

VENTILATOR-ASSOCIATED PNEUMONIA RATES AT MAJOR TRAUMA CENTERS COMPARED TO A NATIONAL BENCHMARK: A MULTI-INSTITUTIONAL STUDY OF THE AAST

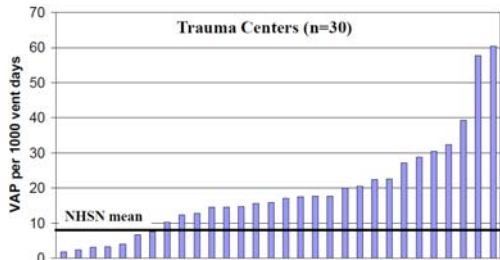
Christopher P Michetti, MD*, Samir M Fakhry, MD*, Pamela L Ferguson, PhD, Alan Cook, MD, Forrest O Moore, MD*, Ronald Gross, MD*. Inova Fairfax Hospital.

Invited Discussant: Karen Brasel

Introduction: Ventilator-associated pneumonia (VAP) rates reported by the National Healthcare Safety Network (NHSN) are used as a benchmark and quality measure, yet different rates are reported from many trauma centers. This multi-institutional study was undertaken to elucidate VAP rates at major trauma centers.

Methods: VAP rates, diagnostic methods, institutional and aggregate patient data were collected retrospectively from a convenience sample of trauma centers for 2008 & 2009, analyzed with descriptive statistics, and compared to the latest NHSN data, 2006 - 2008.

Results: 33 Level I & II centers submitted data (table). VAP was diagnosed clinically in 59% and by quantitative bacteriology in 41% of centers. VAP patients had median ISS of 26.3 and mean ICU length of stay of 21 days. Mortality of VAP patients was 12.0% and 50.4% of patients with VAP had a traumatic brain injury. Individual center VAP rates/1000 ventilator days (figure) were highly variable; 76.6 % of centers are above NHSN's mean.



Conclusion: VAP rates at large trauma centers are generally higher than those reported by NHSN and vary significantly among centers. Available data are insufficient to set benchmarks,

and application of a single benchmark to all centers may be inappropriate. Prospective analysis of a larger data set is warranted, with attention to injury severity, diagnostic method used, size of trauma center, and other risk factors specific to trauma patients.

	Study	NHSN
# Centers	33	41
# VAP patients (n=30)	2029	1173
# Ventilator days (n=30)	109,939	145,294
VAP rate (mean, n=30)	18.5	8.1
VAP rate (median, n=30)	16.5	N/A
Median VAP rates in patients with:		
Clinical VAP dx (n=18)	14.7	N/A
Bacteriologic dx (n=12)	17.6	N/A
Blunt trauma (n=23)	2008=17.3, 2009=15.5	N/A
Penetrating trauma (n=23)	2008=14.4, 2009=10.1	N/A

GET ON THE NERVE: PREVENTING ORGAN DYSFUNCTION BY PHARMACOLOGICALLY INCREASING VAGAL OUTPUT

Michael Krzyzaniak, MD, Yan Ortiz Pomales, MD, Nicole Lopez, MD, Gerald Cheadle, BS, Luiz Reys, MD, Ann Marie Hageny, BS, Brian Eliceiri, PhD, Andrew Baird, PhD, Vishal Bansal*, MD, Raul Coimbra*, MD, PhD. University of California San Diego.

Invited Discussant: Basil A. Pruitt, Jr.

Introduction: We have shown the role of electrical vagus nerve stimulation (VNS), both pre- and post-injury, as a means to protect against gut and lung injury. However, a pharmacologic approach would be ideal to the trauma population. Guanylylhydrazone compounds, when administered both IV and intracerebroventricularly, increase efferent vagus nerve output and reduce systemic inflammation in endotoxemia. We hypothesized that a new generation guanylylhydrazone, CPSI-121, administered post-burn would prevent intestinal mucosal barrier breakdown.

Methods: Male balb/c mice were subjected to a full-thickness, 30% TBSA steam burn. Efficacy of CPSI-121 was tested against (VNS) post-burn. The use of surgical vagotomy was used to demonstrate the necessity of an intact neuro-enteric axis in gut injury prevention after drug administration. Gut barrier dysfunction was quantified by permeability to 4kDa FITC-Dextran. Gut injury was assessed by histologic evaluation. Tight junction protein expression (ZO-1 and occludin) was characterized by immunofluorescence.

Results: Cervical VNS and IV CPSI-121 administration significantly reduced the permeability to 4kDa FITC-Dextran compared to burn ($18.75 \pm 6 \mu\text{g/ml}$ and $13.75 \pm 3.1 \mu\text{g/ml}$ vs. $182.95 \pm 20 \mu\text{g/ml}$; $p < 0.04$). Abdominal vagotomy eliminated the protective effects of both VNS and CPSI-121. ZO-1 and occludin expression was similar to sham in VNS and CPSI-121 treated animals, but significantly altered in burn-vagotomized animals.

Histological examination documented mucosal integrity similar to sham in VNS and CPSI-121 treated animals. Vagotomy produced histological changes similar to burn.

Conclusion: CPSI-121 is an effective pharmacologic vagomimetic that protects the intestinal mucosal barrier from breakdown after severe burn similar to direct electrical VNS. This could represent a non-invasive therapy to prevent end-organ dysfunction after trauma that would be administered during resuscitation.

Session 1

Paper 3 1:30 PM

MANAGEMENT AND OUTCOMES OF RETAINED HEMOTHORAX AFTER TRAUMA: AN AAST MULTICENTER PROSPECTIVE OBSERVATIONAL TRIAL

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Invited Discussant: C. Clay Cothren

Introduction: The natural history and optimal management of retained hemothorax (RH) after chest tube (CT) placement is unknown. The intent of our study was to determine practice patterns utilized and identify independent predictors of the need for thoracotomy.

Methods: An AAST multicenter prospective observational trial was conducted, enrolling patients with placement of CT within 24 hours of trauma admission and RH on subsequent computed tomography of the chest. Demographics, interventions and outcomes were analyzed. Logistic regression analysis was utilized to identify the independent predictors of successful intervention for each of the management choices chosen and complications.

Results: RH was identified in 328 patients from 20 centers. VATS was the most commonly utilized initial procedure in 33.5%, but 26.5% required two and 5.4% required three procedures to clear RH or subsequent empyema. Thoracotomy was ultimately required in 20.4%. The strongest independent predictor of successful observation was estimated volume of RH = 300 cc [OR 3.7 (2.0, 7.0), $p < 0.001$]. Independent predictors of successful VATS as definitive treatment were absence of an associated diaphragm injury [OR 4.7 (1.6, 13.7), $p = 0.005$], use of peri-procedural antibiotics for thoracostomy placement [OR 3.3 (1.2, 9.0), $p = 0.023$] and volume of RH = 900 cc [OR 3.9 (1.4, 13.2), $p = 0.03$]. No relationship between timing of VATS and success rate was identified.

Independent predictors of the need for thoracotomy included diaphragm injury [OR 4.9 (2.4, 9.9), $p < 0.001$], RH > 900 cc [OR 3.2 (1.4, 7.5), $p = 0.007$] and failure to give peri-procedural antibiotics for initial CT placement [OR 2.3 (1.2, 4.6), $p = 0.015$]. The overall empyema and pneumonia rates for RH patients were 26.8% and 19.5%, respectively.

Conclusion: Retained Hemothorax in trauma is associated with high rates of empyema and pneumonia. VATS can be performed with high success rates, although optimal timing is unknown. Approximately 25% of patients require at least two procedures to effectively clear RH or subsequent pleural space infections and 20.4% require thoracotomy.

**ADMISSION RAPID THROMBEOLASTOGRAPHY (R-TEG) PREDICTS
DEVELOPMENT OF PULMONARY EMBOLISM IN TRAUMA PATIENTS**

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Jeanette Podbielski, BSN, Rosemary A Kozar*, MD, PhD, Charles E Wade, PhD, John B
Holcomb*, MD. University of Texas Health Science Center-Houston.

Invited Discussant: Preston Miller

Background: Injury leads to dramatic disturbances in coagulation with increased risk of bleeding followed by a hypercoagulable state. A comprehensive assessment of these coagulation abnormalities can be measured and described by thromboelastography. The purpose of this study was to identify if admission Rapid-TEG (r-TEG) could identify patients at risk of developing pulmonary embolism (PE) during their hospital stay.

Methods Patients admitted between 10/09-09/10 who met criteria for our highest-level trauma activation and were transported directly from the scene were included in the study. PE defined as clinically suspected and CT-angiography confirmed pulmonary embolic. We evaluated r-TEG values with particular attention to the maximal amplitude (mA) parameter that is indicative of overall clot strength. Demographics, vital signs, injury severity and rTEG values were then evaluated. In addition to rTEG values, gender and ISS were chosen a priori for developing a multiple logistic regression model predicting development of PE

Results: rTEG was obtained on 1225 consecutive trauma activations. Of these, 2.7% (33) developed PE, 97.3% (1192) did not develop PE. PE and non-PE patients were similar in age, vitals, and PT, PTT, and platelet count. PE patients were more likely to be female (42% vs. 25%, $p<0.001$), have higher mA values (median 70 vs. 64, $p<0.001$), higher ISS (median 22 vs. 13, $p<0.001$) and were all blunt mechanism (100% vs. 71%, $p<0.001$). Controlling for gender and ISS, elevated mA at admission was predictive of PE.

	Odds ratio	95% confidence interval	p-value
Admission mA value >65	6.26	2.172, 17.828	<0.001
Injury severity score (ISS)	1.08	1.042, 1.114	<0.001
Male gender	0.68	0.279, 1.653	0.394

Conclusion: Admission r-TEG (using mA > 65) can identify patients with an increased risk of in-hospital PE. Further studies are needed to determine if alternative anticoagulation strategies should be employed for these high-risk patients.

RECOMBINANT HUMAN SOLUBLE THROMBOMODULIN IMPROVES MORTALITY AND RESPIRATORY DYSFUNCTION IN PATIENTS WITH SEVERE SEPSIS

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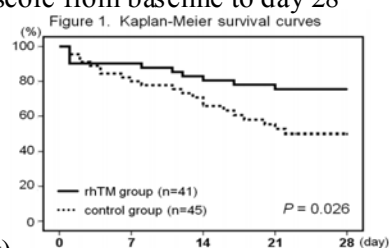
Invited Discussant: Saman Arbabi

Introduction: Patients with severe sepsis fall into a vicious cycle between the coagulation and inflammatory systems and result in multiple organ dysfunction or even death. So, it is necessary at the early stage to control the cycle for improving the outcome. The aim of this study was to examine the impact of recombinant human soluble thrombomodulin (rhTM) to mortality and organ dysfunction in patients with severe sepsis.

Materials and Methods: Eighty-six consecutive patients with sepsis-induced DIC who needed ventilator management were included in this study from Jan. 2006 to Jan. 2011. DIC was diagnosed by using the ISTH criteria for overt DIC. All patients were treated according to the strategy of Surviving Sepsis Campaign Guidelines. Initial 45 patients were not treated with rhTM (historical control group). The following 41 patients were given rhTM (380U/kg/day) for 6 days (rhTM group). Patients were followed for 28 days after the entry. In addition, SOFA score was recorded on day 0, 1, 2, 3, 7, 14, and 28.

Results: As baseline characteristics, the severity of illness, as indicated by APACHE II and SOFA scores, was significantly higher in the rhTM group compared to the control group. Nevertheless, the 28-day mortality rate in the rhTM group was significantly lower compared to that in the control group (22% vs. 47%, $P = 0.026$ by the log-rank test). There was a significant difference in the serial change of SOFA score from baseline to day 28 between the two groups, especially in respiratory component ($P = 0.032$ and $P = 0.034$, respectively, by repeated measures ANOVA). In the post-hoc test, SOFA score rapidly decreased on day 1 in the rhTM group as compared to the control group ($P < 0.05$ by Bonferroni test).

Conclusions: We found that rhTM has a significant beneficial effect on mortality in patients with sepsis-induced DIC. We also demonstrated that rhTM administration clearly made respiratory function better and improved SOFA score.



CHANGES IN LYMPH PROTEOME INDUCED BY HEMORRHAGIC SHOCK: THE APPEARANCE OF DAMAGE-ASSOCIATED MOLECULAR PATTERNS

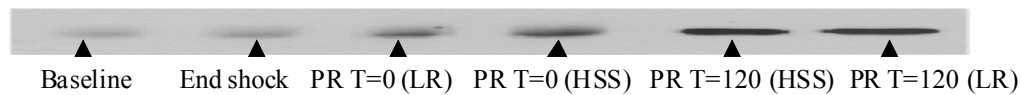
Lawrence N Diebel*, MD, Charles Lucas*, MD, Anna Ledgerwood, MD*, David M Liberati, MS. Wayne State University.

Invited Discussant: Edwin Deitch

Introduction: Damage-associated molecular patterns (DAMPs) released from host tissue following trauma and hemorrhagic shock (HS) have been shown to activate PMNs and lead to acute lung injury and SIRS. The avenue by which DAMPs reach the circulation is unclear; however post-HS lymph has been shown to contain biologically active mediators. We therefore studied the time course of DAMP detection in systemic lymph and the effect of isotonic vs. hypertonic resuscitation on DAMPs production and PMN activation *in vivo*.

Methods: A canine HS/hind limb lymph cannulation model was used. Animals were bled to a MAP of 40 mmHg and were resuscitated with shed blood plus equivalent amounts of Na⁺ as either Lactated Ringers (LR) solution or 7.5% saline (HSS). Lymph samples were collected at baseline, end-shock, and at various times post-resuscitation (PR). DAMPs were isolated from lymph samples and detected by Western blot analysis of the chromatin-associated protein high-mobility group box 1 (HMGB1). Activation of naïve PMNs was indexed by mitogen-associated protein kinase (MAPK) phosphorylation.

Results: Typical Western blot comparing DAMPs in different resuscitation groups.



	DAMPs	PMN activation
Baseline	0.26 ± 0.04	0.21 ± 0.02
Post-resus. T=0 (LR)	0.44 ± 0.05	0.49 ± 0.03
Post-resus. T=0 (HSS)	0.49 ± 0.03	0.52 ± 0.04
Post-resus. T=120 (LR)	1.71 ± 0.06*	1.84 ± 0.04*
Post-resus. T=120 (HSS)	1.94 ± 0.06*#	2.15 ± 0.05*#

Relative density normalized to β-actin, Mean±S.D. (N = 4 for each group)*p<0.001 vs. all other groups, #p<0.001 vs. LR at same timepoint.

Conclusions: Lymph represents an important avenue for the delivery of DAMPs into the systemic circulation following HS. HSS lead to a significant increase in DAMPs production in this model. This finding may account for the conflicting data regarding the salutary effects of HSS resuscitation noted in clinical vs. experimental shock studies.

HOST SUSCEPTIBILITY TO GRAM NEGATIVE PNEUMONIA FOLLOWING LUNG CONTUSION

Vladislav A Dolgachev, PhD, Bi Yu, PhD, Julia M Reinke, MD, Krishnan Raghavendran*, MD, Mark R Hemmila*, MD. University of Michigan.

Invited Discussant: Frederick Moore

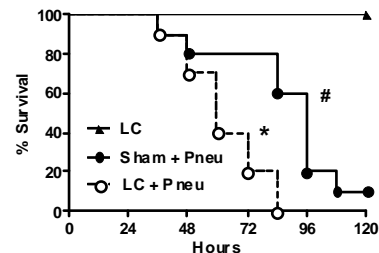
Objective: Lung contusion (LC) induces inflammation with high local concentrations of pro-inflammatory mediators stimulating chemotaxis and activation of neutrophils. LC is also a risk factor for pneumonia, however the reason for this increased susceptibility is not known. We hypothesize that LC creates acute changes in the host pulmonary innate immune system that leads to vulnerability from a “second” hit bacterial infection.

Methods: Female C57Bl/6 mice underwent lung contusion injury at time 0 hrs. At 6 hrs mice were inoculated intratracheally with 500-1000 CFU of *Klebsiella pneumoniae* (LC+Pneu) or vehicle (LC). Control animals underwent a sham LC followed by pneumonia (Sham+Pneu). Bronchoalveolar lavage fluid (BAL), lung tissue, and serum specimens were collected at 24hrs. Lung bacteria levels were quantified by serial dilution, plating and counting CFU's. Cytokines were assayed by cytometric bead array. Cell type identification and quantification was done using flow cytometry.

Results: 72 hr survival was markedly different for the LC, Sham+Pneu and LC+Pneu groups (100%, 80%, 20%, *p<0.05 vs Sham+LC, #p<0.05 vs LC).

LC+Pneu animals had decreased pulmonary bacterial clearance compared to the Sham+Pneu group (4×10^7 vs. 8×10^6 CFU's, p<0.05,). BAL levels of IL-1 β , IL-6, and KC were all significantly elevated in LC+Pneu mice compared to the Sham+Pneu group. Conversely the Sham+Pneu mice had increased levels of total cells, macrophages, and neutrophils in BAL compared to the LC+Pneu group. LC+Pneu animals demonstrated a rise in the level of IL-10 in BAL (116 vs. 7 pg/mL, p<0.05) and serum (920 vs. 90 pg/mL, p<0.05) compared to LC.

Conclusions: Acute inflammation following LC acts as a sump leading to consumption of inflammatory cells necessary to combat Gram negative bacteria. This leads to decreased bacterial clearance and increased mortality from pneumonia.



**PROSPECTIVE EVALUATION OF SELECTIVE NONOPERATIVE
MANAGEMENT OF TORSO GUNSHOT WOUNDS: WHEN IS IT SAFE TO
DISCHARGE?**

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Invited Discussant: Timothy Fabian

Background: Selective nonoperative management (NOM) has been increasingly utilized for patients who have sustained torso gunshot wounds (GSWs). The optimal observation time required to exclude a hollow viscus injury before discharge is not clear. The purpose of this study was to determine the safe period of observation prior to discharge.

Methods: After IRB approval, all patients aged ≥ 16 sustaining a torso GSW and undergoing a trial of NOM were prospectively enrolled (Jan 2009 to Jan 2011). Patient demographics, initial CT results, time to failure of NOM, operative procedures and outcomes were collected. Failure of NOM was defined as the need for operation.

Results: A total of 270 patients sustained a GSW to the torso. Of those, 25 (9.3%) died in the ED and were excluded leaving 245 available for analysis. Mean age was 26.4 ± 9.8 years (range 16-62), 92.7% (227) were male and mean Injury Severity Score was 11.3 ± 10.9 . Overall, 107 (43.7%) underwent immediate exploratory laparotomy based on clinical criteria (80.4% had peritonitis upon hospital admission, 15.0% hypotension, 3.7% evisceration and 0.9% unevaluable), and 138 patients (56.3%) underwent a trial of NOM. Of these, 8 (5.8%) failed NOM and underwent laparotomy (5 developed peritonitis and 3 hypotension). One patient had a non-therapeutic laparotomy (liver injury); the remainder had stomach (37.5%), colon or rectum (37.5%) or small bowel (12.5%). The mean time from admission to development of clinical or laboratory signs of NOM failure was 4.7 ± 5.3 hours (range 0.3-18.4 hs). All patients failed NOM within 24 hours of hospital observation.

Conclusions: In the initial evaluation of patients sustaining a GSW to the torso, clinical examination is essential in identifying those who will require emergency operation. For those undergoing a trial of NOM, all failures occurred within 24 hours of hospital admission, setting a minimum required observation period prior to discharge.

**RISK FACTORS FOR CENTRAL LINE-ASSOCIATED BLOODSTREAM
INFECTIONS IN THE ERA OF BEST PRACTICE**

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Invited Discussant: Tina Palmieri

Introduction: Reducing central line-associated bloodstream infections (CLABSI) improves care. Best practice aims to eliminate CLABSI. Despite this, CLABSIs still occur. This study was undertaken to identify risk factors for CLABSI in the era of best practice.

Hypothesis: Patients at risk for non-preventable CLABSI can be identified.

Methods: Critically ill surgical patients admitted between April 2008 and April 2010 to a non-trauma, general surgical ICU for ≥ 4 days that had a central line were studied. Patients with a CLABSI as cause for ICU admission were excluded. Patients who developed CLABSI (National Healthcare Safety Network definition) were compared to those who didn't. Hand hygiene, maximal sterile barriers, chlorhexidine scrub, avoidance of femoral vein, and proper catheter maintenance were emphasized. Variables collected included demographics, diagnosis, and severity of illness using APACHE IV methodology.

Student's t-test was used to compare continuous variables, chi-square test for categorical.

Results: Of 990 patients studied, 51 (5.2%) developed 59 CLABSIs. Mean time from ICU admission to CLABSI was 26 ± 26 days. The CLABSI group was more likely to be male (70% vs. 53%, $p < 0.05$), more critically ill on ICU admission (APACHE IV score 86.3 ± 21.0 vs. 65.3 ± 23.2 , $p < 0.01$; predicted mortality $35 \pm 22\%$ vs. $18 \pm 19\%$), more likely admitted to the emergency surgery service (49% vs. 21%, $p < 0.01$), be transferred from floor, step-down unit, or other facility for higher level care (56% vs. 33%, $p < 0.01$), be an ICU readmission (24% vs. 11%, $p < 0.01$), be admitted with abdominal sepsis as primary diagnosis (17% vs. 5%, $p < 0.01$), and be admitted with sepsis in general (22% vs. 8% $p < 0.01$). Multivariate analysis confirmed independence of the above variables. There were no differences between groups for age, history of AIDS, cirrhosis, COPD, or diabetes.

