDC FALL PREVENTION PROGRAM DOES NOT PREVENT IN-HOSPITAL FALLS OR REDUCE FALL RECIDIVISM RATES**

Alexander L. Eastman, MD, MPH, FACS\*, Courtney Edwards, Michael Cripps, MD, Garrett Hall, Christian T. Minshall, MD, PhD\*, Kareem R AbdelFattah, MD, Brian H. Williams, MD, FACS\*, Herb A. Phelan III, MD, FACS\*, Steven E. Wolf, MD\*, Joseph P. Minei, MD, FACS\*  
University of Texas Southwestern Medical Center

**Presenter:** Alexander L. Eastman, MD, MPH, FACS

**Discussant:** Stephanie Bonne, MD, Washington University School of Medicine

**Objectives:** Despite an aging population and an increased incidence of unintentional fall, few studies have addressed in-hospital and fall recidivism rates in the elderly. Additionally, prevention programs for unintentional fall are outpatient-focused and not well studied in the trauma patient population. We wondered whether introduction of a hospital-based fall prevention program reduces both overall in-house fall rate and fall recidivism rate in the elderly.

**Methods:** A multidisciplinary team at an urban, Level I trauma center was established to adapt the CDC STEADI fall prevention program for inpatient, trauma center use. STEADI integrates fall prevention into daily clinical practice using a fall prevention checklist. Those over age 65 admitted for fall were enrolled in a modified STEADI (mSTEADI) program, studied prospectively for one year (July 2012-June 2013) and compared with sequential controls from the same period a year prior (FALL). Mann-Whitney U was used for comparison where appropriate.

**Results:** During the study period, 218 patients were admitted into the mSTEADI group; 194 were identified in the FALL group. mSTEADI and FALL groups were not different with respect to median age, ISS, AIS Head, AIS Face, AIS Chest and AIS Abdomen. We found no differences in the in-house fall rate (4.1% in both groups) nor the rate of fall recidivism between groups (2.8% v. 2.1%,  $p=NS$ ). mSTEADI patients had more severe extremity injuries (mean AIS Extremity 2.69 v. 2.51,  $p=.01$ ), yet shorter median [IQR] LOS (6.0 [7.0] days v. 5.0 [6.0] days ( $p<.01$ ), a higher proportion of discharges home (54.5% v. 46.8%,  $p<.01$ ), and lower mean hospital charges (\$60,585 v. \$45,538,  $p=.02$ ).

**Conclusions:** mSTEADI had no effect on in-hospital fall or fall recidivism rates after introduction at a level one trauma center. These results question whether resources to maintain an mSTEADI program are justified.

## Notes



January 15, 2015  
Paper 17  
8:20 am

**IMPACT OF GRADUATED DRIVER'S LICENSE LAW ON CRASHES INVOLVING YOUNG PASSENGERS IN NEW YORK STATE**

Linda Ding, MD\*, Julius D. Cheng, MD, MPH\*, Nicole A. Stassen, MD, FACS, FCCM\*, Mark L. Gestring, MD, FACS\*, Ayodele T. Sangosanya, MD\*, Paul E. Bankey, MD, PhD\*  
University of Rochester School of Medicine and Dentistry

**Presenter:** Linda Ding, MD

**Discussant:** Richard A. Falcone, Jr., MD, MPH, Cincinnati Children's Hospital

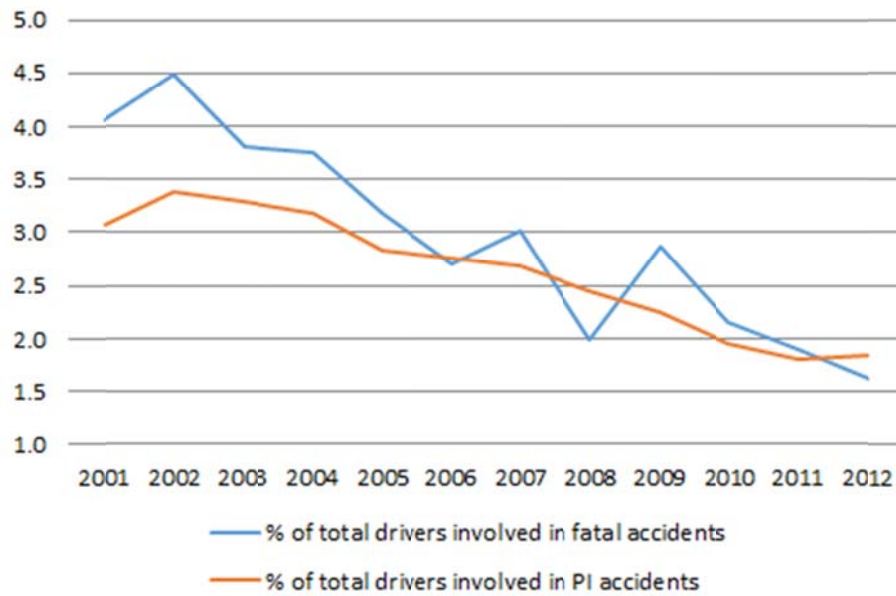
**Objectives:** To investigate the impact of strengthened graduated driver's license (GDL) laws on injury rates of passengers under 17 years of age in New York State.

**Methods:** A retrospective review of New York State DMV databases from 2001 to 2012 was performed. A state-wide GDL requirement was implemented in 2003 and restrictions strengthened in 2010 to include passenger restrictions. Database review included all reported crashes to the New York State Department of Motor Vehicles by cause and driver age. Injury rates for drivers under 18 and injury rates of passengers under the age of 17 were analyzed.

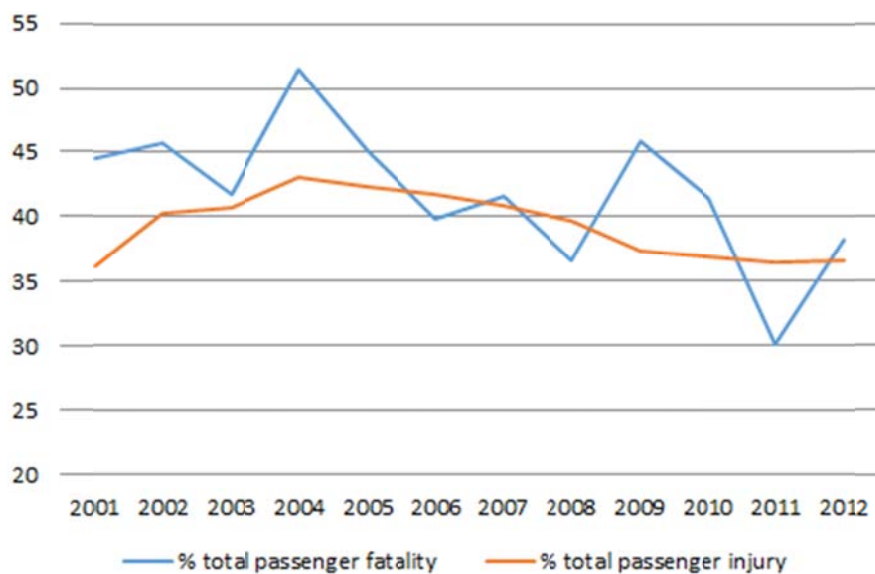
**Results:** From 2001-2003, prior to the institution of a GDL law in New York State, the number of fatal crashes involving drivers younger than 18 years old comprised of 4.2% of all fatal crashes during that time. Personal injury crashes involving young drivers constituted 3.3% of all personal injury crashes. Over the next 6 years, after the first GDLs were passed, from 2004-2009, the proportion of fatal crashes for this age group compared to all age groups dropped to 2.9%, and proportion of personal injury crashes for the under-18 driver were 2.7% of all PI crashes. In 2010, the GDLs added restrictions on number of youth passengers allowed, and this was associated with a reduced fatality rate for passengers under age 17 compared to all passengers killed during the period 2010-2012, from 43.4% to 36.6%, approaching statistical significance ( $p=0.058$ ). Personal injury rates for these youth passengers also decreased during this time from 40.9% to 36.7% of all passenger injuries ( $p=0.002$ ). The fatality and injury rates associated with drivers under age 18 were also reduced after the strengthening of the GDL in 2010.

**Conclusions:** In addition to reducing teenage driver injury, the strengthening of a GDL law in New York State has shown a decrease in the number of fatalities and injuries of passengers under the age of 17.

