

Session 4

Poster # 1

**POST-OPERATIVE NEUROMUSCULAR BLOCKER USE IS ASSOCIATED WITH HIGHER PRIMARY FASCIAL CLOSURE RATES FOLLOWING DAMAGE CONTROL LAPAROTOMY**

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**Background:** Failure to achieve fascial primary closure following damage control laparotomy (DCL) is associated with increased morbidity, higher health care expenditures, and a reduction in quality of life. The use of neuromuscular blockers (NMB) to facilitate closure remains controversial and poorly studied. The purpose of this study was to determine if exposure to NMB is associated a higher likelihood of primary fascial closure.

**Methods:** All adult trauma patients admitted between 01/02-05/08 who (1) went directly to the operating room, (2) were managed initially by DCL, and (3) survived to undergo a second laparotomy. Study group (NMB+): those receiving NMB in the first 24 hours after DCL. Comparison group (NMB-): those not receiving NMB in the first 24 hours after DCL. Primary fascial closure defined as fascia-to-fascia approximation by hospital day 7.

**Results:** 191 patients met inclusion (92 in NMB+ group, 99 in NMB- group). While the NMB+ patients were younger (31 yrs vs. 37 yrs,  $p=0.009$ ), there were no other differences in demographics, severity of injury, or lengths of stay between the groups. However, NMB+ patients achieved primary closure faster (5.1 vs. 3.5 days,  $p=0.046$ ) and were more likely to achieve closure by day 7 (93% vs. 83%,  $p=0.023$ ). Logistic regression identified NMB use as an independent predictor of achieving primary fascial closure by day 7.

	Odds Ratio	95% C.I.	p-value
Exposure to NMB	3.24	1.15-9.16	0.026
Age (years)	0.99	0.96-1.02	0.882
Male gender	0.29	0.06-1.35	0.117
White race	2.81	0.98-8.06	0.055
Penetrating mechanism	0.25	0.07-0.92	0.037
Injury severity score	0.99	0.95-1.02	0.707

**Conclusions:** Early NMB use is associated with faster and more frequent achievement of primary fascial closure in patients initially managed with damage control laparotomy. Patients exposed to NMB had a 3-times higher likelihood of achieving primary fascial closure by hospital day seven.

**CT IDENTIFICATION OF LATENT PSEUDOANEURYSM FOLLOWING BLUNT SPLENIC INJURY: PATHOLOGY OR TECHNOLOGY?**

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**Background:** Serial CT imaging of blunt splenic injury (BSI) can identify the latent formation of splenic artery pseudoaneurysms (PSAs), potentially contributing to improved success in nonoperative management (NOM). It remains unclear, however, whether the delayed appearance of such PSAs is truly pathophysiologic or attributable to imaging quality and timing. The objective of this study was to evaluate the influence of recent advancements in imaging technology on the incidence of the latent PSA.

**Methods:** Consecutive BSI patients over 4.5 years were identified from our trauma registry. Follow-up CT was performed for all but low-grade BSI 24 to 48 hours following initial CT. Incidences of both early and latent PSA formation were reviewed and compared with respect to imaging technology (4-slice vs. 16-slice or greater).

**Results:** 411 BSI patients underwent NOM. PSAs were detected as follows:

CT Type	Patients (n)	Early PSA (%)	Latent PSA (%)
4-slice	135	6.2	3.8
? 16-slice	276	6.6	4.1

Comparing 4-slice to ? 16-slice, there were no significant differences in the incidence of early PSA (p = 0.91) or latent PSA (p = 0.90). Splenic injury grade on initial CT was not associated with latent PSA (p = 0.44). PSAs were managed by embolization (14), splenectomy (13), and observation (2). 18 patients (4%) underwent unplanned splenectomy (i.e. dropping hematocrit or hemodynamic instability). 88% of patients had follow-up > 7 days. Overall, NOM was successful in 92% of patients.

**Conclusions:** The incidences of both early and latent PSA have remained remarkably stable despite advances in CT technology. This suggests that latent PSA is not a result of imaging technique, but rather a true pathophysiologic phenomenon. While the natural history of latent vs. early PSA remains unclear, adherence to a NOM protocol guided by serial CT results in a high nonoperative success rate with a limited incidence of unplanned splenectomies. Injury grade is unhelpful concerning the prediction of latent PSA formation.

Session 4

Poster # 3

**A MULTI-CENTER STUDY EXAMINING THE ROLE OF IMAGING AND CLINICAL FINDINGS AS INDICATIONS TO OPERATE FOR PEDIATRIC BLUNT INTESTINAL INJURY**

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**Purpose:** Although CT scans are accurate in diagnosing solid organ injuries, their ability to diagnose a blunt intestinal injury (BII) is limited, occasionally requiring repeat imaging. The purpose of this study was to evaluate the role of clinical findings, as well as, original and repeat CT imaging in the ultimate decision to operate for BII.

**Methods:** An 18 institution record review of children (< 15 yrs) diagnosed with a BII confirmed during surgery or autopsy between 2002 and 2007 was conducted by the APSA Trauma Committee. The incidence of imaging, repeat imaging, and final reported indications for operative exploration were evaluated.

**Results:** Among 353 patients identified with a BII, 313 (89%) underwent at least one abdominal CT scan. Sixty-six (21%) underwent at least one repeat scan before operation. Most children who underwent a CT scan (129, 47%) were taken to the operating room based only on clinical indications (fever, abdominal pain, shock or elevated WBC), while 31% were operated on based on both a clinical and CT indication and 22% based on a CT indication alone ( $p < 0.001$ ). Although free air was the most common radiographic indication for surgery, 17% of patients with a repeat scan had free air diagnosed on their first CT. Most children undergoing a repeat CT (56 children, 85%) had findings on the original scan suggesting a BII. Among the 10 patients whose first CT scan was normal, only one went to the OR based only on radiographic findings. Children who had their first CT scan at a referring hospital were more likely to have a repeat study than those imaged at a trauma center (33% vs. 13%,  $p < 0.001$ ).

**Conclusions:** Although abdominal CT imaging may contribute to diagnosing intestinal injury following blunt trauma, most children undergo operation based on clinical findings. Repeat imaging should be limited to select patients with diagnostic uncertainty to avoid unneeded delay and radiation exposure.

Session 4

Poster # 4

**DIAGNOSTIC LAPAROSCOPY VERSUS NON-THERAPEUTIC  
LAPAROTOMY IN THE EVALUATION OF ACUTE ABDOMINAL TRAUMA**

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**Objective:** To evaluate the safety and efficacy of diagnostic laparoscopy (DL) versus non-therapeutic laparotomy (NTL) in the setting of acute abdominal trauma.

**Methods:** A retrospective analysis of prospectively collected data on trauma patients older than 16 years admitted from September 1, 2005 to January 31, 2009 was performed. Hemodynamically normal patients with suspicion for intraabdominal injury after physical exam and/or CT scan underwent either diagnostic laparoscopy or exploratory laparotomy based on the attending surgeon's preference. Patient demographics, hospital length of stay (LOS) and hospital complications were analyzed. Univariate statistical analysis was performed to identify statistically significant differences defined as a p value <0.05

**Results:** 3665 patients, 2895 blunt and 767 penetrating, were seen during the study period. Thirty underwent NTL and 27 underwent DL. Fourteen DL patients had negative explorations (NDL) and all were discharged within 3 days. Five DL patients underwent laparoscopic repair of stomach, bowel or diaphragm injuries. Eight DL patients required conversion to open laparotomy for injury repair. Age (31.3 v. 32), male gender (87% v. 78%) and ISS (8.4 v. 9.5) were similar. Blunt and penetrating injuries were seen in 6 and 24 of NTL and in 10 and 17 of DL patients. Mean hospital LOS was 1.4 days in NDL and 5.1 days in NTL patients (p<0.05). NDL patients had one complication (cutaneous abscess) and NTL patients had 19 complications including wound infections, *C. difficile* colitis, pneumonia, urinary tract infections, reintubation, splenectomy, atrial fibrillation and ileus. No NDL patient had missed injuries achieving a negative predictive value of 100%. Fifty-two percent of DL patients safely avoided NTL.

**Conclusion:** Diagnostic laparoscopy in the evaluation of acute abdominal trauma is safe and allows for earlier discharge and return to normal activities when negative. Significantly more complications and longer LOS are associated with NTL.

Session 4

Poster # 5

**PROSPECTIVE VALIDATION OF AN ALGORITHM DEFINING INDICATIONS FOR PELVIC RADIOGRAPHS IN THE EVALUATION OF BLUNT TRAUMA PATIENTS**

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**Introduction:** In a previous retrospective study, we demonstrated that plain film pelvic radiographs (PXR) in the evaluation of blunt trauma patients undergoing abdominal CT scan have limited utility in the absence of hemodynamic instability and significant physical findings. The purpose of this study was to prospectively validate an algorithm defining indications for PXR in blunt trauma patients in the emergency department.

**Methods:** We performed a prospective observational study of consecutive blunt trauma patients over six months at a single Level 1 trauma center. The trauma faculty agreed to implement an algorithm of obtaining PXR in patients undergoing abdominal CT scan only if a specific set of criteria were met: systolic blood pressure < 90mmHg, hemoglobin < 8mg/dL, a drop in Hgb of more than 3mg/dL while in the trauma resuscitation room, or significant physical exam findings.

**Results:** 979 consecutive blunt trauma patients whose evaluation was to include an abdominal CT scan were included in the study. Only 55 (5.6%) patients received a PXR. 57 indications for PXR were provided: 35 (61%) severe pelvic pain, 14 (25%) proximal femur fractures, and 3 (5%) hip dislocations. Only 5 (9%) pts had unexplained hypotension. No adverse events or delays in care occurred. The algorithm selected patients for PXR who were more likely to have a pelvic fracture (36.4% v 4.3%,  $p < 0.001$ ), hip dislocation (5.4% v 0.1%,  $p < 0.001$ ), femur fracture (24.0% v 2.5%,  $p < 0.001$ ) and to require blood transfusion (11.0% v 1.7%,  $p < 0.001$ ). Implementation of this algorithm resulted in a potential decrease in charges of over \$222, 000 in 6 months.

**Conclusion:** When objective evaluation of the abdomen is to be obtained via CT scan, PXR in the ED is obsolete in the absence of hemodynamic instability and significant physical exam findings. Implementation of a selective algorithm in this patient population can result in significant cost savings without adverse patient outcomes.

## TREATMENT OF MAJOR HEPATIC NECROSIS: LOBECTOMY VS. SERIAL DEBRIDEMENT

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**Background:** Major hepatic necrosis (MHN) is a common complication after angiographic embolization (AE) for major liver injuries. We compared the outcome of two treatment modalities.

**Methods:** Patients with MHN were retrospectively reviewed from January 2002 to October 2007. Demographics, ISS, LOS, GCS, mortality, transfusion requirement, intra-abdominal complications, admission physiologic variables and the number and type of abdominal procedures (operative or non-operative) were collected. These patients were then divided into two groups- those treated with hepatic lobectomy (HL) and those treated with multiple procedures including serial operative debridements and/or percutaneous drainage (IR/OR).

**Results:**

30 patients (41%) with MHN were identified from 73 patient who had AE. 16 patients with MHN underwent HL and 14 patients underwent

	HL Group (n=16)	IR/OR Group (n=14)	<i>p value</i>
Age (years)	31.3 ± 15.7	30.1 ± 9.2	0.799
ISS	40.2 ± 9.2	34.1 ± 10.1	<b>0.092</b>
LOS	34.1 ± 21.7	37.8 ± 18.3	0.617
# of procedures	2 ± 0	4 ± 0.9	<b>&lt;0.001</b>
Blood products	34.6 ± 23.5	23.3 ± 18.7	0.159
Complications	7 ± 0.6	17 ± 1.1	<b>0.029</b>
Hepatic mortality	1	0	0.315

multiple IR/OR procedures. The outcomes of the two groups were similar, except the HL group had a higher ISS (*ns*). There was a significantly higher complication rate and increased number of procedures in the IR/OR group. There were no deaths in patients who had early HL (< 5 days). There was one death in the later lobectomy group.

**Conclusion:** MHN is a common complication after AE. This complication can be safely managed with series of operative debridements in conjunction with interventional procedures or with lobectomy. Lobectomy is associated with a lower complication rate and a fewer number of procedures. Early lobectomy may be better than a delayed procedure.

Session 4

Poster # 7

**PROSPECTIVE ANALYSIS OF INDICATIONS FOR ABDOMINAL  
COMPUTED TOMOGRAPHY IN CHILDREN SUSTAINING BLUNT TRAUMA**

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**Objective:** Computed Tomography (CT) has become the mainstay of imaging children who are victims of blunt trauma. However, absolute indications have never been studied to best target patients with probable injuries. The aim of this study is to identify indicators increasing the positive yield of Abdominal CT (ACT).

**Methods:** Infants and children from two urban Level 1 trauma centers sustaining blunt traumatic injury and receiving ACT were enrolled prospectively between May 2007 and February 2009. Physicians provided an indication prior to scan. Data was entered in two phases; first, patient demographics and indications for studies and second, results of CT scans. Logistic regression was used with  $p < 0.05$  considered significant.

**Results:** Of the 153 children enrolled, 56% were male and the average age was 12.7 years (range, 9 mo to 18 yrs). Seventy-four percent had the highest level of trauma activation. Motor vehicle crash (MVC) was the most common mechanism (61%) followed by auto versus pedestrian (18%) and fall (8%). The most common indications for ACT were mechanism of injury (MOI) (30%), intubation (29%), and decreased mental status (29%). Fifty-three scans showed an injury related to trauma (35%). Children with positive ACT scans were more likely to have sustained injury from MVC ( $p=0.0012$ ), have been hypotensive in transport ( $p=0.0062$ ), and have the highest level of trauma activation ( $p=0.012$ ). Selecting mechanism of injury alone was associated with significantly fewer positive findings on ACT ( $p=0.0045$ , OR=0.29, CI=0.12-0.68). Other indications not associated with injury included: abdominal/pelvic tenderness; mental status; seatbelt sign; and intubation.

**Conclusion:** Mechanism of injury (MOI) as an isolated *indication* seems less durable than specific signs and symptoms as indications for ACT. MOI may represent a catchall indication that likely needs further scrutiny while a specific mechanism, MVC, seems to be predictive of positive findings on ACT.

Session 4

Poster # 8

**CLINICAL JUDGMENT IS BETTER THAN AN ARBITRARY BEDREST  
PROTOCOL FOR SOLID ORGAN INJURY**

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**Background:** Non-operative management (NOM) of blunt solid organ injury (SOI) has become standard care in hemodynamically stable patients. Most of the early studies describing NOM of SOI prescribed some duration of bed rest, although it is unclear if this is beneficial. We sought to compare outcomes of two distinct bed rest protocols for SOI.

**Methods:** A retrospective chart and database review of all blunt trauma patients with SOI (liver and spleen) admitted to two ACS verified trauma centers over 24 months was performed. Mean ISS, AAST liver/spleen injury grade, success of NOM, and length of stay (LOS) were compared. Each trauma center had a unique protocol for bed rest after blunt SOI. Trauma Center A (TC-A) mandated bed rest for a standard duration of time (days of bed rest = grade of injury plus one). Trauma Center B (TC-B) had no bed rest requirement, but relied on surgeon's judgment with an emphasis on early mobilization and discharge.

**Results:** TC-A attempted NOM in 164 of 219 patients (75%) with blunt SOI. 116 were treated with bed rest solely for the purpose of managing SOI. The remaining 48 were kept on bed rest for associated injuries. TC-B attempted NOM in 180 of 261 patients (69%) with blunt SOI. 118 of these were mobilized according to surgeon's judgment. The remaining 62 were kept on bed rest for associated injuries. Study groups were similar for mean AAST injury grade (liver 2.2 vs. 1.9; spleen 2.3 vs. 2.4) and mean ISS (17.2 vs. 17.3). Failure of NOM was seen in 8 patients in TC-A (95.1% successful NOM) and 6 patients in TC-B (96.7% successful NOM) (p=NS). The mean length of stay was substantially longer for TC-A (6.6 days) than TC-B (3.7 days,) (p<.0001).

**Conclusion:** Our results illustrate that an arbitrary bed rest protocol does not improve the success of NOM of SOI. A mobilization and discharge strategy based on surgeon's judgment is safe and in our comparison reduced the mean LOS by almost 3 days for similarly injured patients.



Session 4

Poster # 9

## FOLLOW-UP CT FREQUENTLY MANDATES INTERVENTION AFTER PENETRATING HEPATIC INJURY

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**Background:** The role of follow-up abdominal CT after blunt liver injuries has been established. The aim of this study was to examine whether follow-up CT scans change management in patients sustaining a penetrating liver injury.

**Methods:** After IRB approval, patients sustaining a penetrating liver injury between the years 2005 and 2007 were retrospectively reviewed. Demographics, associated injuries, surgical procedures, and abdominal CT results were collected. All liver-related complications and subsequent interventions were recorded.

**Results:** During the 3-year study period, 183 patients sustained a penetrating liver injury. Of these, 35 (19.1%) died on arrival and 91 (49.7%) did not undergo a follow-up abdominal CT. Of the remaining 57 patients who underwent follow-up CT, 51 (89.5%) sustained GSWs, and 6 (10.5%) SWs. The majority of these patients (87.7%) underwent laparotomy prior to follow-up CT. The average interval for follow-up CT was  $18.5 \pm 20.7$  days with  $2.1 \pm 1.1$  abdominal CTs performed per patient. Overall, 25 (43.9%) patients developed a complication detected on CT, of which, 12 (21.1%) required an intervention. The most common complication requiring an intervention was perihepatic abscess (66.7%), followed by biloma and hematoma (16.7% each). The incidence of these complications was 15.0% in minor injuries (grade I-II) with a 2-fold increase in moderate and severe injuries (27.3% for grade III-V). The time interval from admission to the diagnosis of these complications was  $12.8 \pm 7.6$  days (range: 1 to 29) and all were managed with percutaneous drainage.

**Conclusion:** Local complications requiring intervention occur frequently after penetrating liver injury. Our findings suggest an early follow-up abdominal CT in all instances of penetrating hepatic injuries as a significant number of complications will be detected. In selected patients, a subsequent follow up scan, as late as 30 days post-admission may also result in a change in management..