Conclusion: In the era of best practice, patients who develop CLABSI in a surgical ICU are clinically distinct from those who do not. These CLABSIs may be non-preventable, or related to underlying diagnosis, rather than caused by lack of proper precautions.

DAMAGE CONTROL LAPAROTOMY IN LOWER RISK TRAUMA PATIENTS: HELPFUL OR HARMFUL?

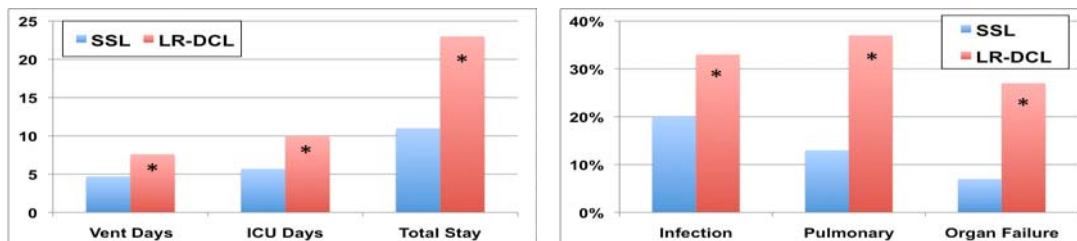
Matthew Martin*, MD, Quinton Hatch, MD, Bryan Cotton*, MD, John Holcomb, MD. Legacy Emanuel Hospital and University of Texas Health Science Center - Houston.

Invited Discussant: Raul Coimbra

Background: Damage control laparotomy (DCL) has become a widely used technique in severely injured patients. However, there is growing concern that DCL is being over-utilized. We sought to identify less severely injured patients who underwent DCL and to compare their outcomes to patients managed with a single-stage laparotomy (SSL).

Methods: Analysis of all trauma patients who underwent immediate laparotomy between 2004-2008. Risk modeling identified DCL patients that met all low risk criteria: SBP > 90, no severe head injury, no combined solid + hollow viscus injury or vascular injury. The low risk cohort (LR-DCL) was compared to a matched similarly injured cohort managed with SSL using uni and multi variate regression analysis.

Results: Among the 282 patients undergoing DCL, 62 (22%) met low risk criteria and were included in the LR-DCL group. There were 566 patients identified in the SSL group. There was no significant difference between groups for age, mechanism, ISS, associated injuries, base deficit, temperature, blood transfusion, solid organ injury, or bowel resection. The LR-DCL group had more hospital and ventilator days and increased complications (Figs, *= $p < 0.05$). This included a higher rate of bowel ischemia/perforation with LR-DCL (7% vs 0.7%). The use of DCL in the low risk group was independently associated with increased complications (OR 3.0, $p = 0.01$) and prolonged hospital stays (OR 9.6, $p < 0.01$).



Conclusions: DCL was associated with increased morbidity and resource utilization when applied to less severely injured patients. Further study is indicated to clarify populations that may be harmed or benefitted by abdominal damage control surgery.

LAPAROSCOPIC MANAGEMENT OF ACUTE SMALL BOWEL OBSTRUCTION: EVALUATING THE NEED FOR RESECTION

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Invited Discussant: Andrew Peitzman

Objective: Acute small bowel obstruction (SBO) is a common condition encountered by the on-call emergency surgeon. The role of laparoscopy in the management of SBO continues to be defined. This modality can be limited by dilated bowel and inadequate assessment of compromised tissue. This review was undertaken to determine the reliability of laparoscopic evaluation and the subsequent need for bowel resection.

Methods: A retrospective review of all patients surgically managed for acute SBO between July 2005 and July 2010 was conducted. The clinical presentation, CT findings, indications for surgery, type of intervention, need for re-operation, length of stay and outcomes were all abstracted.

Results: A total of 119 patients were surgically managed for acute SBO during this period, 64 with initial laparoscopy and 55 with an open procedure. 26 (41%) of the laparoscopy patients were converted to open, leaving 38 completed laparoscopically. Reasons for conversion included ischemia (6), dense adhesions (5), mass/tumor (5), exposure (5), enterotomy (4), and perforation (1). Of the completed group, 2 patients underwent bowel resection compared to 17 in the converted group (5% vs. 65 %, $p < 0.0001$). No patients in the completed group required a subsequent procedure for bowel resection. 23 (42%) patients in the open cohort required a resection. Length of stay was significantly reduced in the completed group (7.8 days) compared to the converted (11.0 days, $p = .01$) and open groups (11.3 days, $p = .001$). There were no deaths in any group during the period of study.

Conclusions: Overall, 32% of acute SBO's were managed solely with laparoscopy. No patients requiring a bowel resection were missed using this method of evaluation. Laparoscopic management should be considered as safe and effective initial therapy in most cases of acute SBO.

EVIDENCE BASED GUIDELINES ARE EQUIVALENT TO A LIBERAL CT SCAN PROTOCOL FOR INITIAL PATIENT EVALUATION BUT ARE ASSOCIATED WITH DECREASED CT SCAN USE, COST, AND RADIATION EXPOSURE

Eric J Mahoney, MD, Suresh Agarwal*, MD, Stephan Anderson, MD, Alan Sherburne, MD, Dinesh Kurian, BS, Peter A Burke*, MD. Boston Medical Center.

Invited Discussant: Robert Mackersie

Introduction: We hypothesized trauma patient evaluations utilizing evidence-based treatment guidelines (EBG), which include serial examinations and limited CT scans in an established trauma center, would be associated with equivalent outcomes but with decreased CT scan usage, decreased cost and less radiation exposure compared to a liberal CT scan approach (CONV).

Methods: Fifteen EBG were developed utilizing published literature and in collaboration with other institutional departments. These were implemented on July 1, 2010. Prospectively collected data over a 4 month period was compared to a similar time period in 2008 when CONV was utilized.

Results: In 2010 there were 595 patients compared with 632 in 2008. Their average ISS was 10.5 ± 0.76 and 8.0 ± 0.84 ($p < 0.05$) respectively. Total CT scans: 583 and 1233, respectively. Average APACHE II, hospital LOS, ICU LOS did not significantly vary. No missed or delayed injuries were identified. Estimated CT scan charges were \$1,420,824 vs. \$3,025,229 ($p < 0.05$). The average number of scans per patient were 0.96 ± 0.23 vs. 1.95 ± 0.04 ($p < 0.05$). Regarding radiation dosimetry, the estimated average CTDI per patient were 28.65 mGy vs. 54.66 mGy ($p < 0.05$) and the estimated average DLP per patient were 703.69 mGy-cm vs. 1395.44 mGy-cm ($p < 0.05$).

Conclusions: EBG, including serial examinations, provided equivalent diagnostic data to CONV for initial workup but reduced CT scan usage, CT scan charges, and average radiation exposure per patient. This strategy may be beneficial in institutions where serial monitoring can be assiduously provided.

**ISCHEMIC BLUNT HOLLOW VISCUS AND MESENTERIC INJURY (BHVM):
STILL UNDERRECOGNIZED WITH MODERN TRAUMA WORK UP**

Kazuhide Matsushima, MD, Patricia S Mangel, BA, Eric W Schaefer, MS, Samer Rajjoub, MD, Dan A Galvan, MD, Heidi L Frankel, MD. Penn State Milton S. Hershey Medical Center.

Invited Discussant: Kimberly Davis

Background: Despite more accurate imaging modalities, the diagnosis of non-ischemic (NI-) and ischemic (I-) BHVMI remains challenging. We hypothesized that discrete factors are associated with BHVMI and that I-BHVMI have worse outcome than NI-BHVMI.

Methods: We performed a nine-year retrospective review at a Level I trauma center. I-BHVMI was defined as laparotomy-confirmed devascularization; NI-BHVMI included perforation, laceration and hematoma. The BHVMI group was compared to a 1:1 matched control group (No-BHVMI) using a multiple exact conditional logistic regression model. Potential predictors and outcome of I-BHVMI were compared to the NI-BHVMI group.

Results: Of 7875 blunt trauma patients, 67 (0.8%) had BHVMI (19 mesenteric injury alone). One of six CT findings noted was strongly associated with BHVMI (OR 15.7, $p < 0.001$) adjusted for potential confounders. Only associated pelvic fracture and normal initial amylase level suggested I-BHVMI. I-BHVMI patients had significantly longer LOS (14 vs 9 days, $p = 0.02$) than NI-BHVMI but no greater complications (46.2% vs 22.0%, $p = 0.06$) or mortality (7.7% vs 4.9%, $p = 0.63$).

Conclusion: Modern imaging can improve the diagnosis of BHVMI. Nonetheless, I-BHVMI can still be missed with significant negative impact on patient outcome.

	NI-BHVMI N=41	I-BHVMI N=26	p value	No-BHVMI N=67
CT: Mesenteric stranding	29.3%	30.8%	1.00	7%
CT: Mesenteric hematoma	19.5%	23.1%	0.76	3.5%
CT: Bowel wall thickening	26.8%	19.2%	0.56	3.5%
CT: Isolated free fluid	53.7%	61.5%	0.61	5.3%
CT: Extraluminal gas	26.8%	7.7%	0.06	3.5%
CT: Bowel wall enhancement	12.2%	19.2%	0.49	0.0%
WBC > 10,000	85.4%	84.6%	1.00	
Elevated serum amylase	28.2%	0.0%	<0.01	
Associated pelvic fracture	17.1%	42.3%	0.04	

PREDICTORS OF CRITICAL CARE RELATED COMPLICATIONS IN COLECTOMY PATIENTS USING THE NATIONAL SURGICAL QUALITY IMPROVEMENT PROGRAM: EXPLORING FRAILTY AND AGGRESSIVE LAPAROSCOPIC APPROACHES.

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Invited Discussant: Gregory Jurkovich

Introduction: Colectomy patients experience a broad set of adverse outcomes.

Complications requiring critical care support are common in this group. We sought to identify predictive factors of Clavien class IV complications and death.

Methods: Using the NSQIP Public Use files (2005-2009), we identified all laparoscopic and open colectomies by CPT code. Using the Clavien classification for postoperative complications, we identified NSQIP data points most consistent with Clavien Class IV requiring ICU care (postoperative septic shock, postoperative dialysis, pulmonary embolism, MI, cardiac arrest, prolonged ventilatory requirements, need for reintubation) or class V (mortality). A Simplified Frailty index was created based on the “Canadian Study of Health and Aging,” mapping 11 existing NSQIP variables. Logistic regression was performed to acuity adjust the findings.

Results: There were a total of 58,448 colectomies identified. As Frailty index increased from 0 to 0.55, the proportion of those experiencing Clavien class IV or V increased from 3.2% at baseline to 56.3% by Chi-square. The following variables were significant in logistic regression (Odds ratio): Frailty index (10.7), Open Procedure (2.17), ASA > 4 (2.66) and respiratory comorbidity (1.37). These results were confirmed by segmentation of data and all data reported here as $p < 0.001$.

Discussion: Complications requiring critical care represent a significant morbidity in the colectomy patient population. The Frailty index appears to contribute significantly to such occurrences, and laparoscopic approaches appear to be protective. Data regarding preoperative decision-making is not available and contraindications to laparoscopy are not tracked in this data. Further work is necessary to confirm these findings.

RESECTION AND PRIMARY ANASTOMOSIS WITH PROXIMAL DIVERSION INSTEAD OF HARTMANN'S - EVOLVING THE MANAGEMENT OF DIVERTICULITIS USING NSQIP DATA

Ute Gawlick, MD PhD, Raminder Nirula*, MD MPH. University of Utah Hospitals and Clinics.

Invited Discussant: David Spain

Introduction: The emergency surgical treatment of acute diverticulitis with feculent or purulent peritonitis has traditionally been the Hartmann's procedure. Debate continues over whether primary resection with anastomosis and proximal diversion may be performed in the setting of a high risk anastomosis in complicated diverticular disease. In contrast to a loop ileostomy takedown, the morbidity of a Hartmann's reversal is preventative for many patients, leaving them with a permanent stoma. Our study compared the surgical outcomes of patients with perforated diverticulitis who underwent a Hartmann's procedure (HP) to primary anastomosis with proximal diversion (PAPD).

Methods: The National Surgical Quality Improvement Program (NSQIP) database was queried from 2005-2009 to identify all cases of perforated diverticulitis classified as contaminated or dirty/infected. Patients were stratified into HP or PAPD and logistic regression models were created to control for patient demographics, comorbidities, perioperative risk and illness severity in order to determine the impact of surgical procedure on outcome.

Results: There were 2,018 patients who met the inclusion criteria of which 340 (17%) underwent PAPD and the remainder underwent HP. Significant independent predictors of infectious outcomes were alcohol use, preoperative sepsis and operative time. There was no significant difference in risk of infectious complications, return to the OR, prolonged ventilator use, death or hospital length of stay between the two procedures.

Conclusion: The treatment of acute diverticulitis in the setting of contamination can be safely treated with resection, primary anastomosis and proximal diversion as opposed to a Hartmann's procedure. Given the decreased morbidity of subsequent loop ileostomy takedown compared to a Hartmann's reversal, this procedure should be given serious consideration in the management of acute, perforated diverticulitis.

ARE THE FRAIL DESTINED TO FAIL?: FRAILITY INDEX AS A PREDICTOR OF SURGICAL MORBIDITY AND MORTALITY IN THE ELDERLY

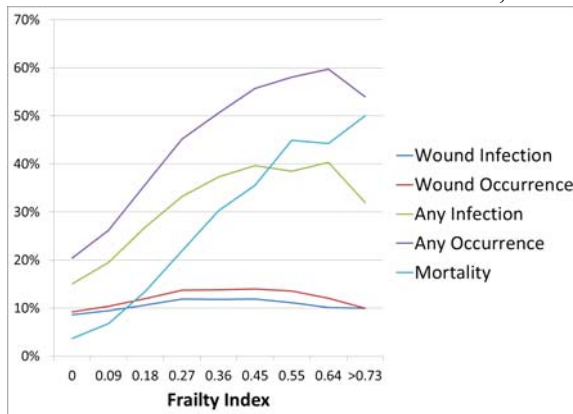
Joseph S Farhat, MD, Anthony J Falvo, DO, H Mathilda Horst, MD, Andrew Swartz, BS, Vic Velanovich, MD, Joe H Patton, Jr, MD*, Ilan S Rubinfeld, MD. Henry Ford Hospital.

Invited Discussant: Avery Nathans

Objective: Our aging population has led to an increase in the number of elderly patients necessitating emergency general surgery operations. Previous studies have demonstrated that increased frailty is a predictor of outcomes in medicine and surgical patients. We hypothesized that use of a modification of the Canadian Study of Health and Aging Frailty Index would be a predictor of morbidity and mortality in patients greater than 60 years of age undergoing emergency general surgery.

Methods: Data was obtained from the National Surgical Quality Improvement Project (NSQIP) Public Use Database in compliance with the NSQIP Data Use Agreement. We selected all emergency cases in patients greater than 60 years of age performed by general surgeons from 2005-2009. The effect of increasing frailty on multiple outcomes including wound infection, wound occurrence, any infection, any occurrence, and mortality were then evaluated.

Results: Total sample size was 33706 patients. As the frailty index increased, there were associated increases in wound infection, wound occurrence, any infection, any occurrence and mortality as demonstrated in the accompanying graph. Logistic regression of multiple variables demonstrated that frailty index was associated with increased mortality with an odds ratio of 1.94 (p<0.001).



and mortality as demonstrated in the accompanying graph. Logistic regression of multiple variables demonstrated that frailty index was associated with increased mortality with an odds ratio of 1.94 (p<0.001).

Conclusion: Frailty index is an important predictive variable in emergency general surgery patients over the age of 60 years. It can be used to evaluate risk of both morbidity and mortality in these patients. Frailty index will be a valuable preoperative risk assessment tool for the acute care surgeon.

**SEPSIS WORSENS OUTCOME AFTER EMERGENCY COLON SURGERY:
WHAT EVERY GENERAL SURGEON SHOULD KNOW**

Robert D Becher MD, J Jason Hoth* MD, PhD, Preston R Miller* MD, J Wayne Meredith* MD,
Michael C Chang* MD. Wake Forest University School of Medicine.

Invited Discussant: Philip Barie

Background: Acute care surgeons are uniquely aware of the importance of the systemic inflammatory response and its influence on postoperative outcomes; concepts like damage control have evolved from this experience. However, for surgeons whose practice is mostly elective, the significance of such systemic inflammation is often under appreciated. In this study, we sought to determine the influence of preoperative systemic inflammation on postoperative outcome in patients requiring emergent colon surgery.

Methods: Emergent colorectal operations were identified in the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) 2008 dataset. Four patient groups were defined by the presence and magnitude of the inflammatory response prior to operation: no inflammation, systemic inflammatory response syndrome (SIRS), sepsis, or septic shock. 30-day survival was analyzed by Kaplan-Meier method. Cox regression models quantified risk of 30-day mortality; logistic regression models determined the influence of operative time on mortality and postoperative complications.

Results: 3305 patients were identified. 30-day survival was significantly different ($p < 0.0001$) among the four groups; increasing magnitudes of preoperative inflammation had increasing probability of mortality ($p < 0.0001$). Hazard ratios indicated that, compared to patients without preoperative systemic inflammation, the relative risk of death from SIRS was 1.9 ($p < 0.0001$), from sepsis was 2.5 ($p < 0.0001$), and from septic shock was 6.7 ($p < 0.0001$). Operative time of < 120 minutes was associated with decreased risk of morbidity ($OR = 0.64$; $p < 0.0001$) but not 30-day mortality in patients with inflammation.

Conclusions: Severity of the preoperative inflammatory response has a substantial impact on mortality following emergency colon surgery. In patients with SIRS, sepsis, or septic shock, operations lasting longer than 2 hours are associated with greater postoperative morbidity. These results further reinforce the concept of timely surgical intervention, and potentially suggest a role for damage control operations in emergency surgical patients.

**USE OF THE CLINICAL PULMONARY INFECTION SCORE TO GUIDE
THERAPY FOR VENTILATOR-ASSOCIATED PNEUMONIA RISKS
ANTIBIOTIC OVEREXPOSURE IN TRAUMA PATIENTS**

Nancy A Parks, MD, Louis J Magnotti*, MD, Jordan A Weinberg*, MD, Ben L Zarzaur*, MD, MPH, Thomas J Schroepel, MD, Joseph M Swanson, PharmD, Timothy C Fabian*, MD, Martin A Croce*, MD. University of Tennessee Health Science Center.

Invited Discussant: Lena Napolitano

Introduction: The Clinical Pulmonary Infection Score (CPIS) has been advocated to guide both the diagnosis and duration of therapy in patients with ventilator-associated pneumonia (VAP). However, the clinical, physiologic, and radiologic components of the CPIS may be difficult to differentiate from the systemic effects of injury and inflammation, thereby unnecessarily prolonging VAP therapy in trauma patients. The purpose of this study was to evaluate the potential use of CPIS for determining the appropriate duration of antimicrobial therapy for VAP in critically injured trauma patients.

Methods: Patients with VAP ($\geq 10^5$ CFU/ml in BAL effluent) over 6 years were evaluated. Duration of antimicrobial therapy was determined by microbiological resolution ($\leq 10^3$ CFU/ml) on repeat BAL on day 4 of appropriate therapy and as clinically indicated. Recurrence was defined as $> 10^5$ CFU/ml on subsequent BAL performed within 2 weeks after completion of appropriate therapy. A CPIS of < 6 was used as a threshold for VAP resolution and calculated at the time of repeat BAL and cessation of antimicrobial therapy.

Results: 1028 patients with VAP were identified: 812 (79%) men and 216 (21%) women (mean age 43, mean ISS 31, 89% blunt). 523 had community-acquired (CA) pathogens (mean CPIS 6.9) and 505 had hospital-acquired (HA) pathogens (mean CPIS 6.3). Using a CPIS < 6 yielded a sensitivity and specificity of 69% and 51% for CA pathogens and 72% and 53% for HA pathogens, respectively. Antimicrobial therapy would have continued inappropriately in 59% of patients. Overall recurrence was 1%, occurring only with HA pathogens (mean CPIS 5.9).

Conclusions: CPIS should not be used to determine VAP resolution in critically injured trauma patients. It cannot reliably differentiate VAP from SIRS in this patient population in the face of potentially confounding clinical factors. In fact, using CPIS to determine appropriate duration of antimicrobial therapy in trauma patients is costly and could be harmful by unnecessarily prolonging exposure to antibiotics.

**INFECTIONS AFTER TRAUMA ARE ASSOCIATED WITH SUBSEQUENT
CARDIAC INJURY**

Daithi S Heffernan, MD, Sean F Monaghan MD, Michael D Connolly MD, Shea Gregg MD,
Jason T Machan PhD, Charles A Adams Jr* MD, William G Cioffi* MD. Brown University
Rhode Island Hospital.