## Proportion of Drivers <18



## Proportion of Passengers <17



January 15, 2015

Paper 18

8:40 am

**CRASH INJURY PREVENTION: A RANDOMIZED TRIAL OF TRANSITIONING HIGH-RISK  
ELDERS FROM DRIVING**

James D. Stowe, MS, Teresa Cooney, Thomas Meuser, Marla Berg-Weger,  
Nicholas Schmidt, Colter Snethen  
University of Missouri

**Presenter:** James D. Stowe, MS

**Discussant:** Marie Crandall, MD, MPH, Northwestern University Feinberg School of Medicine

**Objectives:** Older drivers with medical conditions that impair function are at risk for experiencing a Motor Vehicle Crash (MVC). This study used scientifically-rigorous methods to test an intervention to reduce crash-related risk among older hospital patients.

**Methods:** A randomized, controlled, experimental design study was used to test the efficacy of counseling on driving retirement, traffic-related behavior, and health outcomes among older patients with vision, cognitive, or psychomotor impairment. 39 currently driving patients were enrolled (26 intervention; 13 control) at a research and referral hospital through inpatient and outpatient settings. The intervention consisted of two sessions of facilitated planning in which the patients' health, transportation alternatives, attitudes/emotions regarding a change in mobility, and actions to ensure continued safe mobility were discussed. Moreover, all patients received supportive phone calls during the 6 month intervention period.

**Results:** Repeated measures analyses revealed that the intervention group was more likely to report riskier driving behavior ( $p = .051$ ) and increased scores on cognition ( $p = .088$ ) than the control group. The intervention group avoided thinking about mobility less than the control group ( $p = .075$ ), and mean trends suggest increased readiness to retire from driving.

Qualitative data confirmed that increased planning for driving retirement occurred in the intervention group only. One third of the intervention group was unwilling to engage in planning for driving retirement (labeled as "non-compliant").

**Conclusions:** Facilitated planning may increase readiness to retire from driving among high-risk patients. Greater sample sizes and study duration are needed to confirm these effects and to measure direct crash and injury outcomes. A significant proportion of high-risk patients do not plan for driving retirement, yet remain at-risk for crashes.

## Notes

January 15, 2015  
Paper 19  
9:00 am

**TEENAGE MOTOR VEHICLE CRASH FATALITIES IN CONNECTICUT, 2008-2013: A CRITICAL APPRAISAL AFTER THE PASSAGE OF A STRONGER GRADUATED DRIVER LICENSING LAW**

William Schreiber-Stainthorp, William Seymour, MPA, Shefali Thaker, MPH  
Kevin Borup, JD, MPA, Garry Lapidus, PA-C, Brendan Campbell, MD, MPH\*  
Connecticut Children's Medical Center

**Presenter:** William Schreiber-Stainthorp

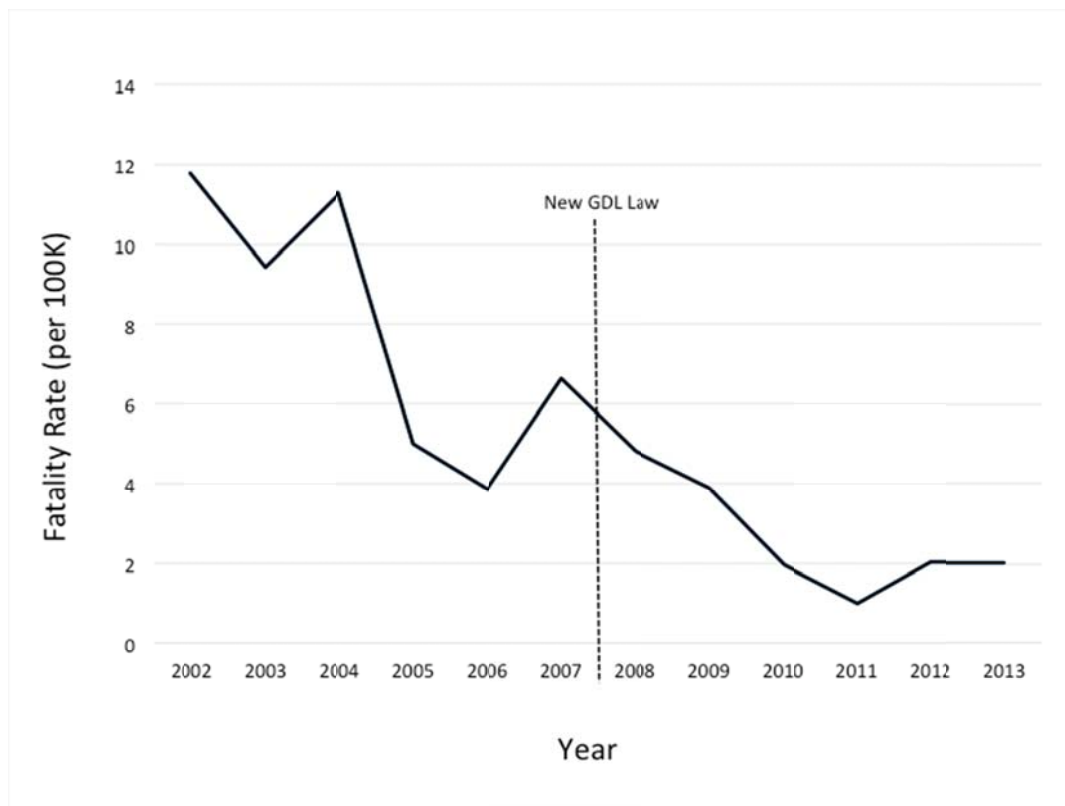
**Discussant:** Luis Llerena, MD, USF Health, CAMLS

**Objectives:** Graduated driver licensing (GDL) laws have been shown to lower crash risk for novice teen drivers. The purpose of this study was to evaluate motor vehicle crash (MVC) characteristics and compliance with GDL requirements for all fatal crashes involving novice teen drivers after a law with stricter GDL provisions was passed.

**Methods:** Comprehensive crash data for all fatal MVCs involving a teenage driver from August 2008 through December 2013 were reviewed. Data sources included Department of Transportation crash files and Department of Motor Vehicles licensing data. Annualized crash rates for drivers ages 16 and 17 years were compared between the 5 years before and after the new GDL law was passed.

**Results:** During the 5 year period following the passage of a stricter GDL law there were 26 fatal MVCs involving a novice teen driver (15, 16 or 17 years). Thirty individuals were killed in these crashes: 11 (37%) were drivers (15-17 years), 8 (27%) were passengers of those drivers, 5 (17%) were drivers or passengers of other vehicles, and 6 (20%) were pedestrians. In the five years since Connecticut passed stronger GDLs, the 5-year annualized fatality rate for crashes involving 16-17 year old drivers decreased from 6.3 (2003-2008) to 2.2 (2009-2013) per 100,000 population. In half of fatal crashes (n=13, 50%) a novice teen driver was violating the new GDL law: passenger violation (n=20, 77%), curfew violation (n=4, 15%), and multiple (n=2, 8%).

**Conclusions:** Strengthening Connecticut's GDL law was associated with a significant decrease in fatalities among novice teen drivers. Importantly, half of fatal crashes occurred when a novice teen driver was in violation of the new GDL law. Developing programs directed toward parents and law enforcement that increase compliance with GDL laws are an opportunity to lower fatal crash risk for novice teen drivers.



Annual rate for drivers ages 16 or 17 years involved in fatal crashes, 2002-2013

January 15, 2015  
Paper 20  
9:20 am

**EVALUATING THREE METHODS TO ENCOURAGE MENTALLY COMPETENT OLDER  
ADULTS TO ASSESS THEIR DRIVING BEHAVIOR**

Tarsicio Uribe-Leitz, MD, MSCN, MPH, Jonathan Howland, Vonne Lee,  
Peter Burke, MD, FACS\*, Lisa Allee Barmak, MSW, LICSW\*  
Boston Medical Center

**Presenter:** Tarsicio Uribe-Leitz, MD, MSCN, MPH

**Discussant:** Andy Kerwin, MD, University of Florida, College of Medicine-Jacksonville

**Objectives:** Thirteen percent (41.4 million) of the population in the United States was 65 and older in 2011. This population is projected to reach 20 % (88.5 million) by 2050. Older adults accounted for 17% of all traffic fatalities and 16% of all vehicle occupant fatalities, in 2011. We explored the efficacy of three interventions to help older adults assess their current driving behaviors at a level 1 trauma center.