Session 4

Poster # 10

**CT-SCAN DETECTED PNEUMOPERITONEUM IN BLUNT TRAUMA NOT ASSOCIATED WITH HOLLOW VISCUS INJURY**

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**Background/Purpose:** Free intraperitoneal air in blunt trauma is a classic sign associated with hollow viscus injury and management traditionally mandates exploratory laparotomy. The purpose of this study is to determine the incidence of free intraperitoneal air following blunt trauma, and identify CT scan characteristics of free air without associated bowel injury.

**Methods:** A retrospective chart review was performed on 2744 blunt trauma patients admitted to our institution with an abdominal CT from 1/1/03 to 1/1/08. Patients with free air without bowel perforation at laparotomy and those managed without surgery were included in the review.

**Results:** 86 of 2744 blunt trauma patients had free intraperitoneal air on CT for an incidence of 3.1%. 9 without peritoneal signs were observed safely. Of 77 patients who underwent laparotomy, 10 had no bowel perforation. 1 scan on review had no free air for a total of 18 (21%) patients with free air and no clinically significant bowel injury. 11 CT scans demonstrated thin (<5mm) pockets of free air anterior to the liver. 6 scans showed massive amounts of subcutaneous air around the chest and abdomen with intraperitoneal free air. 1 patient had a G-tube in place with a small amount of free air around the G-tube site.

**Conclusion:** CT scans are very sensitive at detecting intraperitoneal free air. In our patient population, the incidence of free intraperitoneal air in blunt trauma patients was 3.1%. The two most common signs of benign free air on CT scan were small foci of free air anterior to the liver less than 5mm in thickness, and extensive subcutaneous air associated with intraperitoneal air.

**BILATERAL INTERNAL ILIAC ARTERY LIGATION AS A DAMAGE CONTROL APPROACH IN MASSIVE RETROPERITONEAL BLEEDING**

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**Introduction:** Massive retroperitoneal hemorrhage associated with pelvic fractures remains a considerable therapeutic challenge following blunt mechanisms of injury. When this finding is encountered during emergent laparotomy, the use of damage control (DC) packing and pelvic angioembolization (AE) has been advocated. We present our series utilizing an alternative and more rapid approach: emergent ligation of the bilateral internal iliac arteries (LIA) and pelvic packing.

**Methods:** We reviewed our experience over 22 months (May 2006-March 2008) with damage control management of massive retroperitoneal hemorrhage due to blunt pelvic injury identified at the time of emergent laparotomy. Clinical courses were reviewed.

**Results:** Pelvic fractures due to blunt mechanisms that required surgical intervention were identified in 201 patients. Damage control management of retroperitoneal hematoma was utilized in 33. Severe head injury (Head AIS ? 5) resulting in brain death occurred in 7. Of the remaining patients, 21 underwent LIA and five underwent AE. Mean ISS was similar between patients selected for LIA or AE (33 vs. 35, respectively), however 48% of patients undergoing LIA presented with hypotension (SBP < 90), versus none selected for AE. Survival following LIA was 47.6% (10 of 21), and 40% (2 of 5) after AE. Mean HLOS among survivors was 29 days after LIA, and 56 days after AE. Among survivors following LIA, techniques utilized included Rummel tourniquet (1), clip occlusion (5) and suture ligation (4). Four patients had subsequent removal of Rummel tourniquet /clips at 24 to 72 hours after initial procedure, with the remainder undergoing permanent ligation. No survivors after LIA were noted to have any adverse ischemic sequelae at discharge.

**Conclusion:** Ligation of the bilateral internal iliac arteries is an important damage control tool in the treatment of massive retroperitoneal hemorrhage after blunt pelvic fracture. Further study is required to determine the appropriate selection criteria for this potentially life-saving maneuver.

## THE ROLE OF LAPAROSCOPY IN STABLE PENETRATING LOWER THORACIC AND ABDOMINAL INJURIES

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**Introduction** Despite increasing applications of laparoscopic surgical procedures in general surgery, its use in trauma surgery is still limited. Diagnostic laparoscopy has an excellent sensitivity and specificity (>95%) when used as a diagnostic tool to establish the presence of peritoneal violation, hemoperitoneum and enteric content spillage. The major limitations of diagnostic laparoscopy in trauma are related to the inability diagnose retroperitoneal injuries, expose adequately deep deep-lying organs, and to accurately detect bowel injury. This last limitation can be, at least in part, overcome by our recently described method of laparoscopic peritoneal lavage (L-DPL).

**Methods** Between March 1998 and January 2009, 79 patients with stable lower thoracic or abdominal penetrating injuries underwent a laparoscopic procedure for diagnosis of peritoneal penetration and treatment. All patients underwent focused abdominal sonography for trauma (FAST) and abdominal CT as part of the initial evaluation.

**Results** There were 53 lower thoracic injuries, 9 upper abdominal injuries, 10 combined thoracic and abdominal injuries, and 7 flank injuries. In 37 patients no peritoneal violation was detected, while in 42 patients the peritoneal cavity was penetrated. In 22 of these patients the procedure was immediately converted to open laparotomy because of significant intra-abdominal injuries. In 15 of the 20 patients with penetrating abdominal injuries, and a negative L-DPL, the diaphragmatic and abdominal wall lacerations were repaired laparoscopically without conversion. In 5 patients with penetrating injury limited to the liver or spleen, hemostasis was achieved by laparoscopy.

**Conclusions** In stable trauma patients with penetrating lower thoracic and/or abdominal injuries, laparoscopy prevented the use of open laparotomy in 72% of the patients. No peritoneal violation was detected in 47% of the patients, and in 15 of the 20 patients with proven peritoneal penetration, the combination of laparoscopy and peritoneal lavage (L-DPL) enabled total laparoscopic repair of significant abdominal injuries without conversion.

## ORTHOPEDECS OWNS THE BONES: LET THEM HAVE IT

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**Introduction:** Shortages in trauma faculty and increased clinical load as we assumed the role of the emergency surgeon forced us to redefine our role as trauma surgeons. Based on a long standing clinical guideline, trauma surgeons admitted all high risk orthopedic and spine patients. A major change was implemented in 2006: the orthopedic service, rather than the trauma service, admitted stable patients with isolated orthopedic and spine fractures. The objective of the current study was to determine if this change in admitting service resulted in increased morbidity (missed intra abdominal injuries, IAI), or mortality.

**Methods:** Data from stable patients (pts) with a) femur fractures, b) multiple long bone fractures, c) pelvic fractures or d) spine injuries were retrospectively reviewed. Fall from standing was excluded. Demographics, injury severity, gastrointestinal and thromboembolic complications, and deaths were reviewed for pts admitted directly to orthopedics from 7-2006 thru 6-2008 and compared to pts with similar injuries admitted to trauma from 7-2004 thru 6-2006. Data was analyzed by t test or Chi square test; mean  $\pm$  SEM,  $p < 0.05$

**Results:** 19,296 patients were admitted over the 4 years, 863 (4.5%) met inclusion criteria; 389 were admitted to trauma and 474 to orthopedics. Age ( $37 \pm 0.8$  vs  $39 \pm 0.1$ ), % male (256 or 65% vs 333 or 70%), and ISS ( $9.6 \pm 29.1$  vs  $10.2 \pm 19.5$ ) was comparable. % blunt (370 or 95% vs 464 or 97%,  $p=0.02$ ) was statistically higher for orthopedic admissions.

Variables	Trauma Admissions	Orthopedic Admissions	P value
GI complications (%)	2 (0.5%)	3 (0.6%)	0.99
Missed IAI (%)	0 (0%)	0 (0%)	1.0
Ulcer related (%)	2 (0.5%)	3 (0.6%)	0.99
Thromboembolic (%)	6 (1.5%)	7 (1.5%)	0.78
Mortality (%)	3 (0.2%)	1 (0.7%)	0.33

**Conclusion:** Reallocation of even high risk patients with isolated orthopedic and spine injuries admitted to the orthopedic service is a safe and feasible option that should be further explored until workforce shortages can be better addressed.

Session 4  
Poster # 14

**GENDER-BASED DISPARITIES IN GERIATRIC TRAUMA PATIENTS: DO WOMEN NEED HORMONES TO DO BETTER THAN MEN?**

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**Background:** Recent clinical studies show that pre-menopausal women develop fewer complications and have a survival advantage over men after severe injury. Laboratory research suggests that these improved outcomes in women are mediated by sex hormones.

**Objective:** To determine if there are sex-based differences in the odds of developing inpatient complications and mortality among geriatric trauma patients.

**Methods:** Review of patients greater than 64 years of age included in the National Trauma Databank (v7.0; 2002- 2006). Only patients with a hospital length of stay  $\geq 3$  days from hospitals that report complications to the NTDB were included. Multiple logistic regression was employed to analyze the independent effect of sex on complications and in-hospital mortality adjusting for age, race, insurance status, injury severity score, severity of head and extremity injury, presence of shock on arrival, and mechanism and type of injury.

**Results:** 165,074 patients met inclusion criteria. Women had decreased odds [0.75 (95% CI 0.71-0.75)] of developing any life threatening complications including pneumonia, ARDS, acute renal failure, and pulmonary embolism. After controlling for complications women demonstrated a 33% lower risk of death 0.67 (0.63-0.71) compared to men. In examining the interaction between sex and complications on mortality, women without complications had improved odds of survival, whereas women with any complication had worse odds of survival when compared to men without complications (see table).

? with no Complication	? with Complication	? with no complication	? with Complication
<b>Ref (95% CI)</b>	<b>2.08 (1.87-2.31)</b>	<b>0.61 (0.57-0.66)</b>	<b>2.28 (2.00-2.60)</b>

**Conclusion:** Among geriatric trauma patients who are physiologically known to have diminished sex hormones, women demonstrate a survival advantage and are less likely to develop complications after severe trauma. These data suggest that in addition to sex hormones, other yet undiscovered factors are likely associated with improved outcomes among females after trauma.

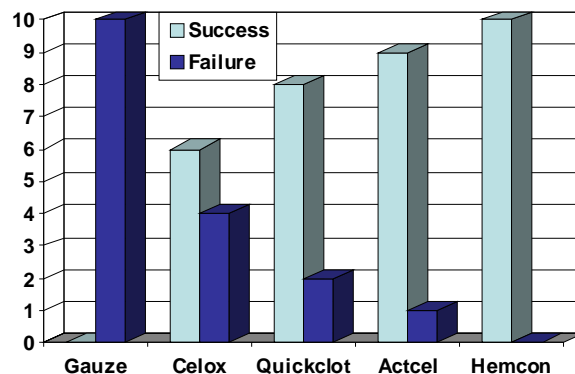
## COMBAT APPLICATION TOURNIQUET PLUS HEMOSTATIC DRESSING REDUCES TOURNIQUET TIME WHILE MAINTAINING HEMORRHAGE CONTROL

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**Objective:** Tourniquet application has become first line treatment for extremity hemorrhage on the battlefield. We hypothesized that an effective Combat Application Tourniquet (CAT<sup>®</sup>) could be removed after application of a hemostatic dressing in a swine model of peripheral vascular injury.

**Methods:** CAT was placed proximally in 50 forelimb injured swine after 30 seconds of hemorrhage with cessation of hemorrhage in all cases. Hemcon<sup>®</sup>, ActCel, Quickclot<sup>®</sup>, Celox<sup>™</sup>, or standard gauze was then placed over the wound with direct pressure for 3 minutes. CAT<sup>®</sup> was then removed. Failure was determined if bleeding was identified after CAT<sup>®</sup> removal.

**Results** Standard gauze resulted in a 100% failure rate, with active bleeding present after each application. Celox<sup>™</sup> was successful in maintaining hemostasis in six of 10 (60%) subjects. Quikclot<sup>®</sup> succeeded in 80% of subjects. ActCel maintained hemostasis in nine (90%) subjects, while HemCon<sup>®</sup> was successful in all instances (100%).



**Conclusions:** All four hemostatic dressings were superior to gauze in maintaining hemostasis after removal of the effective CAT<sup>®</sup>. Use of hemostatic dressings in conjunction with a tourniquet may reduce tourniquet times and improve outcomes in peripheral vascular injury and warrants more study.

**DAMAGE CONTROL IN THE MANAGEMENT OF RUPTURED ABDOMINAL AORTIC ANEURYSM: PRELIMINARY RESULTS**

Matthew D Tadlock, MD, Michael J Sise, MD\*, Steven T Riccoboni, BA, Daniel I Sack, BA, C Beth Sise, MSN, JD, Robert G Sise, MPH MBA, Steven R Shackford, MD\*, Jack C Yang, MD, Jeffrey S Borut, DO, Bryan S King, MD. Scripps Mercy Hospital, Trauma Department.

**Background:** We recently implemented damage control operative techniques (DCO) and resuscitative measures (DCR) in the management of ruptured abdominal aortic aneurysm (rAAA) at our Level I trauma center where all rAAA repairs are performed by members of our trauma service. We evaluated this approach by comparing results with a concurrent standard treatment (ST) group managed without damage control measures.

**Methods:** Operative repairs of rAAA during the 70 month study period were identified. Clinical variables before, during, and after operation and patient outcomes were reviewed.

**Results:** Thirty patients underwent repair of rAAA; 3 (10.0%) died in the OR. Two died at 43 and 47 minutes and were excluded as ineligible for DCO; neither received DCR. The third received ST. Of the remaining 28, 13 (46.4%) had DCO and/or DCR (DCO/DCR): 8 (28.6%) DCO, 4 (14.3%) DCO and DCR, and 1 (3.6%) DCR. Preoperative systolic BP was significantly lower in DCO/DCR patients than in ST patients (64.6 mmHg vs. 83.2 mmHg;  $p=0.03$ ). Although not significantly different compared to ST patients, DCO/DCR patients were older (mean age 79.8 vs. 74.8), had longer OR times (mean 163.8 min. vs. 149.4 min.), and higher mortality (53.8% vs. 26.7%). Mean time to abdominal wound closure was 49.3 hours in the DCO group. The incidence of postoperative hypothermia, acidosis and/or coagulopathy among DCO/DCR vs. ST patients was similar (12 [100%] vs. 13 [92.9%]). Mean hours to correct these abnormalities were lower in DCR/DCO patients (9.3 vs. 19.3) but not significantly different. Among survivors, mean hours of mechanical ventilation were greater (332.8 vs. 296.2), as were mean hours of ICU stay (414.0 vs. 397.1); neither was significant. There were no aortic graft infections in either group.

**Conclusion:** DCO/DCR was used in nearly half of our rAAA patients. Overall, these patients were somewhat older, presented with significantly more hypotension, and were more challenging to manage. DCO/DCR may ultimately prove beneficial in this high risk group of patients and become an accepted option in the management of rAAA.



Session 4

Poster # 17

**OUT WITH THE OLD, IN WITH THE NEW:  
A NOVEL APPROACH TO TREATING PAIN ASSOCIATED WITH RIB  
FRACTURES**

Michael S Truitt, MD, Darryl Amos, MD, Alicia Mangram, MD\*, Manuel Lorenzo, MD\*, Ernest  
Dunn, MD\*. Methodist Medical Center.

**Objective:** Rib fractures continue to be a challenging problem from both a pulmonary and analgesia standpoint. As a result, numerous modalities have been used to treat this condition, but none have proven universally available and efficacious. The objective of this study was to assess a surgeon developed technique for the placement of an elastometric infusion pump (EIP) (On-Q, Lake Forest, CA) in the paravertebral space to create a continuous nerve block in lieu of multiple rib blocks or an epidural.

**Methods:** This was a prospective, nonrandomized study, conducted in the surgical intensive care unit (SICU) of an urban Level II Trauma Center. We evaluated thirty consecutive blunt trauma patients with  $\geq 3$  unilateral rib fractures. Mean age was 65 years (22-92), mean ISS was 24 (16-29), and the mean number of rib fractures was 4.4 (3-8). We then developed a novel technique to place EIP catheters in the paravertebral space to provide continuous pain relief. These catheters were infused with local anesthetic and the dose was titrated to achieve adequate analgesia for the next 72-144 hours.

**Results:** For each patient, preplacement numeric pain scale scores (NPS) and sustained maximal inspiration (SMI) lung volumes were determined. Sixty minutes following the placement of the paravertebral catheters the NPS and SMI were repeated. Overall, the mean NPS significantly improved (preplacement NPS = 9.03, postplacement NPS = 3.06,  $p < .05$ ) and this was associated with a near 300% increase in the SMI (preplacement SMI = 0.40L, postplacement SMI = 1.1L,  $p < .05$ ). The catheters remained in place for an average of 98 hours (72-146), and there were no procedural or drug related complications.

**Conclusions:** These data indicate that the placement of EIP catheters in the paravertebral space are a safe, viable, and efficacious procedure for the amelioration of pain secondary to rib fractures. Additional investigation on a larger scale is needed to verify these findings, and to assess the effect on narcotic use, ICU/hospital stay, and overall cost. A prospective randomized trial has been initiated by the author to answer these questions.

**DAMAGE CONTROL LAPAROTOMY: BEYOND TRAUMA**

Krista Turner, MD, Laura Moore, MD, Joseph Sucher, MD, S Rob Todd, MD, Bruce McKinley, PhD, R Matthew Sailors, BE, Frederick Moore\*, MD. The Methodist Hospital.

**Objective:** As a new group of Acute Care Surgeons in a large tertiary referral center, we developed a sepsis management protocol for our surgical intensive care unit (SICU) which utilizes damage control laparotomy (DCL) in the setting of septic shock (SS). This practice has been questioned in our institution because it consumes a lot of resources. To rationalize its use, we set out to determine the mortality of DCL in the setting of SS compared to predicted mortality for this cohort of patients.

**Methods:** We queried our prospective sepsis database to identify patients with a) SS (i.e. required vasopressors despite volume loading), b) intra-abdominal infection (IAI), and c) DCL. These patients were evaluated using APACHE II and a surgical prognostic scoring system, P-POSSUM. Their actual mortality rate was compared to predicted mortality using the Fischer Exact Test.

**Results:** Over 2 years, we had 22 patients who met inclusion criteria, of which 14 (64%) were women. The median age was 57 years (range 25 - 88). Sources of IAI were colon (11 patients), small bowel (4), stomach (2), and pancreas (1). Four patients had peritonitis with no identified source. Of the 22 patients, 6 died from multiple organ failure, for an actual mortality rate of 27%. The mean P-POSSUM predicted mortality was significantly higher at 69.4% ( $p < 0.02$ ), as was the predicted mortality of 76% based on a mean APACHE II score of 31.8 ( $p < 0.02$ ).