Invited Discussant: David Wisner

Objective: Trauma produces profound inflammatory/immune responses. A second hit such as an infection further disrupts the inflammatory cascade. Infections have been associated with increased mortality in trauma patients. The inflammatory and immune systems are emerging as critical biological mediators of cardiac disease including myocardial ischemia and infarction. We postulate that the increased mortality associated with trauma patients who develop infections is due to increased rates of cardiac damage.

Methods: All trauma patients admitted to a level 1 TICU over 5 years. Data included age, ISS, co-morbidities, infections (urinary tract infection (UTI) and ventilator associated pneumonia (VAP), troponin levels, and mortality. Proportional hazard regression analysis was done to predict suspicion of cardiac injury (troponin ordered), cardiac damage (troponin > 0.15 ng/mL), or heart attack (troponin > 1 ng/mL) using age, gender, ISS, pulmonary disease (COPD), heart failure, hypertension, diabetes, and the presence of a UTI or VAP. A similar proportion hazard regression was performed to predict mortality.

Results: 1757 patients, 29.5% female, mean ISS 19.4 and mean age 46.7yrs were included. 21.2% of patients had a UTI, and 18% of ventilated patients developed VAP. The overall mortality was 8.9%. In the model to predict cardiac damage COPD (HR 1.9 (p=0.02)), ISS (HR 1.01 (p=0.04)), VAP (HR 5.6 (p<0.01)), and UTI (HR 2.4 (p=0.03)) were associated with a troponin > 0.15. Interestingly VAP was associated with an increased risk of troponin ordered (HR 3.0 (p<0.01)) but UTI was not (HR 1.5 (p=0.08)). Neither VAP or UTI could predict a troponin > 1.0 ng/mL. In the model to predict death, cardiac damage was not associated with mortality. Heart attack was associated with mortality as age increased.

Conclusion: Infectious complications have been associated with increased mortality in trauma patients. Our data demonstrates that development of VAP or UTI is associated with an increased risk of developing cardiac damage in trauma patients, which may explain the noted increased mortality.

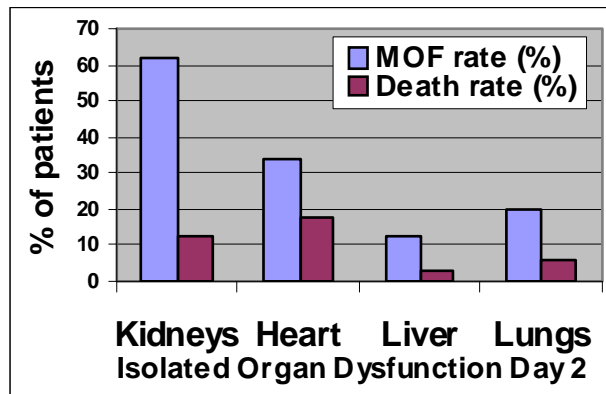
ACUTE KIDNEY INJURY AND POST-TRAUMA MULTIPLE ORGAN FAILURE: THE CANARY IN THE COAL MINE.

Max V Wohlaer, MD, Angela Sauaia, MD, PhD, Jeffrey Johnson, MD, Anirban Banerjee, PhD,
Ernest E Moore, MD. Denver Health Medical Center.

Invited Discussant: Erik Barquist

Objective: In spite of improved resuscitation strategies, acute kidney injury (AKI) continues to be a major source of morbidity and mortality among critically ill patients. Thus, we evaluated the role of early AKI in the incidence and prognosis of postinjury multiple organ failure. **Methods:** We queried our 12-year database of high risk postinjury patients (ISS>15, age>15, survival>48 hrs, no isolated head injury). MOF and AKI were defined using the Denver MOF score. After excluding 116 patients with documented previous renal, heart, lungs, or liver disease, 1273 trauma patients were studied. Logistic regression was used to calculate the odds ratios. **Results:** MOF developed in 21% of patients with an overall mortality of 8%. Mean age was 36.1±0.4 yrs and mean ISS 29.7±0.3. Median ICU stay was 11 days (IQR 5-21), and median ventilation time, 6 days (IQR:

1-15). Early (Day 2) AKI (creatinine>1.8 mg/dL), either isolated or in conjunction with other organ dysfunction, was detected in 3% of the patients, associated with an 80% MOF incidence and a 34% death rate. Both rates were higher than those associated with early



(Day 2) heart, lung, or liver failure [Figure]. Early AKI was associated with a 25-fold increased MOF risk and 7-fold higher death risk. These were higher odds ratios of MOF than those observed when heart, lung, or liver failure were detected on Day 2, and inferior only to heart failure on day 2 as a predictor of death (OR=8.8). **Conclusion:** Early AKI is a harbinger of doom postinjury, outperforming heart, lung and liver dysfunction as a predictor of MOF and death. Prevention of early AKI and a better understanding of organ crosstalk mechanisms may help reduce mortality in this population.

ANTI-INFLAMMATORY PROPERTIES OF HISTONE DEACETYLSE INHIBITORS: A MECHANISTIC STUDY

Wei Chong, MD, PhD, Yongqing Li, MD, PhD, Baoling Li, MD, Andrew L Kung, MD, PhD, Diane Wonsey, Zhengcai Liu, MD, PhD, Jennifer Lu, BS, Marc A deMoya, George C Velmahos, MD, PhD*, Hasan B Alam, MD*. Harvard Medical School/ Massachusetts General Hospital.

Invited Discussant: Joseph Cuschieri

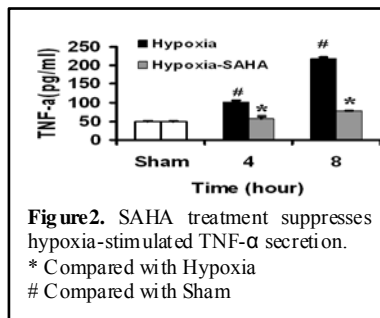
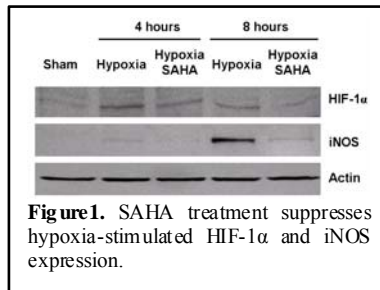
Introduction: We have demonstrated that post-shock administration of suberoylani lide hydroxamic acid (SAHA), a histone deacetylase inhibitor (HDACI), can significantly improve early survival in a highly lethal model of hemorrhagic shock without conventional fluid resuscitation. As the primary insult in hemorrhagic shock is cellular hypoxia, and because transcription factor hypoxia-inducible factor-1 α (HIF-1 α) controls pro-inflammatory gene expression in macrophages, we hypothesized that SAHA would attenuate the HIF-1 α associated pro-inflammatory pathway.

Methods: Mouse macrophages were exposed to hypoxic conditions (0.5% O₂, 10% CO₂, and 89.5% N₂) at 37°C in the presence or absence of SAHA (1 μ M). The cells and incubation medium were harvested at 4 and 8 h. Sham (no hypoxia, no SAHA) served as the control. Western blots were performed to assess expression of HIF-1 α and inducible nitric oxide synthase (iNOS) in the cells. ELISA and colorimetric biochemical assay were utilized to analyze secretion of tumor necrosis factor α (TNF- α) and nitric oxide (NO) respectively in the cell medium.

Results: Hypoxia significantly enhanced the expression of HIF-1 α at 4 h, iNOS at 8 h and secretion of NO at 8 h (fig 1) and TNF- α at 4 and 8 h (fig 2). In contrast, SAHA treatment significantly attenuated all of these changes.

Conclusions: Treatment of hypoxia-stimulated macrophages with SAHA decreases expression of HIF-

1 α and iNOS proteins, and reduces secretion of pro-inflammatory NO and TNF- α cytokines. Our data demonstrate for the first time that a down-regulation of the hypoxia-HIF-inflammatory pathway plays an important role in the protective effects of HDACI.



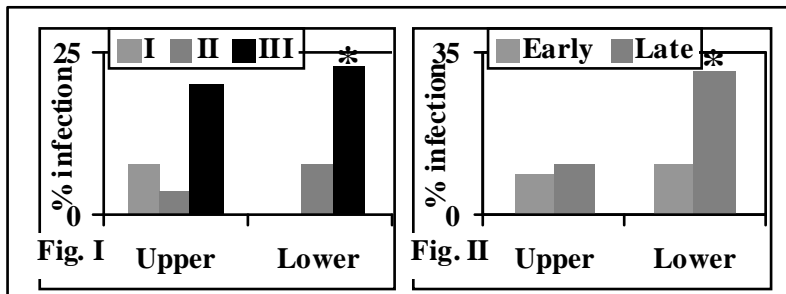
OPEN EXTREMITY FRACTURES: DOES DELAY IN OPERATIVE DEBRIDEMENT AND IRRIGATION IMPACT INFECTION RATES?

Stephanie Goldberg, MD, Ajai K Malhotra* MD, Nancy R Martin ACNP, Mark C Willis MD, Varatharaj Mounasamy MD, Kelly Guilford RN, Therese M Duane* MD, Michel B Aboutanos* MD, Julie Mayglothling MD, Rao R Ivatury* MD. VCU.

Invited Discussant: Rosemary Kozar

Background: Early (<8-hours) operative debridement and irrigation (D&I) of open fractures is considered essential to reduce the risk of deep infection. With the advent of powerful anti-microbials, this axiom has been challenged. The current study evaluates the rates of deep infections of open extremity fractures in relation to the time to first D&I.

Methods: All patients with blunt open extremity fractures over a 4 year period were evaluated for age, injury severity (ISS), physiologic derangement (SBP, Lactate, RTS), and fracture type (Gustilo). Time to first D&I was calculated. All patients received appropriate prophylactic anti-microbials. Deep infection rates were correlated to the time to first D&I (Early – <8-hours vs Late – >8-hours). **Results:** 248 patients with 251 open extremity fractures (upper – 83; lower – 168) met criteria. Age was lower and ISS higher in the Late group. Infection rates were: Early – 23/203 (11%) and Late – 10/48 (21%) – p>0.05. Rates by Gustilo type were: I-2/48 (4%), II-6/89 (7%) and III-25/114 (22%) – p<0.05 I and II vs



III. When fractures were sub-grouped by extremity, in the lower extremity, delay (>8-hours) and higher Gustilo type,

both correlated with development of infection, while in the upper extremity, *only* higher Gustilo type correlated and delay did not increase the risk of infection (Figs. I & II).

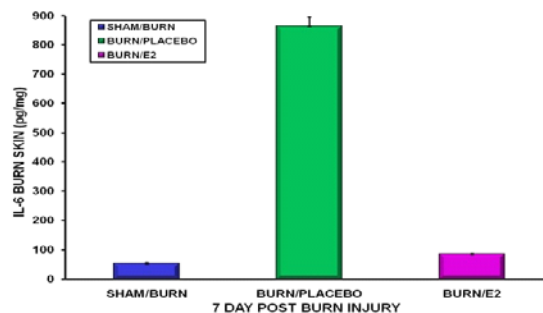
Conclusions: With appropriate anti-microbial prophylaxis, infection rates following open extremity fractures are dependent upon Gustilo type and time to D&I for lower extremity, but only Gustilo type for upper extremity. Despite limitations on health care resources and surgeon availability, early operative D&I should remain a standard of care for open lower extremity fractures, but may not be necessary for upper extremity fractures.

EARLY, SINGLE-DOSE POST-BURN ESTROGEN SIGNIFICANTLY DECREASES BURNED SKIN AND SYSTEMIC INFLAMMATORY RESPONSE FOR 7 DAYS FOLLOWING SEVERE BURN INJURY

Jane Wigginton, MD, Paul E Pepe, MD*, James W Simpkins, PhD, Joshua W Gatson, PhD, Katharine G Wigginton, Kareem R AbdelFattah, MD, Joseph P Minei, MD*, David L Maass, BS. University of Texas Southwestern Medical Center at Dallas.

Invited Discussant: Leopoldo Cancio

Introduction: Early on in severe burn injury, pro-inflammatory cytokines are produced in the burned skin, including the “dead tissue” in 3° burns. This response is then followed by a deleterious systemic surge in cytokines. Immediate debridement (minutes after burn) can blunt this detrimental inflammatory response in animal models, yet such rapid debridement is not practical in the clinical setting. As an alternative, we tested intra-peritoneal (IP) estrogen (a powerful anti-oxidant/anti-apoptotic/anti-inflammatory drug) as a potential therapy for early mitigation of this pro-inflammatory response. **Methods:** 168 male rats were randomly assigned into 1 of 3 groups: 1) sham/burn (n=8); 2) burn/placebo (n=80); 3) burn/17 β -estradiol (n=80). Burned rats received a 40% (3°) TBSA dorsal burn, immediate fluid resuscitation and then one dose of 17 β -estradiol or placebo (0.5 mg/kg IP) 15 minutes post-burn. 8 animals from each of the two burn groups (burn/placebo; burn/17 β -estradiol) were sacrificed at one of the following 10 time points: 0.5; 1; 2; 4; 6; 8; 12; 18; 24 hours and 7 days (sham group at 7 days only). Skin tissue and systemic blood samples were analyzed by ELISA at all time points for pro-inflammatory cytokines (IL-6, TNF- α , IL-1 β). **Results:** In the placebo group, high levels of cytokines appeared very early on in 3° burned skin, persisting at 7 days post-injury. In the 17 β -estradiol group, skin cytokine levels remained significantly lower at each time point, including skin IL-6 at 7 days post-burn (see graph). 17 β -estradiol also significantly decreased circulating cytokines at all measured time points. **Conclusions:** Early, single-dose estrogen administration following severe burn injury significantly controlled the pro-inflammatory response in both skin tissue and circulating bloodstream. Early estrogen administration may be an efficacious, simple-to-administer, and cost-effective therapy for burn patients.



**PORTABLE CHEST X-RAYS ADD NO PREDICTIVE VALUE IN DIAGNOSIS
OF VENTILATOR ASSOCIATED PNEUMONIA**

Ellen A Carraro, MD, David C Evans, MD, Gary S Phillips, MAS, Stanislaw P Stawicki, MD, Angelina Postoev, MD, Vanessa Olcese, MD, PhD, Charles H Cook*, MD, Daniel S Eiferman, MD. Ohio State University Medical Center.

Invited Discussant: George Velmahos

Background: Diagnosis of ventilator associated pneumonia (VAP) in the Surgical ICU is problematic. In our unit, patients with high suspicion based on clinical pulmonary infection scores (CPIS) and concomitant infiltrates on portable chest x-ray (pCXr) undergo diagnostic bronchoalveolar lavage (BAL) with quantitative cultures followed by empiric antibiotic therapy. We became skeptical of the predictive value of pCXr for VAP, and hypothesized that pCXr findings on the day of BAL add little to the diagnosis of VAP in the ICU setting.

Methods: Intubated patients with suspected VAP undergoing concomitant pCXr and BAL testing (n=295) were included. Blinded pCXr were evaluated by surgical intensivists, fellows, residents, and radiologists and rated as (0) not, (1) possibly, or (2) definitely suspicious for pneumonia. These results were compared to BAL results for patients with and without culture confirmed VAP. Analyses included random effects logistic regression to determine the predictive value of the pCXr.

Results: Regardless of interpreter specialty or level of training, pCXr had no predictive value for VAP. Positive predictive value, negative predictive value, and ROC curve all had values below 50%. The inter-rater agreement (Rho) was 0.965, showing little to no discrepancy between raters. Knowing the rater or the score assigned yielded no diagnostic value to determining VAP (p=0.9995).

Conclusion: pCXr appears to add no predictive value in elucidating which patients should be evaluated for VAP. Clinical suspicion and diagnostic decision making for VAP should therefore not be influenced by pCXr findings.

MILK FAT GLOBULE EGF-FACTOR 8 MITIGATES INFLAMMATION AND TISSUE INJURY AFTER HEMORRHAGIC SHOCK IN EXPERIMENTAL ANIMALS

Fangming Zhang, MD, PhD, Kavin Shah, MD, MPH, Lei Qi, MD, Rongqian Wu, MD, PhD, Rafael Barrera, MD, Jeffrey Nicastro, MD, Gene F Coppa, MD, Ping Wang, MD. The Feinstein Institute for Medical Research and North Shore - Long Island Jewish Health System.

Invited Discussant: Steven Wolf

Objective: Apoptosis plays an important role in the pathogenesis of hemorrhagic shock. Insufficient clearance of apoptotic cells leads to the increased inflammation and exaggerated organ injury. The opsonizing protein milk fat globule EGF-factor VIII (MFG-E8) is involved in apoptotic cell clearance. The purpose of this study was to determine whether enhancing apoptotic cell clearance by MFG-E8 reduces organ injury and inflammation after hemorrhagic shock.

Methods: Male C57/BL6 mice (20-25 g) were bled to and maintained at a mean blood pressure of 25 ± 5 mmHg for 90 min. They were then resuscitated with normal saline with or without our newly-expressed recombinant human MFG-E8 (rhMFG-E8, $0.4 \mu\text{g}/20 \text{g}$ BW) over 30 min. At 3.5 h post-resuscitation, blood and tissue samples were collected. MFG-E8 levels in the plasma, spleen and lungs were measured by Western blot analysis. Cleaved caspase-3 levels in the spleen and lungs, an indicator of apoptosis, were assessed by Western blot analysis. Plasma and tissue levels of pro-inflammatory cytokines (TNF- α , IL-1 β and IL-6) were measured by ELISA. Neutrophil infiltration was assessed by examining myeloperoxidase activity in the spleen and lungs.

Results: MFG-E8 levels in the plasma, spleen and lungs decreased by 33%, 44%, and 55%, respectively at 3.5 h after hemorrhage and resuscitation ($n=9-11$, $P<0.05$). Along with the reduced MFG-E8 expression, we observed significantly elevated expression of cleaved caspase-3 in the spleen and lungs, escalated levels of pro-inflammatory cytokines in the plasma, spleen and lungs, and increased neutrophil infiltration in the spleen and lungs following hemorrhage and resuscitation. Administration of rhMFG-E8 during crystalloid resuscitation significantly reduced apoptosis, downregulated proinflammatory cytokines and inhibited neutrophil infiltration after hemorrhage.

Conclusion: Enhancing apoptotic cell clearance by rhMFG-E8 can be developed as a novel approach in the treatment of hemorrhagic shock.

STRONG ION DIFFERENCE AND GAP PREDICT OUTCOMES AFTER ADULT BURN INJURY

Allison E Berndtson, MD, Tina L Palmieri*, MD, David G Greenhalgh, MD, Soman Sen, MD.
University of California, Davis.

Invited Discussant: James Jeng

Introduction: The Strong Ion Difference (apparent – SIDa and effective – SIDe) and Strong Ion Gap (SIG) have been suggested as a comprehensive method of evaluating acid-base status in critically ill patients. The SID is the difference between strong cations and strong anions in plasma, while the SIG demonstrates the presence of unmeasured ions. In addition, this approach accounts for changes in a patient's protein status, which is particularly important in those with burn injuries. We hypothesized that the SIDa, SIDe and SIG during the first 72 hours after admission would be predictive of mortality in burned patients.

Methods: This study is a retrospective chart review of adults with $\geq 20\%$ TBSA burns admitted over a 7 year period to a regional burn center. SIDa, SIDe and SIG were calculated at admission and for the first 3 days. These results were then compared to admission APACHEII and daily SOFA scores.

Results: 78 patients met inclusion criteria and had full data sets, with mean \pm SEM age 43.9 ± 1.7 years and TBSA burn $46.8 \pm 2.1\%$. Mortality was 29.5%. Among admission scores, APACHEII remained most predictive of mortality ($p = 0.002$) after controlling for %TBSA. However, Day1 SIDa ($\text{Na}^+ + \text{K}^+ + \text{Ca}^{2+} + \text{Mg}^{2+} - \text{Cl}^-$) was also predictive of later mortality ($p = 0.01$, OR 1.22), with values significantly higher in the non-survivors. In addition, Day1 SIDe ($[2.46 \times 10^{-8} \times \text{PaCO}_2/10^{\text{pH}}] + [[\text{albumin}] \times (0.123 \times \text{pH} - 0.631)] + [[\text{PO}_4] \times (0.309) \times \text{pH} - 0.469]$) was predictive of hospital length of stay ($p = 0.003$, Beta - 2.80), while Day1 SIG (SIDa – SIDe) predicted total ventilator days ($p = 0.02$, Beta 2.27).

Conclusion: Strong Ion Difference and Strong Ion Gap measured on the first day after admission are predictive of mortality, hospital length of stay and ventilator days in burned patients.

BARRIERS TO EVIDENCE BASED CARE IN TRAUMA

Nadine Rayan, MHA, Sunni Barnes, PhD, Neil Fleming, PhD, Rustam Kudyakov, MD, MPH, David Ballard, MD, PhD, Larry Gentilello*, MD, Shahid Shafi*, MD, MPH. Baylor Institute for Health Care Research and Improvement.