**Methods:** 1216 in-patients  $\geq 70$  years old admitted for surgical and medical services, were assessed for eligibility, 120 screened and enrolled during 2010 to 2012. First, enrolled patients completed a driving assessment questionnaire and pre-intervention questionnaire. Second, patients were randomized to one of the following interventions: 1) brief negotiated interventions (BNI) plus document developed by the American Automobile Association (AAA) about older driving, 2) AAA document and online referral sheet, 3) referral sheet only. Third, a 3 month follow up post-intervention questionnaire was conducted over the phone. Univariate and multivariate analyses were performed in SAS 9.3 (SAS Institute, Cary NC).

**Results:** A total of 113 randomized patients were included in the analysis. Mean age was 76.8 (SD 5.23), most patients were white (64%), followed by black African American (33%), 51% males and 49% females. 34% were randomized to BNI, 32% to AAA package and 35% to online resources. Multiple linear regression analysis showed an association in driving knowledge, awareness and beliefs post intervention ( $R^2$  0.329,  $p < .0001$ ). Furthermore, there was an association in older adults who had positively changed their driving behaviors and/or intentions ( $R^2$  0.264,  $p < .0001$ ) compared to baseline.

**Conclusions:** Older driver safety is a growing public health concern. Our pilot study suggests that older adults are likely to make changes in their driving behavior after eliciting related conversations.

## Notes



Scientific Session IV-A - Basic Science and Education

January 16, 2015

Paper 21

8:00 am

**VARIABILITY IN INTER-HOSPITAL TRAUMA DATA ABSTRACTION: A CHALLENGE TO THE ACCURACY OF TRAUMA REGISTRIES**

Sandra Strack Arabian, CSTR, CAISS, Janis Breeze, Michael Marcus, Michelle Pomphrey,  
Kevin Captain, Jennefer Wolfe, Nikolay Bugaev  
Tufts Medical Center

**Presenter:** Sandra Strack Arabian, CSTR, CAISS

**Discussant:** Haytham Kaafarani, MD, MPH, Massachusetts General Hospital

**Objectives:** Analyses of data aggregated in state and national trauma registries provide the platform for clinical, research, development, and quality improvement efforts in trauma systems. However, the inter-hospital variability in data abstraction and coding, a significant determinant of accuracy, has not yet been evaluated.

**Methods:** This is a multi-institutional, web-based, anonymous study examining variability in data abstraction, coding and scoring by registrars. 85 ACS/State-verified trauma centers nationwide were invited to determine diagnostic, procedure, and Abbreviated Injury Scale (AIS) coding as well as selected NTDB definitions for the same fictitious case. Variability in all data entries was assessed by the maximal percent agreement among the registrars for each of the abstraction items, and 95% confidence intervals were computed to compare this level of agreement to the ideal value of 100%. Comparisons based on Trauma Quality Improvement Program (TQIP) membership, level of trauma center, ACS accreditation, and registrar's certifications were made using chi-square tests.

**Results:** 50 registrars completed the survey (Table 1). Variability was noted in many entries (Table 2) including pre-hospital vital signs, ED procedures, ICD-9 diagnosis, external cause codes, and length of stay. No differences were noted among the various group comparisons, with the exception of pre-hospital GCS, where TQIP respondents agreed more than non-TQIP centers ( $p=0.004$ ). The presence and type of registrars' certification affected variability.

**Conclusions:** There is wide variability in inter-hospital data abstraction and coding of injury information, which may cast doubt on the validity of registry data used in all aspects of trauma care and injury surveillance.

	N, (%)
Level of TC	
I	28 (53%)
II	22 (41%)
TQIP	36 (68%)
TC Accreditation	
State	21 (42%)
ACS	11 (22%)
Both	17 (34%)
Registrar years' of experience:	
1 - 3	7 (14%)
>3 - 5	11 (22%)
>5 years	31 (62%)
Registrar certification:	
CSTR	23 (43%)
CAISS	9 (18%)
None/other	18 (41%)
State:	
Florida	30 (60%)
Other	20 (40%)

**Table 1: Trauma Center/Registrar Profile.** TQIP, Trauma Quality Improvement Program; ACS, American College of Surgeons; CSTR, Certified Specialist in Trauma Registry; CAISS, Certified Abbreviated Injury Scale Specialist.

Data Element	Overall (n=50)	TQIP (n=36)	Level 1 (n=28)	Level 2 (n=22)	ACS (n=28)	CSTR (n=23)	CAISS (n=9)
Pre Hospital GCS	34* (68%)	26* (72%)	20* (71%)	14* (63%)	21* (75%)	14* (61%)	6* (67%)
Pre Hospital vitals	18* (36%)	11* 36%	15* (35%)	8* (36%)	9* (32%)	9* (39%)	6* (67%)
Emergency Department Procedures	30* (60%)	21* 58%	19* (54%)	15* (68%)	15* (57%)	16* (70%)	6* (67%)
AIS Coding for Heart injury	28* (56%)	23* 64%	24* (68%)	9* (41%)	18* (64%)	14* (61%)	6* (67%)
AIS Coding for Lower Extremity	43* (86%)	31* 86%	24* (86%)	19 (86%)	23* (82%)	21 (91%)	8(86%)
Length of Stay (LOS)	26* (52%)	21* 58%	14* (50%)	21* (58%)	13* (46%)	13* (53%)	6* (67%)
External Cause Code	30* (60%)	22* 61%	16* (57%)	14* (63%)	15* (57%)	11* (48%)	6* (67%)
Place of Occurrence Code	48 (96%)	35 (97%)	25 (93%)	22 (100%)	26 (93%)	23 (100%)	9 (100%)
Mean maximal agreement	N=65%	N=66%	N=64%	N=66%	N=63%	N=65%	N=74%

**Table 2:** Data element variability expressed as the number of registrars agreeing on the most common answer. \*, maximum percent agreement less than 100% ( $p < 0.05$ ); TQIP, Trauma Quality Improvement Program; ACS, American College of Surgeons; CSTR, Certified Specialist in Trauma Registry; CAISS, Certified Abbreviated Injury Scale Specialist; GCS, Glasgow Coma Scale; AIS, Abbreviated Injury Scale.

January 16, 2015  
Paper 22  
8:20 am

**RACIAL AND REGIONAL DISPARITIES IN THE EFFECT OF THE ACA DEPENDENT  
COVERAGE PROVISION ON YOUNG ADULT TRAUMA PATIENTS**

Jonathan W. Scott, MD, Ali Salim, MD\*, Benjamin Sommers,  
Thomas Tsai, Kirstin Scott, Zirui Song  
Harvard Medical School

**Presenter:** Jonathan W. Scott, MD

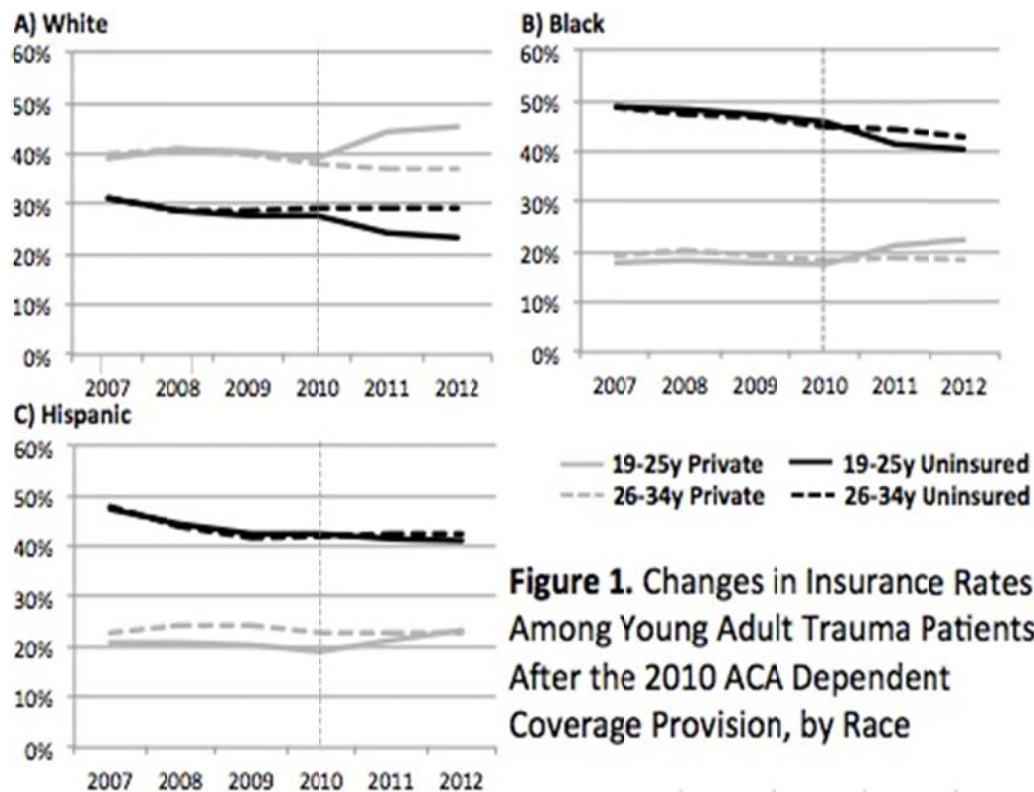
**Discussant:** Catherine Velopulos, MD, MHS, Johns Hopkins School of Medicine