**Conclusion:** The adoption of DCL into our emergency general surgery practice makes sense physiologically. By truncating the OR procedure we can limit ongoing hypoperfusion (i.e. from bleeding and excessive vasopressors) and more quickly complete resuscitation in the SICU. However, this practice caused considerable consternation among our OR staff because it is labor intensive. The above data indicate that we are saving patients' lives with DCL and that this practice is therefore rational. While a prospective randomized trial is warranted, it is unlikely to be done due to the complexity of SS.

**ACUTE CARE SURGERY ROTATION CONTRIBUTES SIGNIFICANT OPERATIVE VOLUME TO RESIDENCY TRAINING COMPARED TO OTHER ROTATIONS**

Jacob Perry, MD, Paul Kearney, MD\*, Bernard Boulanger, MD\*, Phil Chang, MD, Matt Simpson, MD, Brian Sonka, MD, Tony Bottiggi, MD, Andrew Bernard, MD\*. University of Kentucky.

**Introduction:** Resident trauma rotations are criticized for little operative experience relative to large non-operative workload. Acute care surgery (ACS) combines trauma and emergency/elective general surgery, enhancing operative volume and balance of op/non-op effort. To maintain resident commitment and attract residents to ACS as a specialty, op volume on ACS must be demonstrable. It is hypothesized that a mature ACS service is a significant source of op experience for senior residents.

**Methods:** A retrospective review was performed of ACGME case logs of 10 graduates from a major academic program with a level 1 trauma center. Total index case op experience during PGY-4/5 ACS rotations was compared with the overall case totals and op experience on other services. Case numbers/weeks on service = case/week index.

**Results:** 4769 cases were analyzed. Mean cases/resident for PGY-4 and -5 were 254±34 and 223±50 respectively. Mean ACS case volume for both years was 150 and exceeded all other services (Table). Case/week index on ACS exceeded all other services except private

Rotation	Total Cases	%	Weeks On	Cases/Week
ACS	1500	32	30	5
GI/MIS/Peds	1011	21	20	5.1
Off-Site/Private	963	19	10	9.6
Oncology	574	12	20	2.9
Vascular	390	8	10	3.9
VA GS	331	7	10	3.3
Total	4769	99	100	4.8

GS and university GI/MIS/Peds rotations. More small bowel, colon, gastric, spleen and laparotomy cases occurred on ACS than on any other service.

**Conclusions:** Residents receive a large operative experience on ACS. An ACS model is viable in training, provides valuable op experience, and should not be considered a drain on resident effort. Favorable ACS rotations as a resident may encourage ACS as a career.

Session 4

Poster # 20

**IMPACT OF AN ACUTE CARE SURGERY (ACS) SERVICE ON AN  
ACADEMIC SURGICAL PRACTICE**

David P Blake\*, MD, MPH, Rebecca C Britt, MD, Leonard J Weireter Jr\*, MD, Jay N Collins\*, MD, Timothy J Novosel, MD, Scott F Reed, MD, LD Britt\*, MD, MPH. Eastern Virginia Medical School.

**Purpose:** Acute Care Surgery (ACS) has become a topic of much discussion over the past several years. Surgeons advocate for this paradigm shift to provide more efficient care to the critically ill emergency surgical patient, and to allow both the trauma surgeon and the surgical subspecialists to enjoy a more favorable spectrum of surgical cases. The impetus for this study was to assess the impact of a dedicated ACS service on the practice demographics of an academic general surgery group.

**Methods:** A retrospective analysis of the operating room database and corresponding electronic patient records from a tertiary care teaching hospital was performed in a before-and-after fashion. Data included surgeon, time and day of week, urgency category of case (trauma/burns [**TB**], scheduled [**S**], and urgent/emergent general surgery [**UE**]), and type of surgery. The timeframe covered by this review included 1 July 2006 – 28 Feb 2007 (**PRE**), and 1 July 2007 – 28 Feb 2008 (**POST**), with the intervening four months representing a transition period for initiating the ACS service.

**Results:** Eight attending surgeons – including six surgical intensivists, all of whom have additional areas of academic interest, and two surgical oncologists – performed a total of 1068 (**PRE**) and 987 (**POST**) cases for these eight-month intervals, respectively.

Approximately 75% of **UE** cases occurred during the work week, with an average start time in mid-afternoon. Case distribution was predominantly intra-abdominal (~65%) and soft tissue pathology (~25%), and was similar during each of the study intervals.

Significant changes were noted in the proportion of **UE** cases (32% vs 23% of total cases,  $p < 0.004$ ) and **S** cases (57% vs 71% of total cases,  $p < 0.004$ ) done by all surgeons, and in **UE** and **S** cases done by intensivists (34% vs 29%,  $p < 0.02$ ; 51% vs 62%,  $p < 0.02$ ).

**Conclusions:** The initiation of an ACS service appears to provide a more favorable distribution of emergency surgical cases, and permits a complimentary enhancement of an elective surgical schedule.

## EVALUATION OF TRAUMATIC AXONAL INJURY USING DIFFUSION TENSOR IMAGING TRACTOGRAPHY

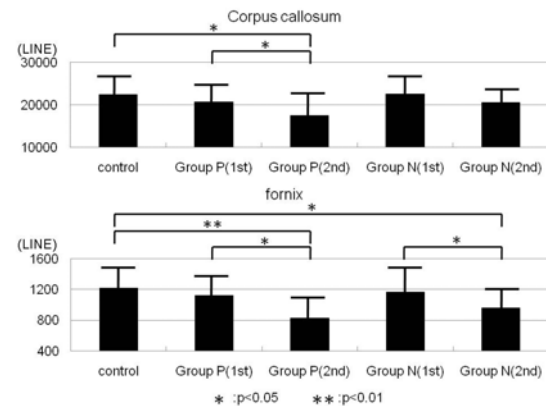
Yasushi Nakamori, MD, Tomoyoshi Mohri, MD, Kazuma Yamakawa, MD, Junko Ozaki, CP, Masao Funahashi, RT, Satoshi Fujimi, MD. Osaka General Medical Center.

**Background:** Diffuse axonal injury (DAI) is a common consequence of traumatic brain injury (TBI). Although a magnetic resonance imaging (MRI) has been useful for detecting DAI, it is known that some patients do not show abnormalities of the image. Current reports demonstrated the usefulness of diffusion tensor imaging (DTI) to reveal the fiber damage in the white matter. The objective of our study is to evaluate the axonal injury in the patient with TBI using DTI.

**Patients and Methods:** 13 consecutive patients with TBI and 10 healthy volunteers were included. All patients were unconscious on arrival and did not show macroscopic focal lesions in computed tomography. A Conventional MRI was performed in all patients within 5 days after injury. Seven patients represent the image of DAI in conventional MRI (group P). Six patients did not show abnormal images (group N). DTI examinations were also done at the same time with a conventional MRI (1st). All patients got second DTI examinations on one month following TBI (2nd). The number of axonal fibers in the corpus callosum and the fornix were quantified with Fibertrak specialist software. Cognitive function of patients was evaluated by the Wechsler Adult Intelligence Scale –III(WAIS-III) at one month following TBI.

**Result:** In group P, the number of the line was significantly decreased in 2nd examination compared with 1st and controls. In group N, there were significant decrease just in the fornix. Full-scale intelligence quotient was below normal range in group P and N ( $85.2 \pm 21.4$  and  $80.2 \pm 8.4$ ).

**Conclusion:** We demonstrated serial loss of axon in the patients with TBI using DTI. The finding demonstrates the utility of DTI for evaluating DAI.



**THE TEMPORAL COURSE OF INTRACRANIAL HEMORRHAGE  
PROGRESSION: HOW LONG IS OBSERVATION NECESSARY?**

Adena T Homnick, RPA-C, PhD(c), Ziad C Sifri, MD, Elie Elovic, MD, Alicia M Mohr, MD\*,  
David H Livingston, MD\*. UMDNJ.

**Introduction:** Patients with Mild Traumatic Brain Injury (MTBI) and intracranial hemorrhage (ICH) are hospitalized and monitored for progression of injury. The timeframe for ICH progression is unknown, and so the optimal duration and location of observation are generally discretionary. The goal of this study was to examine the temporal course of ICH progression and establish a timeframe for when hemorrhage ceases.

**Methods:** We performed a retrospective review of all adult patients (age  $\geq 18$ ) with MTBI (GCS  $\geq 13$ ) and ICH admitted to a level 1 trauma center over a consecutive 36 month period, who underwent a minimum of 2 cranial CT scans (CT) within 48 hours from ED presentation prior to any neurosurgical intervention (NSI). Patients with a history of NSI or nontraumatic cerebral lesions were excluded. Data collected included demographics and the number, timing and findings of serial CT scans and NSI.

**Results:** A total of 331 patients met inclusion criteria. The timing for cessation of bleeding could not be confirmed in 41 patients (7 had NSI after a worsening 2nd CT (<24 hrs), 34 had no follow-up CT that could confirm the cessation of bleeding). Of the remaining 290 ICH, 96% stopped progressing by 24 hours and 99% by 48 hours. The remaining 1% stopped by 72 hours. Additionally, 260 (76%) ICH showed no progression after initial CT, indicating that hemorrhage had stopped by that time (1.2 hrs  $\pm$  1.1 from admission). None required a NSI.

**Conclusion:** Almost all ICH in MTBI stop progressing within the first 24 hours post injury, supporting a 24-hour observational period. In fact, over three quarters of ICH have stopped by the time of the initial CT (< 2 hrs from arrival). This suggests that early repeat CT in the ED may identify those ICH no longer progressing, and possibly avoid unnecessary admission and prolonged observation in those patients not requiring admission for post-TBI symptom management. Prospective data is needed to evaluate this suggested paradigm change in the management of MTBI.

**TIME COURSE OF COAGULOPATHY AND COMPLICATIONS IN ISOLATED SEVERE TRAUMATIC BRAIN INJURY: A PROSPECTIVE STUDY**

Peep Talving, MD, PhD, Thomas Lustenberger, MD, Rodd Benfield, MD, Kenji Inaba\*, MD, Lydia Lam, MD, Demetrios Demetriades\*, MD, PhD. LAC + USC Medical Center, Division of Trauma and Critical Care.

**Background:** Coagulopathy after severe traumatic brain injury (sTBI) is associated with detrimental outcomes. The time course of coagulopathy and its effects on in-hospital morbidity in isolated sTBI (isTBI) has not been documented in any large prospective study.

**Methods:** A prospective study of all patients admitted to a level I trauma center from 6/2005 to 12/2007 with isTBI, defined as sTBI (AIS head  $\geq$  3) with a chest, abdomen, and extremity AIS  $\geq$  3. Criteria for TBI-coagulopathy included sTBI in conjunction with thrombocytopenia and/or elevated INR and/or prolonged aPTT. Onset and duration of coagulopathy in addition to in-hospital morbidity were documented for study purposes. All data are expressed as mean  $\pm$  standard error of the mean.

**Results:** A total of 408 patients met study criteria. Thirty four percent (n=139) of patients developed coagulopathy with a significantly higher incidence after penetrating isTBI (penetrating 54% vs. blunt 32%; p=0.005). Coagulopathy was diagnosed at  $23 \pm 2.5$  hours [range, 0 – 178 hrs (0 – 7 days)] post admission with a mean duration of  $83 \pm 6.3$  hours [range, 5 – 399 hrs (0 – 17 days)]. Coagulopathy lasted significantly longer in patients with blunt isTBI compared to penetrating trauma ( $90 \pm 7.3$  hrs vs.  $49 \pm 7$  hrs; p=0.014). The overall incidence of complications was 21% (n=86) with a significantly higher occurrence in patients with coagulopathy (37% vs. 13%; p=0.008). The development of coagulopathy was also associated with significantly protracted ventilator days, ICU and hospital lengths of stay (all adjusted p<0.05).

**Conclusions:** The incidence of coagulopathy in isTBI is high, especially in patients sustaining penetrating sTBI. A more protracted course of TBI-coagulopathy is associated with blunt injury mechanism. Screening of coagulation markers is warranted for a minimum duration of 7 days from admission. ARDS and acute renal failure occurred more frequently in coagulopathic patients.

Session 4

Poster # 24

## THE PREDICTIVE VALUE OF THE INITIAL PLATELET COUNT ON THE EVOLUTION OF A TRAUMATIC INTRA-CRANIAL HEMORRHAGE

Beat Schnüriger, MD, Kenji Inaba\*, MD, George Abdelsayed, BS, Galinos Barmparas, MD, Thomas Lustenberger, MD, Barbara M Eberle, MD, Peep Talving, MD, PhD, Demetrios Demetriades\*, MD, PhD. LAC+USC Medical Center.

**Introduction:** Although the importance of clotting factor deficiency in the progression of traumatic brain injury has been well delineated, the role of the platelet count (PLT) is poorly understood. The aim of this study was to determine the correlation between the admission PLT count and the progression of traumatic isolated intra-cranial hemorrhage (ICH).

**Methods:** After IRB approval, all trauma patients admitted to a level I trauma center for a 2 year period (01/2006 to 12/2007) with an ICH detected on the admission CT scan were included in a retrospective analysis. Patients with a chest, abdomen, or extremity AIS > 3 were excluded from analysis. Demographics, clinical injury data and outcomes were abstracted from the trauma registry. All brain CT scans and neuroradiologist final reads were reviewed by a consensus panel, with ICH worsening defined as an increase in the volume of the bleed.

**Results:** During the study period, 635 patients met inclusion criteria. Forty-four patients (6.9%) had a PLT count  $<150 \times 10^3/\text{cc}$ . Below this threshold, patients had a significantly higher risk for ICH progression, [adjusted OR (95% CI): 3.7 (1.6-8.4);  $p=0.002$ ]. ICH progression was strongly associated with the need for a craniotomy [adjusted OR (95% CI): 10.9 (3.6-33.1);  $p<0.001$ ]. A PLT count  $<100 \times 10^3/\text{cc}$  was an independent predictor of mortality [adjusted OR (95% CI): 3.2 (1.1-9.5);  $p=0.042$ ]. The positive predictive value of a PLT count  $<150 \times 10^3/\text{cc}$  for ICH progression was 71%.

**Conclusion:** Admission PLT counts  $<150 \times 10^3/\text{cc}$  are associated with ICH progression. An admission PLT count  $<100 \times 10^3/\text{cc}$  is an independent predictor of mortality. Whether an early correction of PLT counts  $<150 \times 10^3/\text{cc}$  on admission improves outcomes needs further validation.



**THE EFFECT OF ADMISSION SPONTANEOUS HYPOTHERMIA ON PATIENTS WITH SEVERE TRAUMATIC BRAIN INJURY**

Andres M Rubiano, MD, Alvaro Sanchez, MD, Jason Sperry\*, MD, Andrew B Peitzman\*, MD, Juan Carlos Puyana\*, MD. University of Pittsburgh Medical Center.

**Introduction:** The effect of hypothermia on head injured patients is not well understood. It has been suggested that induced hypothermia may have a protective role. Furthermore, there is recent but limited information about the harmful effects of spontaneous hypothermia at admission. The objective of this study was to evaluate the association between admission hypothermia and severe traumatic brain injury (TBI) mortality in a large statewide trauma registry.

**Methods:** Secondary data analysis of TBI patients was performed. The primary outcome was death at hospital discharge. Severity of TBI was defined by head/neck AIS > 4 and GCS ≤ 8. Hypothermia was defined as body temperature ≤ 35°C at admission. A multivariate regression model was used for risk factors analysis that included age, hypotension, prehospital time, intubation and prehospital intravenous fluid therapy. Data analysis was also adjusted for other confounders including isolated TBI vs. multiple trauma, and the use of paralytic drugs and changes in the motor component of the GCS.

**Results:** 10,505 patients with severe TBI were identified, of these, 1,875 patients (17.8%) arrived hypothermic. Mortality rate was higher in hypothermic patients than normothermic patients (45% vs. 29.6%, p<0.001). Hypothermia was associated with increased risk of death in the crude analysis (OR 1.98, 95% CI 1.79 - 2.19) and also in the adjusted model for risk factors and confounders (OR 1.64, 95% CI 1.33 – 2.02).

**Conclusion:** Spontaneous hypothermia at admission is strongly associated with increased risk of death after severe TBI. This finding was statistically significant even after adjusting for well know confounders including use of paralytic drugs, intubation and hypotension. These data suggest that admission temperature below 35°C may have a predictive role as a secondary insult and increased mortality in severe head injury.

## EXTRAVASATION ON 3D-CT ANGIOGRAPHY PREDICTS HEMATOMA EXPANSION OF TRAUMATIC INTRACRANIAL HEMORRHAGE

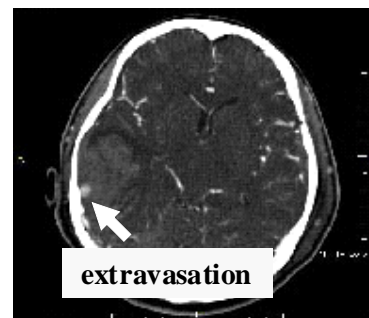
Kazuhiya Yoshiya, MD, PhD, Osamu Tasaki, MD, PhD, Tadahiko Shiozaki, MD, PhD, Yasuyuki Fujii, MD, Hiroshi Ogura\*, MD, PhD, Yasuyuki Kuwagata, MD, PhD, Hisashi Sugimoto, MD, PhD. Department of Traumatology and Acute Critical Medicine, Osaka University Graduate School of Medicine.

**Objectives:** Expansion of traumatic intracranial hemorrhage is one of the most important causes of clinical deterioration and death in patients with traumatic brain injury (TBI). Purpose of this study was to determine whether extravasation on three dimensional-CT (3D-CT) angiography is associated with hematoma expansion after TBI and their clinical courses.

**Methods:** Seventy seven patients with traumatic intracranial hemorrhage were included in this study, who were admitted to our Critical Care Medical Center during 6 years from 2003 to 2008, underwent 3D-CT angiography within 3 hours after admission, and were followed with serial CT scans. We evaluated the relationship between extravasation on 3D-CT angiography and expansion of hematoma, and also investigated coagulopathy and clinical courses of these patients. Extravasation was defined as high density spot within the hematoma clearly distinguished from blood vessels, or high density leakage from adjoining blood vessel within the hematoma (Figure).