Invited Discussant: L.D. Britt

Objective: We previously demonstrated that evidence-based medicine (EBM) is often not practiced in trauma care, as patients receive less than two-thirds of the care recommended by EBM. We hypothesized that patients least likely to receive EBM-based care can be prospectively identified, which may be used to increase adoption of EBM in trauma care.

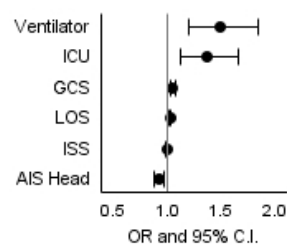
Methods: Records of a random sample of 1000 patients admitted to a Level 1 trauma center (2006-08) with moderate to severe injuries (AIS ≥ 3) were reviewed for compliance with 25 EBM-based processes of care (POC) endorsed by ATLS, EAST, the Brain Trauma Foundation, SCIP, and the Glue Grant Consortium. These encompassed all aspects of care, including initial evaluation, resuscitation, operative care, critical care, rehabilitation, and injury prevention. Multivariate logistic regression was used to identify patients likely to receive EBM-based POC's. Results are reported as odds of compliance with 95% C.I.]

Results: 774 patients were eligible for 2603 POC's.

However, only 1515 of these POC's (58%) were provided to patients. Compliance was highest for POC's involving resuscitation (83%), and were lowest for neurosurgical interventions (17%). Increasing injury severity (higher ISS,

lower GCS, higher head AIS) was associated with lower compliance, while ICU stay and ventilator use were associated with higher compliance (Figure). There was no relationship between compliance and the following: age, gender, race, insurance status, household income, or initial care during a night or weekend shift.

Conclusion: Patients with increased injury severity who are in greatest need of optimal care are least likely to receive it. Hence, patients with the most severe injuries should be targeted to ensure compliance with EBM-based processes of care. Studies to investigate barriers to closing this quality chasm should focus on patients with the most severe injuries, especially those with significant traumatic brain injuries.



CAN ANGIOEMBOLIZATION BE SAFELY DELAYED FOR OPERATIVE INTERVENTION IN PATIENTS WITH PELVIC FRACTURES?

Chad M Thorson, MD, Mark L Ryan, MD, Christian A Otero, MD, Thai Vu, MD, Carl I Schulman*, MD, Alan S Livingstone, MD, Kenneth G Proctor*, MD. University of Miami.

Invited Discussant: David Livingston

Background: Pelvic fractures requiring angiographic embolization (AE) are among the most challenging injury patterns to address. Pelvic hemorrhage is best managed by initial stabilization followed by AE. Indications for urgent laparotomy (OR) are essentially the same with or without pelvic fracture, but consequences for delaying definitive AE are unknown. This study tested the hypothesis that urgent indications for OR could safely delay AE in patients with pelvic fractures.

Methods: All pelvic fractures were identified in a Level I trauma center database from 1999-2010 and stratified by initial management to OR or AE.

Results: Of 2,759 patients with pelvic fractures, 154 (6%) received angiography and 94 (61%) required embolization. For OR first vs. AE, heart rate was higher (116 ± 25 vs. 102 ± 25 b/min, $p=0.018$) and base excess was lower (-9 ± 6 vs. -4 ± 5 mEq/L, $p<0.001$) at presentation, but ISS (41 ± 16 vs. 38 ± 16), length of stay (LOS, 33 ± 29 vs. 25 ± 28 days) and mortality (38 vs. 39%) were all similar.

Variables	AE (n=70)	OR (n=24)	p=
Resus Crystalloid, ml	$5,075 \pm 3,125$	$10,384 \pm 4,896$	< 0.001
Resus PRBC, U	8 ± 7	14 ± 9	< 0.001
Resus FFP, U	5 ± 5	8 ± 8	NS
Resus Total Fluid, ml	$8,646 \pm 5,524$	$16,340 \pm 8,315$	< 0.001
24 hr Crystalloid, ml	$9,019(7,117)$	$15,185(8,394)$	< 0.001
24 hr PRBC, U	$8(11)$	$20(15)$	< 0.001
24 hr FFP, U	$5(11)$	$10(13)$	0.025
24 hr Total Fluid, ml	$13,306(12,677)$	$22,273(15,021)$	< 0.001

Data are Mean \pm SD for parametric and Median (IQR) for non-parametric. Resus: until AE.

Conclusion: Patients with pelvic fractures who went to the OR first were sicker upon arrival and required more resuscitation fluid in the time before AE and in the first 24-hours vs. those who received AE alone. Nevertheless, they had the same LOS and mortality. These findings suggest that AE can be delayed in unstable polytrauma patients with urgent indications for OR.

USING A CHECKLIST TO IMPROVE FAMILY COMMUNICATION IN TRAUMA CARE

Bradley M Dennis, MD, Leon N Sykes, MD, Robert L Vogel, PhD, Cecil E Brown, MD, Tracy L Nolan, MD, Kristin A Flowers, MS, Kristina E Lam, MS, Don K Nakayama, MD, MBA, Dennis W Ashley*, MD. Medical Center of Central Georgia/Mercer University School of Medicine.

Invited Discussant: Frederick Luchette

Introduction: Modern concepts of patient-centered care emphasize effective communication with patients and families, a requirement even more important in acute trauma settings. To improve communication between the trauma team and families of trauma patients, we employed a checklist of topics for surgical residents to cover during interviews with a family member.

Methods: We received IRB approval for a prospective study involving families of all trauma patients admitted to our Level I trauma center for more than 24 hours. In the control group, families received information according to our existing practices on the trauma service. In the study group, residents gave patient information using a checklist that guided the interaction with a first-degree family member. Items included an introduction with name and title, patient condition, list of known injuries, in-hospital unit or ICU, any consultants involved, plans for additional studies or operations, and whether the family had any questions. 24-48 h after admission, an 11-item survey was administered to each group that evaluated the trauma team's communication in the areas of physician introduction, patient condition, ongoing treatment and family perception of the interaction. Responses were in a Likert scale (5 - strongly agree to 1 - strongly disagree) and analyzed using the Wilcoxon-Mann-Whitney test, with $p < 0.05$ as significant.

Results: There were 130 patients in each group. Using a checklist led to significantly better responses in 8 of 11 items surveyed: physician spoke to family ($p = 0.004$), physician introduction ($p = 0.004$), understanding of their relative's injuries ($p = 0.04$), admitting unit ($p = 0.01$), consultants involved ($p = 0.01$), urgent surgical procedures required ($p = 0.006$), ongoing diagnostic studies ($p = 0.008$), and understanding of the treatment plan ($p = 0.0006$).

Conclusion: Utilizing a checklist enhances communication between the trauma team and family members of trauma patients, especially their understanding of the treatment plan.

FALL FROM STANDING INDUCES SIGNIFICANT INJURIES: A PLEA FOR CHANGING TRIAGE CRITERIA

Martin C Young Jr, MS, John Radtka, MD, Heidi Frankel*, MD, Sandra Arabian, CSTR, CAISS, Reuven Rabinovici*, MD. Tufts Medical Center.

Invited Discussant: John Fildes

Objective: The study aims to show that fall from standing (FFS) induces significant injuries, and thus to prompt modification of triage criteria.

Methods: Charts of FFS adult (>18 yrs) pts from 2 trauma centers during 2009 (n=458) were reviewed. Demographics, PMH, injuries, ISS, morbidities and outcome were recorded and compared to fall from height (FFH, 10-25 feet) pts (n=107).

Results: FFS pts were older (68 vs 51 yo, $p < .001$), had more comorbidities [HTN (54 vs 29%, $p < .001$), CHF (6 vs 0%, $p = .02$), CVA (9 vs 2%, $p = .02$) and DM (20 vs 7%, $p < .04$),] and took more medications [warfarin (14 vs 0%, $p = .003$), aspirin (24 vs 5%, $p < .001$) and β -blockers (19 vs 4.0%, $p < .001$)]. The 2 groups had a similar incidence of skull, face, abdomen, pelvis, and extremity injuries as well as AIS Body Region (BR)2, BR3, BR4, and BR6. However, there were more head injuries (42 vs. 26%, $p = .003$) and a higher AIS BR1 in the FFS group (3.49 vs. 3.11, $p = .03$) while FFH patients had a higher rate of chest wall (25 vs. 10%, $p = .001$) and spinal injuries (43 vs 13%, $p < .001$). The ISS and GCS were similar in the 2 groups (12.06 vs 12.2, $p = .44$; 14.32 vs. 14.29, $p = 0.926$). There were no differences in the incidence of death, major complications, need for intubation, floor admission, or ICU LOS. FFS had greater ICU admissions, and total LOS, and more FFS pts were discharged to nursing homes.

Conclusion: FFS induces significant injuries of similar injury patterns as FFH. This supports the modification of triage criteria. However, more studies are needed to identify risk factors for injuries in FFS pts.

WHO WILL COVER THE COST OF UNDOCUMENTED IMMIGRANT TRAUMA CARE?

Michael S Truitt, MD, Chris Mitchell, MD, Vanessa Shifflette, MD, Manuel Lorenzo, MD*, Alicia Mangram, MD, Ernest Dunn, MD*. Methodist Hospital of Dallas.

Invited Discussant: Thomas Esposito

Background: Health care reform under the “Patient Protection and Affordable Care Act” (PPACA) will lead to changes in reimbursement. While this legislation provides a mechanism for uninsured Americans to obtain coverage, it does not address coverage for undocumented immigrants (UDI). Reimbursement for UDIs is partially supported by the Disproportionate Share Hospital (DSH) program and was previously supported by Section-1011 (S1011) until its 2008 termination. The PPACA includes rhetoric detailing a cut of DSH funds starting in 2014. If this occurs, UDI care could be completely unfunded and this could impose a significant financial burden on Trauma Centers (TC) with a high volume of UDIs. **Methods:** From 5/05 to 5/08, we retrospectively reviewed all trauma related emergency room visits by UDIs. The financial records were reviewed. We quantified charges for 3 entities: ED physicians (EDP), trauma surgeons (TS), and the hospital (HOSP). We applied our average institutional collection rate to these charges and compared these projected collections to the actual collections. We then modeled funding scenarios given current/future legislative dynamics. **Results:** Over a 3 year period, we identified 6691 ED patients confirmed as UDIs. Of these, 19.8% were trauma patients. The financial records of the trauma patients revealed a projected EDP collection of \$452,686, a TS collection of \$1.2 million, and a HOSP collection of \$6.9 million, for a total of \$8.5 million. Actual funding from S1011 provided \$1.7 million and DSH provided \$1.9 million, for a total of \$3.6 million. Overall, our institution had a reimbursement discrepancy of \$4.9 million over 3 years with DSH/S1011 assistance. This increased to \$6.6 million after the termination of S1011 and will increase to \$8.5 million in 2014 under PPACA. **Conclusion:** These figures underestimate the total cost of UDI trauma care since it includes only EDP, TS, and HOSP charges. This \$8.5 million, while significant, represents only a fraction of national figures. There needs to be recognition of UDI trauma care and its costs. Failure to address these issues could result in ongoing financial problems for trauma centers.

WITHDRAWAL OF CARE: A 10-YEAR PERSPECTIVE AT A LEVEL I TRAUMA CENTER

C Beth Sise, MSN, JD, Michael J Sise*, MD, Jonathan F Thorndike, BA, Jessica E Kahl, BA, Richard Y Calvo, MPH, Steven R Shackford*, MD. Scripps Mercy Hospital Trauma Service.

Invited Discussant: Susan Brundage

Introduction: The process for withdrawal or limitation of care (WLC) in trauma patients has not been well described. We examined WLC at our adult Level I trauma center where it is managed by in-house attending trauma surgeons (TS).

Methods: Retrospective review of WLC. Each patient was assigned one of three modes of WLC: Care Withdrawn (CW); Limited/No Resuscitation (LNR); or Organ Harvest (OH). We reviewed the frequency, timing, and circumstances of WLC, including family involvement and referral to hospital ethics committee. For all non-OH patients, the rationale for WLC and use of palliative care (available 2003) and hospice were determined.

Results: From 2000 through 2009, 376 died with WLC, representing 54% of all deaths and 93% of patients who died at > 24 hours. Of deaths at age > 65, 80% were WLC; 23% had advance directives. Overall WLC cause of death was traumatic brain or cervical spine (TBIC) injury in 63%, purely medical disease in 15%, trauma & comorbidities in 14%, and other causes in 8%. Initial poor prognosis was noted in 48%. Conflicts over WLC occurred in 6% and were not specific to any demographic group. When family identified, end-of-life discussion with physicians occurred in 99%. Ethics committee was involved in 4%. Mode of WLC was CW in 77%, OH in 17%, and LNR in 6%. In non-OH, 60% were extubated. Median time to death from first WLS order was 17 hours; site was ICU in 72% and floor in 26%. Palliative care and hospice consults (8% and 9%) increased yearly (trend p<0.01).

WLC: Non-Organ Harvest Cases		
Rationale	CW	LNR
Neurologic Prognosis	82%	52%
Family Wishes	77%	83%
Futility of Care	74%	48%
Comorbidities	23%	26%
Advanced Age	15%	26%

Conclusion: At our Level I trauma center where WLC is managed by the attending TS, it is the predominant theme in deaths at or after 24 hours. TBIC and futility are frequently associated. Both conflicts over WLC and ethics committee consultation are uncommon while hospice and palliative care are increasingly important adjuncts to end-of-life care. The role of WLC is likely to expand with the rising numbers of elderly trauma patients.

**PREDICTORS OF POST-TRAUMATIC STRESS DISORDER (PTSD)
FOLLOWING CIVILIAN TRAUMA: HIGHEST INCIDENCE AND SEVERITY
OF SYMPTOMS AFTER ASSAULT**

Louis H Alarcon*, MD, Anne Germain, PhD, Amy S Clontz, RN MSN, Eileen Roach, RN MSN, Dederia H Nicholas, RN MSN, Mazen S Zenati, MD PhD, Andrew B Peitzman*, MD, Jason L Sperry, MD MPH. University of Pittsburgh.

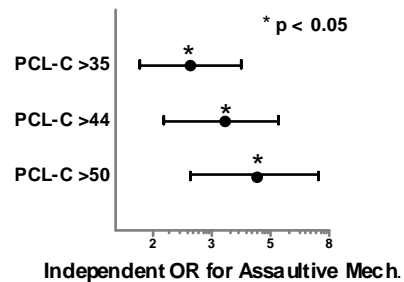
Invited Discussant: James Davis

Introduction: Post-traumatic stress disorder (PTSD) is associated with significant morbidity following traumatic injury. The incidence and risk factors for PTSD are not well described in the civilian trauma population. We proposed to screen all trauma patients for PTSD in the outpatient trauma clinic and identify the risk factors for PTSD.

Methods: We prospectively screened 1,386 injured patients who presented for follow-up in trauma clinic (Jan 2009-Sept 2010) using an established screening test for PTSD (PTSD Checklist-Civilian, PCL-C). A PCL-C score of ≥ 35 , with a known sensitivity of $> 85\%$ for PTSD, was considered screen-positive (PCL-C+). Backwards stepwise logistic regression was used to determine independent risk factors for PCL-C+.

Results: Over 25% of trauma clinic patients met the threshold for positive PTSD screen (PCL-C+). The highest incidence (43%) was in patients who sustained assault (blunt and penetrating). Regression analysis revealed that age <55 years, female gender, motor vehicle collision, and assaultive mechanism (blunt or penetrating) were independent predictors of PCL-C+ status. As the severity of symptoms increased (higher PCL-C scores), the risk associated with assaultive mechanism significantly increased in a dose response fashion ($p < 0.05$) (figure).

Conclusions: This study confirms the high incidence of PTSD symptoms in trauma patients and supports the feasibility of PTSD screening in the outpatient trauma clinic. Among all mechanisms of injury, patients who sustain interpersonal violence are at the highest risk of developing symptoms of PTSD. These results suggest that PTSD screening in outpatient trauma clinic may allow for the early detection and referral of patients with PTSD.



UNDIAGNOSED MEDICAL CO-MORBIDITIES IN THE UNINSURED: A SIGNIFICANT PREDICTOR OF MORTALITY FOLLOWING TRAUMA

Vincent Duron, MD, Daithi S Heffernan MD, Sean F Monaghan MD, Michael D Connolly MD, Shea Gregg MD, Charles A Adams MD*, William G Cioffi MD*. Brown University Rhode Island Hospital.

Invited Discussant: C. William Schwab

Objective: Un-insured status has been correlated with increased mortality after trauma, even when controlling for age, gender, race, mechanism, and injury severity. The objective of this study was to determine whether un-diagnosed pre-existing co-morbidities significantly contribute to disparities in mortality rates observed between insured and uninsured trauma patients.

Methods: Patients over 5 years were reviewed from the trauma registry of a Level I trauma center. Data extracted from the registry included age, gender, race, ISS, co-morbidities, mortality and insurance status. Multiple logistic regression analysis was done using age, gender, and insurance status to predict co-morbidities and age, gender, ISS, and insurance status to predict mortality.

Results: Insured trauma patients were older (54 years versus 38, $P < 0.001$) and more likely female (41.3% versus 22.5%, $P < 0.001$). When adjusting for age and gender, insured patients were more likely to have a pre-trauma diagnosis of coronary artery disease (Odds Ratio (OR) 2.09; 95% Confidence Interval (CI) 1.54-2.83), diabetes mellitus (OR 2.09; CI 1.61-2.72), hypertension (OR 1.97; CI 1.65-2.35), asthma/emphysema (odds ratio 1.64; CI 1.32-2.04), neurological problems (OR 1.79; CI 1.31-2.44), and GERD (OR 2.03; CI 1.33-3.11), than patients without insurance. In the analysis to predict mortality, having insurance was protective (OR 0.57; CI 0.45-0.71). Among patients with no diagnosed co-morbidities, insured patients had the lowest mortality risk (OR 0.5; 0.38-0.67). Yet, when analyzing only patients with diagnosed co-morbidities, insurance status had no impact on mortality risk (OR 0.81; CI 0.53-1.22).

Conclusion: Undiagnosed pre-existing co-morbidities play a crucial role in determining outcomes following trauma. Diagnosis of medical co-morbidities may be a marker of access to healthcare and may be associated with treatment which may explain the gap in mortality rates between insured and uninsured trauma patients.

CERVICAL SPINE INJURIES AND HELMET LAWS, POPULATION BASED STUDY

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Invited Discussant: Therese Duane

Objective: To assess the incidence of cervical spine injuries in patients admitted after motorcycle crash (MCC) in states with mandatory helmet laws (MHL) compared to states without helmet laws or selective helmet laws (SHL).

Methods: The Nationwide Inpatient Sample (NIS) from the Healthcare and Utilization Project (HCUP) for the year 2008 was analyzed. ICD-9 E-codes were used to identify patients admitted with a diagnosis of motorcycle crash and cervical spine injuries. National estimates were generated based on weighted analysis of the data. Outcome variables investigated were: length of stay (LOS), in-hospital mortality, demographics, hospital teaching status and discharge disposition. States were then stratified into states with MHL or SHL.

Results: A total of 30,117 discharges were identified during the study period. Mean age was 40.6 ± 14.6 years (17.6% > 55 years old). 15,381(51%) patients were treated in teaching facilities. 2,041 (6.7%) patients had a cervical spine injury. Median LOS for patients with C-spine injuries was 6.0 days (0 – 144 days). Patients in MHL states had a lower incidence of cervical spine injuries 5.6 vs. 6.4%, [p= 0.003], and less in-hospital mortality rate 1.8 vs. 2.6%, [p= 0.0001]. Overall in-hospital mortality was 2.3%. 70% of all patients were discharged home; there was no statistically significant difference in the rate of home discharges between MHL and SHL states. Patients over 55 years old were less likely to be discharge home 57.5% vs. 72.5%, [p= 0.0001] more likely to die in-hospital 3.0% vs. 2.1%, [p= 0.0001] and more likely to have a hospital LOS over 21 days 7.7% vs. 6.2%, [p = 0.0001].

Conclusion: Patients admitted to the hospital in states with MHLs have a decreased rate of cervical spine injuries than those patients admitted in states with more flexible helmet laws. Patients with age over 55 years old are more likely to die in the hospital, have a prolonged length of stay, and require services after discharge.

TARGETED RESUSCITATION IMPROVES COAGULATION AND OUTCOME.

Catherine M DORAN, MB BCh, Callie A DORAN, BSc, Tom WHOLLEY MB BCh, Mark MIDWINTER, MD, Peter F MAHONEY, MD, Sarah WATTS, PhD, Emrys KIRKMAN, PhD, (SPONSOR, non-author - Todd RASMUSSEN*, MD). Academic Department of Military Surgery & Trauma.

Invited Discussant: Ronald Maier

Introduction: Acute trauma coagulopathy in seriously injured casualties may be initiated by tissue hypoperfusion. Targeted (or Novel Hybrid - NH) resuscitation was developed to overcome poor tissue oxygen delivery associated with prolonged hypotension.