**Objectives:** Prior studies have shown disparities in outcomes for trauma patients based on insurance and race. The 2010 dependent coverage provision (DCP) of the Affordable Care Act (ACA) let young adults remain on their parent's health insurance plans until age 26, resulting in over 3 million young adults gaining insurance in the first year. We investigated the impact of the reduction in the uninsured attributable to DCP on racial disparities in trauma.

**Methods:** Using a difference-in-differences design and the National Trauma Databank (2007-2012), we compared changes in rates of uninsurance among 19-25 yos to a control group of 26-34 yos not eligible for the DCP. Subgroup analyses were conducted by race and by census region. We also examined outcomes such as mortality, intensive care unit length of stay (ICU LOS) and discharge to a rehab facility. Models were adjusted for patient and injury characteristics.

**Results:** The DCP led to a 3.7 percentage-point reduction in the uninsured among 19-25 year-old trauma patients ( $p<0.001$ ). Whites had a significantly greater reduction in insurance (-5.0%, Ref) than Blacks (-3.3%,  $p=0.01$ ) and Hispanics (-1.7%,  $p<0.001$ ). Such disparities were greatest in the South and Southwest regions. Subgroups with the smallest reductions included minorities, assault intent, gunshot wound, motor vehicle collision, greater injury severity, and those going to safety-net facilities. No significant changes in in-hospital mortality, ICU LOS, or discharge to rehab were identified between racial subgroups.

**Conclusions:** The DCP significantly reduced uninsurance for young adult trauma patients. This impact was heterogeneous with the lowest reductions in uninsured status occurring among minorities, those with worse injuries, and those already relying on safety-net facilities. Understanding the differential impact of such policies is critical for future trauma disparities research.



Source: NTDB 2007-2013, n=782,670; Solid lines: policy-eligible group (19-25 yo); Dashed lines: policy-ineligible control group (26-34 yo); Black lines: rates of uninsured; Grey lines: rates of private insurance; vertical dashed line: implementation of ACA DCP (Sept. 2010)

January 16, 2015

Paper 23

8:40 am

**DOES PROXIMITY TO VIOLENCE NEGATIVELY INFLUENCE ATTITUDES TOWARD  
EXCEPTION FROM INFORMED CONSENT IN EMERGENCY RESEARCH?**

Zoë Maher, MD\*, Elena Grill, Brian P. Smith, MD\*, Carrie A. Sims, MD\*  
Hospital of the University of Pennsylvania

**Presenter:** Zoë Maher, MD

**Discussant:** Sherry L. Sixta, MD, Christiana Care Health System

**Objectives:** Trauma research has been limited by perceived patient reluctance to participate in exception from informed consent (EFIC) studies. We hypothesized that race, socioeconomic status and proximity to violence influence willingness to participate in, and perception of, EFIC research among at risk populations.

**Methods:** Trauma patients, families and community members ranked statements regarding EFIC and willingness to participate in emergency research using a 5-point Likert scale during an EFIC community consultation. Higher total scores reflected a more positive attitude regarding EFIC (range 6-30; neutral = 18) and willingness (range 23-115, neutral = 69). Subject zip code was used to calculate median income, as an estimate for socioeconomic status, and proximity to the 5 most violent city zip codes. Linear regression, Pearson correlation and omnibus tests ( $p < 0.05$ ) were used to evaluate relationships between estimated socioeconomic status, race, mechanism of injury, proximity to violence, and attitudes toward EFIC.

**Results:** 179 subjects participated including trauma patients ( $n=99$ ), families ( $n=33$ ) and community members ( $n=47$ ). Overall, participants were supportive of EFIC and reported high willingness to participate scores (median 24, IQR 13-30 and median 89, IQR 52-115). Estimated median income and race did not correlate with perception of, or willingness to participate in, EFIC. Proximity to violence did correlate with violent mechanism of injury ( $p=0.021$ ), but was not associated with perception of EFIC or willingness to participate in emergency research.

**Conclusions:** Based on our data, there is no correlation between either proximity to violence or estimated socioeconomic status and willingness to participate in EFIC research. Given this lack of correlation, researchers should partner with at risk communities to conduct EFIC studies without concern for limited participation.

## Notes

January 16, 2015

Paper 24

9:00 am

**ENOXAPARIN AMELIORATES POST-TBI EDEMA BY BLUNTING LEUKOCYTE  
ENDOTHELIAL INTERACTIONS AND VESSEL PERMEABILITY  
IN THE CEREBRAL CIRCULATION**

Shengjie Li, Shengjie Li, Joshua A. Marks, MD, Rachel Eisenstadt, Kenichiro Kumasaka, Davoud Samadi, Victoria Johnson, Daniel N. Holena, MD\*, Steven Allen, MD\*, Kevin Browne, Jianning Zhang, Douglas Smith, Jose L. Pascual Lopez, MD, PhD, FRCS(C), FACS\*  
Hospital of the University of Pennsylvania

**Presenter:** Joshua A. Marks, MD

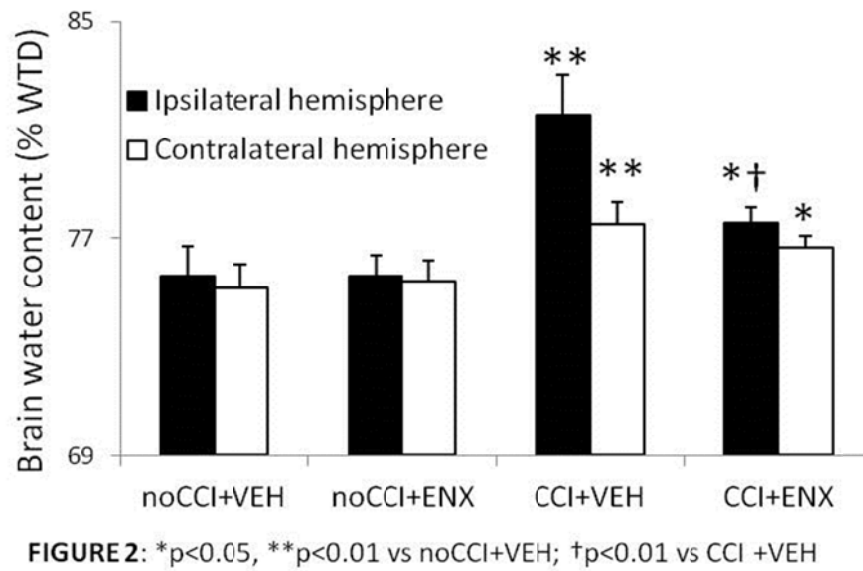
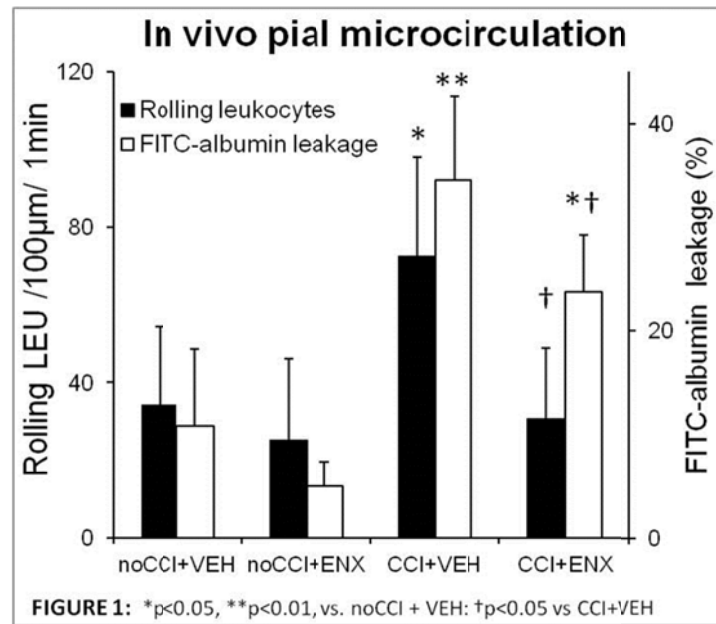
**Discussant:** Oscar D. Guillaumondegui, MD, MPH, Vanderbilt University Medical Center