**Results:** Out of 77 patients, extravasation was observed in 9 patients (12%). Eight of 9 patients (89%) deteriorated due to hematoma expansion and required surgical evacuation. In the other patients without extravasation (n=68), only 12 patients (18%) deteriorated due to hematoma expansion. We also evaluated several coagulation tests in these groups (n=68) D-dimer was significantly higher in deteriorated group ( $61.2 \pm 49.8 \mu\text{g/mL}$ , n=12) than in those without deterioration ( $14.1 \pm 13.8 \mu\text{g/mL}$ , n=56).

**Conclusions:** Extravasation on 3D-CT angiography is an effective predictive indicator of hematoma expansion following traumatic intracranial hemorrhage. D-dimer also may be one of the important risk factor of hematoma expansion in patients without extravasation.



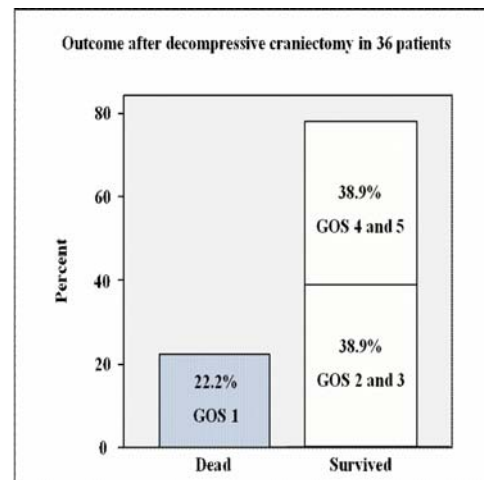
## DECOMPRESSIVE CRANIECTOMY: A ROLE FOR SURGICAL CONTROL OF INTRACRANIAL PRESSURE

Barbara M Eberle, MD, Beat Schnüriger, MD, Kenji Inaba\*, MD, J Peter Gruen, MD, Demetrios Demetriades\*, MD, PhD, Howard Belzberg\*, MD. LAC+USC Medical Center.

**Introduction:** The purpose of this study was to assess the role of decompressive craniectomy (DC) in patients with post-traumatic malignant brain swelling or intractable intracranial pressure (ICP).

**Methods:** Trauma registry and medical record review study at the LAC+USC Medical Center which included all patients who underwent DC for post-traumatic malignant brain swelling or intractable intracranial hypertension, during the period 01/2004 to 12/2008. The analysis included the effect of DC on ICP, survival and functional outcomes.

**Results:** During the study period, 36 patients met inclusion criteria. Indications for DC were: Neurological or neuroradiological worsening in 17 patients (47.2%) and intractable monitored ICP in 19 patients (52.8%). In the group with pre- and postoperative intracranial pressure monitoring, the ICP significantly decreased from  $30.9 \pm 18.8$  mmHg to  $14.8 \pm 11.8$  mmHg postoperatively ( $p=0.002$ ). Overall 8 patients (22.2%) died, and 14 (38.9%) either remained in vegetative state (2 patients) or were severely disabled (12 patients). Fourteen patients (38.9%) had a moderate to good functional outcome (Glasgow outcome score (GOS) 4-5).



**Conclusions:** DC is associated with acceptable survival and functional outcomes and should be considered in patients with intractable intracranial pressure.

Session 4

Poster # 28

**SEXUAL DIMORPHISM DOES PLAY A ROLE IN OUTCOMES IN  
MODERATE TO SEVERE TRAUMATIC BRAIN INJURY**

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**Background:** The role of gender on trauma outcome continues to yield conflicting results. With traumatic brain injury (TBI) clinical and animal studies suggest that sex hormones may influence outcomes. This study's objective was to investigate the association between gender and outcome in patients with moderate to severe isolated TBI.

**Methods:** We conducted a retrospective review of all isolated moderate to severe TBI patients admitted to one of the 13 Los Angeles County Trauma Centers between 1998 and 2005. Isolated TBI was defined as head AIS  $\geq$  3 in combination with other AIS  $\geq$  3. Demographics and outcomes were compared between genders. The population was further stratified into age subgroups: 0-14 (pre-pubescent), 14-44 (premenopausal), 45-54 (perimenopausal), and  $>$ 55 years (postmenopausal). Multivariate logistic regression was used to determine independent risk factors for mortality.

**Results:** A total of 17,977 severe TBI patients (23.8% Female, 76.2% Male) were evaluated. Overall, there was no significant difference in mortality between females and males (12.3% vs. 12.6%,  $p=0.6$ ). However, after age stratification, women in the premenopausal group showed a significant lower risk of mortality than their male counterparts (9.4% vs. 12.2%,  $p=0.001$ ). After multivariable logistic regression, again, overall no difference in mortality was observed (AOR 0.94 95%CI: 0.83-1.06,  $p=0.32$ ). However, after age stratification, there continued to be a significant survival benefit in the premenopausal group (AOR 0.72 95% CI: 0.59-0.89,  $p = 0.003$ ).

**Conclusions:** Our study suggests that hormonally active females have improved survival compared to their age matched male counterparts in moderate to severe TBI. This data supports the hypothesis that female sex hormones have a neuroprotective effect.

**ARE BENZODIAZEPINES SAFE FOR SEDATION OF MECHANICALLY VENTILATED TRAUMA PATIENTS?**

Nick W Lonardo, PharmD , Edward J Kimball, MD, Mary C Mone, RN BSE, Gabriele K Baraghoshi, RN, Kevin Nechodom, Yao Li, MS, Xiaoming Sheng, PhD, Stephen Alder, PhD, Richard G Barton\*, MD. University of Utah Hospital and Clinics.

**Introduction:** The optimal sedative agent for mechanically ventilated (MV) patients (pts) is controversial. The 2002 SCCM guidelines recommend lorazepam (LRZ) intermittent or continuous infusion for most MV pts. Recent data suggests that use of a benzodiazepine (BZD), in particular LRZ, may result in worse outcomes.

**Hypothesis:** In adult MV trauma pts, sedation with a continuous infusion BZD, i.e., midazolam (MDZ) or LRZ, increases MV time, length of stay (LOS), and mortality rates, as compared to pts sedated with Propofol (PROP).

**Methods:** Retrospectively, a multi-institutional (131) database (Project Impact®) was queried for the years 2000 to 2007 to identify trauma pts MV for > 48 hrs and treated with a single, continuously infused sedative: PROP, MDZ, or LRZ. Exclusion criteria included: multiple MV events, use of other sedatives or neuromuscular blocking agents, and/or admission diagnosis of head or spinal cord injury.

**Results:** Of 2,379 pts, 1631 (69%) received PROP, 411 (17%) LRZ, and 337 (14%) MDZ. Univariate analysis showed the MV time (days) for PROP was  $6.9 \pm 5.9$ , for MDZ  $6.9 \pm 7.0$  ( $p=NS$ ) and for LRZ  $9.7 \pm 7.5$  ( $p<0.001$ ). ICU LOS (days) for PROP was  $9.1 \pm 6.4$ , for MDZ  $8.9 \pm 7.4$  ( $p=NS$ ), and for LRZ  $11.4 \pm 7.5$  ( $p<0.001$ ). ICU mortality with PROP was 6.6%, for MDZ 12.8% ( $p<0.001$ ) and for LRZ 10% ( $p=0.018$ ). Hospital mortality was 9.7% with PROP, 14.3% with MDZ ( $p=0.013$ ) and 12.2% with LRZ ( $p=0.149$ ). Multiple regression models show that hospital survivors treated with LRZ had significantly longer MV time, ICU and hospital LOS and increased morbidity (ventilator associated pneumonia and tracheostomy). In pts > 65 years of age ( $n=404$ ), use of either BZD significantly increased the ICU mortality 17.1% PROP vs. 37.8% MDZ ( $p=0.003$ ) vs. 34.3% LRZ ( $p=0.002$ ).

**Conclusions:** MV trauma patients sedated with Propofol had significantly better outcomes than those sedated with a BZD. The use of a BZD in ICU patients, especially the elderly, should be reconsidered.

**EVALUATION OF INTUBATION PATTERNS AND OUTCOMES IN PATIENTS WITH CT VERIFIED TRAUMATIC BRAIN INJURY**

Marianne J Vandromme, MD, Sherry M Melton\*, MD, Russell Griffin, MPH, Richard George, MD, MSPH, Jordan A Weinberg\*, MD, Michael Minor, EMT-P, Loring W Rue\* III, MD, Jeffrey D Kerby\*, MD, PhD. University of Alabama- Birmingham.

**Background:** Studies evaluating traumatic brain injury (TBI) patients have shown an association between prehospital (PH) intubation and worse outcomes. However, previous studies have used surrogates, e.g. GCS < 8, AIS > 3, which may overestimate the true presence of TBI. This study evaluated the impact of PH intubation in patients with PH GCS < 8 and radiographically proven TBI.

**Methods:** Trauma patients routed to a level I trauma center over a 2 year period with blunt injury and a PH GCS  $\leq$  8 were included. PH and in-hospital records were linked and head CT scans were assigned a Marshall Score (MS). Patients with TBI (MS > 1) were categorized into groups based on intubation status (PH, Emergency Department (ED), and no intubation). Comparisons were made using student's t-test, Kruskal-Wallis test and chi-square statistics. Mortality differences, crude and adjusted risk ratios (RRs) and 95% confidence intervals (CI) were calculated using proportions hazards modeling.

**Results:** Of 271 patients with PH GCS  $\leq$  8, 135 (49.8%) had TBI by MS. Among the TBI patients, 59 (43.7%) patients were PH intubated, 66 (48.9%) were intubated in the ED, and 10 (7.4%) were not intubated. PH intubated patients had lower GCS (4.5 vs. 4.8 vs. 6.3;  $p=0.009$ ), higher head AIS score (5 vs. 5 vs. 3;  $p < 0.001$ ), and higher mean ISS (38.0 vs. 32.3 vs. 23.7,  $p < 0.001$ ) as compared to ED intubated and non-intubated patients. None of the non-intubated patients had a MS > 2. Mortality for patients who required intubation, PH or ED, was 45.8% vs. 40.9%, while there were no deaths among the non-intubated. When assessing the mortality risk of PH intubation as compared to ED intubation in patients with TBI, the crude RR of mortality was 1.12 (95% CI 0.66-1.91), and when adjusted for key markers of injury severity decreased to 0.91 (95% CI 0.50-1.64).

**Conclusions:** Patients with PH GCS  $\leq$  8 and proven TBI had a high overall rate of intubation (>90%). PH intubation appears to be a marker for more severe injury and conveyed no increased risk for mortality over ED intubation.

**IMPROVING OUTCOMES IN PATIENTS REQUIRING AN EMERGENCY COLECTOMY: THE ACUTE CARE SURGERY MODEL**

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Vanderbilt University Medical Center.

**Introduction:** The Acute Care Surgery (ACS) model has demonstrated improved outcomes (appendicitis & necrotizing infection). Emergency colectomy (EC) patients are commonly sicker. There are no studies comparing emergency general surgery (EGS) v. elective general surgeons (ELS) performing (EC). We hypothesize that patients requiring EC by EGS are sicker and have higher complications vs. EC done by ELS.

**Methods:** A retrospective review was performed of a prospectively collected EGS repository (1/05 to 9/07). Inclusion criteria were: emergent admission and EC. Trauma was an exclusion criteria. Patients were divided into 2 groups: EGS and ELS. Data collected included: age, gender, LOS, time to OR, and University Hospital Consortium - severity of illness (UHC-SOI). Primary outcomes were mortality and complications. Non-parametric and multivariable logistic regression analysis (LRA) was performed.

**Results:** 147 patients met study criteria. The mean age was 53.8 y ( $\pm 18.7$ ) and 51% were men. Mean LOS was 12.8 d ( $\pm 10.1$ ). Overall mortality was 12.2% (n=18). EGS had higher UHC-SOI ( $p < .001$ ) v. the ELS. There were no differences in mortality, LOS, or complications between groups. LRA showed age (OR 1.03,  $p = 0.05$ ) and ASA (OR 4.3,  $p = 0.001$ ) were independent risk

factors for death. Admit to EGS service trended towards a protective effect (OR 0.55,  $p = 0.32$ ).

**Conclusion:** In the ACS model, EGS patients were sicker and

arrived to the OR sooner. EGS patients had the same mortality and complication rate as the ELS emergency colectomy patients. While age and ASA were independent risk factors for death, the ACS/EGS model trended towards a protective effect.

Outcomes: EGS vs. ELS			
	EGS	ELS	p
n	91	56	
UHC-SOI	48 (53%)	16 (29%)	<.001
Complication	53 (58%)	39 (70%)	0.22
Time to OR (hrs)	16.5 (6.5-66.9)	66.8 (16.2-115.8)	0.01
Mortality	11 (12%)	7 (13%)	~1

**PROCALCITONIN AS AN INDICATOR OF SEVERE SEPSIS IN BURN PATIENTS**

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**Introduction:** Exact diagnosis of infectious complication of burn patients is essential in burn care. Serum procalcitonin (PCT) is known as a reliable marker to diagnose sepsis or severe sepsis, however, in acute phase of burn patients PCT level is not fully evaluated. In this study, we measured serum PCT level and assessed PCT to diagnose infectious complication in burn patients.

**Method:** Serum samples and laboratory data of burn patients were collected daily from their admission to our burn care unit. PCT was measured using quantitative immunoluminometric method (PCT-Lumi; cut off value of sepsis > 0.5 ng/ml, severe sepsis > 2.0 ng/ml). The definition of the society of critical care medicine was referred to diagnose sepsis and severe sepsis in each sample.

**Results:** Serum PCT of 124 time point from 12 patients with  $32.8 \pm 27.1$  (mean  $\pm$  SD) % TBSA was measured. Thirty eight samples were taken from non-sepsis, 50 samples were from sepsis and 36 samples were from severe sepsis. The origins of sepsis were burn wound in 8 patients, pneumonia in 6 patients and catheter in 2 patients. Serum PCT level was  $0.30 \pm 0.25$  ng/ml in non-sepsis,  $0.41 \pm 0.42$  ng/ml in sepsis and  $6.1 \pm 9.0$  ng/ml in severe sepsis ( $p < 0.05$ ; non-sepsis versus severe sepsis, sepsis versus severe sepsis). Sensitivity and specificity of PCT in sepsis was 52% and 76%, positive predictive value (PPV) and negative predictive value (NPV) was 83% and 41% respectively. In severe sepsis sensitivity and specificity of PCT was 44% and 100%, PPV and NPV was 100% and 82% respectively.

**Conclusion:** In burn patients, serum PCT is not sensitive to diagnose sepsis, however, it is useful to differentiate severe sepsis from systemic inflammation or local wound infection. Serum PCT in burn patients is a reliable marker to define severe sepsis that needs intensive systemic antibiotic administration and wound treatment.



## COMPUTERIZED INTENSIVE INSULIN THERAPY IN BURNED PATIENTS IS SAFE AND EFFECTIVE

Jeanne Lee, MD, Dale Fortlage, BS, Kevin Box, PharmD, Lois Nwakanma, MD, Dhaval Bhavsar, MD, Bruce Potenza\*, MD, Raul Coimbra\*, MD. University of California San Diego.

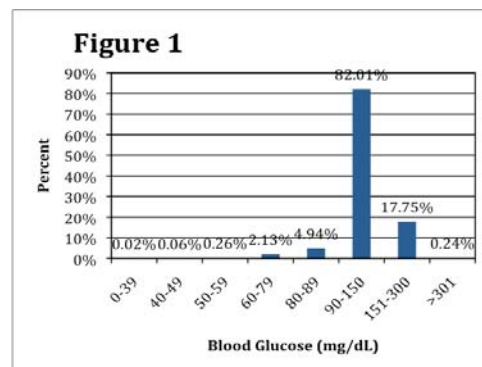
**Objective:** Intensive insulin therapy has recently been associated with reduced infections complications in burn patients. Traditional protocols, however, are associated with rates of severe hypoglycemia (blood glucose <40mg/dL) as high as 19%. Two commercially available computer glucose control programs have reported rates of severe hypoglycemia of 2.6% and .4%. Recently, our burn intensive care unit (BICU) adopted an intensive insulin computer based protocol created at our institution. Already successfully in use in our surgical intensive care unit, it is user friendly and effective. We hypothesize that the use of this protocol is associated with a decreased incidence of hypoglycemia in our BICU.

**Methods:** All patients admitted to the BICU have blood glucose values checked routinely. With two consecutive hyperglycemic values >200, patients are placed on a computer based protocol intravenous insulin drip. Once initiated, blood glucoses are tested hourly with adjustments made according to the computer protocol. Values recorded in Jan-Dec 2008 were abstracted from the database and analyzed.

**Results:** Thirty-five patients were treated using the computer glucose control protocol and 12,898 measurements were performed. Two

patients experienced one episode each of severe hypoglycemia for an overall incidence of .02% (Figure 1). 82% of values were within our normal range of 90-150. Few patients had severe hyperglycemia with FSBG >300 (.24%). There were no adverse events associated with the hypoglycemic episodes.

**Conclusion:** Computer based protocols are safe for burned patients. Our protocol is as effective and perhaps superior to those currently available. It is user friendly, easy to learn and provides consistent, reliable results.



**INSULIN RESISTANCE AND ENDOGENOUS INSULIN PRODUCTION IN PATIENTS WITH THERMAL INJURIES ON INTENSIVE INSULIN THERAPY**

Alejandra G Mora, BS , Heather F Pidcoke, MD , Elizabeth Mann, MS , Chaitanya K Dahagam, MD , Steven E Wolf\*, MD, Charles E Wade\*, PhD. Institute of Surgical Research.

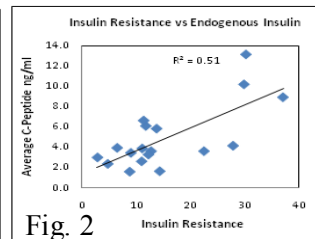
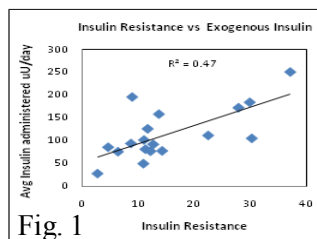
**Introduction:** Secondary to reported improvements in clinical outcomes of critically ill patients, glycemic control via insulin administration has increased. Patients with thermal injuries are characterized by a hypermetabolic state and hyperglycemia with associated insulin resistance. We hypothesize intensive insulin therapy (IIT) to counter-regulate glycemic dysregulation would disrupt and decrease endogenous insulin production.