Methods: Under the Animals (Scientific Procedures) Act 1986, terminally anaesthetised Large White pigs were divided into 4 groups (n=6). Groups 1 & 2 received blast injury (BI) and 3 & 4 no blast (Sham). All were given a controlled haemorrhage (35% blood volume) and an uncompressed Grade IV liver injury. 5 min later all were resuscitated with 0.9% saline to a systolic arterial pressure (SBP) of 80 mmHg. After 60 min the NH groups (1 & 3) were resuscitated to a SBP (110 mmHg) while hypotensive groups (2 & 4) continued with SBP 80 mmHg for up to 8h from onset of resuscitation.

Results: Mean survival time was shorter in Group 2 (258 min) compared to 1, 3 & 4 (452, 448, 369 min). By the end of the study hypotension was associated with a significantly greater Prothrombin Time, PT (1.73 ± 0.10 and 1.87 ± 0.15 times baseline, Groups 2 & 4) compared to NH (1.44 ± 0.09 and 1.36 ± 0.06 , Groups 1 & 3, $P=0.001$). Blast vs sham had no significant effect on PT ($P=0.56$). Arterial base excess was significantly lower with Hypotension (-18.4 ± 2.7 and -12.1 ± 3.2 mM) vs NH (-3.7 ± 2.8 and -1.8 ± 1.8 mM, $P=0.0001$). Haematocrit was not significantly different between groups ($P=0.16$)

Conclusion: Targeted, NH, resuscitation significantly attenuates the development of trauma coagulopathy, with improved tissue perfusion and reduced metabolic acidosis.

Take-home message: Prolonged hypotensive resuscitation after major trauma leads to coagulopathy and adverse outcomes which can be ameliorated by a targeted (hypotensive, then normotensive) resuscitation strategy.

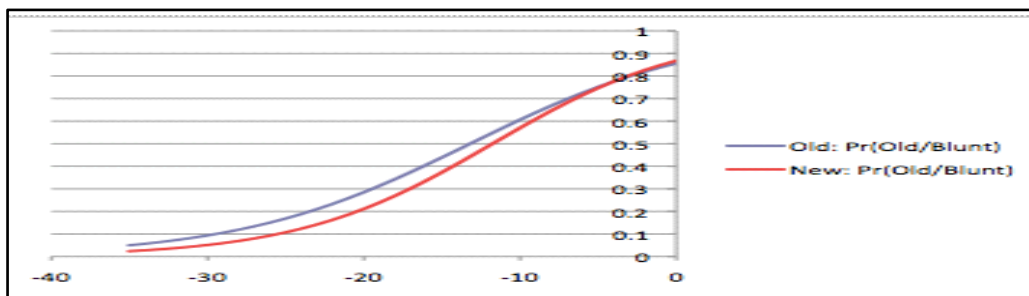
**ADMISSION BASE DEFICIT AS A MARKER OF SURVIVAL AFTER
TRAUMA: DESPITE CHANGING POPULATIONS AND PARADIGMS, THE
CURVES REMAIN THE SAME**

Bryan C Morse, MD, Christopher J Dente MD *, Erica I Hodgman BS, Beth H Shaz MD, Jeffrey M Nicholas MD *, Amy D Wyrzykowski MD *, Jeffrey P Salomone MD *, Walter L Ingram MD *, Gary A Vercruysse MD , Grace S Rozycki MD *, David V Feliciano MD *. Emory University.

Invited Discussant: Patrick Offner

Background: Both patterns of injury and resuscitation paradigms have changed over the past ten years, with a decrease in penetrating trauma and a focus on empiric fixed ratio damage control resuscitation (DCR). Admission base deficit (BD) is a simple, reliable marker of a patient's (pts) initial physiology & has been predictive of mortality in the past.

Methods: Previously published demographic, laboratory & outcome data from trauma pts treated in 1995-2003 (Control) were collected & compared to similar data collected from a prospectively maintained data base of pts treated from 2007-2010 (DCR) at the same institution. These data were used to create survival curves stratified by mechanism of injury & BD. **Results:** 4548 control pts & 2206 DCR pts had admission BD data. The populations had a similar gender distribution (79% male both groups) but differed slightly in age (36.0 vs. 38.6 years), percentage of blunt trauma (60% vs. 69%), ISS (15.6 vs. 16.8) and 24 hour transfusion requirement (3.3 vs. 6.6 units). Despite these differences, when stratified by mechanism of injury & admission BD, survival curves were identical (sample curve = Figure). DCR principles were used most commonly in pts with evidence of hypoperfusion (BD < -6). When examining these pts (n=220), improvement in survival was most marked in those presenting with extreme (< -24) BD (72.5% vs. 32.6%, p<.01).



Conclusions: When utilized, DCR techniques have improved survival in the most critically injured patients (BD < -24). However, overall survival curves after trauma, stratified by admission BD and mechanism of injury are unchanged over the last decade.

THE INITIAL HEMATOCRIT MATTERS IN TRAUMA: A PARADIGM SHIFT?

Mark L Ryan, MD, Chad M Thorson, MD, Christian A Otero, MD, Thai Vu, MD, Carl I Schulman, MD*, Mark G McKenney, MD*, Alan S Livingstone, MD, Kenneth G Proctor, PhD*. University of Miami Miller School of Medicine.

Invited Discussant: Charles Adams Jr.

Introduction: After severe trauma and hemorrhage, it is assumed that the rate of fluid shift from the interstitial space into the vasculature is relatively slow. Therefore initial hematocrit (Hct) is not regarded as a reliable estimate of blood loss (EBL). This study challenges that idea and tests the hypothesis that initial Hct is correlated with signs of shock and hemorrhage in patients requiring emergency surgery.

Methods: We retrospectively reviewed data from 198 trauma patients requiring emergent surgery at a level I trauma center from July 2009 to April 2010. Patients were divided into quartiles based on the initial Hct taken within 10 minutes of arrival. These groups were compared using data from the immediate resuscitation period (resuscitation bay + operating room), including vital signs, base excess (BE), estimated blood loss (EBL), transfusion of PRBCs and FFP, and Injury Severity Score (ISS).

Results: The study population was 83% male with a mean age (\pm SD) of 35 \pm 16. 71.4% presented with penetrating injuries. Indicators of shock, hemorrhage, and injury severity were significantly more pronounced in patients with decreased initial Hct (Table 1).

Hct (N=)	> 40 (47)	37-40 (49)	33-36 (51)	= 32 (51)	p =
HR, b/min	100 \pm 3	104 \pm 4	101 \pm 4	99 \pm 5	0.824
SBP, mmHg	130 \pm 4	107 \pm 6	100 \pm 7	94 \pm 6	<0.001
BE, mEq/L	-3.7 \pm 0.7	-4.3 \pm 0.7	-5.8 \pm 0.9	-7.6 \pm 0.8	0.003
GCS	14 \pm 0	14 \pm 0	13 \pm 1	11 \pm 1	<0.001
Crystalloid, ml	4296 \pm 367	5614 \pm 435	6138 \pm 538	6150 \pm 509	0.007
PRBCs, ml	397 \pm 100	1249 \pm 261	2261 \pm 350	2878 \pm 389	<0.001
FFP, ml	164 \pm 50	622 \pm 179	1117 \pm 304	1236 \pm 243	0.070
EBL, ml	780 \pm 129	1446 \pm 284	2297 \pm 411	3070 \pm 462	<0.001
ISS	18 \pm 2	20 \pm 2	23 \pm 2	31 \pm 2	<0.001
Mortality,%(N=)	2(1)	8(4)	18(9)	37(19)	<0.001

Conclusions: Initial Hct is significantly correlated with EBL, transfusion requirements, and hypotension in trauma patients requiring operation, even at levels greater than 30%. Decreased initial Hct can most likely be explained by rapid fluid shift from the interstitial space, because there is minimal fluid resuscitation prior to the measurement.

LYOPHILIZED PLATELETS HAVE A MINIMAL BIOLOGIC RESPONSE MODULATOR BURDEN AND LIMITED TRANSFUSION RELATED IMMUNE RESPONSE DESPITE LONG-TERM STORAGE

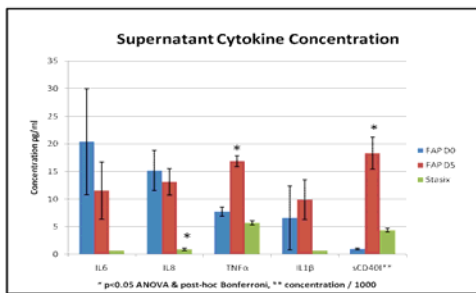
Alan A Strawn, MD, Marguerite R Kelher, MS, Douglas K Tadaki, PhD, Eric A Elster, MD, Christopher C Silliman, MD PhD, Forest R Sheppard, MD, *Sponsoring member: Ernest E Moore*, MD. Naval Medical Research Center, Dept of Regenerative Medicine.

Invited Discussant: H. Gill Cryer

Introduction: Liquid stored, fresh apheresed platelets (FAP) outdate five days post-collection; FAP additionally accumulate biologic response modulators (BRMs) implicated in post-transfusion inflammatory responses and PMN mediated organ injury. In contrast, storage by lyophilization preserves platelets in a metabolically inactive state permitting long-term storage (>6 mos) and intuitively limited BRM accumulation. Stasix[®] is a lyophilized platelet product. We hypothesized that lyophilized platelets, Stasix[®], have a low BRM burden and limited inflammatory effect despite long-term storage.

Methods: Supernatants (SUP) of post-collection day 0 (D0) & day 5 (D5) FAP and Stasix[®] were analyzed for BRMs (IL-6, IL-8, TNF α , IL-1 β , sCD40L) and activation of the PMN oxidase. Separately, 0.9% NaCl (control) or single unit transfusions of FAP or Stasix[®] were administered to Rhesus macaques. Animals were continuously monitored for adverse effects, systemic IL-6, IL-8, TNF α , IL-1 β and sCD40L quantified prior to and for 480 min (T480) post-treatment. At T480 animals were euthanized, necropsy and tissue histology performed. Results: mean \pm SEM; Stats: ANOVA with post-hoc Bonferroni, p<0.05.

Results: Stasix[®] SUP BRM levels were statistically equivalent or lower than D0 and D5



FAP SUP levels (Fig). PMN oxidase activation (nmol O₂/min): Stasix[®] = 2.7 \pm 0.4, D0 FAP = 2.5 \pm 0.5, D5 FAP = 2.9 \pm 0.3 (p=0.836); all significantly less than PAF-fMLP stimulated (5.0 \pm 0.7, p<0.01). At all time points no statistically significant difference in systemic

IL-6, IL-8, TNF α , IL-1 β or sCD40L between groups & tissue histology equivalent.

Conclusions: Stasix[®], despite long-term storage, has minimal BRM burden and does not prime the PMN oxidase and exerts a minimal transfusion related immune response equivalent to fresh (D=5) liquid stored FAP. Further investigations are warranted.

**AN FFP/RBC RESUSCITATION REGIMEN THAT RESTORES
PROCOAGULANTS WITHOUT CAUSING ARDS**

Charles E Lucas*, MD, Anna M Ledgerwood*, MD. Wayne State University.

Invited Discussant: Ernest E. Moore

Introduction - Controversy exists about the ideal FFP/RBC ratio for resuscitation of severely injured patients requiring massive transfusion (MT). A 1/1 ratio may restore coagulation (coag) but cause organ failure (ARDS). This study correlates the FFP/RBC with prothrombin time (PT, partial thromboplastin time (PTT), and thrombin time (TT), the procoagulants (FI, FV, FVIII), and ARDS (pO_2/FiO_2).

Methods - 394 injured patients [admit SBP=82 torr, P=120, shock time (SBP<80)=41 minutes] who received 17.1 RBC units, 1064 ml FFP, and 12.6 L crystalloids during an average 8.1 hour operation (OR) were studied on 625 occasions including 34 patients during OR and 153 patients immediately after OR (Ave 4 hours). Serial measurements were made.

Results - The FFP/RBC averaged 0.25/1 and ranged from 0.1/1 to 0.7/1. The intraoperative study, done after a minimum of 10 RBC units at 1.9 ± 2 hours, showed restoration of PT (2.45 ± 0.3 SE sec off normal; (INR<1.3), PTT (31.1 ± 1.4 sec), and TT (8.5 ± 1.2 sec off normal). FI, FV, and FVIII were restored to 58%, 54%, and 81% of normal. The early post OR levels were PT=2.3 sec off normal, PTT=34 sec, TT=7 sec off normal, FI=74%, FV=65%, FVIII=105%. Coagulation occurs when factor levels exceed 25%. The pO_2/FiO_2 levels were 282 ± 2 and 331 ± 0.1 during OR and early post OR. Correlations coefficients between coag tests and factor levels confirm that the FI, FV, and FVIII are routinely over 50% with an FFP/RBC of 0.4/1.

Conclusion - An FFP/RBC ratio above 0.4/1 in injured patients requiring MT restores coag tests, maintains factor levels, and does not cause ARDS from crystalloids. Future studies on defining the ideal FFP/RBC ratio for MT should monitor procoagulants and organ function.

**AN ASSESSMENT OF CLOTTING FACTOR DEFICIENCIES AND
APPROPRIATE PLASMA USE IN TRAUMA PATIENTS**

Paul T Engels, MD, JB Rezende-Neto, MD PhD, J Pacher, MD, H Tien, MD MSc, L Tremblay*, MD PhD, A Beckett, MD, JD Paton-Gay, MD, SB Rizoli*, MD PhD. Sunnybrook Health Sciences Centre.

Invited Discussant: Grant Bochicchio

Introduction: One quarter of all severely injured patients are coagulopathic upon hospital presentation. Damage Control Resuscitation (DCR) has been proposed and widely implemented to manage these patients. DCR consists of empiric use of large volumes of frozen plasma (FP) with red blood cells in a fixed ratio for all trauma patients that may be massively bleeding. FP contains all clotting factors (CF) and is primarily used to correct CF deficits. It is unclear how many trauma patients have CF deficiencies and may benefit from DCR. We hypothesized that many trauma patients are inappropriately transfused FP.

Methods: Over 7 months we measured clotting factor II, V, VII, VIII, IX, X, XI levels in trauma patients on arrival to hospital. Critical CF deficit was defined as any CF activity $\leq 30\%$, a threshold whereupon CF deficits have been demonstrated to have clinical effect. FP use was deemed inappropriate when transfused to patients without any critical CF deficit or not transfused to those with critical deficits.

Results: Of the 309 enrolled, 65 (21%) patients had critically low CF levels on admission, mostly of factor V. Only 28% of these patients received any FP in the first 24h of admission while 53% of those transfused FP had no critical CF deficit. Overall, inappropriate FP transfusion occurred in 67 patients, 21.6% of all patients in the first 24h. On multi variate logistic regression, significant predictors of FP transfusion were INR >1.5 (OR=7.02 (1.97 – 24.99)), ISS (OR=1.104 (1.062 – 1.147)) and penetrating mechanism (OR=8.44 (2.71 – 26.25)). Despite blunt trauma patients being more severely injured (ISS 26.8 vs. 16.3) they were less likely to receive FP. Of those with critical CF deficits who received FP, only 36% received enough to correct the deficit.

Conclusion: Trauma surgeons are not readily identifying which patients have true critical CF deficits. Consequently, they often fail to transfuse FP to patients in need while administering it to patients with normal CF levels. Surgeons appear biased towards transfusing frozen plasma to penetrating victims.

THE EFFECT OF EXCLUSION CRITERIA ON RISK-ADJUSTED PERFORMANCE IN THE AMERICAN COLLEGE OF SURGEONS TRAUMA QUALITY IMPROVEMENT PROGRAM: DOA OR DIE?

James Forrest Calland, MD, Avery B Nathens*, MD, Jeffrey S Young*, MD, Melanie Neal, MS, Sandra Gobles, MS, John Fildes*, MD, Mark Hemmila*, MD. University of Virginia School of Medicine.

Invited Discussant: Samir Fakhry

Objective: The ACS Trauma Quality Improvement Program (TQIP) provides an opportunity to identify variations in outcomes across trauma centers for the purposes of performance improvement. In previous TQIP reports, patients classified as dead-on-arrival (DOA) were excluded from mortality analyses. There exists significant potential for misclassification of DOA versus DIE (died in the emergency department), which might impact on risk-adjusted mortality. To further evaluate the possible impact on TQIP reporting we investigated whether exclusion of DOA’s alters trauma center performance.

Methods: Data for 54,024 patients admitted to 65 TQIP hospitals during 2009 were used. A logistic regression model was developed to estimate risk-adjusted mortality. Trauma centers were then ranked based on observed to expected (O/E) mortality ratio with 90% confidence intervals (CI) and classified by outlier status: low outliers/high performers had a 90% CI for O/E < 1, and high outliers/low performers had a 90% CI for O/E > 1. Changes in outlier status, rank, and quartile were examined with and without DOA’s to discern the impact of such exclusions on performance.

Results: Thirty-eight centers (58%) reported no DOA’s in 2009, while 6 centers (9%) reported > 10. Thirty five centers (54%) demonstrated a change in performance of > 2 ranks when their DOA deaths were excluded from analyses, and 11 centers (17%) changed rank by > 5 positions. Ten centers changed their overall quartile position. Seven centers changed their outlier status when DOA deaths were excluded.

Change in Outlier Status after Exclusion of DOA's	# of Centers
Average to High Performer	2
Average to Low Performer	3
Low Performer to Average	1
High Performer to Average	1

Conclusions: The relative frequency of DOA deaths varies greatly between centers. DOA exclusion may exert a substantial impact on the graded performance of trauma centers that participate in risk-adjusted mortality benchmarking efforts such as TQIP. Future efforts should focus on standardizing the classification of early injury-related deaths in the National Trauma Data Standard.

**PEDIATRIC TRAUMA CENTERS: IMPACT OF LEVEL I AND LEVEL II ACS
VERIFIED TRAUMA CENTERS ON CDCP STATEWIDE PEDIATRIC
MORTALITY RATES**

David M Notrica*, MD, Jeffrey Weiss, MD, Pamela Garcia Fillion MPH, Erin Kuroiwa, MS,
Daxa Clarke, MD, Sally Moffat, MSN. Phoenix Childrens Hospital.

Invited Discussant: Arthur Cooper

Background: The goal of trauma centers is to improve outcomes and save lives that might otherwise have been lost. Research on the impact of pediatric trauma centers (PTCs) on pediatric trauma has been conflicting, most likely because of differing methodologies. The purpose of this study was to assess whether the presence of ACS-verified PTCs is associated with reduced overall state pediatric injury mortality.

Methods: State crude and age-adjusted rates of pediatric injury mortality (per 100,000 children < 18 years) were obtained from the CDC WISQARS database for 2007. The number of Level I or II ACS-PTC per state was determined and compared to statewide age-adjusted pediatric injury mortality rates using linear regression, adjusting for population and rural/urban miles driven. Data were further used to estimate the ideal number of ACS-PTC per population.

Results: Pediatric injury mortality rates for the 29 states with no ACS verified Level I PTC (ACS-PTC-1) was 22.9 +/-7.4. Mortality was inversely correlated with the number of ACS-PTC-I. The mortality rates for states with a single ACS-PTC-I was 21.2 +/- 5.2 and two ACS-PTC-I was 16.7 +/-4.7, but there was no further decrease observed if more than two ACS-PTC-I were present (17.1 ± 3.8). Overall, mortality decreased by 2.1 deaths per 100,000 for each additional ACS-PTC-I ($R^2 = 9.2\%$, $p=0.03$) up to 2 centers per state. After adjusting for confounders, the regression model accounted for 51.1% of the variance in mortality ($p=0.01$). There was no association between pediatric injury mortality and availability of a Level II ACS-PTCs ($p=0.46$). One ACS-PTC-I per 2.5 million total population was associated with the lowest statewide pediatric mortality.

Conclusions: The findings observed highlight a correlation between statewide pediatric injury mortality and the number of Level I ACS-PTCs. A similar association for Level II ACS-PTCs was not observed. This study may provide guidance on the ideal number of Level I ACS-PTCs population and benefit threshold.

"PLAY OR PLAY" A FINANCIAL MODEL FOR UNCOMPENSATED CARE IN A REGIONAL TRAUMA SYSTEM

Ben L. Zarzaur*, MD, MPH, Martin A. Croce*, MD, Timothy C. Fabian*, MD. University of Tennessee Health Science Center.

Invited Discussant: David Hoyt

Introduction: Trauma systems are threatened from declining reimbursement. To increase trauma system participation a novel “Play or Pay” (PoP) state trauma funding law went into effect on 9/1/08. Hospitals were asked to participate in the trauma system or pay up to \$1.5 million per year. Funds generated are distributed for uncompensated care to hospitals participating in the trauma system. This study was designed to evaluate the effect of PoP on a bordering Level I trauma center that participates in the PoP state’s trauma system.

Methods: Patients living in the PoP state at the time of injury who were admitted to a regional Level I trauma center from 2006 – 2009 were eligible. Demographics, payer source and injury severity were determined. The reimbursement ratio (reimbursement/charges) (ReimbR) was calculated for

each patient. Patients admitted prior to PoP (PRE) were compared to those admitted after (POST).