**Objectives:** Traumatic brain injury (TBI) confers a high risk of venous thrombosis but early prevention with heparinoids is often withheld fearing hematoma expansion. Yet, animal studies not only have shown heparinoids to be safe but also to limit brain edema and lesion size after TBI. Human TBI data also suggests faster neurological recovery with earlier heparinoid administration. We hypothesized that enoxaparin (ENX) blunts in vivo leukocyte (LEU) mobilization to injured brain, reduces cerebral edema and improves neurological recovery without increasing the size of the hemorrhagic contusion.

**Methods:** 26 CD1 mice underwent either severe TBI by controlled cortical impact (CCI: 1mm depth, 6m/sec) or sham craniotomy. ENX (1mg/kg) or vehicle (VEH - 30 $\mu$ l 0.9% saline) was administered 2, 8, 14, 23 & 32h after TBI. At 48 hours, intravital microscopy of the pial microcirculation visualized LEU interacting with endothelium and vascular leakage of FITC-albumin (50mg/kg). Neurological function (Neurological severity score - NSS), contusion size and wet-to-dry (WTD) ratios were also evaluated. ANOVA with Bonferroni correction was used for statistical comparisons.

**Results:** Compared to VEH, ENX reduced in vivo LEU rolling and cerebrovascular albumin leakage significantly (Fig1). Ipsilateral cerebral hemisphere WTD ratios were increased by CCI but ENX reduced ratios to near control levels (Fig2). Compared to VEH, ENX improved NSS at 24h (14.5 $\pm$ 0.5 vs 16.2 $\pm$ 0.4,  $p$ <0.01) and 48h (15.1 $\pm$ 0.4 vs 16.7  $\pm$ 0.5,  $p$ <0.01). There were no significant differences in hemorrhagic contusion size between groups.

**Conclusions:** Enoxaparin reduces LEU recruitment to injured brain, diminishing cerebrovascular permeability and brain edema. ENX may also hasten neurologic recovery without increasing contusion size. Further study in humans is necessary to determine safety and efficacy of enoxaparin early after TBI.





January 16, 2015

Paper 25

9:20 am

**THROMBIN GENERATION AND PROCOAGULANT MICROPARTICLE PROFILES AFTER  
ACUTE TRAUMA: A PROSPECTIVE COHORT STUDY**

Myung Park, MD\*, Ailing Xue, Grant Spears, Timothy Halling, ASc,  
Satbir K Dhillon, MD, Donald H. Jenkins, MD\*, Michael Ferrara, Melissa Kuntz,  
William Harmsen, MS, Karla V Ballman, PhD, John Heit  
Mayo Clinic

**Presenter:** Myung Park, MD

**Discussant:** Amy Makley, MD, University of Cincinnati

**Objectives:** To identify potential mechanisms for venous thromboembolism and bleeding after acute trauma, we estimated thrombin generation parameters and procoagulant microparticle (MP) concentration in a prospective cohort study of acute trauma patients.

**Methods:** Whole blood was collected by venipuncture into 3.2% trisodium citrate at 0, 6, and 12 hours and days 1 and 3 after injury, and at discharge. Platelet poor plasma was harvested and stored at -80°C until analysis. Thrombin generation was determined using the calibrated automated thrombogram (CAT), reported as lagtime (minutes) and thrombin peak height (nM thrombin). The concentration of procoagulant MPs expressing phosphatidylserine (number/uL) was measured by flow cytometry. Data presented as median and interquartile range (IQR). Wilcoxon rank-sum test was used as needed.

**Results:** Among 443 trauma patients (1734 samples; ISS = 13 [6, 22], hospital LOS = 4 [2, 10] days, age = 48 [28, 65] years, 71% male, 95% blunt mechanism, mortality 3.2%). Healthy volunteers (n=89) were enrolled. In the injured, no discernable patterns in thrombin and MP characteristics were observed over time. The comparisons between patients and volunteers are shown in Table 1. Extreme (defined as highest or lowest 5% ) values reflecting a possible “hypercoagulable state” were reached within 12 hours after acute trauma, while extreme values representing a possible “hypocoagulable state” were not reached until 1-3 days (Table 2).

**Conclusions:** Although there was no discernable pattern of coagulopathy observed after acute trauma, injured patients had greater number of procoagulant MPs and accelerated thrombin generation when compared to healthy volunteers. Additionally, those who reached extreme values did so relatively early after injury. These findings should be taken into account when designing risk model tools involving coagulation laboratory parameters.

Variable	Patient median (IQR)	Volunteer median (IQR)	P-value
Lagtime (min)	2.7 (2.4, 3.3)	2.7 (2.3, 2.9)	0.016
Peak Height (nM)	337 (285, 395)	322 (288, 343)	0.051
Procoagulant MP (per uL plasma)	401 (212, 772)	241 (146, 530)	0.0011

Table 1: Comparisons between Trauma Patients and Healthy Volunteers

Variable	N	Extreme 5% Value	Time-to-Extreme Value (Days)
<b><u>Hypercoagulable</u></b>			
Lagtime (min)	1575	$\leq 2$	0.3 (0.12, 0.50)
Peak Height (nM)	1575	$\geq 483$	0.5 (0.08, 2.97)
Procoagulant MP (per uL plasma)	1734	$\geq 2278$	0.3 (0.05, 2.0)
<b><u>Hypocoagulable</u></b>			
Lagtime (min)	1575	$\geq 5$	3.0 (1.03, 7.27)
Peak Height (nM)	1575	$\leq 195$	1.0 (0.49, 3.08)

Table 2: Extreme Values and Time-to-Extreme Values Amongst All Trauma Patient Samples

January 16, 2015  
Paper 26  
9:40 am

**ACCURATE ASSESSMENT OF SURGICAL SKILL IMPROVEMENTS AFTER TRAINING**

Stacy A. Shackelford, MD\*, Evan Garofalo, Valerie Shalin, Kristy Pugh, Jason Pasley, DO\*,  
Babak Sarani, MD, FACS, FCCM\*, Mark Bowyer, Collin Mackenzie, MB, ChB  
University of Maryland

**Presenter:** Stacy A. Shackelford, MD

**Discussant:** Jeffrey E. Carter, MD, Wake Forest University School of Medicine

**Objectives:** Maintaining trauma specific surgical skills is a challenge for surgical training programs. An objective assessment of surgical skills is needed. We hypothesized that a reliable surgical skills assessment tool could detect knowledge and skill differences following a training intervention.

**Methods:** Surgical technical skills assessment metrics were developed by discussion with expert surgeons, video review of 10 experts performing four trauma specific procedures on cadavers, and a consensus conference. We then tested knowledge and skill metrics in 12 surgical residents (year 3-5) before and 2 weeks after skills training with the Advanced Surgical Skills for Exposure in Trauma course. Three components of performance were assessed: knowledge (anatomic and management), procedural steps, and technical skills. Performance scores were calculated as a percentage of expert surgeon performance points. A Trauma Readiness Index was created reflecting scores in each category and procedure time. Wilcoxon paired t was used to examine statistical significance at  $\alpha < 0.05$ .

**Results:** Trauma Readiness Index for three vascular exposures and lower extremity fasciotomy improved by 14% after training. The skill most improved by 1-day skills training was procedural steps with mean score increased 21%. Technical skill improved 12%. Overall knowledge improved 3%, with an 18% improvement in anatomic knowledge and 2% increase in management knowledge. Time to complete procedures decreased 4.3 minutes (13.4 to 9.1 min).