**Methods:** From a single burn ICU, 18 patients on IIT were studied within their first 14 days of hospitalization. Units of insulin administered and hourly plasma glucose levels were obtained. Insulin resistance was calculated using homeostasis model assessment-insulin resistance (HOMA-IR). Plasma samples were collected three times a day for 7 days and assayed by ELISA to quantify total circulating insulin and C-peptide levels. Values within the text are reported as mean±standard deviation.

**Results:** Patients (age 35±17 yrs) in our study were critically injured with thermal burns (TBSA 43±20% and ISS 32±10) and had a total daily insulin administration of 115.2±56.9 uU/day with an average glucose measurement of 110±10 mg/dL. A significant ( $p<0.0001$ ) insulin resistance (15.3±9.8) was found compared to normals (1.1±0.4). Circulating C-peptide and insulin levels were 4.9±3.1 ng/ml and 55.5±32.8 uU/ml, respectively, while daily C-peptide levels increased throughout hospitalization ( $R=0.35$ ,  $p<.0001$ ). Increased insulin resistance was associated with both increased administered insulin (Fig.1;  $p<0.01$ ) and C-peptide levels (Fig. 2,  $p<0.001$ ).

**Conclusions:** Patients with burns

demonstrated significant insulin resistance compared to healthy controls. In spite of high rates of exogenous insulin administration, patient's endogenous insulin production increased, indicated by C-peptide level, in response to severity of insulin resistance.



## UTILITY OF BLOOD VOLUME MEASUREMENTS IN RESUSCITATION: AN EVALUATION OF TWO NON INVASIVE METHODS

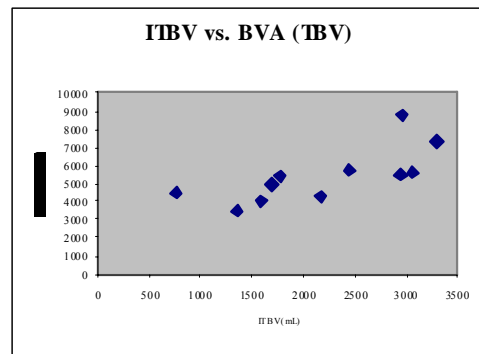
Jaime C Giraldo, MD, Nicole Fox, MD, Steven A Johnson\*, MD, James Reed, PhD, Mark Cipolle\*, MD, PhD, Gerard Fulda\*, MD. Christiana Care Health Services.

**Introduction:** Management of the critically ill patient frequently requires an assessment of their blood volume (BV) to guide resuscitation. Different methods with direct and indirect measurements have been used in the ICU. Total BV (TBV) measured with Albumin I<sup>131</sup> and intrathoracic BV (ITBV) utilizing lithium dilution are two indirect, minimally invasive methods for volume analysis used in our ICU. Our study compares the correlation between these two methods of volume assessment.

**Methods:** After approval by the IRB, this prospective study enrolled patients admitted to the SICU in whom an evaluation of fluid status was clinically indicated. After obtaining consent, simultaneous measurements of TBV using I<sup>131</sup> dilution (BVA-100 Daxor, NY, NY) and ITBV using Li dilution (LiDCO, LiDCO Group, London) were performed. Statistical analyses were performed with Pearson correlation and ANOVA.

**Results:** From 4/08-2/09, 11 patients were enrolled. By ITVB results: 5 patients were hypovolemic (<40% TBV), 3 hypervolemic (>50% TBV) and 3 normovolemic (40 to 50% TBV). Mean ITBV was 2232mL and mean TBV was 5410mL (3499-8745mL). From the I<sup>131</sup> BVA, 8 of 11 patients were anemic (>228mL RBC deficit) and 1 patient had a plasma volume deficit (836mL). Correlation between ITVB and TBV was statistically significant (p<0.006).

**Conclusions:** A linear correlation between both methods exists. Complementary information from the I<sup>131</sup> BVA assisted in the fluid management of critically ill surgical patients by revealing red cell volume in addition to plasma volume. This information was used to distinguish between patients requiring RBCs versus fluid resuscitation.



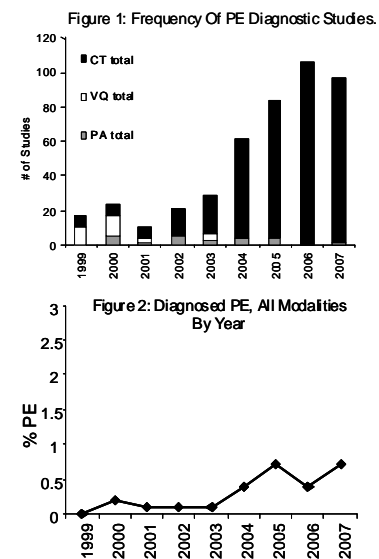
## IMPACT OF CHEST COMPUTERIZED TOMOGRAPHY FOR THE DIAGNOSIS OF PULMONARY EMBOLUS IN TRAUMA PATIENTS: A NINE YEAR EXPERIENCE AT A LEVEL ONE TRAUMA CENTER

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**Introduction:** Pulmonary embolus (PE), a serious threat to trauma patients, remains challenging to diagnose. Spiral computed tomography (CT) for PE diagnosis provides a relatively accurate, non-invasive, widely available diagnostic test. This study reviews experience with diagnostic technologies for PE at a level 1 trauma center and evaluates the impact of CT on diagnosis and cost-effectiveness.

**Methods:** All trauma patients undergoing CT for PE, ventilation-perfusion scan (VQ) or pulmonary angiography (PA) from 1999-2007 were selected from the radiology database. Radiology reports, charts and trauma registry data were reviewed. Charges for diagnostic procedures were obtained from radiology. **Results:** From 1999 to 2007, there were 21,283 trauma activations (66% male, 92% blunt, mean age 34, mean ISS 9). 406 patients had CT for PE, 23 had VQ and 21 had PA. CT for PE use increased over 5 fold in the latter years of the study (fig 1) but was not accompanied by an equal increase in diagnosed PEs. PEs diagnosed by CT, VQ or PA ranged from 0% to 0.7% of all patients per year (fig 2). 10% to 20 % of CTs produced positive findings. Total CT charges equaled \$647,678, increasing from \$11,382 in 1999 to a high of \$172,621 in 2006. An average of 7 CTs were performed to diagnose one PE at an approximate charge of \$11,000/diagnosed PE.

**Conclusions:** CT for PE has replaced all other diagnostic tests for PE with positive yields of 10-20%. Despite dramatic increases in test number and charges, numbers of diagnosed PEs remain relatively low. These findings suggest that continued opportunities exist for the cost-effective diagnosis of PE in trauma patients.



**BEST PRACTICE DEVELOPMENT: COMPARISON OF  
BRONCHOALVEOLAR LAVAGE EFFICACY IN TWO TRAUMA CENTERS**

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**Objective:** Treatment of pneumonia (PNA) requires accurate specimen retrieval. Because bronchoalveolar lavage (BAL) is invasive, and can cause life threatening hypoxia and dysrhythmia, risk analysis should define a “standard” rate of negative results. Overuse adds risk, underuse risks delayed diagnosis. We sought to define this negativity rate by comparing experience in two geographically distant trauma centers.

**Methods:** Trauma registry and bacteriology data from a state designated Level I (LI) and Level II (LII) trauma center were queried for BAL results from ventilated trauma patients. PNA was defined using TRACS<sup>®</sup> code #3008. BAL was negative if no organisms exceeded 10<sup>5</sup> colonies/cc. BAL frequency was calculated as number of procedures/1000 ventilator days (VD). PNA incidence was defined as cases/1000 VD. Frequency distribution of PNA microorganisms was compared between centers. CuSum analysis of monthly negative BAL rate was performed to define variability and similarity of trends.

**Results:** During 2008 LI performed 346 BAL, and reported 192 PNA patients, yielding a frequency of 67 BAL/1000 VD, and a PNA rate of 37/1000 VD. LII reported 140 BAL and 52 cases of PNA, indicating 48 BAL/1000 VD and a similar PNA rate of 34/1000 VD. Incidence of negative BAL was 56% in both centers. Monthly CuSum analysis indicated equal fluctuation about an established trend of 56%. Terminology and PNA microorganism frequency varied between the centers. Most common in LI was “mixed flora” (24%).

*Pseudomonas*, MSSA, MRSA, and *H. influenzae* represented the next 44%. *H. influenzae*, *Kleb. pneumoniae*, MSSA, and *Acinetobacter baum.* were 48% of LII isolates.

**Conclusions:** The consistent BAL negativity rate of 56% suggests that it is being used with equal efficacy in two separate trauma centers with a similar incidence of PNA despite differences in microorganisms encountered. Monthly CuSum monitoring of BAL negativity rate and PNA incidence will assure that best practice strategies to adjust BAL usage in LI to that of LII do not diminish patient outcome by increasing PNA.

**LOWER INTERBREATH PERIOD COMPLEXITY IS ASSOCIATED WITH EXTUBATION FAILURE DURING SPONTANEOUS BREATHING TRIALS IN MECHANICALLY VENTILATED PATIENTS**

Christopher E White, MD, Andriy I Batchinsky, MD, Corina Necsoiu, MD, Ruth Nguyen, MD, Kerfoot Walker III, MS, Steven E Wolf, MD, Lee C Cancio\*, MD. Institution of Surgical Research.

**Objective:** To determine if higher complexity of respiratory periods as measured with nonlinear analysis techniques will identify intubated patients who will successfully separate from mechanical ventilation after 30 minute spontaneous breathing trials (SBT).

**Methods:** Respiratory waveforms from SBT of patients in Surgical and Burn ICUs were recorded for analysis. The decision to extubate was made by attending physician. Extubated patients were observed for 48 hours; reintubation or non-invasive positive pressure ventilation (NIPPV) was marked as failure. Analysis of waveform data by complexity software was performed *post-hoc* and metrics compared between successful extubation versus respiratory embarrassment within 48 hours of extubation.

**Results:** 64 patients (44 burn, 12 trauma, 8 surgical admissions; mean age 43.3 +/- 18.4; 51 men and 13 women) who were intubated >24 hours underwent 76 SBT. 46 were successfully extubated and 8 failed (1 required rescue with NIPPV). Age, gender and mechanism of injury did not influence outcome. Failures occurred on average 14.4 (range 0.93 to 47.25) hours after extubation. Results from complexity analysis are summarized below (SampEn = Sample entropy; SOD = similarity of distribution):

Variable	Pass				Fail				p
	N	Mean	Std Dev	Median	N	Mean	Std Dev	Median	
SampEn	46	1.7325	0.344	1.802	8	1.3578	0.39	1.5045	0.01
SOD	46	0.1752	0.038	0.17	8	0.2263	0.059	0.23	0.02

**Conclusion:** In intubated patients, the respiratory periods in those who successfully separated from mechanical ventilation were more irregular than those who failed. This implies a higher regulatory complexity of respiration as measured by SampEn and SOD. These metrics may then be useful markers of pulmonary and/or over-all health and assist in clinical decision making when available at bedside.

## ORGAN DONATION AND TIME TO PROCUREMENT: LATE IS NOT TOO LATE

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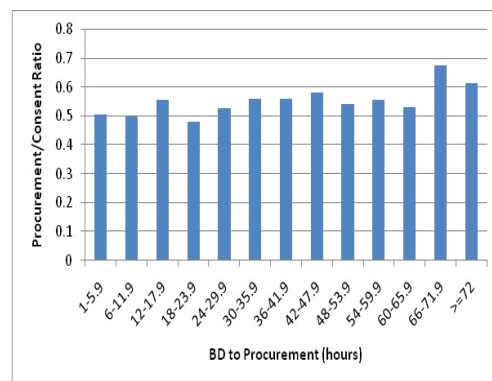
**Objective:** No consensus exists as to the maximal period of time allowable after brain death (BD) before organ procurement rates begin to deteriorate. This is a critical question for trauma patients in particular, as next of kin may not be immediately available for the consenting process. The aim of this study was to examine organ procurement rates as a function of time after BD.

**Methods:** All consented donors from 2006-2008 were identified from the regional Organ Procurement Organization which serves 224 hospitals in seven counties in Southern California. Demographics, organ procurement data and the time from BD to procurement were abstracted. The organs procured to consented ratio was analyzed from the time of BD to recovery in 6 hours intervals.

**Results:** Of 1,554 organ donors, 678 (46.3%) were trauma patients. Mean age was  $37.1 \pm 17.6$  years; 62.6% were male. The mean time from BD to procurement was  $34.5 \pm 19.8$  hours. A total of 9,364 organs were consented for and 4,695 (50.1%) procured (kidneys 95.2%, livers 88.5%, hearts 40.1%, pancreas 23.1%, lungs 1.6%, and intestines 3.3%). Poor organ function was the major reason for procurement failure (35.6%). For individual organ systems and all organs combined, there was no significant change in the procurement/consent ratio with increasing time after BD (post-hoc ANOVA,  $p=0.19$ ).

Additionally, there was no increase in the number of organs rejected for procurement due to poor organ function (post-hoc ANOVA,  $p=0.27$ ).

**Conclusion:** These results demonstrated that the time interval between BD and organ procurement was not associated with decreased organ procurement rates or an increased number of non-salvageable organs due to poor organ function.



## SCREENING FOR DRUG USE: WHY AREN'T PATIENTS HONEST?

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**Introduction:** Positive urine drug screens (UDS) are frequent in trauma patients but may be insufficient to identify all those at risk for drug use. Screening for alcohol misuse by self-report in trauma centers is reliable, but the validity of self-report of drug use has not been examined. This study sought to determine the veracity of screening for drug use by self-report in trauma patients. We also aimed to identify screening barriers and define patient perceptions towards self-report of drug use in the trauma setting.

**Methods:** Patients at a Level 1 Trauma Center, > 18 years old were prospectively screened face to face for drug and alcohol use with validated screening tests and asked to complete a survey about discussing drug use. Blood alcohol concentration (BAC) and UDS were recorded when available. Comparison of UDS and self-report excluded opiates and benzodiazepines to avoid misclassification of chronic use with potential use during trauma care. Data analysis evaluated the veracity of self-report in UDS positive patients and survey results.

**Results:** Sixty-three patients were screened. A UDS was recorded in 45 (71.4%) patients with 12 (19.0%) positive results. Only 4 (33.3%) with a positive UDS (truthful group) admitted to drug use while 8 (66.7%) denied it (non-truthful group). The non-truthful group was older (34.2 vs. 19.5 yrs,  $p=.01$ ), more concerned this information would be part of their medical record ( $p=.03$ ), and more concerned about being embarrassed or ashamed by talking about their drug use ( $p=.04$ ) compared to the truthful group. Seven (11.1%) patients self-reported drug use in the past year. Only 4 had a positive UDS while 2 were UDS negative and 1 had no UDS recorded. All patients were also asked about alcohol use; all those with a BAC > 0 admitted to alcohol use.

**Conclusion:** A UDS alone is insufficient to identify those that use drugs, but self-report is problematic. Stigmatization appears to be of concern to drug using trauma patients and, unlike drinkers, they may be less comfortable engaging in dialogue regarding behavior



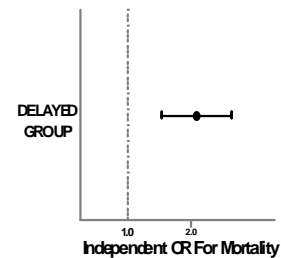
**DELAY TO THERAPEUTIC INTERVENTIONAL RADIOLOGY FOLLOWING  
INJURY: TIME IS OF THE ESSENCE**

Gina Howell, MD, Andrew B Peitzman\*, MD, Raminder Nirula\*, MD, MPH, Matthew Rosengart, MD, MPH, Louis H Alarcon\*, MD, Timothy R Billiar\*, MD, Jason L Sperry, MD, MPH. University Of Pittsburgh Medical Center.

**Objective:** Hemorrhage remains a leading cause of early mortality in injured patients, and definitive control of bleeding remains a fundamental management principal. It is known that delay to laparotomy, in patients with abdominal hemorrhage, is associated with a greater risk of mortality. Interventional radiology (IR) procedures are increasingly being utilized in the management of traumatic injury. However, the time to IR and the risks associated with delay to IR in the injured patient has not been adequately characterized.

**Methods:** We performed a retrospective analysis of data from the National Trauma Data Bank (NTDB version 7.1). Inclusion criteria were adult patients (age  $\geq$  14 years), who were hypotensive upon arrival (SBP  $<$ 90 mmHg), and who underwent procedures coded as occlusion of a non-intracranial arterial vessel (ICD-9-CM 38.80, 38.82-86, and 38.88) within 3 hrs of arrival. To attribute results to the IR procedure, patients undergoing any abdominal, thoracic, or vascular operation throughout their hospital stay were excluded. Logistic regression was used to determine the independent risk of mortality associated with time to IR after controlling for important confounders.

**Results:** Patients with a RAPID time to IR (1st hour, n=543) were similar in TRISS predicted survival vs. those with DELAYED time to IR (1-3 hours, n=446). Crude mortality for the RAPID group was significantly lower. (23% vs 34%, p=0.01) Logistic regression revealed that DELAYED time to IR was independently associated



with over a 2-fold higher risk of mortality (OR 2.14, 95%CI 1.5-3.1). For every hour delay to IR, the risk of mortality increased by nearly 30% (OR 1.29, 95%CI 1.0-1.6)

**Conclusions:** In hypotensive trauma patients undergoing therapeutic IR procedures, delay to IR is independently associated with mortality. These results suggest that urgent therapeutic IR procedures should be performed as expeditiously as possible and held to the same dogma as applied to definitive operative control of hemorrhage.

## HAVE WE FORGOTTEN OUR ELDERS? TRAUMA CENTER PERFORMANCE ACROSS AGE GROUPS

David Gomez, MD, Barbara Haas, MD, Wei Xiong, MSc, Najma Ahmed\*, MD, Avery B Nathens\*, MD. St Michaels Hospital - University of Toronto.

**Background:** External benchmarking of trauma center (TC) outcomes identifies above average performers, and might allow for the identification and dissemination of best practices. Trauma patients are not homogeneous however, and practices that might benefit one population might not benefit another. The elderly have been identified as a population with unique needs and therefore potentially different best practices. With this in mind, we postulated that TC performance might differ across age groups.

**Methods:** Data were derived from the NTDB (2007 admissions), limited to Level I and II centers, and adults with an ISS>9 (excluding isolated hip fractures). Separate logistic regression models were constructed to estimate TC risk-adjusted mortality for both the young and the elderly (age $\geq$ 65 yrs). Observed-to-Expected mortality ratios were used to identify outliers, and the concordance across age strata was assessed using a weighted kappa statistic.