Results: Trauma system participation increased in the PoP state PRE (70/107 (65%)) vs. POST (85/106 (80%)) $p < 0.05$. There was no difference in the percent of the PoP state’s population treated at the regional trauma center

*p<0.05	PRE	POST
	n=1829	n=986
Transfers (%)	30.0	36.8*
Payer Source (%)		
Commercial	41.0	36.0*
Government	22.5	26.7*
Self-Pay	36.5	37.4*
ReimbR	0.26	0.22*

PRE versus POST (4%). Transfers from referring hospitals to the regional Level I trauma center within the PoP state increased but patients received from the scene decreased. Payer mix and ReimbR were significantly different PRE versus POST. There was an increase in funds received from the PoP state (\$674,779 vs \$1,475,127).

Conclusions: A PoP policy in a neighboring state was associated with more transfers, decreased scene transports, a change in payer mix and a decrease in the ReimbR. However, funds received from the PoP state ameliorates negative financial impact on bordering state’s hospitals. PoP may be a model funding policy for regional trauma systems.

DOES TRAUMA CENTER VOLUME FOR PENETRATING TRAUMA IMPROVE SURVIVAL AMONG PATIENTS WITH PENETRATING INJURIES?

Cassandra V Villegas, Adil H Haider*, MD MPH, Eric B Schneider, PhD, Elliott R Haut*, MD, Dave T Efron*, MD, Albert Chi, MD, Kent A Stevens, MD MPH. Center for Surgery Trials and Outcomes, Johns Hopkins School of Medicine.

Invited Discussant: Kenji Inaba

Introduction: Previous research has demonstrated a relationship between increasing trauma center volume and reduced mortality, but it is unclear whether this volume/outcome relationship is injury-type specific. Our objective was to determine if penetrating or blunt trauma volumes were independently associated with reduced penetrating trauma mortality.

Methods: Retrospective analysis of patients ≥ 15 years old with a penetrating injury seen at Level I or II trauma centers in the 2007-08 NTDB. Transfer, burn, and dead on arrival patients were excluded, and the outcome was mortality. Annual blunt, penetrating, and overall trauma volumes were calculated for each center as well as the volume of severely injured patients (ISS=16). Patient (age, gender, race, insurance status) and injury (ISS, hypotension, GCS motor, mechanism) characteristics were modeled using hierarchical regression (Patient Model), and different subsets of volume were added to determine its association with mortality. Akaike Information Criteria and log likelihood ratio tests assessed model performance and the effect of different volume subsets on mortality.

Results: A total of 438 trauma centers encompassing 103,392 patients met study criteria with an overall mortality rate of 9.8%. Median annual volume across centers was 1180, 977, and 80 patients for overall, blunt, and penetrating injuries respectively. Once adjusted for patient-level effects, only overall and blunt volumes were significantly associated with reduced mortality (reported as the change in the probability of mortality per 100 patients, Δ PrM). This effect was magnified when volumes were based on severely injured patients.

Table. Contribution of Subsets of Trauma Center Volume to Penetrating Mortality

	Patient Model	Overall	Blunt	Penetrating	Overall ISS=16	Blunt ISS=16	Penetrating ISS=16
Δ PrM	-	-0.2%	-0.3%	-0.01%	-0.7%	-0.9%	-0.2%
(p value)	-	(<0.001)	(<0.001)	(0.990)	(<0.001)	(<0.001)	(0.879)

Conclusion: As in other fields of surgery, we show a volume/outcome effect on survival after penetrating trauma. At the hospital level, the number of severely injured, blunt trauma patients is strongly associated with survival after penetrating injury.

THE FORGOTTEN TRAUMA PATIENT: OUTCOMES FOR INJURED PATIENTS EVALUATED BY EMS BUT NOT TRANSPORTED

Kristan Staudenmayer, MD, MS, Renee Hsia, MD, MSc, Ewen Wang, MD, Karl Sporer, MD, David Ghilarducci, MD, David Spain*, MD, Robert Mackersie, MD, Richard Kline, MD, John Sherck, MD, Craig Newgard, MD, MPH. Stanford University.

Invited Discussant: Norman McSwain, Jr.

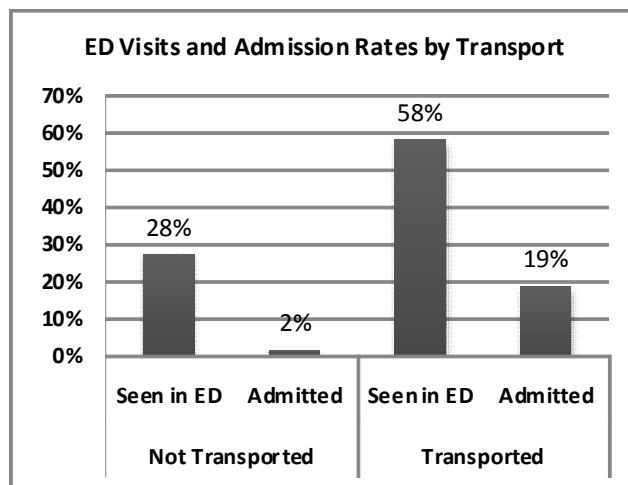
Introduction: Injured patients who are not transported by ambulance to the hospital are often not included in trauma registries. The outcomes of these patients have until now been unknown. Understanding what happens to non-transported patients is necessary to better understand triage validity, patient outcomes, and costs associated with injury. We hypothesized that a subset of patients who were not transported from the scene would later present for evaluation and that these patients would have a non-zero mortality rate.

Methods: This is a population-based, retrospective cohort study of injured adults and children for three counties in California from 2006-2008. Pre-hospital data for injured patients for whom an ambulance was dispatched were probabilistically linked to trauma registry data from four trauma centers, state-level discharge data, ED records and death files (1-year mortality).

Results: A total of 69,412 injured persons that were evaluated at the scene by EMS were included in the analysis. Of these, 5,865 (8%) were not transported. At least 29% of patients not transported by ambulance later sought health care in an ED and/or died. Of those not transported, 1,616 (28%) were later seen in an ED and 92 (2%) were admitted.

For the counties where vital statistics data was available, 7 (0.14%) patients later died.

Conclusion: Patients evaluated by EMS, but not initially transported from the field after injury often present later to the hospital. The mortality rate in this population was not zero and these patients may represent preventable deaths.



DECREASED TIME TO TRAUMA CENTER ARRIVAL AFTER THE RURAL TRAUMA TEAM DEVELOPMENT COURSE: AN IMPROVEMENT IN TRAUMA SYSTEMS

R Shayn Martin, MD, Nathan T Mowery, MD, Amy N Hildreth, MD, Preston R Miller, MD*, J Jason Hoth, MD*, J Wayne Meredith, MD*, Michael C Chang, MD*. Wake Forest University School of Medicine.

Invited Discussant: Michael Rotondo

Introduction: Rapid transport to a trauma center after severe injury is associated with improved outcomes. Transfer from the rural setting can be particularly challenging and delays in definitive management can result. The Rural Trauma Team Development Course (RTTDC) educates rural providers on early stabilization and transfer of critically injured patients. The effect of the RTTDC between trauma centers is known but the impact of the course on transfer from non-trauma centers has not been studied.

Methods: The RTTDC was provided to 10 hospitals over a one year period of time. All patients transferred from a referring non-trauma center hospital to a level 1 trauma center during the 12 months before and after the RTTDC was provided were included in the analysis. The time spent at referral emergency departments (ED) and the total time from referral ED arrival to trauma center arrival were compared from before the RTTDC was provided to after. Similarly, these time differences were compared to hospitals having not had the RTTDC.

Results: In the RTTDC hospitals, there were 174 patients transferred before the course and 95 after. In the 10 hospitals that held the RTTDC, there was a significant decrease in referral ED time and total time from

		Before	After	p-value
RTTDC Hospitals	Referral ED Time (hrs)	2.7	2.1	0.04
	Total Time (hrs)	3.6	3.0	0.01
Non-RTTDC Hospitals	Referral ED Time (hrs)	2.7	2.7	0.96
	Total Time (hrs)	4.1	3.9	0.48

before to after the RTTDC (See figure). Hospitals that did not receive the RTTDC experienced no change in referral ED time or total time during the same time period.

Conclusion: Providing the RTTDC to non-trauma center referral hospitals was associated with a reduction in referral ED time and total time to presentation at the level 1 trauma center. The RTTDC potentially provides a method to reduce delays in transferring severely injured patients and thus improve trauma system performance.

MAJOR INJURY IN GERIATRIC TRAUMA PATIENTS: IS THE GLASS EMPTY OR HALF FULL?

Ulunna Oforum, MD, Michael D Grossman*, MD, Christy D Stehly, BS. St Lukes Hospital.

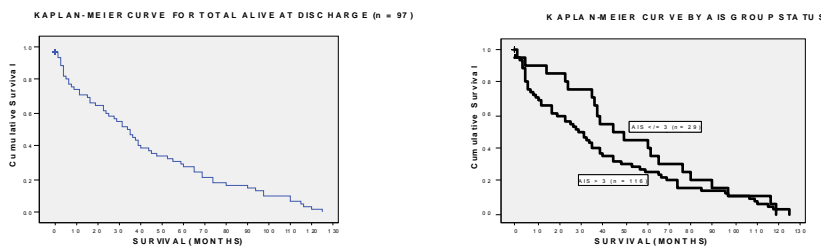
Invited Discussant: Roxie Albrecht

Purpose: Examine long term survival of geriatric trauma patients (GTP) with severe injury. **Methods:** 10-year retrospective study at a Level I trauma center with GTP defined as ≥ 65 yo and ISS ≥ 30 . Primary endpoints: survival at hospital discharge in months (mo); long-term survival and discharge status. Two groups were defined: AIS Head >3 (G1 n=116) and AIS Head = 3 (G2 n=29). For GTP surviving hospitalization, two sub-groups defined: AIS Head >3 (SG1 n=77) and AIS Head = 3 (SG2 n=20). Comparisons were analyzed by independent t-tests or Mann-Whitney rank sums test.

Results: In-hospital mortality was 48/145 (33.1%). Age was similar (77.9 vs 79.3, $p = .34$) between survivors and non-survivors. Non-survivors had lower GCS (6 vs 14, $p < .001$), higher ISS (38 v 34, $p < .03$) and lower RTS (5.97 v 7.84, $p < .002$). Hospital mortality for Group 1 was 39/116 (33.6%), and for group 2, 9/29 (31.0%). 97/145 (66.9%) survived to discharge; 32/97 survivors (32.9%) died post-discharge with a median survival of 35 mo. (95% CI = 27.09-42.91). In SG1, 25/77 (33%) GTP died; median survival 24 ± 26.5 mo. In sub-group 2, 7/20 (35%) GTP died, median survival 39.7 ± 29.8 . 28 mo. 65/145 (45%) patients are alive post-discharge and have a median survival of 48 ± 38.8 mo. 28/145 (19%) GTP have survived more than five years after discharge. Living status was determined by telephone follow-up in 47/6 (72%) survivors; 31/47(65.3%) currently live at home.

Conclusions: This study documents acceptable long-term survival for GTP with major injury comparable to some malignant diseases for which aggressive treatment is

Figure 1: 116 of these patients were able to return home.



OPERATION FIRECRACKER: ONLY A FULL SCALE REGIONAL EXERCISE CAN IDENTIFY THE GAPS

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Invited Discussant: Susan Briggs

Introduction: Man-made (9/11) and natural (Hurricane Katrina) disasters have enlightened the medical community to the importance of disaster preparedness. In response to JCAHO requirements medical centers should have in place protocols to respond to such events. We examined a full scale regional exercise (FSRE) to identify gaps in the logistics and operations in the event of a mass casualty incident. **Methods:** A multi-agency, multi-jurisdictional, multi-disciplinary exercise (FSRE) was performed including 22 counties and 16 area hospitals including a Level 1 Trauma Center (TC). The scenario simulated a train derailment and chemical spill 20 miles from the TC using 281 moulaged volunteers. Third party contracted evaluators assessed each hospital in 5 areas: communications, command structure, decontamination, staffing and patient tracking. Further analysis examined logistical and operational deficiencies. **Results:** None (0%) of the 16 hospitals were compliant with all 5 areas. Mean hospital compliance was 2.1 (+ 1.1 SD) areas. One hospital was unable to participate due to an air conditioner outage and was deemed 0% compliant. The most common deficiency was communications (SMARTT system deficiencies, lack of working knowledge of VIPER radio system) noted in 15 hospitals (94%) followed by deficient decontamination in 12 (75%). Other deficiencies included inadequate staffing based on pre-determined protocols in 9 hospitals (56%), suboptimal command structure in 8 (50%) and patient tracking deficiencies in 4 (25%). An additional 11 operational and 5 logistical failures were identified. The TC had an appropriate command structure, but was deficient in 4 of 5 categories with understaffing and a decontamination leak into the emergency room which required diversion of 90 patients. **Conclusion:** Communication remains a significant gap in the mass casualty scenario 10 years post 9/11. Our findings demonstrate that tabletop exercises are inadequate to expose operational and logistical gaps in response to a disaster. Full scale regional exercises should be routinely performed to adequately prepare for catastrophic events.

**THE MORTALITY BENEFIT OF DIRECT TRAUMA CENTER TRANSPORT
IN A REGIONAL TRAUMA SYSTEM: A POPULATION-BASED ANALYSIS**

Barbara Haas, MD, David Gomez, MD, Charles de Mestral, MD, Sunjay Sharma, MD, Jennifer Bridge, MPA MHSc, Brandon Zagorski, MS, Therese A Stukel, PhD, Gordon D Rubenfeld, MD MSc, Avery B Nathens, MD PhD*. University of Toronto.

Invited Discussant: J. Wayne Meredith

Introduction: Field trauma triage criteria and appropriate use of transportation assets are critical components of a regional trauma system. If well disseminated, implemented and monitored, they have the potential to significantly reduce injury-related mortality.

However, undertriage continues to be a significant problem in many regional trauma systems. Taking a novel, population-based approach, we estimated the potential detrimental impact of undertriage to a non-trauma center (NTC) within a regional system.

Methods: We performed a population-based, retrospective cohort study of trauma center (TC) effectiveness in a region with urban, suburban and rural areas. Data were derived from administrative databases capturing all ED deaths and admissions in the region. Adult motor vehicle collision (MVC) occupants presenting to any ED (TC and NTC) in the study region were included (2002-2010). Data were limited to patients with severe injury (ISS > 15 or death within 24 hrs of presentation). The exposure of interest was initial triage destination (TC or NTC), regardless of later transfer to TC. Mortality at 24 and 48 hrs were compared across groups, using an instrumental variable analysis to adjust for confounding.

Results: Among 6,341 MVC occupants, 45.1% (n = 2,857) were triaged from the scene of injury to a TC. Among patients transported from the scene to a NTC, 57.5% (n = 2,003) were transferred to a TC within 24h of initial evaluation, 4.5% (n=158) died in the ED and 33.5% (n=1,323) were admitted to NTC. Overall, 76.6% of the cohort received definitive care at a TC. 48 hr mortality in the cohort was 8.4% (n = 535); 8.1% (n = 231) among those triaged directly to TC and 8.7% (n = 304) among those triaged to NTC. Compared to patients triaged to a NTC, adjusted mortality was lower among patients triaged directly to a TC, both at 24 hrs (OR 0.58, 95%CI 0.41-0.84) and at 48 hrs (OR 0.68, 95% CI 0.48-0.96).

Conclusion: Our data are population-based evidence of the early benefits of direct triage to TC. Although many surviving patients are later transferred to a TC, initial triage to a NTC is associated with at least a 30% increase in mortality in the first 48 hours following injury.

EARLY TREATMENT OF BLUNT CEREBROVASCULAR INJURY (BCVI) WITH CONCOMITANT HEMORRHAGIC NEUROLOGIC INJURY IS SAFE AND EFFECTIVE

Rachael A Callcut, MD, MSPH, Dennis J Hanseman, PhD, Patrick D Solan, MD, Kurt S Kadon, BA, Nichole K Ingalls, MD, Gerald R Fortuna, Jr, MD, Jay A Johannigman*, MD, Betty J Tsuei*, MD, Bryce RH Robinson, MD. Stanford University / University of Cincinnati.

Invited Discussant: Walter Biffi

Introduction: Early pharmacologic treatment for blunt cerebrovascular injury (BCVI) is often withheld when concomitant hemorrhagic traumatic brain injury (TBI) or cervical spinal cord injury (SCI) occurs. This study examines the safety and efficacy of early treatment for patients presenting with both BCVI and neurologic injury (TBI or SCI).

Methods: Ten year retrospective medical records review of patients with concomitant BCVI and a traumatic neurologic injury (TNI) was performed. Stroke outcomes for those treated with pharmacologic therapy for their BCVI (carotid or vertebral artery injury) were compared to those not treated. Also, the likelihood of worsening of hemorrhagic TNI (TBI or SCI) was determined for those exposed to pharmacologic therapy (therapeutic heparin or antiplatelet) compared to those not exposed. Multivariate logistic regression (SAS v. 9.2) techniques were used to determine adjusted OR (95% CI) for ischemic stroke risk.

Results: 78 patients were identified with BCVI + TNI (57 TBI, 21 SCI) with 1 immediate non-survivable brain injury death. Strokes occurred in 21/77 (27%) patients with 3/21 (14%) strokes present at the time of arrival. There was no differences between groups with respect to GCS, ISS, age, BCVI type or grade, diagnostic method, hospital day of diagnosis, injury year, or TNI type (TBI or SCI). Stroke rate was markedly higher in the untreated group compared with treated (57% vs 4%, $p < 0.0001$, unadjusted OR stroke [untreated] 29.3, 5.9-143). On multivariate regression, treatment status remained the most significant predictor of stroke (adjusted OR 19.6, 4.4-88.4, $p < 0.0001$, c-stat 0.93). There was no difference in risk of hemorrhagic deterioration of TBI based upon pharmacologic exposure vs. no exposure (4.9% vs. 6.3%, $p = 0.6$). Likewise, no SCI patient worsened as a result of pharmacologic exposure. Of the potentially preventable strokes, 28% (5/18) resulted in a stroke related death and all 5 deaths occurred in the untreated group.

Conclusion: The benefit of early treatment for BCVI markedly outweighs the risk of treatment in patients suffering concomitant BCVI and hemorrhagic neurologic injury.

"BLUSH" ON CT: OFTEN UNIMPORTANT!

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Invited Discussant: Thomas Scalea

Introduction: IV contrast extravasation (“blush”) on the trauma CT has been quoted as a reason for intervention (angiographic embolization or operation) after blunt trauma. The new generation CT scanners identify blushes with increasing frequency. We hypothesized that most blushes do not require an intervention.

Methods: Retrospective evaluation of 70 blunt trauma patients with 82 blushes on CT scan of the abdomen or pelvis (1/05-12/09). Along with demographic and hemodynamic variables, the following characteristics of a blush were examined as potential risk factors for intervention: maximal dimension, small (≤ 1.5 cm) vs. large (> 1.5 cm), contained vs. free, single vs. multiple and location.

Results: Of 82 blushes, 48 occurred in intra-abdominal solid organs, 18 in the pelvic retroperitoneal space and 16 in the soft tissues or mesentery. Of 52 blushes initially managed expectantly, 13 required an intervention. Finally, a total of 43 (52%) blushes required angiographic embolization or an operation and 39 (48%) did not. Blushes without an intervention were more frequently large (72 % vs. 16 %, $p < 0.0001$), multiple (77% vs. 50%, $p = 0.02$), extravasating freely (58 % vs. 27 %, $p = 0.013$), and associated with a higher grade of organ injury (61 % vs. 25%, $p = 0.019$). The only independent blush-related characteristic predicting an intervention, as identified by multivariate analysis, was the presence of a large blush (OR= 15.6, 95% CI: 3.6-67.5). Additionally, an admission systolic blood pressure < 100 mmHg and Abbreviated Injury Score of the abdomen = 3 were independent predictors of an intervention (OR=13.3, 95% CI: 2.5-70.4 and OR=29.8, 95% CI: 2.7-325.8, respectively). 100% of the patients who had all three independent risk factors received an intervention.

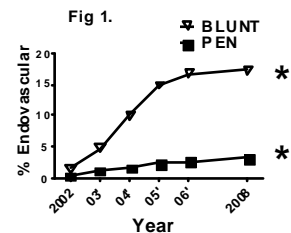
Conclusions: Nearly half of the blushes on CT scan do not require an intervention. Hypotension on admission, severe abdominal trauma, and a blush diameter larger than 1.5 cm predict the need for intervention.

THE EVOLVING ROLE OF ENDOVASCULAR TECHNIQUES FOR TRAUMATIC VASCULAR INJURY

Laura E Hiltner, MD, Kurt Stahlfeld, MD, Alain C Corcos, MD, Aaron M Scifres, MD, Jenny A Ziembicki, MD, Greg A Watson, MD, Raquel M Forsythe, MD, Timothy R Billiar, MD, Andrew B Peitzman*, MD, Jason L Sperry, MD, MPH. University of Pittsburgh.