**Conclusions:** A detailed surgical skills assessment is a valuable tool to assess surgical training. The measurement tool detected improvements in procedural steps and anatomic knowledge taught during a 1-day course. The tool also detected improvements in technical skills and management normally acquired during the course of residency training. Future applications will include assessing specific skills during various stages of residency training.

Surgical Skills Assessment Scores						
	Pre-training		Post-training			
	Mean	Std Dev	Mean	Std Dev	Improvement	P-value
Knowledge score*						
• Overall	50	13	53	14	3	0.013
○ Anatomic	50	16	68	12	18	0.00001
○ Management	43	17	45	15	2	0.044
Technical skills score*	59	18	71	17	12	0.0001
Procedure steps score*	46	23	67	16	21	0.0000001
Time (minutes)	13.4	5.9	9.1	4.5	-4.3	0.000001
Trauma Readiness Index*	50	12	64	10	14	0.0001
*Scores represent the percentage of expert surgeon performance skills found in residents						



January 16, 2015

Paper 27

8:00 am

**THE IMPACT OF A MULTIDISCIPLINARY SAFETY CHECKLIST ON ADVERSE PROCEDURAL EVENTS DURING BEDSIDE BRONCHOSCOPY-GUIDED PERCUTANEOUS TRACHEOSTOMY**

Joshua P. Hazelton, DO\*, Erika Orfe, Anthony Colacino, Krystal Hunter, Mary Lachant,  
Lisa Capano-Wehrle, MPH, Mark J. Seamon, MD\*  
Cooper University Hospital

**Presenter:** Joshua P. Hazelton, DO

**Discussant:** Bradley M. Dennis, MD, Vanderbilt University Medical Center

**Objectives:** Bedside procedures are seldom subject to the same safety precautions as OR procedures. Since July 2013, we have performed a multidisciplinary checklist prior to all bedside bronchoscopy-guided percutaneous tracheostomy (BBPT) insertions. We hypothesized that the implementation of this checklist before BBPT would decrease adverse procedural events.

**Methods:** A prospective study of all patients who underwent BBPT after checklist implementation (PostCL, 2013-2014, n=63) at our Level-I Trauma Center were compared to all patients (retrospectively reviewed historical controls) who underwent BBPT without the checklist (PreCL, 2010-2013, n=184). Exclusion criteria included age <16, OR and open tracheostomy. The checklist included both a procedural and timeout component with the trauma technician, respiratory therapist, nurse and surgeon. Demographics and variables focusing on BBPT risk factors were compared. Variables associated with the primary endpoint, adverse procedural events (Fig 1), during univariate analysis were utilized in the multivariate (MVLRL) model. A  $p \leq 0.05$  was significant.

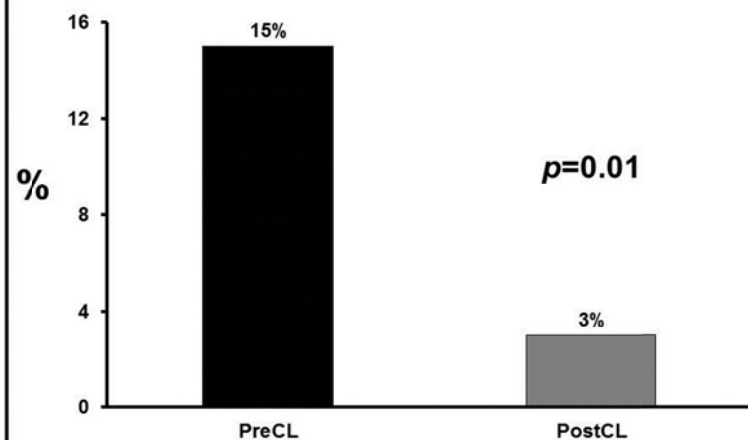
**Results:** Of 247 study sample patients, no difference existed in BMI, baseline MAP, duration or mode of mechanical ventilation, cervical spine or maxillofacial injury, or prior neck surgery between Pre and PostCL BBPT patients. PreCL patients were younger ( $48 \pm 20$  vs.  $57 \pm 21$  yrs;  $p < 0.01$ ), but more often had adverse procedural events than PostCL patients (Fig 2). After adjusting for age, vitals, BBPT risk factors, and ICU duration after BBPT, MVLRL determined that performing the safety checklist alone was independently associated with a 580% reduction in adverse procedural events (OR 5.8,  $p = 0.02$ ).

**Conclusions:** Our results suggest that the implementation of a multidisciplinary safety checklist similar to those used in the OR would benefit patients during invasive bedside procedures.

### Figure 1. Studied Adverse Procedural Events

- Decrease in O2 saturation to <85% or decrease >10% of baseline
- Decrease in MAP to <60mmHg or decrease >20% of baseline
- Need for initiation of IV vasopressors or antiarrhythmics
- Conversion to open tracheostomy
- Loss of airway
- Death

Figure 2. Adverse Procedural Events during BBPT



Scientific Session IV-B - Performance Improvement

January 16, 2015

Paper 28

8:20 am

**MAINTAINING AN OPEN ICU BED FOR RAPID ACCESS TO THE TRAUMA INTENSIVE CARE UNIT IS COST EFFECTIVE**

Lisa J. Fryman, BSN, Cynthia Talley, MD\*, Paul A. Kearney, MD\*  
University of Kentucky

**Presenter:** Lisa J. Fryman, BSN

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

**Objectives:** Our hypothesis is that a charge nurse without an assignment will address the potential constraints of staffing and bed availability in Trauma ICU (TICU) with potential cost savings and good clinical outcomes.

**Methods:** A charge nurse without an assignment was implemented in the TICU. All level 1 activations admitted directly to the ICU for the study pre (n = 303) and post (n=261) implementation were examined. Exclusion criteria were as follows: patients taken directly to operating room from the ED, deaths within 24 hours of admission, severe head injuries (AIS > 4), and level 2 trauma activations. We then examined the process for cost effectiveness.

**Results:** The two groups did not differ significantly: age (42.5 +/- SD 17.8), gender (71.1% male), and injury severity score (14.9 +/- SD 10.5). Patients transferred to TICU (n = 245) experienced a decrease in ED LOS from 4:17 to 2:34 average hours (t-test p < .001). Patients transferred to TICU had a decreased mean ICU LOS 7.2 to 5.6 days (t-test p = .207) and total LOS 15.3 to 12.1 (t-test p = .133). The LOS decrease occurred despite a small increase in ISS (15.7 to 18.4). The O/E mortality showed an insignificant difference of 0.87 pre- (z-score of 7.2353, chi trend <.0001) to 0.92 post (z-score 3.3026, chi trend<.0001) implementation groups. Nursing productivity showed an increase of 1 FTE pre and post-implementation at a rate of \$624/day for an average ICU nurse at our institution. The ICU LOS savings of 1.4 days at a rate of \$1144 average ICU daily cost of room and board totaled \$1601/patient. The decreased ICU LOS dollars minus the increase nurse pay results in an overall savings of \$977 per patient.

**Conclusions:** Rapid access to the TICU made possible by the charge nurse without an assignment has a potential cost savings without adversely affecting patient outcomes.