**Results:** 87,816 patients across 132 facilities were identified; 25% were elderly. Case mix differed across age strata: elderly patients were more likely to be female and to have suffered blunt injury,

Performance	Young population		
	High n=9	Average n=117	Low n=6
Elderly population			
High, n=10	3	7	0
Average, n=112	6	104	2
Low, n=10	0	6	4

specifically falls. While their injury severity (ISS) was lower, the elderly had a greater proportion of severe head injuries and had a higher mortality rate when compared to the young. Although 9 centers were identified as high performers in the young, only a third of these TCs were high performers for the elderly. Similarly, only 40% of low performers in the young were low performers in the elderly. TC outlier concordance was limited, with kappa=0.3 (95% CI 0.07 – 0.5).

**Conclusions:** Performance is not consistent across age groups. Specific populations such as the elderly might benefit from identifying the unique processes of care that lead to improved outcomes at higher performing centers.

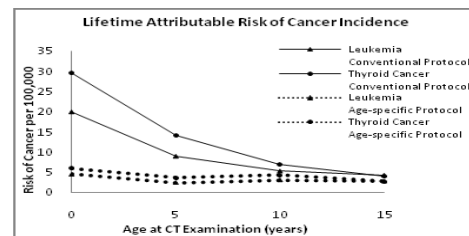
## REDUCTION OF RADIATION DOSE IN PEDIATRIC BRAIN COMPUTED TOMOGRAPHY IS NOT ASSOCIATED WITH MISSED INJURIES OR DELAYED DIAGNOSIS

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**Introduction:** The increased diagnostic accuracy of computed tomography (CT) in the identification of traumatic injuries compared to physical examination or conventional radiography is well documented. There is concern, however, about the increased radiation exposure, particularly in children. Our goal was to identify the most effective strategy for decreasing radiation exposure while retaining the benefits of computerized imaging.

**Methods:** Based on a literature review and our trauma registry data (5 yr period), the mortality risk of untreated injuries to the head, neck, chest, abdomen, and pelvis was compared with that of blunt trauma patients who received treatment of injuries diagnosed by CT. Because automated exposure control of tube current is not routinely used with brain CT, this region was identified as the initial focus for a dose-saving algorithm. Computed tomography settings were adjusted for children studies and the new settings were implemented into four protocols based on age (0-1 yr, 1-5 yr, 6-10 yr and 11-15 yr). The resulting images were compared with conventional dose images and reviewed qualitatively by radiologists for the ability to identify traumatic injuries. Effective dose (ED) and organ specific doses were estimated using Monte Carlo simulations and the lifetime attributable incidence and mortality for thyroid cancer and leukemia were assessed and compared.

**Results:** The in hospital mortality of unidentified injury in high-risk trauma patients is 8.0%. Forty dose-saving brain CT's were performed and no injuries were missed. The ED decreased 4.3-fold, 3.4-fold, 2.8-fold and 2.6-fold.



The theoretical decrease in leukemia and thyroid cancer incidence is shown in the figure.

**Conclusion:** Decreasing the ED is achievable, theoretically decreases the cancer risk, and does not increase the missed injury rate. Trauma centers should incorporate reductions of CT radiation dose into their quality improvement programs.

Session 4

Poster # 44

## OUTCOMES OF THE MECHANICALLY VENTILATED TRAUMA PATIENT AT THE REGIONAL TRAUMA CENTER

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**Introduction:** Previous studies show a correlation between large hospital volumes and improved outcomes in mechanically ventilated medical patients. No study has tested this association in trauma patients. We hypothesize that treatment of ventilated trauma patients at centers with higher trauma volumes have better outcomes.

**Methods:** Study Design: Retrospective county-wide population-based trauma registry query. Setting: County of 1.5 million people with 11 hospitals: 1 Regional Trauma Center (RTC, mean of 620 trauma registry admissions/yr), 4 Area Trauma Centers (ATC, mean of 213 trauma registry admissions/center/yr) & 6 Non-Trauma Centers (NTC, mean of 35 trauma registry admissions/center/yr). Subjects: Trauma patients > 17 years old who are ventilated >96 hours from 2004-2007. Measures: Demographic & injury characteristics, co-morbidities, and location of treatment (RTC vs other) Outcomes: Vent days, ICU length of stay (LOS), hospital length of stay (HLOS), mortality. Analysis: Chi-square, student's t and Wilcoxon tests for bivariate analysis, and multivariate logistic regression.

**Results:** Of the 608 patients identified, 372 (61.2%) were treated at the RTC, 209 (34.4%) at ATCs and 27 (4.4%) at NTCs. While patients at the RTC were younger with a mean age of 49.1 vs 54.5, ( $p=0.004$ ), they were also more severely injured (Median ISS 31.3 vs 20.7,  $p<0.001$ , Median GCS 8.96 vs 10.2,  $p=0.003$ ) when compared to non-RTC patients.

Although the two groups had similar mean ventilator days (13.9 vs 16.9,  $p=0.09$ ), ICU LOS (20.5 vs 20.4 days,  $p=0.948$ ), and HLOS (32.5 vs 31.5 days,  $p=0.723$ ), mortality in the RTC group was significantly lower (19.9% vs 36.4%,  $p<0.001$ ). In multivariate analysis, treatment at the RTC was associated with decreased risk of mortality (OR=0.36, 95% CI 0.22-0.58) when holding patient characteristics constant.

**Conclusion:** Treatment at a Regional Trauma Center is correlated with improved outcomes in mechanically ventilated trauma patients. The relationship between center designation, patient volume, and patient outcomes merits additional study.

**LONG-TERM SURVIVAL AND RETURN ON INVESTMENT AFTER NON-NEUROLOGIC INJURY: IMPLICATIONS FOR THE ELDERLY TRAUMA PATIENT**

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**Objective:** One strategy used by countries with universal health coverage to control costs is rationing care based on accepted cost-utility thresholds (\$50,000/year). Similar rationing could occur in the United States. Vulnerable populations include the elderly injured patient. The purpose of this study was to evaluate the cost per 2-year survivor stratified by age after moderate to severe non-neurologic injury.

**Methods:** The trauma registry from a Level I trauma center was queried for adults (>18), discharged alive after blunt injury (ISS >15), without significant brain or spinal cord injury, and with hospital charge data. Survival was determined using the Social Security Death Master File. Patients were stratified by age. Hospital costs were calculated by multiplying hospital charge by the cost:charge ratio.

**Results:** 1914 patients made up the study population. Mean hospital cost per patient was \$10,021. Mean cost per 2-year survivor was \$10,328. Overall 2-year survival was 97%. (\*p<0.05 vs Youngest).

Age Group	Cost at discharge	% 2-year Survival	Cost per 2 year survivor
18 – 25	\$9,978	99.4	\$10,043
25.1 – 55	\$10,023	98.0	\$10,446
55.1 – 75	\$9,719	92.5*	\$10,510
> 75	\$12,099	79.6*	\$15,201

**Conclusion:** While costs are similar by age at time of discharge, cost per 2-year survivor increases as age increases. However, cost per 2-year survivor does not exceed current cost-utility thresholds for any age group. Any future healthcare financing reforms should include aggressive funding for injury prevention efforts aimed at vulnerable populations instead of rationing care once an injury occurs.

**WHAT IS THE ATTRIBUTABLE MORTALITY OF TRAUMA-RELATED COMPLICATIONS? A MATCHED COHORT STUDY**

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**Introduction:** When putting resources into performance improvement (PI) activities, it is important to focus on complications that significantly impact mortality. To evaluate which post-traumatic complications impact mortality, we evaluated the attributable mortality (AM) of complications or complication groupings in the National Trauma Data Standard. AM is the proportion of all deaths that can be prevented if the complication did not occur.

**Methods:** We used the National Trauma Databank (NTDB) to identify severely injured patients (ISS $\geq$ 9) at centers that contribute complications to the NTDB. A matched cohort design was used. Each patient with a specific complication was matched to 5 patients without the complication to estimate the AM. Matching was based on demographics and injury characteristics. Residual confounding was addressed through a logistic regression model.

**Results:** Of the 94,795 patients that met the inclusion criteria, 3,153 died. The overall mortality rate was 3.33%. 10,478 (11.1%) patients developed at least 1 complication. Four complication groupings were associated with significant AM (Table). Several complications, including pulmonary embolism and selected infectious complications, had no significant AM.

**Conclusion:** This study utilized AM to identify trauma-related complications for external benchmarking. Guideline development and PI activities need to be

Complication	Attributable Mortality (%)
Cardiovascular	29*
Renal Failure	22*
Sepsis	14*
ARDS	13*
Pulmonary Embolism	4
Pneumonia	1.8
UTI	2.4

\*p<0.05

focused on these complications to significantly reduce the probability of death following injury.

## DO FLEXION EXTENSION PLAIN FILMS FACILITATE TREATMENT OF THE CERVICAL SPINE AFTER TRAUMA?

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**Hypothesis** : Flexion and extension films of the cervical spine (FE) do not facilitate treatment after trauma.

**Methods**: Retrospective review (2000-2006) of trauma patients who underwent FE.

**Results**: Of a total of 12670 patients, 227 patients had 253 FE films. The patients had an average age of 39.8 years, ISS of 10.7, GCS of 14.1, lactate of 2.6 mmol/liter, and hospital length of stay of 6.1 days. They sustained MVC in 62.8% and fall in 15%. 95 had both CT and 5-view with a sensitivity of 5view to CT of 25.6% (11/43). Of the 253 FE's, 163 were done on inpatients, 90 on outpatients. There were 26 patients who had both. The incidence of ligament injury was 0.08% (10/12670). Comparing 5view and CTC to FE as the gold standard to diagnose ligament injuries the results are shown in Tables 1.

Table 1	+CTC/5view	-CTC/5view	Total
+FE in and outpatient	3	4	7
-FE in and outpatient	7	213	220
Total	10	217	227

Specificity =96.8% Sensitivity = 42.9% Negative predictive value(PV)= 98.2%

For purposes of analysis, incomplete and ambiguous FE were listed as negative but for inpatient FE, 28.8%(47/163) were incomplete and 11.7%(19/163) were ambiguous and for outpatient, 12.2%(11/90) were incomplete and 10%(9/90) were ambiguous. All 4 patients who had ligament injuries found on FE not seen on 5view or CTC also had fractures that required prolonged C-collars. No patients required surgery for their ligament injury. Because of the high percentage of inadequate FE films, 27.6% (45/163) of inpatients were sent home with a c-collar and 15.3% (25/163) went on to have an MRI.

**Conclusion**: C-Spine ligament injury is extremely uncommon. Those with ligament injury usually have other injuries diagnosed by CT. FE are often incomplete and unreliable making it difficult to use them to base management decisions. They do not facilitate treatment and may lead to increased cost and prolonged C-collars.

**THE IMPACT OF CHRONIC DISEASE ON OUTCOME FOLLOWING  
TRAUMA: A STUDY FROM THE NTDB**

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**Introduction:** Data regarding pre-existing comorbidities is often poorly recorded in trauma registries and reports of their impact on outcomes are conflicting. Our objective was to identify a subset of patients in the National Trauma Data Bank (NTDB) with reliable comorbidity and complication data in order to determine the impact of chronic organ system dysfunction on morbidity and mortality.

**Methods:** A refined dataset from National Trauma Data Bank 7.1 (2002-2006) containing admissions to Level 1 and 2 trauma centers that specified using chart abstraction to document comorbidities and complications was analyzed. Patients with a history of cirrhosis, dialysis, Human Immunodeficiency Virus (HIV), and Coumadin were compared to those without any of these conditions. Data regarding age; injury severity score (ISS); ventilator (vent), ICU and hospital (hosp) days; complications (comp) and mortality (mort) were obtained. The Pearson Chi-square, Fischer's exact and t-test were used to compare the demographics and outcomes of each comorbidity group with the control group (table).

(n)	Control 358,900	Cirrhosis 992	Dialysis 917	HIV 700	Coumadin 5547
ISS	12 ± 11	15±11, p<.001	13±10, p=.017	12 ± 10, p=.694	13±10, p<.001
Age	38 ± 22	55±13, p<.001	66±16, p<.001	43 ± 10, p<.001	73±13, p<.001
Vent(d)	1 ± 5	3±8, p<.001	2±7, p<.001	2 ± 6, p=.001	2±7, p<.001
ICU(d)	2 ± 6	5±9, p<.001	3±7, p<.001	3 ± 8, p<.001	3±7, p<.001
Hosp(d)	6 ± 10	10±14, p<.001	9±13, p<.001	8 ± 11, p<.001	8±10, p<.001
Comp.	5.7%	20.5%, p<.001	10.4%, p<.001	7%, p=.136	12.6%, p<.001
Mort.	5.3%	21.5%, p<.001	16.5%, p=.001	6.9%, p=.069	14.5%, p<.001

**Results:** Notable findings include significantly more ARDS, coagulopathy, pneumonia (PNA), acute renal failure (ARF), and urinary tract infections (UTI) in the cirrhosis group; more aspiration PNA and UTI in the dialysis group; more deep venous thrombosis, PNA, ARF, and UTI in the Coumadin group; and more PNA in the HIV group (all p <= 0.002).

**Conclusion:** Pre-existing organ system dysfunction is associated with higher resource utilization, complication rates, and mortality in trauma patients.



**PREMORBID STATIN USE IS ASSOCIATED WITH IMPROVED SURVIVAL AND FUNCTIONAL OUTCOMES IN OLDER HEAD INJURED ADULTS**

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**Objective:** To determine whether pre-injury statin use is associated with survival and functional recovery in older adult victims of moderate/severe head trauma.

**Methods:** Using a trauma dataset compiled from 69 U.S. hospitals, patients aged  $\geq 65$  with head injury AIS $\geq 3$  were analyzed for in-hospital mortality and functional outcome with respect to pre-injury statin use. Individuals dying within 24 hours of admission or presenting with fixed dilated pupils were excluded. A revised Glasgow Outcome Scale (rGOS) dichotomized at the level of the ability to return to premorbid major activity measured functional outcome. Multivariate regression modeled statin use and outcomes, adjusting for potential confounders including demographic, comorbidity and injury characteristics.

**Results:** Of 523 individuals identified for study, 117 (22%) were on statins at the time of injury. Statin users demonstrated a 70% lower adjusted risk of in-hospital death (R.R. = 0.30, 95% CI, 0.11 – 0.83). Of 395 individuals discharged alive, 303 survived one year and 266 had complete rGOS scores. Statin users and non-users demonstrated similar recovery at 3 months (R.R. = 0.83, 95% CI, 0.46 – 1.49). At 12 months post-injury, statin users had 19% higher risk of good recovery (R.R. = 1.19, 95% CI, 1.06 – 1.33). The presence of cardiovascular comorbidities abrogated this effect (death R.R. = 0.87, 95% CI, 0.50 – 1.50; good outcome R.R. = 1.11, 95% CI, 0.82 – 1.50).

**Conclusion:** Pre-injury statin use in older adult head trauma victims is associated with reduced risk of death and improved potential for functional recovery at 12 months post-injury. Individuals carrying cardiovascular comorbidities lose this benefit of premorbid statin use. Statins, as possible protective agents in head trauma, warrant further study.

**PRE-INJURY HIGH-RISK BEHAVIORS PREDICT PTSD AFTER MAJOR TRAUMA IN ADOLESCENTS AND YOUNG ADULTS: A UNIQUE AND UNPRECEDENTED OPPORTUNITY FOR PTSD RISK REDUCTION**

Troy Lisa Holbrook,\*MS, PhD, Peggy P Han, MPH, John P Anderson, PhD. EPI-SOAR Consulting.

**Introduction:** Post-traumatic Stress Disorder (PTSD) is an important and extremely detrimental outcome after major trauma in adolescents and young adults. Little is known about the effect of pre-injury high-risk behaviors, including alcohol abuse, drug abuse, and suicide attempts or ideology on PTSD risk after injury. The objectives of the present report are to describe the rates and association of pre-injury high-risk behaviors with PTSD onset in adolescents and young adults after major trauma.

**Methods:** 213 trauma patients were studied (Ages 12-19 years; ISS  $\geq$  4, length of stay  $>$  24 hours). Pre-injury high-risk behaviors were assessed using the Youth Risk Behavior Survey (YRBS; Centers for Disease Control). PTSD was diagnosed at 6 to 24 months post-injury with the Impact of Events Scale Revised (24+ = PTSD+).

**Results:** PTSD was diagnosed in 27% of 213 adolescent trauma survivors with complete YRBS data. Acute Stress Disorder was also frequently diagnosed, 41% (N = 88). Pre-injury high-risk behaviors were common (high-risk injury behaviors 68%, suicide attempts 10%, alcohol abuse 40%). Pre-injury high-risk behaviors were strongly and independently associated with PTSD onset after major trauma in adolescents and young adults (Table).

<b>Pre-Injury High-Risk Behaviors for PTSD Onset</b>	<b>Odds Ratios</b>	
<b>High-Risk Injury Behaviors (e.g. No Safety System Used While Driving or Riding in Motor Vehicles)</b>	<b>4.1**</b>	<b>P &lt; 0.001</b>
<b>Suicide Attempts or Suicidal Ideology</b>	<b>3.1*</b>	<b>P &lt; 0.05</b>
<b>Marijuana Use</b>	<b>2.0*</b>	<b>P &lt; 0.05</b>
<b>Alcohol Abuse</b>	<b>3.2**</b>	<b>P &lt; 0.001</b>

**Conclusions:** Pre-injury high-risk behaviors are not only common in adolescents, but are strongly and independently associated with PTSD onset after major trauma. Early recognition and assessment of risk factors for PTSD will be vital in order to improve outcomes. These findings provide the groundwork for new, effective and practical screening approaches to PTSD risk reduction in young adult and adolescent trauma patients.

**ATTENDINGS MATTER: RE-FOCUSING ON TRAUMA INPATIENTS  
IMPROVES OUTCOMES AND PATIENT SATISFACTION**

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**Introduction:** The optimal faculty-level staffing of a trauma service (TS) is unknown. Based on clinical demands, we restructured our TS, increasing attending (ATT) inpatient staffing. We evaluated the effect of this change on patient outcomes and satisfaction.