Invited Discussant: Ryad Karmy-Jones

Introduction: Endovascular management of blunt aortic injury has dramatically reduced the morbidity associated with this specific injury. There remains a paucity of evidence quantifying the beneficial effects associated with endovascular (ENDO) techniques for other vascular injury types. **Methods:** We performed a retrospective review of the NTDB over 2002-2006 and 2008 time periods (n=2.5 million pts). Injured patients undergoing any arterial vascular procedure (ICD-9-CM proc 38.0-4, 39.0-9) employing ENDO or open techniques were determined. AIS codes were used to select subclavian, carotid and vertebral artery injuries. Mortality trends and %ENDO were compared over time. Logistic regression was used to determine if early ENDO procedures (< 24hrs) were independently associated with a lower risk of mortality. **Results:** The % of ENDO procedures has increased over time. (Fig 1, * p<0.05). A significant lower mortality and increased % ENDO was found for subclavian, carotid and vertebral injuries. In year 2008, 75% of ENDO procedures occurred early (initial 24hrs) with 20% being hypotensive upon arrival. Regression analysis revealed that early ENDO procedures were independently associated with a 35% reduction in mortality risk (OR 0.65 p<0.001, 95%CI 0.5-0.8) **Conclusions:** ENDO procedures for arterial injury have increased over time while mortality has decreased. Early ENDO procedures are common, even in the unstable, and are associated with a lower risk of mortality. These results suggest vascular injury outcomes may benefit from ENDO expertise and ENDO techniques should be incorporated into the early treatment algorithm of trauma patients with vascular injury, particularly those with difficult exposure.



DOES HEMOPERICARDIUM AFTER CHEST TRAUMA MANDATE STERNOTOMY?

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Invited Discussant: David Feliciano

Background: After trauma, hemopericardium is an indication for sternotomy and is often urgent and life-saving. It is unknown, however, how frequently these operations are therapeutic (T). Based on our recent experience, we hypothesized that a significant fraction are non-therapeutic (NT).

Method: Patients with a positive diagnostic subxiphoid pericardial window followed by sternotomy (n=44) were identified in a Level 1 trauma center database from 1/1998-10/2010. "NT" was defined as no identifiable cardiac or great vessel injury (or injury not requiring repair). Every repair was defined as "T" and was further classified according to the AAST-OIS cardiac injury grade.

Results: Only 45% of sternotomies after hemopericardium were therapeutic (20/44). Penetrating injury was the dominant mechanism (35/44=80%). Demographics and initial vital signs were comparable between T and NT, including age (33±14 vs 33±13 yrs), base excess (-8.5±7.2 vs -5.0±6.4 mEq/L), hematocrit (35±5 vs 35±8), ISS (30±17 vs 25±12), median systolic blood pressure (108 vs 116 mm Hg), and median GCS (12 vs 12).

% (n=)	T (n=20)	NT (n=24)	P
Injury grade 0-III	35% (7)	92% (22)	0.0001
Injury grade IV-V	65% (13)	8% (2)	0.0001
Hemodynamically stable in OR	50% (10)	58% (14)	0.7619
Overall mortality	20% (4)	21% (5)	1.0000

Conclusions: Although it is counterintuitive, hemopericardium is not reliable for diagnosing cardiac or great vessel injuries after chest trauma. In this series, over half had non-therapeutic sternotomies, but all who remained hemodynamically stable in the OR survived. Altogether, these provocative data suggest that in stable blunt or penetrating trauma patients with low injury grades, sternotomy could be deferred in some cases. Because this interpretation is limited by a small sample size, a multicenter study is necessary before these findings can be accepted with confidence.

ELECTROPORATION MEDIATED IN-VIVO GENE DELIVERY OF THE Na⁺/K⁺-ATPASE PUMP REDUCES LUNG INJURY IN A MOUSE MODEL OF LUNG CONTUSION

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Invited Discussant: Hasan Alam

Objective: Lung contusion (LC) is an independent risk factor for Adult Respiratory Distress Syndrome (ARDS). The final common pathway in ARDS involves accumulation of fluid in the alveoli. In this study we demonstrate the application of a potential gene therapy approach by delivering the Na⁺/K⁺-ATPase pump sub-units in a murine model of lung contusion. We hypothesized that restoring the activity of the pump will result in removal of excess alveolar fluid and additionally reduce inflammation.

Methods: Under anesthesia, C57/BL6 mice were struck along the right posterior axillary line 1 cm above the costal margin with a cortical contusion impactor. Immediately afterwards; 100 µg of plasmid DNA coding for the α/β subunits of the Na⁺/K⁺-ATPase pump were instilled into the lungs (pNa⁺/K⁺ group). A sham saline instillation group after contusion was used as control. Using a BTX 830 Electroporator, 8 electrical pulses of 200-V/cm field strength were applied transthoracically. Mice were sacrificed at 24h, 48h and 72h post-delivery. Bronchial alveolar lavage (BAL) fluid was recollected to measure albumin and cytokines by ELISA. Lung-compliance was measured and lungs were subjected to histopathologic analysis.

Results: Following the electroporation of plasmids coding for the α,β subunits of the Na⁺/K⁺-ATPase pump there was a significant mitigation of acute lung injury as evidenced by reduction in BAL levels of albumin, improved hysteresis, diminished cytokine response and reduced neutrophil and fluid accumulation in the alveoli.

Conclusion: Electroporation mediated gene transfer of the subunits of Na⁺/K⁺-ATPase pump enhanced recovery from acute inflammatory lung injury following lung contusion.

Figure 1. Pressure volume curves at 48 h post contusion

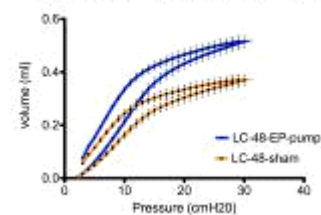
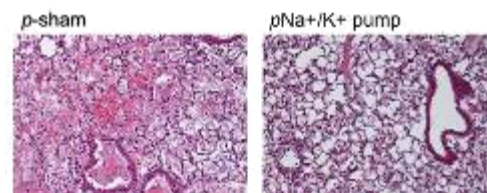


Figure 2. H-E lung right upper lobe 24 h after contusion



DAMAGE CONTROL TECHNIQUES IN THE MANAGEMENT OF SEVERE LUNG TRAUMA

Juan Martinez, MD, Julio Rodriguez, MD, Mauricio Millan, MD, Juliana Suarez, MD, Carlos Ordoñez, MD, Juan C Puyana*, MD. Universidad del Valle. Clinica Valle del Lili.

Invited Discussant: Kenneth Mattox

Objective: Damage Control (DC) techniques have improved survival in severe abdominal and extremities injuries. However, there is a paucity of data on the specific surgical strategies and outcomes in patients with DC for severe thoracic injuries. We reviewed 25 patients who required DC in the treatment of their thoracic/pulmonary complex trauma.

Methods: We included patients 14 and older that were managed at two level I trauma centers (TC) with damage control thoracotomy (DCT). Demographics, trauma characteristics, surgical techniques and resuscitation strategies were reviewed

Results: Thoracotomies for trauma were performed in 840 patients from 2003 to 2007.

DCT was performed in 31 (3,6%). Pulmonary trauma was found in 25 cases.

The average age was 26,6 (+/-9,9) years, RTS was 6.12 (+/- 1,99), and average ISS was 31,0 (+/-11.3). There were 19 patients with GSW, 4 with stab-wounds and 4 a with blunt chest trauma. Resuscitative thoracotomy was performed in 8 cases. In 17 patients there was an extrathoracic source of bleeding resulting from either the neck or the abdomen. Lung bleeding was controlled with pneumorrhaphy in 3 cases, tractotomy in 12, and wedge resection in one. Bleeding was controlled in 7 patients by clamping of the pulmonary hilum as a last resource technique. Four patients returned to the ICU with the pulmonary hilum clamped left in place. These 4 patients underwent a deferred operation within 16 to 90 hours after the initial DCT. Two of these patients had a deferred pneumonectomy, 1 required a lobectomy and 1 had a bi-lobectomy. All these 4 patients survived. Bleeding from other sources was found in 20 cases. Major vessels in 9, heart in 3 and thoracic wall in 9. DCT mortality in pulmonary trauma was 6/25. (24%)

Conclusion: This is a preliminary series describing our experience with DCT in severe lung trauma. We describe pulmonary hilum clamping and deferred lung surgery as a viable surgical alternative for major pulmonary injuries.

**SURGICAL STABILIZATION OF SEVERE RIB FRACTURES IMPROVES
LIBERATION FROM MECHANICAL VENTILATION**

Jay N Collins*, MD, Leonard J Weireter*, MD, LD Britt*, MD, MPH. EVMS.

Invited Discussant: R. Stephen Smith

INTRODUCTION: Traditional treatment of rib fractures has historically been analgesia via oral, intravenous or epidural methods and aggressive pulmonary toilet. We sought to determine if surgical stabilization of severe rib fractures and flail chest would decrease length of stay (LOS) from mechanical ventilation, the ICU or total hospital days.

METHODS: All patients with flail chest or severely displaced rib fractures admitted to the trauma service from January 2006 to January 2011 were identified. Age, gender, ISS, mechanism of injury, admission GCS, ventilator LOS, ICU LOS, hospital LOS and morbidities were obtained from our trauma database.

RESULTS: From July 2009 to January 2011, 18 patients underwent stabilization of displaced rib fractures and flail chest. Fifteen of these were placed on mechanical ventilation within 24 hours of admission and comprise the study group (SURG). The historical cohort contained 18 patients in the previous 3 1/2 years who were ventilated, diagnosed with flail chest and had admission GCS > 9 (NONOP). The SURG and NONOP groups were similar in age (47.2 vs. 52.4), male gender (87% vs. 63%), ISS (26.5 vs. 29.6) and admission GCS (13.9 vs. 12.8). SURG patients had a decreased ventilator LOS at 6.3 vs. 11.8 d (p=0.036). ICU LOS 12.1 vs. 17.4 d (p=0.063) and hospital LOS 21.5 vs. 31.2 d (p=0.091) tended to be lower but were not statistically different. No patient developed a surgical site infection or prolonged use of tube thoracostomy.

DISCUSSION: In patients with displaced rib fractures or flail chest surgical stabilization makes breathing more comfortable and allows for quicker liberation from mechanical ventilation. It may ultimately decrease ICU LOS and total hospital LOS as well. It is a safe procedure with minimal morbidity and should be considered in all patients with severe rib fractures or flail chest requiring mechanical ventilation.

BLUNT CEREBROVASCULAR INJURIES: REDEFINING SCREENING CRITERIA IN THE ERA OF NON-INVASIVE DIAGNOSIS

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Invited Discussant: Timothy Fabian

Objectives: Screening for blunt cerebrovascular injuries (BCVI) and early treatment has virtually eliminated injury-related strokes. Screening protocols developed in the 1990's historically capture approximately 80% of identified BCVI. With the availability of non-invasive diagnosis with computed tomographic angiography (CTA), broader indications for screening have been suggested. The *purpose* of this study was to identify injury patterns of patients with BCVI that are not currently recommended screening criteria.

Methods: Our prospective BCVI database was queried from 1/97 to 1/11. Indications for screening, injury mechanism, and outcomes were analyzed. Patients < 18 years were excluded.

Results: During the 14 year study period, 585 BCVIs were identified in 418 patients (66% men, age 40 ± 0.7). 83 (20%) patients with BCVI did not have defined screening criteria.

	Asymptomatic Pts (n=55)	Pts with Stroke (n=28)
Mandible fx	21	6
Any basilar skull fx/occipital condyle fx	11	3
Frontal skull fx and orbit fx	6	0
High mechanism injury with TBI and thoracic injuries	2	4
Scalp degloving	4	2
Great vessel or cardiac injury	4	0
Other	7	5
No injuries	0	8

Pts = patients; Fx = fracture; TBI = traumatic brain injury

Of the 307 asymptomatic patients that received antithrombotic treatment, one patient suffered stroke (0.3%) and one patient a transient ischemic attack (0.3%).

Conclusions: A significant number of patients suffering BCVI are not captured by current screening guidelines. Screening for BCVI should be considered in patients with mandible fractures and complex skull fractures. Other injury patterns identified in patients with BCVI include TBI with thoracic injuries, scalp degloving, and thoracic vascular injuries.

PENETRATING CARDIAC INJURES: A 36-YEAR PERSPECTIVE AT AN URBAN, LEVEL I TRAUMA CENTER

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Invited Discussant: Rao Ivatury

Background: Penetrating cardiac injuries (PCI) are associated with high mortality rates and present diagnostic and therapeutic challenges to the surgeon. This study compares patient (pt) injuries & outcomes with PCI at an urban, level I trauma center over 36 years.

Methods: PCI pts were identified from the trauma registry & surgery database (1975-2010). Demographics & outcomes were compared over three time intervals: Period 1 (1975-1985; n=113), Period 2 (1986-1996; n=79), and Period 3 (1999-2010; n=79).

Results: 271 patients (87% male, mean age = 32 years, initial base deficit = -11.3) sustained cardiac stab (SW,61%) & gunshot wounds (GSW,39%). Emergency department thoracotomy was performed for 67/271 (25%) pts. Mortality data is summarized in the table. In Period 3, GSWs (n=45) resulted in multi-cavity injuries (MCI) in 19 (42%) pts with the diaphragm (100%), liver (53%), and stomach (47%) most frequently injured, while only 3 (9%) of 34 SWs had MCI. Pericardial window procedures decreased from Period 1 (34%) to Periods 2 (8%) and 3 (10%). Surgeon-performed ultrasound (US) accurately identified pericardial blood in 55 of 55 pts. Cardiopulmonary bypass (CPB) was required for cardiac repair in 2 (2%) of 79 pts in Period 3. Postoperative echocardiogram (n=25) was abnormal in 3 pts with new symptoms (2 murmurs; 1 cardiac failure) & normal in all 23 asymptomatic pts.

	Period 1	Period 2	Period 3	<i>p-value</i>
Overall Mortality	27%	22%	42%	0.02
GSW Mortality	36%	42%	56%	0.2
SW Mortality	23%	11%	23%	0.18
Gunshot Wounds	32%	33%	57%	0.001
Multi Chamber Injury	12%	18%	35%	0.02

Conclusions: 1) Overall mortality after PCI has increased over the past decade with increasing mortality in GSWs & MCIs. 2) Surgeon-performed US has decreased the time to diagnosis of PCI. 3) CPB is needed in <2% of PCI repairs. 4) Postoperative echocardiogram may only be necessary in symptomatic pts.

**EMERGENCY UNCROSSMATCHED TRANSFUSION EFFECT ON BLOOD
TYPE ALLOANTIBODIES**

Emily Miraflor, MD, Louise Yeung, MD, Aaron Strumwasser, MD, Terrance Liu, MD*,
Gregory P Victorino, MD*. UCSF East Bay.

Invited Discussant: Greg Beilman

Introduction: Increased reliance on blood transfusion for resuscitation of trauma patients strains the limited resources of blood banking systems. Resuscitation of trauma patients often requires emergency transfusion of unmatched blood products; typically Type O Rh negative (Rh-) is given until matched blood is available. When supplies of Type O negative blood are low, Type O Rh positive (Rh+) may be given to males, to conserve remaining supplies for woman and infants. We hypothesized that those patients given uncrossedmatched blood (UCMB) may be at risk of alloantibody development, placing them at risk for hemolytic transfusion reactions (HTR) in the future.

Methods: The records of trauma patients who received emergency UCMB transfusion from July 2009-August 2010 were reviewed. Data regarding demographics, vital signs, injury severity scores, alloantibody profiles, and the occurrence of HTR were collected.

Results: Fifty patients received 600 units of PRBC. The average ISS was 26 ± 2.7 . Sixteen (32%) patients died; 12 died on arrival or in the operating room, the remaining 4 had no evidence of HTR prior to death. There were four Rh- patients (8%). No Rh- females received Rh+ blood. Two Rh- males received Rh+ blood, one developed anti-Rh D antibodies; neither experienced HTR. One female patient had an HTR due to reactivation of amnestic JK-A antibodies. Eight of 14 patients tested (57%) met criteria for HTR based on urinalysis and 10 of 21 patients tested (48%) met criteria for HTR based on hemoglobin and bilirubin values, yet only one patient developed a confirmed HTR.

Conclusion: Victims of penetrating trauma have high rates of injury recidivism, increasing the likelihood of receiving multiple blood transfusions over their lifetime. Rh- patients who receive Rh+ blood are at risk of developing anti-Rh antibodies putting them at risk for HTR in the future. The conservation of Rh- blood for use in female patients may be detrimental to Rh- males. Additionally, laboratory diagnostic criteria for HTR are non-specific in the trauma population and should be used with caution.

**EVALUATION OF MULTIDETECTOR COMPUTED TOMOGRAPHY FOR
NECK PENETRATING NECK INJURY: A PROSPECTIVE MULTICENTER
STUDY**

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Invited Discussant: Ronald Stewart

Background: Multidetector CT Angiography (MDCTA) is increasingly being utilized for the assessment of penetrating neck injury. A prospective multi-center study was performed to evaluate the sensitivity and specificity of MDCTA for penetrating trauma to the neck.

Methods: All penetrating neck injuries assessed at two Level I trauma centers (01/2009-01/2011) underwent a structured clinical examination. Those with hard signs of vascular or aerodigestive tract injury underwent exploration, those with no signs, observation. The remainder underwent MDCTA. Sensitivity and specificity were tested against an aggregate gold standard of operative intervention, clinical follow-up and all imaging obtained.

Results: Of 369 patients with penetrating neck trauma, 5.7% had hard signs of injury with a 95.2% incidence of clinically significant injuries requiring operative intervention. 51.2% had no signs of injury with no missed injuries detected during mean follow-up of 5.4 ± 8.3 d (range 1-131d). The remaining 159 patients (43.1%) underwent MDCTA (SW 53.8%, GSW 41.5% and other 4.7%). 41.5% of external wounds were in zone 2, 23.7% in zone 3, 21.2% in zone 1 and 13.6% involved multiple zones. 14 positive studies in 13 patients were confirmed at traditional angiography or OR (6 IJV, 3 ICA, 2 ECA, 2 Vertebral, 2 SCA). MDCTA also detected two tracheal, two esophageal and 1 laryngeal injury. 3 patients had false positive findings of vascular injury and 1 of aerodigestive tract injury. For the 135 negative studies, follow-up was available for a mean of 5.7 ± 5.9 d (range 1-27d). MDCTA was non diagnostic in 3 patients (1.9%), secondary to artifact from retained missile fragments. MDCTA achieved 100% sensitivity and 97.1% specificity in detecting all clinically significant neck injuries.

Conclusions: In the initial evaluation of patients who have sustained penetrating neck trauma, a structured physical examination may reduce unnecessary imaging. If imaging is required, MDCTA is a highly sensitive screening modality for the evaluation of vascular and aerodigestive structures in the neck.

**DECISION MAKING CRITERIA FOR IMPLEMENTING DAMAGE CONTROL
RESUSCITATION (DCR) STRATEGIES IN PATIENTS WITH ABDOMINAL
GUNSHOT WOUNDS (AGSWS)**

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Jhon H Loaiza, Biost, Juan Carlos Puyana*, MD. Fundacion Valle del Lili.

Invited Discussant: Juan Asensio

Introduction: DCR is a life saving intervention aimed to avoid irreversible hypothermia, acidosis and coagulopathy. Therefore, DCR must be implemented before the onset of these metabolic derangements. However, immediately available criteria upon initial resuscitation and laparotomy have not been tested as indicators for early DCR implementation. Our objective was to identify anatomic and physiological variables associated with the decision to institute DCR in victims of AGSWS

Methods: We identified AGSWS patients in a prospectively collected ICU data registry. We analyzed variables at admission to the emergency room, at the initiation of laparotomy and outcome. We performed a bi- and multivariate analysis to identify factors associated with improved identification of patients who underwent DCR and tested the model using bootstrap simulation (4500 replicate samples).

Results: A total of 331 patients with AGSWS were identified (2003-2010). Variables were compared between those who underwent DCR and those who did not (NODCR). A PRC/FFP ratio of 1:1 was used in 80% of DCR patients. The overall mortality was 11.2%. Bootstrap resampling maintained the predictive capacity.

Group	SBP ??±SD	HR ??±SD	Temp.°C ??±SD	BE ??±SD	Hemo- peritoneum >1500cc, n (%)	PATI, Me; IQR	NISS, Me; IQR	Mortality %
DCR n=162	93,5± 41,3	112±20.4	35,4 ± 1,06	-11.3 ± 6.1	105 (64.8)	34; 25-46	41 ; 34-50	20.3
NO DCR n=169	115,7± 36,9	93 ± 19.4	36,23 ± 0,9	-7,7 ± 3.1	32 (18.9)	20;15-26	25 ; 16-34	2.4
<i>p value</i>	<0.001	<0.001	<0.001	<0.001	0.001	<0,001	<0.001	0.001

Multivariate analysis identified Temp < 35°C, initial hemoperitoneum>1500cc, NISS>35 and base excess = -8 as factors significantly associated with implementation of DCR. This model predicted a correct classification in 87.7% of cases (goodness-of-fit test, p = 0.23).

Conclusions: We have identified variables readily measured early in the management of AGSWS patients that may guide the prompt implementation of life-saving DCR.