## Notes



January 16, 2015

Paper 29

8:40 am

**PEER-TO-PEER PHYSICIAN FEEDBACK: IMPROVING ADHERENCE WITH BLOOD  
TRANSFUSION GUIDELINES IN THE SURGICAL INTENSIVE CARE UNIT**

Daniel Dante Yeh, MD\*, Leily Naraghi, Andreas Larentzakis, Nathan Nielsen, Walter Dzik, Edward Bittner, Yuchiao Chang, PhD, David King, MD\*, George Velmahos, MD, PhD, MSED  
Massachusetts General Hospital

**Presenter:** Daniel Dante Yeh, MD

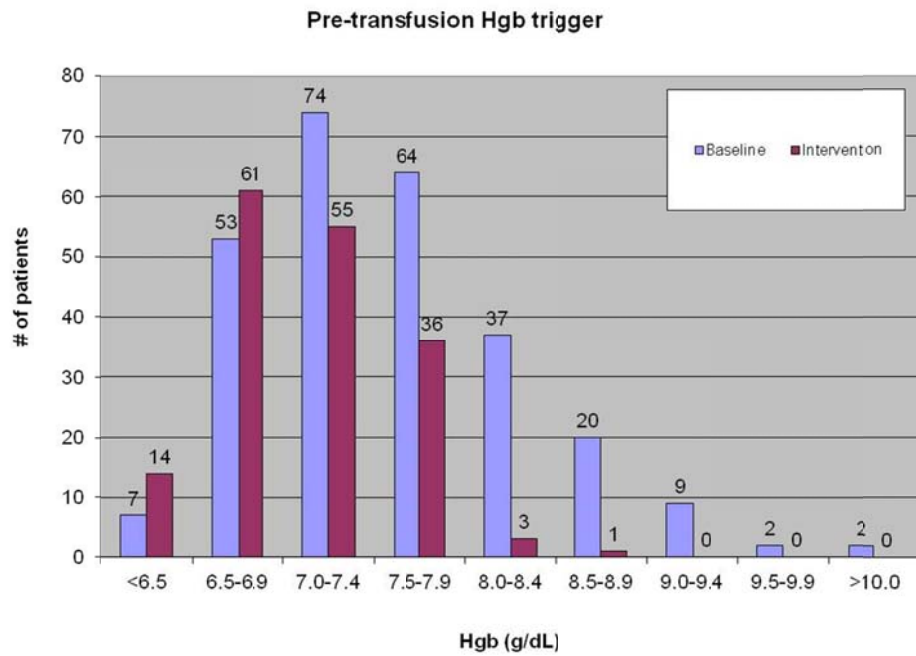
**Discussant:** Laura J. Moore, MD, University of Texas Health Science Center at Houston

**Objectives:** We aim to use a multi-modal intervention, founded on peer-to-peer education and monthly feedback, to increase adherence to restrictive red blood cell (RBC) transfusion guidelines without increasing morbidity.

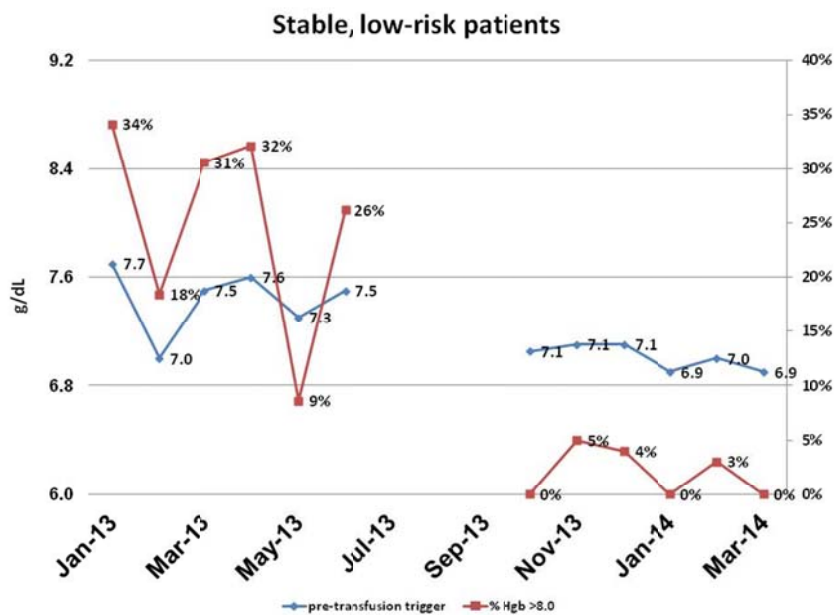
**Methods:** We conducted a prospective interventional study with retrospective control in our tertiary care center. For the 6-month baseline period (from 1/1/13 to 6/31/13) and the 6-month intervention period (from 10/1/13 to 3/31/14), all RBCs transfused in the surgical intensive care unit (SICU) were tracked daily and examined for pre-transfusion hemoglobin (Hgb) trigger (TRIG). During the intervention, if patients were transfused outside of established hospital guidelines, the ordering clinician received email notification and education from a surgeon colleague within 72 hours of transfusion. The independent t-tests and chi-square tests were used for statistical analysis. A p-value of <0.05 was considered significant.

**Results:** For stable, low-risk patients, the average total monthly RBCs transfused decreased 35%, from 47 to 31 units ( $p=0.11$ ), mean TRIG decreased from 7.4 g/dL to 7.0 g/dL ( $p<0.001$ ), % of transfusions with TRIG>8.0 g/dL decreased from 23% to 2% ( $p = 0.002$ ). The overtransfusion rate (post-transfusion Hgb>10.0) decreased from 11% to 3% ( $p=0.001$ ). There was no significant difference in maximum lactate, maximum troponin, median SICU length of stay (LOS) or hospital LOS. Although SICU discharge Hgb and hospital discharge Hgb were significantly lower in the intervention period (8.6 vs. 8.2,  $p=0.01$  and 9.0 vs. 8.6,  $p=0.02$ ), 30-day readmission rate and mortality were not significantly different.

**Conclusions:** A blood management program founded on peer-to-peer review was effective in improving adherence to guideline recommendations for transfusion of RBCs to stable, low-risk anemic SICU patients without an increase in morbidity.



Histogram of pre-transfusion hemoglobin triggers in stable, low-risk patients



Effect of intervention on pre-transfusion hemoglobin triggers and % of transfusions given for hemoglobin trigger >8.0 g/dL

January 16, 2015  
Paper 30  
9:00 am

**ALL THE BANG WITHOUT THE BUCKS: DEFINING ESSENTIAL POINT-OF-CARE TESTING FOR TRAUMATIC COAGULOPATHY**

Michael Goodman, MD\*, Amy Makley, MD\*, Dennis Hanseman, PhD,  
Timothy A. Pritts, MD, PhD\*, Bryce R.H. Robinson, MD\*  
University of Cincinnati

**Presenter:** Michael Goodman, MD

**Discussant:** Martin A. Schreiber, MD, Oregon Health and Science University

**Objectives:** Rapid assessment and treatment of coagulopathy reduces post-injury morbidity and mortality. Although thromboelastography (TEG) may be more accurate and efficient than conventional coagulation tests, it requires significant financial and personnel investments. We hypothesized that point-of-care INR (POC INR) may provide a rapid and accurate alternative to TEG.

**Methods:** A retrospective review of sequential trauma patients who underwent paired POC INR and TEG testing immediately upon presentation to a Level I trauma center from July 2012 to December 2013 was performed. POC INR was correlated with TEG values (*R*-value, *K*-time,  $\alpha$ -angle, MA, LY30) and transfusion requirements. Vital signs, admission labs, and injury severity were analyzed. POC INR testing was performed using i-STAT. All results and correlations (*r*) noted were significant with  $p < 0.05$ .

**Results:** We identified 628 trauma patients with concomitant TEG and POC INR testing. Median ISS was 13, 20% were in shock (base deficit [BD]  $\leq -5$ ), 21% were transfused, and 11% died. POC INR correlated with all TEG values, with improved correlations for patients in shock (Table). Furthermore, POC INR significantly correlated with packed red blood cells ( $r = 0.1$ ) and plasma ( $r = 0.11$ ) transfused in the first 4 hours and platelets and cryoprecipitate given in the first 24 hours ( $r = 0.12$  for both). TEG *K*-time, MA, and LY30, but not *R*-value, had similar correlations for blood products transfused. Test duration was 2 minutes for POC INR, compared to at least 30 minutes for TEG. Cohort charges for POC INR were estimated at \$21,980 vs. \$396,896 for TEG.

**Conclusions:** POC INR testing is faster and more cost effective than TEG. In addition, POC INR correlates not only with TEG values, but also with acute blood product transfusions. POC INR may provide a practical alternative for rapid coagulopathy assessment in the trauma patient at institutions that lack TEG capability.