**Methods:** The study setting is an urban Level I trauma center. Before FY09, our combined trauma & acute care surgery (ACS) service was staffed by 2 ATT/wk: 1 dedicated to rounds and 1 to OR (minor rounding duties), with a separate trauma bay ATT q24hr. In FY09, the service was reorganized into 3 autonomous services (2 TS, 1 ACS), each with 1 ATT/wk who staffed rounds and daytime trauma bay/OR. The trauma registry and hospital QI database were queried for demographics, mortality, morbidity and patient satisfaction of physician care (Press-Ganey®). During the study period, there were no changes in EMS practice, payor mix, or number of trauma fellows, residents, and nurse practitioners.

**Results:** *Table 1:* Trauma volume, acuity, and mortality were unchanged. Length of stay trended shorter (p = 0.14), with a projected one-year savings of 540 inpatient days. Morbidity rates decreased significantly. *Table 2:* Patient satisfaction with physician care increased markedly.

Table 1	FY07	FY08	FY09 8 mos	FY09 annualized
Trauma admissions	1314	1162	797	1196
Mean ISS	9.9	9.8	10.2	--
Mean age, years	41.5	41.8	42.5	--
Penetrating injuries, %	22.1	22.2	22.6	--
Mean hospital LOS, days	4.8	5.3	4.7	--
Total inpatient days	6307	6159	3746	5619
Mortality, %	12.9	13.3	11.2	--
Any PTOS^ morbidity	341	312	165	248
<b>Morbidity: pt ratio</b>	<b>0.260</b>	<b>0.269</b>	<b>0.207*</b>	--
*p <0.01 vs FY07 and FY08. ^Pennsylvania Trauma Outcomes Study				

**Conclusions:** Increased ATT inpatient staffing was associated with shorter stays, better outcomes and higher patient satisfaction, justifying “high-intensity” attending involvement (and its inherent cost) in providing inpatient care.

Table 2	FY07	FY08	FY09 Qtr 1	Change FY08-FY09
<b>Time physician spent with you</b>				
Trauma	73.9	71.9	80.4	<b>+8.5</b>
Dept of Surgery	79.3	79.5	77.9	-1.6
<b>Physician kept you informed</b>				
Trauma	77.9	77.0	84.0	<b>+7.0</b>
Dept of Surgery	85.8	84.7	84.0	-0.7
<b>Overall physician</b>				
Trauma	79.3	77.9	84.1	<b>+6.2</b>
Dept of Surgery	84.7	84.8	84.1	-0.7
<b>Likelihood of recommending hospital</b>				
Trauma	--	78.7	88.2	<b>+9.5</b>
Dept of Surgery	--	88.4	90.1	+1.7

**MORTALITY OF TRAUMA PATIENTS WHO EXPERIENCED ZERO  
SYSTOLIC BLOOD PRESSURE AT EMERGENCY DEPARTMENT**

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**Introduction:** Trauma patients may experience zero systolic blood pressure at the scene or emergency department as a result of pulseless electrical activity. Zero SBP at the scene is associated with a very high mortality. However, when it happens in the ED, the association with mortality is unclear. The purpose of this study was to evaluate the zero SBP at ED and the impact on in hospital mortality.

**Methods:** Patient information was retrieved from the National Trauma Data Bank Research Data Set v7.1. All patients who had either blunt or penetrating injury, were alive at ED arrival and had a zero ED SBP measurement were included. A zero ED SBP was considered valid if either the first unassisted respiratory rate greater than zero or a first temperature in ED was recorded. Multiple logistic regression models were used to assess the association between mortality and variables of interest.

**Results:** Data from 2,025 patients were considered as experiencing zero SBP and evaluated. The overall mortality was 68%, and the majority (95%) died within 48 hours of ED arrival. Patients who survived had a lower ISS score (mean[standard deviation]: 20.7[17.6] vs. 29.2[20.5],  $P<0.0001$ ), a higher total GCS score on admission (8.9[5.6] vs. 3.6[2.3],  $P<0.0001$ ), and a higher proportion of blunt injury (65.0% vs. 60.4%,  $P=0.046$ ). There was also a difference among the four levels of trauma center ( $P<0.0001$ ) and year of admission ( $P=0.03$ ). There was no difference in age ( $P=0.59$ ), the proportions of gender ( $P=0.30$ ) and race ( $P=0.53$ ). From a multivariate logistic regression model, the mortality was significantly associated with race ( $P=0.047$ ), higher ISS score ( $P=0.0007$ ), lower total GCS score ( $P<0.0001$ ), year of admission ( $P=0.0008$ ) and level of trauma center ( $P<0.0001$ ). Patients who admitted to the level II center had a lower chance of mortality than level I center (odds ratio=0.69, 95% confidence interval: [0.54, 0.87],  $P=0.001$ ).

**Conclusion:** Patient who had zero SBP at ED had about one-third chance of survival. Risk factors identified from this study can be used to manage this patient population.

Session 4

Poster # 53

**DEVELOPMENT OF A COMPREHENSIVE GUIDELINE TO IMPROVE  
OUTCOMES IN HIGH RISK TRAUMA PATIENTS MANAGED WITH OPEN  
ABDOMENS**

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**Objective:** To evaluate a comprehensive multidisciplinary guideline developed to standardize the management of patients with an open abdomen (OA) to improve outcomes.

**Methods:** Retrospective study on the effectiveness of a guideline that was developed at a Level I trauma center to standardize the management of trauma patients with OA. Guideline development included: re-definition of the indications for an OA, fluid and blood transfusion guidelines, revised damage control guidelines, expanded use of advanced closure techniques, and expanded use of Vacuum Assisted Closure (VAC). Two cohorts were evaluated pre and post guideline implementation: Group I (PGL) pre-guideline from 2001-2004; Group II (GL) guideline implementation 2004-2008. Groups were compared for rates of mortality, closure, fistula, multiple organ dysfunction syndrome, intra-abdominal hypertension (IAH), and abdominal compartment syndrome (ACS).

**Results:** In the study period 456 trauma patients required laparotomy; 27 of 221 laparotomies (12.7%) were in PGL with and of the 236 laparotomies in GL 57 (24.1%) were opened post procedure. Indications to keep the abdomen open were met in 85% of PGL and 100% in GL. Average ISS was 27 in PGL compared to 24.4 in GL. Closure rates were 70% in PGL with a mean closure time of 23 days and 94% in GL with mean closure time of 6.4 days. Mean IAH for PGL was 29 mmHg compared to 16 mmHg in GL ( $p < .05$ ). GL group had no reported incidences of ACS compared to PGL with 12 patients (45%). PGL had 7 patients (50%) with fistulas compared to 2 (4%) in GL. PGL had VAC therapy in 20% and GL had VAC therapy 100%. There was a 50% incidence of organ failure in the PGL group compared to 4% in GL group. Mortality rates were decreased from 27% in PGL to 17% in GL group ( $p > .05$ ).

**Conclusion:** The development of a comprehensive guideline to manage trauma patients with an OA is effective and had a significant decrease in complications and improved closure rates. Mortality rates decreased but did not meet statistical significance.

**REDUCED MORTALITY FROM SEVERE SEPSIS AMONG FEMALES IS UNRELATED TO NEWER THERAPIES FOR SEPSIS**

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**Background:** Although a mortality (M) advantage for female gender is observed in animal models of sepsis, it remains controversial whether that advantage exists for clinical sepsis. Previously we observed (Arch Surg 1999;134:1342, J Trauma 2006;60:193) that females under our care may be disadvantaged with respect to surgical intensive care unit (SICU) M. Recently we observed the elimination of apparent gender bias (higher M) among our female patients (Crit Care Med 2008;36:A79). We determined whether recent innovations in sepsis care are of greater benefit to females for reduction of M from severe sepsis.

**Hypothesis:** Evidence-based clinical interventions introduced since 2001 have reduced M to a greater degree among female patients with severe sepsis.

**Methods:** Retrospective review of prospective dataset of 262 consecutive SICU patients treated with drotrecogin alfa (activated) (DAA), glucocorticoids, or both for severe sepsis in a tertiary university SICU (Level I center) from February, 2002-February, 2009. Data collected: age, gender, adm. diagnosis, illness severity, sepsis treatments, vasopressor use, basal cortisol conc., MOD score, resuscitation status (DNR), and M. Stats: Mann-Whitney U, Fisher exact tests (coordinate data); ANOVA (continuous data), Kaplan-Meier survival analysis, multivariable logistic regression (MLR) (dependent variable M); \*p < 0.05.

**Results:** Female 44.3%. Glucocorticoids 72%, DAA 52%. Males and females were identical for emergency adm., illness severity, basal cortisol conc., insulin and vasopressor use, length of stay, and MOD score. Males were more likely DNR (48% vs. 35%\*) and less likely to receive DAA (38% vs. 50%). M 43%; lower for females overall (33% vs. 51%,\*), after DAA (30% vs. 54%\*), and after glucocorticoids (33% vs. 51%\*). By MLR, female gender was protective of M [OR 0.457, 95% CI 0.247-0.762], but not DAA or steroid use (H-L p=0.847).

**Conclusion:** Female patients treated for severe sepsis experienced significantly lower M from sepsis, but the reason therefor is apparently unrelated to treatment-related parameters.

Session 4

Poster # 55

## TEACHING PATIENT SAFETY ENHANCES SURGICAL CARE: IS IT TOO LATE FOR SOME?

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**Introduction:** Studying the etiology of errors and modifying the healthcare safety culture by adopting patient safety principles are critical aspects in reducing medical errors. The complexity and urgency inherent in trauma care creates the perfect opportunity to understand and teach the mechanisms of medical errors. We hypothesized that medical students taught patient safety lessons during their clinical rotations would be more likely to mature into patient safety conscious physicians. Our objective was to determine if students who participate in a safety curricula adopt these lessons, are more likely to intervene to avoid patient errors, and if surgeons are receptive to their patient safety suggestions.

**Methods:** A two-part patient safety curriculum was developed: introductory theories of patient safety principles (first year) and a clinically oriented, practical applications safety course during the trauma surgery clinical clerkship (third year). Pre- and post-rotation tests and web-based surveys were collected (Z-test significance  $p < 0.05$ ).

**Results:** 98.1% of students ( $n=107$ ) were conscious of patient safety concerns. Significantly more students receiving both portions of the two-part curriculum intervened during at least one unsafe clinical encounter to avoid a potential patient error than students who had only the first year course (77% vs. 61%,  $p < 0.05$ ). 75% of students rated their surgical exposure to patient safety somewhat/extremely relevant to their clinical rotations compared to 54% of students who rated the first year exposure as somewhat/extremely relevant ( $p < 0.05$ ). Students rated junior house-staff and other students more receptive to patient safety suggestions compared to fellows or faculty (84% vs. 66%,  $p < 0.05$ ).

**Conclusions:** Medical students who have patient safety education reinforced and clinical relevancy emphasized during their trauma surgery rotations are more attuned to patient safety concerns and are more likely to intervene to avoid an error. Students rated junior house-staff more receptive to safety concerns than senior house-staff and faculty surgeons. Education programs for senior surgeons may enhance adoption of patient safety goals.

**CHARACTERISTICS OF LAPAROTOMY CASES AMONG DRIVERS OF MOTOR VEHICLES INJURED IN TRAFFIC ACCIDENTS AND THE RISK FACTORS FOR SEAT BELT INJURY AS JUDGED BY A COMPUTER SIMULATION SYSTEM**

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**Background:** Recently, injuries sustained by drivers of motor vehicles in traffic accidents have changed with improvement in the designs of motor vehicles. However, despite a number of reports of abdominal injury associated with the use of seat belts, the design of seat belts has not been revised too much.

**Material and Methods:** We analyzed the characteristics of motor vehicle accident-related abdominal injury, based on the data from 238 motor vehicle traffic accident cases with more than AIS 3injuries. In order to clarify the effects of both the reclining angle of the occupant’s seat and the slipping between the hip and seat of a cushion on the occupant dynamics in frontal collisions, computer simulations were carried out using multiple whole-body models of humans, and a vehicle interior, including 3-point belts, air bags and seats.

**Results:** The driver was involved in 189 cases (79.4%) and 16 motor vehicle drivers required laparotomy (8.5%). The main indications of laparotomy in motor vehicle drivers involved in traffic accidents were seat belt injury (8 cases in total (50%);small intestinal injury in 4 cases, mesenteric injury in 2 cases, colonic injury in 1 case, duodenal injury in 1 case). All the seat belt injury cases were suggested the “submarine” injury. The computer simulation showed that the seat belt portion moves slightly upward in patterns 2 and 3 and significantly upward in pattern 1 as compared with the case in pattern 4 (Figure).

**Conclusion:** We showed that the principal indication of an emergency laparotomy in injured motor vehicle drivers was seat belt injury. The simulation results showed that upward sliding of the lap belt with the“submarine” causes compression of the abdomen, especially in cases where the friction coefficient is reduced between the hip and a more backward recline of the seat back.





**DECREASED PARTICIPATION IN TRAUMA RESUSCITATIONS IN THE ERA OF WORK HOUR RESTRICTIONS: FURTHER SACRIFICES ON RESIDENT EDUCATION**

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**Introduction:** Several studies have reported no change in resident case volume since the implementation of duty hour restrictions; however, the impact on other aspects of surgical residency remains a grave concern. We undertook this study to determine the effect of duty hour restrictions on resident involvement in patient management, as measured by participation in trauma resuscitations.

**Methods:** We retrospectively analyzed trauma resuscitations before the institution of work hour restrictions from 2001-2003 (PRE) and compared this with resuscitations from 2005-2007 (POST). Patient demographics, outcomes, and chief resident (PGY4 or 5) participation were recorded, as well as number of operative cases and ABSITE scores.

**Results:** During the PRE period, there were 1,222 trauma resuscitations and 2,178 during the POST period. While GCS ( $11 \pm 5$  vs.  $11 \pm 6$ ,  $p=0.35$ ) was similar between the two groups, ISS was higher in the POST period ( $16 \pm 10$  vs.  $18 \pm 11$ ,  $p=0.00001$ ). There was no difference in the average number of operative cases performed per chief ( $372 \pm 86$  vs.  $430 \pm 141$ ,  $p=0.19$ ) or in ABSITE raw scores ( $77 \pm 5$  vs.  $73 \pm 8$ ,  $p=0.12$ ) during these intervals (PRE vs. POST). Residents in the PRE group were present for 46% of resuscitations ( $n=564$ ) compared with only 36% ( $n=783$ ) during the POST interval ( $p<0.0001$ ).

**Conclusion:** After the initiation of work hour restrictions, resident participation in trauma resuscitations significantly decreased, while total chief operative cases and ABSITE scores were unchanged. The decision making process, as measured by management of trauma resuscitations, is a critical part of training. Our data shows that this is being sacrificed to maintain duty hour compliance.

**OPEN FRACTURES: IMPACT OF DELAY IN OPERATIVE INTERVENTION**

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**Background:** Early operative debridement and irrigation (D&I) of open fractures has been considered essential to reduce the risk of deep infection. With the advent of powerful antimicrobials this axiom has been challenged. The current study evaluates the rates of deep infections of open fractures in relation to the timing of first operative D&I.

**Methods:** A list of all blunt open lower extremity fractures was obtained from the trauma registry. The patients were evaluated for the degree of injury (ISS), the degree of physiological derangement (SBP, Lactate, RTS), and the type of fracture (Gustilo type). The timing to first operative D&I was calculated. All patients received prophylactic antimicrobials at presentation. The infection rate of patients was calculated in relation to the timing to first operative D&I. Significance was set at  $p < 0.05$ .

**Results:** Over the 42-month study period, 149 patients presented with blunt open lower extremity fractures. The presentation characteristics are shown in Table.

	Time to first operative D&I		p value
	<8-hours (n=124)	>8-hours (n=25)	
Age	42±1.5	36±2.7	NS
ISS	12±0.7	18±2.3	<0.05
RTS	7.7±0.9	7.8±0.0	NS
SBP	138±2.7	126±3.5	NS
Lactate	2.2±0.3	2.4±0.4	NS
Gustilo type			NS
I	14 (11%)	4 (16%)	
II	45 (36%)	8 (32%)	
III	65 (53%)	13 (52%)	
Deep infection	15 (12%)	8 (32%)	<0.05

The groups were well matched though the ISS in the >8-hour group was higher. The group with >8-hours to first operative D&I had significantly higher rate of deep infection as compared to the group with <8-hours to first operative D&I – 12% vs 32% ( $p < 0.05$ ).

**Conclusions:** Delay of >8-hours to first operative D&I of open fractures is associated with higher rates of deep infection, despite early use of broad spectrum antimicrobials.

Session 4

Poster # 59

**DAMAGE CONTROL LIGATION OF COMMON AND EXTERNAL ILIAC ARTERY INJURIES: HAVE TEMPORARY INTRAVASCULAR SHUNTS REPLACED THE NEED?**

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**Objective:** Trauma to the common or external iliac arteries has a mortality rate of 24% to 60%. “Damage control” options for these severely injured vessels are either ligation or temporary intravascular shunts (TIVS). Complications of ligation include a 50% amputation rate and up to 90% mortality. The primary study goal was to identify the consequences of using ligation versus TIVS for common or external iliac artery injuries in “damage control” scenarios.

**Methods:** All patients with injuries to an iliac artery (1995-2008) at a level 1 trauma center were reviewed. Demographics and outcomes were analyzed using standard statistical methodology.

**Results:** Iliac artery injuries were present in 88 patients (71 external; 17 common) (72% penetrating, median ISS=25, mean hospital stay=28 days). Most non-survivors (73%) died of refractory shock within the first 24 hours after presenting with hemodynamic instability (66%). Ligation was required in 1(6%) common and 14(20%) external iliac arteries. TIVS was employed in 2(12%) common and 5(7%) external iliacs. Patients requiring ligation (1995-2005) or TIVS (2005-2008) for their common or external iliac arteries had similar demographics and injuries ( $p>0.05$ ). Compared to ligation, patients receiving TIVS required fewer amputations (47% vs. 0%) and fasciotomies (93% vs. 43%)( $p<0.05$ ). Mortality in the ligation group was 73%, versus 43% in the TIVS cohort.

**Conclusions:** TIVS have replaced ligation as the primary damage control procedure for injuries to common and external iliac arteries. As a result, the high incidence of subsequent amputation has been virtually eliminated. With increased TIVS experience, an improvement in survival is likely.

**CRITICALLY INJURED PATIENTS WITH HIGH ADMISSION FIBRINOGEN  
ARE AT GREATER RISK FOR PULMONARY EMBOLISM**

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**Introduction:** Recent trials such as CRASH-2 are focusing on the early use of anti-fibrinolytics in critically injured trauma patients. The objective of this study was to examine whether admission serum fibrinogen can be used as a screening tool for patients at risk for thromboembolic event (TVE), multiple blood transfusions and mortality.