DEAD MEN TELL NO TALES: ANALYSIS OF THE UTILITY OF AUTOPSY REPORTS IN TRAUMA SYSTEM PERFORMANCE IMPROVEMENT ACTIVITIES

Thomas J Esposito, MD, MPH*, Teri Sanddal, BS, Nels Sanddal, BS, MS, PhDc, Jolene Whitney, MPA. Loyola University Medical Center.

Invited Discussant: Alicia Mohr

Purpose: To determine the influence and utility of autopsy report review on preventability judgments as part of trauma system performance improvement (PI) activities.

Methods: All cases of trauma fatalities occurring over one year were reviewed as part of a preventable mortality study evaluating a statewide trauma system. Preventability judgments were first determined by multidisciplinary committee consensus without benefit of autopsy report. Deaths were then re-analyzed after the committee was provided with autopsy findings. Changes in committee determinations of preventability and cause of death were noted.

Results: A total of 434 cases were reviewed, autopsies were performed in 240 (55%). Autopsy rate was 83% for pre-hospital deaths (PHD) and 37% for hospital deaths (HD). A complete examination (CA) was performed in 166 cases (69%) and 74 (31%) were limited internal or external examinations only (NCA). Of autopsies performed on HD, 60% were CA vs 75% in PHD. Autopsy review changed preventability determination in 3 cases (1%), 2 from PHD, 1 from HD. All changes were from non-preventable to possibly preventable. For all cases with autopsy, the committee felt the autopsy should have been of sufficient quality to determine cause of death in 83% of cases with any type of autopsy, 95% in cases with CA and 62% in cases with NCA. The autopsy was felt to actually establish a specific cause of death in 70% of all cases with autopsy, 71% in cases with NCA and 74% in cases with CA. The autopsy changed the committee's pre autopsy review determined cause of death in 31% of all cases with autopsy (37% in the CA group; 13% in NCA). For PHD, autopsy changed the panel determined cause of death in 44% and in 13% of HD.

Conclusions: Review of autopsy reports adds little to the trauma PI process. It does not significantly change death review panel determinations. It may, perhaps, be most useful in PHD. Ardent initiatives to expend resources on autopsy performance, and acquisition of autopsy reports, in all trauma cases, is unwarranted.

BETA ADRENERGIC INHIBITION ATTENUATES THE REDUCTION IN CEREBRAL GLUCOSE METABOLISM AFTER TRAUMATIC BRAIN INJURY

Eric J Ley, MD, Morgan A Clond, PhD(c), Matthew B Singer, MD, Ryan Park, MS, Grant Dagliyan, MS, Peter S Conti, MD PhD, Ali Salim*, MD. Cedars-Sinai Medical Center.

Invited Discussant: Alex Valadka

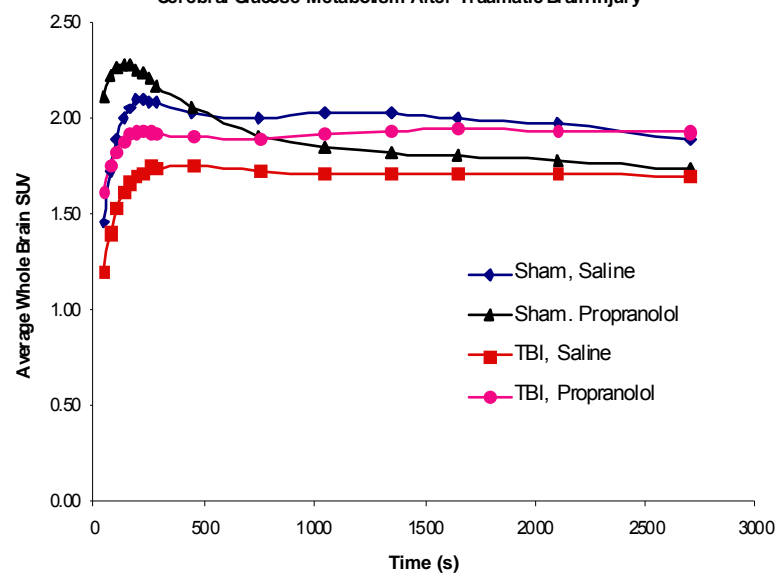
Introduction: The purpose of this study was to evaluate how beta adrenergic receptor (BAR) inhibition affects early cerebral glucose metabolism after traumatic brain injury (TBI) using a mouse electromagnetic controlled cortical impact (CCI) model.

Methods: Mouse cerebral glucose metabolism was measured by microPET fluorodeoxyglucose uptake and converted into standardized uptake values (SUV). Four groups of mice (C57/Bl6) were studied (n=5): sham or CCI, followed by tail vein injection of either saline or a nonselective beta adrenergic receptor inhibitor (propranolol, 4 mg/kg).

Results: Mean SUVs for the 90 minute study were not significantly different for sham injured mice injected with saline or propranolol (1.97 ± 0.20 v. 2.05 ± 0.19 , $p = 0.15$). CCI mice with saline injection noted significantly lowered mean SUV compared to sham injury with saline (1.63 ± 0.24 v. 1.97 ± 0.20 , $p < 0.01$). Mean SUV after CCI with propranolol was significantly higher compared to CCI with saline (1.89 ± 0.37 v. 1.63 ± 0.24 , $p < 0.01$).

Conclusion: Using microPET imaging, we demonstrate that inhibition of BAR signaling attenuates the early

reduction in cerebral glucose metabolism after TBI. We confirmed that glucose metabolism is significantly reduced after TBI consistent with previous reports. Our model suggests that BAR signaling contributes to impaired glucose metabolism after TBI.



THE EMERGENT AIRWAY: VIDEO-ASSISTED INTUBATION IS SUPERIOR TO DIRECT LARYNGOSCOPY FOR TEACHING JUNIOR RESIDENTS

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Invited Discussant: David Harrington

Background: Video-assisted intubation (Vi) is a relatively new technology designed for managing difficult airways. Vi allows for clear visualization of the airway anatomy displayed on a TV monitor where the trainee and supervisor share the same view. Use of Vi for emergent intubations in the SICU setting has not been studied. We hypothesized that Vi would lead to more successful intubations by junior residents while maintaining an excellent safety profile compared with direct laryngoscopy (DL).

Methods: All patients emergently intubated in the SICU at a Level I urban trauma center during a 7-month period were included. Junior residents attempted airway control with Vi under the supervision of the Fellow or Attending and pertinent data were collected prospectively. These data were compared to a retrospective cohort of trauma patients from the same time period intubated in the emergency department with DL.

Results: All patients from both groups were successfully intubated. Junior residents successfully intubated 70 of 74 pts (96%) with Vi vs. 45 of 59 (76%) with DL ($P<0.05$).

Experience level was markedly different between the two groups; residents with <20 prior intubations performed 70/74 intubations (96%) in Vi vs. 24/59 (40%) in DL ($P<0.05$). Residents with <5 prior intubations performed 27/74 (37%) of the intubations in Vi vs. 4/59 (7%) in DL ($P<0.05$). In a failed first pass, junior residents were more likely allowed a second attempt with Vi vs. DL (88% vs. 13%, $P<0.05$). The incidence of desaturations to <80% was similar; Vi 35% vs. DL 29%. There was no difference in hospital mortality; Vi 30% vs DL 34%.

# Prior Intubations	Video (N=74)	Direct (N=59)
<5	27	4
5-20	43	20
>20	4	35

Conclusion: The use of Vi by junior house staff in emergent airway situations is both safe and effective. Our experience suggests that video-assisted intubation is superior to direct laryngoscopy for educational purposes in the emergent intubation setting.

**PREHOSPITAL MODE OF TRANSPORT DOES NOT IMPACT OUTCOME
AFTER SEVERE INJURY**

Eileen M Bulger, MD*, Frank Guyette MD, Danielle Guffey PhD, Laurie J Morrison MD, Jeffery D Kerby MD*, Karen Brasel MD*, Joseph P Minei MD*, Craig Warden MD, Russell D MacDonald MD, Justin Dillingham, Sandro Rizoli MD, PhD*, Graham Nichol MD. University of Washington.

Invited Discussant: Jeffrey Salomone

There is ongoing controversy regarding the role of aeromedical vs. ground transportation by Emergency Medical Services (EMS) for severely injured patients. In some systems aeromedical crews may provide a higher level of advanced life support care, but may require a longer transport time. We sought to evaluate the impact of mode of transport on outcome based on secondary analysis of data from randomized trials of prehospital hypertonic resuscitation conducted by the Resuscitation Outcomes Consortium. **Methods:** Injured patients were enrolled in the trials based on prehospital evidence of hypovolemic shock (SBP < 70mmHg or SBP 71-90mmHg with HR > 108) or severe traumatic brain injury (TBI) (GCS ≤ 8) in 114 EMS agencies in North America. Patient demographics, injury severity, and physiology were compared based on mode of transport. Multivariate logistic regression was used to determine the impact on 28 day survival for all patients and 6 month extended Glasgow Outcome Score (GOSE) for patients with TBI adjusting for differences in injury severity and physiology. **Results:** Included were 2130 patients, 728 (34%) transported by air. Patients transported by air were more severely injured (mean ISS 29.9 vs 22.6*), more likely to be in the TBI cohort (69.5% vs 55.1%*), more likely to have a blunt mechanism (94.2% vs 78.4%*). Patients transported by ground had lower initial SBP (mean 74.1 ± 48.4 vs 89.3 ± 45.9mmHg*). Patients transported by air were more likely to have prehospital intubation (81% vs 36%*), received more IV fluids (mean 1.3L vs 0.8 L*) and had a longer prehospital time (mean 75.7 min vs 43.3 min*). * p < 0.001. When adjusted for the differences in mechanism, injury severity, and initial physiology, there was no significant impact of mode of transport on survival or 6 month neurologic outcome (Air transport: 28 day survival, OR 1.20 (95% CI: 0.86-1.67), 6 month GOSE = 4 OR 0.89 (95% CI: 0.63-1.26). **Conclusion:** Aeromedical services transported more severely injured patients with more advanced life support procedures and longer prehospital time. There was no difference in clinical outcome based on mode of transportation.

CONTEMPORARY MANAGEMENT OF RENAL TRAUMA: DIFFERENCES BETWEEN UROLOGISTS AND TRAUMA SURGEONS

Lawrence L Yeung, MD, Steven B Brandes, MD*. Washington University.

Invited Discussant: David Efron

Introduction and Objectives: Controversy exists as to how renal trauma (RT) should be managed. This study evaluated the contemporary practice patterns of urologists (US) and trauma surgeons (TS) on controversial topics in the management of RT.

Methods: A national survey of Society of Genitourinary Reconstructive Surgeons (GURS) members and a random sampling of American Association for the Surgery of Trauma (AAST) members between October and November 2010 was performed via an email survey regarding management routines for various stages of blunt and penetrating RT.

Results: Response rate was 33% (n= 117 AAST, 39 GURS). 77% practice at level I trauma centers treating adults (95%) at academic teaching hospitals (84%). US obtain a “lay of the land” CT scan prior to surgical exploration for penetrating RT more often than TS (77 vs. 18%, p<0.001). US prefer to use a “one-shot” intravenous pyelogram (82%) whereas TS prefer palpation (61%) to confirm presence of another kidney when a pre-op CT is not done. TS do not obtain primary renal vascular control prior to opening the RP, whereas US do (21 vs. 71%, p<0.001). TS have a lower threshold for utilizing early angiography for the control of intravascular contrast extravasation compared to US (88 vs. 55%, p<0.001). TS over utilize ureteral stenting (50 vs. 24%, p<0.001) and underutilize observation and reimaging (40 vs. 64%, p<0.001) for isolated collecting system injuries compared to US. TS and US agree on conservative management of AAST stable grade 3 blunt and penetrating RT.

Conclusion: There is an apparent lack of communication and differing treatment methods for renal trauma between the two disciplines, which often do not follow published guidelines (BJU Int 2004 93(7):937-54; Eur Urol 2005: 47(1):1-15). That there are two camps with differing “community standards of practice” indicates that there is a desperate need for re-education, and for large scale, multi-institutional prospective studies on renal trauma to “standardize” the management of these injuries.

THE DELAYED VS EARLY ENOXAPARIN PROPHYLAXIS (DEEP) STUDY AFTER TBI: AN ANALYSIS OF RANDOMIZED PILOT STUDY FEASIBILITY

HERB A PHELAN, MD*, SCOTT NORWOOD, MD*, ALEXANDER L EASTMAN, MD, CHRISTOPHER MADDEN, MD, KIM ALDY, MS, SCOTT C BRAKENRIDGE, MD, PAUL NAKONEZNY, PhD, DAVE CHASON, MD, LISA YANG, MD, GARY ARBIQUE, PhD, JOSEPH P MINEI, MD*. University of Texas Southwestern Medical Center.

Invited Discussant: M. Margaret Knudson

Introduction: A randomized control trial of pharmacologic prophylaxis for venous thromboembolism (VTE) after traumatic brain injury (TBI) has never been done in part due to perceived administrative, consent-related and logistical barriers. We are conducting the “Delayed vs Early Enoxaparin Prophylaxis (DEEP)” study, a double-blind, placebo-controlled, randomized pilot trial funded for 80 patients. Here we report an interim analysis at our first data monitoring committee (DMC) review focusing on issues of trial feasibility.

Methods: In this two-institution study, TBI patients meeting modified Norwood criteria and with stable scans at 24 hrs post-injury are being randomized to receive enoxaparin 30 mg SQ q 12 hrs or placebo starting 24 hrs post-injury. A study-funded CT is obtained 24 hrs after starting treatment on all patients. The interventional phase of the study ends at 96 hrs post-injury. Primary and secondary adverse events are radiographic progression of TBI and VTE, respectively. A non-inferiority design will be used with the margin, M , set at 5%.

Results: IRB approval required 61 and 45 days, respectively. At ER presentation, 33% (176/535) of TBI patients have met inclusion criteria after 21 center-months of accrual; the most common exclusions have been pre-injury anticoagulants (32%) and TBI patterns larger than the modified Norwood criteria (43%). Progression before or on 24 hr postinjury CT was seen in 13% (22/176). Fifty five patients have met final eligibility at 24 hrs post-injury and received the intervention (ie, 2.6 patients enrolled per center-month). Identical consent rates of 70% were seen at both institutions despite one being rural and one being urban. Scans scheduled for 24 hrs post-injury were actually obtained at a mean of 23.5 + 3.2 hrs post-injury, and intervention was initiated at 25.9 + 5.7 hrs post-injury. At DMC review, one radiographic but subclinical TBI expansion had been noted as had one VTE.

Conclusion: Interventional studies for anticoagulation after TBI are feasible as perceived barriers are not borne out in practice. The resources needed for randomized trials such as DEEP are justified in order to create data-driven algorithms for VTE prophylaxis after TBI.

IS CONTRAST EXPOSURE SAFE AMONG THE HIGHEST RISK TRAUMA PATIENTS?

Dennis Y Kim, MD, Leslie Kobayashi, MD, Todd Costantini, MD, David Chang, PhD, Dale Fortlage, BA, Susan Wynn, RN, Vishal Bansal, MD, Raul Coimbra*, MD, PhD. University of California San Diego.

Invited Discussant: Michael Sise

Background: Despite improvements in the diagnosis and management of acute kidney injury (AKI), posttraumatic renal dysfunction continues to be associated with both increased morbidity and mortality. Previous studies have shown that in the general trauma population intravenous (IV) contrast is not a risk factor for AKI. However, IV contrast is known to induce renal dysfunction in high risk groups including the elderly and critically ill. We sought to determine if IV contrast exposure among high risk trauma patients resulted in renal dysfunction as defined by the Acute Kidney Injury Network (AKIN) criteria.

Methods: We performed a 3 year retrospective analysis of all patients admitted to our Level 1 Trauma Center surgical intensive care unit (SICU) for >48 hours. Patients with preexisting chronic renal dysfunction were excluded. We defined renal dysfunction as AKIN stages 1, 2, or 3 and examined the role of IV contrast exposure in the development of AKI. We performed univariate analysis to identify risk factors for AKI. Multivariable logistic regression analysis identified independent predictors for AKI. Lastly, subgroup analysis was undertaken among high risk groups to include elderly patients with admission hypotension (systolic blood pressure <90mmHg) and an Injury Severity Score (ISS) =25.

Results: Of the 6,317 patients admitted during the 3 year study period, 571 (9.0%) patients met the inclusion criteria. 170 (29.8%) patients developed AKI. Age =75 (OR 14 95% CI 3.40-57.7, $p < 0.05$) and ISS=25 (OR 3.07 95%CI 1.11-8.51, $p < 0.05$) were determined to be independent predictors of AKI. IV contrast was not identified to be a predictor of AKI on univariate or multivariate analysis. Upon subgroup analysis, IV contrast exposure was not a predictor of AKI among the elderly (≥ 65), hypotensive patients (SBP<90mmHg), or severely injured patients (ISS =25).

Conclusion: A complete trauma workup including studies requiring IV contrast exposure should be considered safe even among high risk trauma patients.

Session 14

Paper 70 11:05 AM

Oral Abstract Withdrawn

FOCUSED RAPID ECHOCARDIOGRAPHIC EVALUATION (FREE) VERSUS VASCULAR CATHETER BASED ASSESSMENT OF CARDIAC OUTPUT AND FUNCTION IN CRITICALLY ILL TRAUMA PATIENTS

Sarah B Murthi, MD, Manjunath Markandaya, MD, John R Hess, MD, William C Chiu*, MD, Thomas M Scalea*, MD. University of Maryland Medical Systems.

Invited Discussant: Steven Shackford

Introduction: Cardiac index (CI) and stroke volume (SV) are the central forms of evaluating cardiac function in the ICU. This study compares vascular catheters (VC) to the Focused Rapid Echocardiographic Evaluation (FREE) in determination of CI and SV.

Methods: The FREE quality assurance (Q/A) database was retrospectively reviewed to identify patients that had a VC, with CI/SV recorded at the time of the FREE. **Results:** Out of 341 FREEs, 78 patients were identified; 17 pulmonary artery catheters (PACs) and 61 arterial hemodynamic catheters (AC). 42% were trauma and 21% were acute care surgery patients. 87% were mechanically ventilated, 66% had undergone thoracic or abdominal surgery. In 95% the FREE was useful and it changed care in 55%. The correlation between the CI for the FREE and PAC was $r=0.83$ and for the FREE and AC was $r=0.61$, when patients with severe heart failure were excluded it increased to $r=0.74$ for AC. Using CI categories (low, low normal, normal and supra-normal) the FREE-PAC were in agreement in 86.6% and the FREE-AC in 86.5%. The FREE detected 21 patients with moderate or severe dysfunction ($EF<40\%$). Using a threshold value ($CI<2.2$), the AC detected cardiac dysfunction in 18.8%, using SV index this increased to 56.2%. The PAC detected dysfunction in 68%. **Conclusion:** There is good correlation between VC and FREE derived measures of CI. Echo provides additional information including the EF and should be used as an adjunct to guide complex resuscitation of trauma patients. Further study is needed to determine the impact of surgeon-performed echo on patient outcome.

PLACEMENT OF INTRACRANIAL PRESSURE MONITORS BY NON-NEUROSURGEONS: GOOD OUTCOMES ARE ACHIEVED

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Campus.

Invited Discussant: J. Wayne Meredith

Introduction: Traumatic Brain Injury remains one of the most prevalent and costly injuries encountered. Traditionally, neurosurgeons have placed intracranial pressure (ICP) monitors. However, neurosurgery coverage problems may result in delayed placement.

This study sought to confirm ICP monitors may be safely inserted by non-neurosurgeons.

Methods: A 10-year retrospective review of ICP placements at a Level 1 Trauma Center.

Results represent demographic variables, the incidence of complications between monitors placed by general surgical residents, trauma surgeons and neurosurgeons, and mortality.

Results: Patients in this study totaled 557. Average age, hospital length of stay and injury severity score were 38.2 ± 22.3 yrs., 15.9 ± 19.1 days and 27.6 ± 11.6 , respectively. The majority of patients were male (71.6%), and injured in motor vehicle crashes (51.5%), or falls (20.1%). The majority of ICP monitors were placed by residents under trauma attending supervision (83.3%), neurosurgeons (11.3%), and trauma surgeons (5.4%). One CNS infection occurred in a patient treated by a resident. Type of physician placing the monitor had no effect on complications. Of the three patients with iatrogenic bleed, no morbidity or mortality was attributed to monitor placement.

Parameter	Resident	Neurosurgeon	Trauma Surgeon	P-Value
Number	464	63	30	
Injury Severity Score	28.0 ± 12.0	23.0 ± 9.0	24.0 ± 8.0	<0.001
Intracranial Bleed due to Monitor	0.7% (3)	0.0% (0)	0.0% (0)	0.738
Monitor Malfunction	5.8% (27)	4.8% (3)	3.4% (1)	0.811
Monitor Dislodgement	4.3% (20)	0.0% (0)	3.3% (1)	0.261
Monitor Replaced	13.1% (61)	11.1% (7)	10.0% (3)	0.899
Death	28.0% (130)	23.8% (15)	13.3% (4)	0.187

Conclusions: Our results demonstrate that the placement of ICP monitors may be performed safely by neurosurgeons and appropriately trained non-neurosurgeons alike with low rates of complication. This procedure should be considered a core skill for trauma surgeons and surgical residents alike.