TEG Parameter	All patients	Patients with BD $\leq$ -5
R-value	0.26	0.49
K-time	0.32	0.77
$\alpha$ -angle	-0.23	-0.61
MA	-0.27	-0.65
LY30	0.31	0.5

Correlations of POC INR to TEG values; BD = base deficit, MA = maximum amplitude; all correlations  $p < 0.05$

January 16, 2015

Paper 31

9:20 am

**OPERATIVE DELAY TO LAPAROSCOPIC CHOLECYSTECTOMY:  
RACKING UP THE COST OF HEALTHCARE**

Diane Schwartz, MD\*, Adil A. Shah, MD, Lauren Nicholas, Catherine Velopulos, MD, MHS\*,  
David T. Efron, MD\*, Eric B Schneider, Cheryl Zogg, Adil H. Haider, MD, MPH\*  
Johns Hopkins School of Medicine

**Presenter:** Diane Schwartz, MD

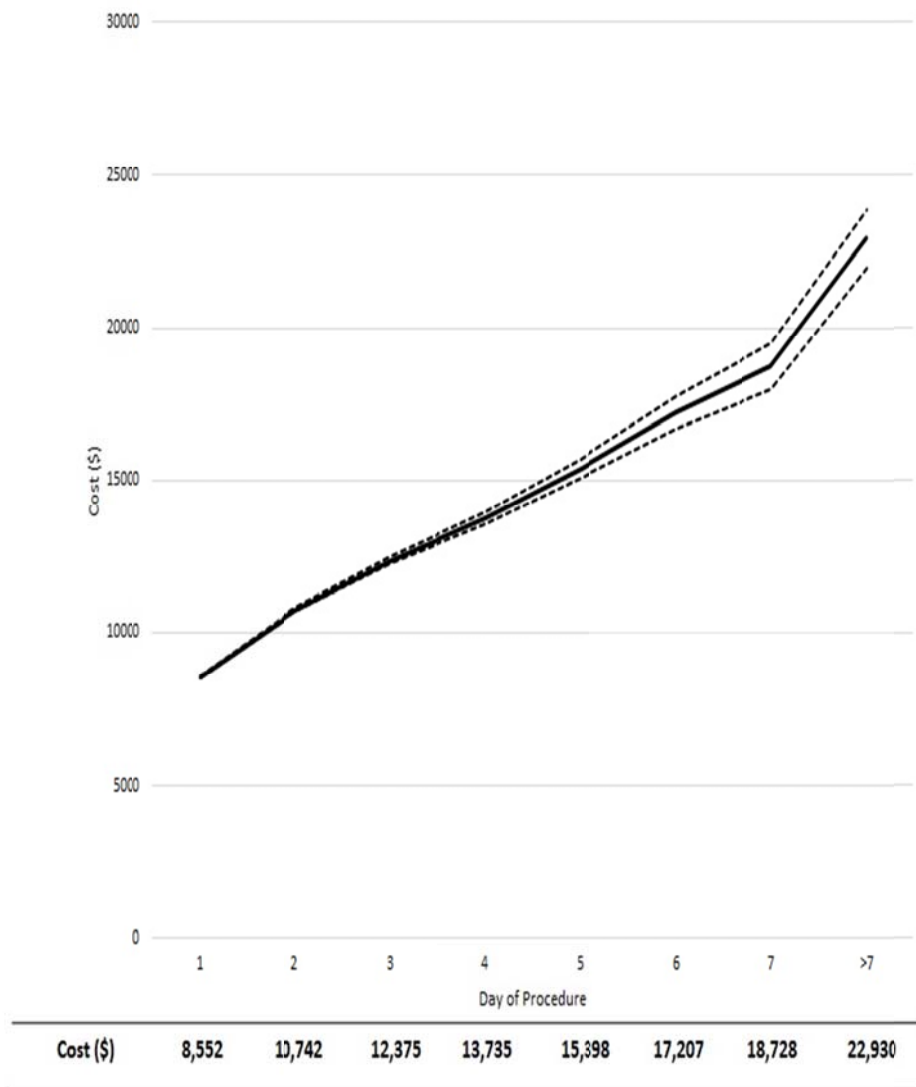
**Discussant:** Douglas J.E. Schuerer, MD, Washington University School of Medicine

**Objectives:** Healthcare providers are increasingly focused on cost containment. One potential target for cost containment is in-hospital management of acute cholecystitis. Despite debate in the literature on optimal timing to operation, it is likely that patients are being delayed longer than necessary. We sought to determine the cost consequences of delaying operative management.

**Methods:** The Nationwide Inpatient Sample (2003-2011) was queried for adult patients ( $\geq 16$  years) that underwent laparoscopic cholecystectomy for a primary diagnosis of acute cholecystitis. Patients that underwent open procedures or endoscopic retrograde cholangiopancreatography (ERCP) were excluded. Generalized linear models were employed to analyze costs for each day's delay in surgery. The multivariate analysis adjusted for patient demographics, hospital descriptors, Charlson comorbidity index, length of stay, and outcomes.

**Results:** We analyzed 191,032 records. Around 65% of patients underwent surgery within 24 hours of admission. The average cost of care for same-day surgeries was \$11,087. Costs increased by 22% for surgeries taking place on the second day (\$13,526), by 37% on the third day (\$15,243), by 52% on the fourth day (\$16,822), by 64% on the fifth day (\$18,196), by 81% on the sixth day (\$20,125), and by 100% on the seventh day (\$22,250) of hospitalization, when compared to the cost of care for procedures performed within 24 hours of admission. Subset analysis of patients discharged  $\leq 24$  hours of surgery demonstrated similar trends.

**Conclusions:** After controlling for patient- and hospital-related factors, we noted significant cost for every day that operation was delayed. Practice patterns should be modified to optimize timing to operation to prevent unnecessary delays.



*\*Adjusted for age, gender, race, insurance status, income quartile, procedure day, geographical region, hospital location and teaching status, hospital bed size, length of stay after the procedure, weekend admission, Charlson Comorbidity Index and mortality*

Adjusted cost of delay per day for patients discharged within 24 hours of surgery

January 16, 2015

Paper 32

9:40 am

**THE IMPACT OF WORK SCHEDULE AND FATIGUE ON OUTCOME OF ACUTE CARE SURGICAL CASES**

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**Presenter:** Michael K. Dalton, MPH

**Discussant:** Alicia R. Privette, MD, Medical University of South Carolina

**Objectives:** The optimal work schedule for acute care surgeons has not been defined. Surgeon fatigue may impact patients undergoing operation at night making a night float system for acute care surgeons more ideal. Prior studies examining surgeon fatigue have had mixed results.

**Methods:** We performed matched retrospective cohort study of all patients undergoing operative intervention at night (starting after 11PM) by acute care surgeons at a single institution over a 2 year period. Cases were matched based on case complexity, age and sex to daytime cases. Other confounders including comorbidities (Charlson comorbidity index) and presenting characteristics, surgical complications, all complications and mortality were then abstracted from the medical record. Outcomes differences between day and night cases were compared. Univariable and multivariable logistic regression was used to identify statistical differences.

**Results:** One hundred fifteen night cases were matched 1:1 to daytime cases. Average age was 41 and 58% were male. Both groups had similar degrees of comorbidity and those operated at night were more acutely ill with trends toward more hypotension and meeting more criteria for sepsis (table). There was no evidence of a difference in outcome with respect to mortality, complications including infections and anastomotic leak, readmission and need for transfusion (table). After controlling for comorbidity and presenting characteristics the odds ratio for mortality after a day case was closer to unity and remained non-significant (0.45, 95% CI 0.11 – 1.90). The odds ratio for complications was similarly near unity and not-significant (0.92, 95% CI 0.52 – 1.63).

**Conclusions:** Acute care surgeons working a traditional call period after a day of work can perform emergency cases with equal outcomes despite a more ill patient cohort. A night float system for acute care surgeons may not impact outcomes.

	Day Cases (n, %)	Night Cases (n, %)	p, OR (95% CI)
Presenting hypotension	6 (5.2)	14 (12.2)	0.061, 0.40 (0.15 – 1.07)
Presenting Sepsis	39 (33.9)	53 (46.1)	0.060, 0.60 (0.35 – 1.02)
Charlson Index (value)	2.11	2.30	p=0.529
Mortality	3 (2.61)	8 (6.96)	0.122, 0.36 (0.09 – 1.39)
Any Complication	38 (33.0)	44 (38.3)	0.408, 1.36 (0.63 – 2.95)
Infectious Complication	19 (16.5)	22 (19.1)	0.605, 0.837 (0.43 – 1.65)
Anastomotic leak	2 (1.7)	2 (1.7)	0.999, 1.00 (0.14 – 7.22)
30 day readmission	17 (14.8)	13 (11.3)	0.434, 1.36 (0.63 – 2.95)
Intra-op transfusion	11 (9.7)	7 (7.4)	0.568, 1.34 (0.50 – 3.61)