**Methods:** Prospective data were collected on 1304 patients admitted to a level 1 trauma ICU. Admission serum fibrinogen levels were collected on all patients and blood transfusion requirements were recorded daily. Fibrinogen was classified as being low, normal or high as per the laboratory standards. The diagnosis of TVE was made by either duplex or CT scan. Multivariate logistical regression was performed to determine the relationship between admission fibrinogen level and pulmonary embolism, transfusion requirements in the first 24 hours and mortality.

**Results:** The mean age was 42 years with an average ISS of  $29 \pm 13$ . Admission fibrinogen level was low ( $<216$  mg/dL) in 29%, normal in 60%, and high ( $>438$  mg/dL) in 11% of patients. When adjusting for age, ISS, gender, and mechanism, a high admission fibrinogen level was predictive of pulmonary embolism (OR= 2.81  $p=0.045$ ) but not DVT. A low fibrinogen level was predictive of increased blood transfusion (packed cells and FFP) in the first 24 hours (OR =2.18  $p<0.001$ ) and mortality (OR =1.94,  $p=0.001$ ).

*Table 1. Outcome Stratified by Fibrinogen level.*

Outcomes	Fibrinogen	Odds Ratio	95% CI	P value
Mortality	Low	1.94	1.31-2.87	*0.001
Pulmonary embolism	High	2.81	1.02-7.71	*0.045
PRBC transfusion in first 24 hours	Low	2.18	1.34-3.02	*0.000
FFP transfusion in the first 24 hours	Low	2.17	1.5-2.84	*0.000

**Conclusion:** Patients with high admission serum fibrinogen are at greater risk for pulmonary embolism and thus caution should be used when administering agents to treat or prevent coagulopathy. Current trials utilizing reversal agents should consider enrolling only patients with low fibrinogen levels.

Session 4

Poster # 61

**VIOLENCE AND INJURY PREVENTION TOUR (VIP): A COLLABORATIVE,  
HOSPITAL-BASED APPROACH TO EDUCATE AND EMPOWER INNER-  
CITY YOUTH**

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We hypothesize that an educational program, directed at youth, showing the injuries sustained from violence and its effects on the victims will improve understanding and awareness of high risk behavior and violence in their neighborhoods.

**Methods:** The Violence & Injury Prevention Program (VIP) is an educational tour in which participants spend 2.5 hours at our urban Level 1 trauma center. They see a presentation about actual trauma cases; tour the ICU, ED and the security operations center; and see a trauma resuscitation scenario with a simulated patient. They receive career information for opportunities in health care fields and a debriefing/evaluation session with the instructors. Participants are at-risk youth, ages 11 to 17. Each group receives the same presentation and tour. A test is given using an electronic audience response system (ARS). Trauma surgeons, RNs, RTs, & hospital security officers comprise the faculty. Data were collected using the ARS, and was anonymous.

**Results:** 185 students participated in VIP from January 2007 to August 2008. 63% were 6th-8th graders, 70% were male. 79% stated they knew someone who had been injured or killed due to violence, with significantly more males stating this than females ( $p=0.05$ ). More boys than girls stated they could obtain a gun if they wanted ( $p<0.05$ ). Almost 60% of participants stated they had engaged in violence within the past 6 months, with no difference by gender ( $p=0.085$ ). After participating in VIP, 84.2% of the respondents reported an increase in their awareness on the consequences of violence. This increased awareness was more significant for girls than boys with 93.2% versus 79.2% ( $p<0.05$ ). The same amount also stated they would recommend VIP to others. 86.3% of participants reported a better understanding of the hospital care of a trauma patient.

**Conclusion:** VIP educated local urban youth about violence and increased their awareness of the injuries resulting from violence. An added bonus was exposing at-risk youth to career opportunities in health care.

**KNOWLEDGE AND ATTITUDES OF TRAUMA CARE PROFESSIONALS  
REGARDING BRIEF INTERVENTION**

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**Background:** Brief intervention (BI) has been shown to reduce drinking and trauma recidivism. As a result, the American College of Surgeons (ACS) has required that Level I trauma centers must have the capability to provide intervention for patients identified as problem drinkers. The purpose of this study is to assess baseline knowledge and attitudes toward BI of trauma care professionals (TCP) in an ACS-verified trauma center prior to implementation of a new BI program.

**Methods:** At a single trauma center a web-based survey was conducted of all TCP and assessed understanding of alcohol problems (possible scores range from 0-10), knowledge regarding BI in the trauma care setting (15 true-false items), and investment in implementing evidenced based practices such as BI (possible scores range from 0-5).

**Results:** Of 578 eligible TCP, 63% (n=363) responded to the survey including 38% with a High School Diploma or Associates Degree, 43% with Bachelors Degree, 9% with a Masters Degree, and 10% with Professional Degrees (MD or PhD). On average, respondents had been working with the trauma population for  $9 \pm 9$  years. TCP were less likely to endorse the moral model ( $2.5 \pm 0.7$ ) of alcohol problems than the psychosocial model ( $3.4 \pm 0.5$ ), which is more consistent with the principles of BI. However, TCP had a limited understanding of the principles of BI with an average of 67% correct responses. TCP were generally supportive of evidenced based approaches to the treatment of alcohol problems ( $9.5 \pm 2.8$ ). TCP indicated that BI diverged from their clinical experience ( $9.8 \pm 2.3$ ) but that they would be likely to adopt the practice ( $9.5 \pm 2.8$ ). TCP also indicated that adoption of BI was not dependent on requirements to provide BI ( $5.8 \pm 2.5$ ).

**Conclusions:** While generally supportive of BI, TCP may benefit from additional training in the principles of BI. Organizational factors which may influence the implementation of BI, such as staff knowledge and attitudes toward BI and the treatment of alcohol problems, is not known but warrant continued investigation.

**CONCORDANCE BETWEEN HEAD-NECK AIS AND GLASGOW COMA SCALE FOR MORTALITY PREDICTION IN HEAD INJURED PATIENTS**

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**Introduction:** We sought to determine concordance of Head-neck Abbreviated Injury Scale (AIS) and Glasgow Coma Scale (GCS) and to compare accuracy of each score in predicting mortality alone and under influence of paralyzing drugs or artificial airway management (AAM), in traumatic brain injury (TBI) patients.

**Methods:** TBI patients were selected from a 10-year statewide database using CDC's Borell Matrix to categorize injury diagnosis. Admission GCS was categorized as severe TBI if calculated total  $GCS \leq 8$ . AIS was derived using the computerized algorithm of International Classification of Disease Programs for Injury Categorization (ICDPIC) and classified as severe TBI if  $AIS \geq 4$ . Concordance between AIS and GCS was measured with kappa statistic. Multivariate logistic regression and receiving operating curve (ROC) analyses were performed.

**Results:** Among 97,731 TBI patients, AIS and GCS agreement was "fair" (Kappa statistic 0.264; 95%CI 0.257-0.270). Agreement was lower in 8,334 patients with paralyzing drugs and AAM (Kappa statistic 0.032; 95%CI 0.022-0.041). In patients without paralyzing drugs or AAM, significant association with mortality for  $GCS \leq 8$  (OR 15.50; 95%CI 14.39-16.69) and for  $AIS > 4$  (OR 7.34; 95%CI 6.83-7.88) was observed. In patients with paralyzing drugs and AAM, significant association with mortality for  $GCS \leq 8$  (OR 2.84; 95%CI 1.97-4.09) and for  $AIS \geq 4$  (OR 3.44; 95%CI 3.04-3.89) was observed. After adjustment by AAM, paralyzing drugs, and interaction terms with severity scores, ROC analyses indicated that AIS had better discrimination in predicting mortality than GCS (ROC area 0.8379[0.8334-0.8424]; and ROC area 0.8231[0.8182-0.8279]; respectively).

**Discussion:** Head-neck AIS and admission GCS have the minimum necessary agreement for classifying severity in TBI patients. However, this is not accurate in patients with paralyzing drugs or AAM. GCS effect on mortality is modified and confounded by paralyzing drugs and AAM, in greater magnitude compared with AIS.

Session 4

Poster # 64

## THE IMPACT OF THE IRAQ WAR ON PHYSICAL CHILD ABUSE IN AMERICA

Michael R Bard, MD\*, Brett H Waibel, MD, Paul J Schenarts, MD\*, Scott G Sagraves, MD\*, Michael F Rotondo, MD\*. East Carolina University.

**Introduction:** As the only Level 1 trauma center and only pediatric ICU covering 29 counties and three military bases we sought to identify the impact the Iraq war, and its resultant stressors, has had on physical child abuse (PCA) in our region.

**Methods:** A retrospective review from Jan. 1999 to March 2008 comparing demographics, injury severity and outcome pre and post war was performed. Pre and post were subdivided into civilian (C) and military (M). Finally those groups were subdivided into white (W) and nonwhite (NW). Fischer's exact and Student's t-tests were used to analyze the data.

**Results:** A total of 135 cases of PCA were admitted (49 pre and 86 post). In comparing pre and post, a higher incidence among whites ( $p=0.049$ ), a trend toward more male victims ( $p=0.07$ ), less severe head injury ( $p=0.02$ ) and shorter hospital stay ( $p=0.03$ ) occurred in the post period. After dividing into C (34 pre vs. 74 post) and M (15 pre vs. 12 post), there were no significant changes pre vs. post in the M population but in the C population a higher incidence in whites ( $p=0.048$ ) and a decreased mortality rate ( $p=0.03$ ), as well as trends towards males ( $p=0.08$ ) and less severe head injury ( $p=0.07$ ) were seen in the post group. Upon further subdividing groups into C-W (11 pre vs. 36 post), C-NW (23 pre vs. 38 post), M-W (6 pre vs. 5 post) and M-NW (9 pre and 7 post), the only significant difference was in the C-W group in which the incidence of severe head injury was less ( $p=0.02$ ) in the post period. There was a trend towards shorter hospital stay in the M-NW group ( $p=0.06$ ) in the post period.

**Conclusion:** Since the start of the Iraq war on March 20<sup>th</sup>, 2003, the incidence of PCA is significantly higher among white civilians. The severity of head injury in the civilian population has lessened, which may explain the decrease in mortality in this group. More importantly despite the stressors of deployment and combat on military personnel and families there was a decreased incidence of PCA and no increase in injury severity or mortality in that population.



**THE COMBINATION OF AN ONLINE ORGAN AND TISSUE REGISTRY WITH A PUBLIC EDUCATION CAMPAIGN CAN HELP INCREASE THE NUMBER OF ORGANS AVAILABLE FOR TRANSPLANTATION**

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**Background:** A persistent shortage of organs and inexhaustible waiting lists continue to result in many people dying while awaiting transplantation. On July 1, 2006, the California Department of Motor Vehicles and California's online organ and tissue registry joined forces and launched a campaign to increase donation rates. This campaign included intense public and media education. The efficacy of such a campaign on donor demographics has not been studied.

**Methods:** Retrospective analysis was conducted of organ donor referrals and donations from all Southern California hospitals covered by a regional organ procurement agency. Organ donor demographics from two years prior (Time A - 2004-2005) and two years after (Time B - 2007-2008) were compared.

**Results:** Time A included 6112 referrals, 1548 potential donors with 696 actual donors. Time B included 7119 referrals, 1409 potential donors and 699 actual donors. Consent for donation improved to 51.0% from 47.5% ( $p=0.064$ ), family decline decreased to 32.6% from 44.1% ( $p<0.0001$ ), and conversion rates improved to 49.6% from 45.0% ( $p=0.011$ ). Coroners also declined donation less frequently during Time B (1.8% v 0.6%,  $p=0.004$ ). Extended criteria donors (ECD) improved to 9.5% from 3.8% ( $p<0.0001$ ) and donation after cardiac death (DCD) improved to 3.0% from 1.4% ( $p=0.002$ ). A decrease in organs per donor was noted (3.57 v 3.14,  $p<0.0001$ ) most likely due to an increase in ECD and DCD.

**Conclusions:** Public and media education significantly improved organ donor demographics. Although this study compares only 2 years before to two years after the donation campaign, the results are extremely favorable. A public donation campaign and an organ donor registry are effective at increasing the number of organs available for transplantation.

**IMPACT OF HELMET USE ON VICTIMS OF ALL TERRAIN VEHICLE  
CRASHES: THE NTDB EXPERIENCE**

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**Introduction:** The current version of the NTDB was analyzed to assess the impact of helmet use in victims of ATV crashes.

**Methods:** All entries in NTDB (ver. 7.1) research data set (2002-2006) which were involved in an ATV crash and sustained an injury (ATV) were identified. These entries were categorized as helmeted (H), non-helmeted (NH), or not-documented/unknown (ND/U). These groups were compared by age, ISS, LOS, hospital charges, AIS region, presence of severe head injury (AIS head  $\geq$  3), and mortality. Using multivariate analysis, the odds ratio (OR) for a risk-adjusted mortality related to helmet use was calculated. Statistical analysis was performed using chi-square, Fisher's Exact test, ANOVA, and a nominal regression procedure as appropriate. All statistical tests were two-sided with  $p < 0.05$ .

**Results:** 30190 ATV's were identified; 36% were H, 20% were NH, and 44% were ND/U. Of the 2538 ATV's with a severe head injury, 21% (536) were H. H-ATV's were associated with a significantly decreased mortality rate as compared to NH and ND/U ATV's for the total study population (0.9% vs. 3.0%, 2.1%) and for the group with a severe head injury (5.7% vs. 9.7%; 8.6%). H-ATV sustained significantly fewer head and facial injuries but more abdominal, and upper and lower extremity injuries compared to NH and ND/U ATV's. Multivariate analysis confirmed helmet use was independently predictive of survival for ATV [OR = 0.2 (0.27 – 0.65)].

**Conclusion:** The experience contained within the current version of the NTDB confirms that helmet use in victims of ATV crashes is associated with significant decreases in the incidence of head and facial injuries and a significant reduction in risk-adjusted mortality. On the other hand, H-ATV crash victims sustain more abdominal and extremity injuries as compared to NH or ND/U ATV crash victims.

Session 4

Poster # 67

## ALCOHOL SCREENING AND BRIEF INTERVENTION: AS EASY AS IT SOUNDS?

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**Purpose:** To identify barriers associated with implementing the ACS requirement for alcohol screening and brief interventions (SBI) at a high volume Level I trauma center and provide direction for such programs to more effectively address the problem of alcohol misuse among trauma patients.

**Background:** The ACSCOT requires all Level I trauma centers to have a mechanism to identify problem drinkers and provide an intervention for those patients. While the COT identified what needed to be done, trauma centers were charged with how it was to be done. A system for patient identification (any + BAC in driver or minor; BAC >0.08 in any patient), secondary screening using the AUDIT tool, staffing, and monitoring the program was established in 2006 and piloted.

**Methods:** A review of 2008 program records identified challenges to SBI program efficiencies. Patient characteristics were collected. Staff logs and time sheets addressed staffing issues. Incremental costs were calculated. Participating patients (SBI) were compared to non-participating patients (Non-SBI).

**Results:** 2,161 patients >12 years of age were admitted during the study period. 97.4% were tested for BAC; 27.2% were positive. 572 met criteria for SBI. 38% of 417 patients receiving intervention committed to a change plan. 155 (27.1%) did not undergo SBI. Reasons included clinical condition (37), lack of staffing (67), early discharge (21), police custody (12), no interpreter (4), patient refusal (3), other (5), unknown (6). Incremental costs were \$32,160 (\$56 per patient). While more severely injured patients were less likely to receive SBI (58.4% vs. 62.9%), no significant differences were found between SBI / Non-SBI patients in demographics, other drug use, age, ethnicity or payor type. Other substance abuse was identified in 437 patients; 184 also had + BAC.

**Conclusions:** Issues related to staffing, patient identification, and resource allocation must be addressed to most efficiently operate a successful SBI program.

**Session 4**  
**Poster # 68**

**INCIDENCE AND MORTALITY OF ARDS IN COMBAT CASUALTY CARE**

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**Objective:** Advances in military medicine and transport have improved coordinated trauma care delivery to the critically injured soldier. In the Vietnam War, approximately 0.4% of hospitalized casualties died from ARDS. We sought to evaluate the current incidence, mortality and resource utilization of ARDS in current combat casualty care.

**Methods:** The Joint Theater Trauma Registry was queried for US military personnel (excluding non-US, non-military cases) injured between June 8, 2001 and July 17, 2008. The cohort was classified as having 1) ARDS, 2) intubation, without ARDS, or 3) neither. Demographics, trauma variables & outcomes were compared.

**Results:** The query yielded 4666 individuals with 4700 separate records. 152 ARDS cases (3.2%) were identified; overall mortality was 12.6%. ARDS was associated with female gender and with higher ISS, shock and tachycardia at the first point of medical care. Ventilator days, ICU days and LOS were significantly increased in the ARDS group.

Variable	ARDS	Non-ARDS Intubated	Neither	All
N	152	2213	2335	4700
Age, mean ± SD	26.1 + 6.0	25.8 + 6.5	26.4 + 6.8	26.1 + 6.6
Gender F, % (n)	5.2 (8) * <sup>§</sup>	2.2 (47) <sup>§</sup>	2.6 (63)	2.6 (118)
Blast Injury, % (n)	69.8 (106) <sup>§</sup>	70.0 (1550) <sup>§</sup>	58.6 (1370)	64.4 (3026)
GCS 3-8, % (n)	42.6 (60) <sup>§</sup>	44.8 (907) <sup>§</sup>	2.4 (40)	25.8 (1007)
ISS05 ≥ 25, % (n)	36.8 (56) * <sup>§</sup>	27.0 (597) <sup>§</sup>	2.6 (61)	15.2 (714)
BP < 90 on admit, % (n)	14.6 (22) * <sup>§</sup>	8.8 (186) <sup>§</sup>	2.0 (43)	5.6 (251)
HR > 90 on admit, % (n)	69.6 (105) * <sup>§</sup>	61.0 (1306) <sup>§</sup>	35.6 (806)	48.6 (2217)
Vent days, mean ± SD	7.1 ± 5.7 <sup>#</sup>	3.7 ± 3.6 <sup>#</sup>	1.0 ± .2	2.5 ± 3.1
ICU days, mean ± SD	11.2 ± 10.1 <sup>#</sup>	5.6 ± 7.0 <sup>#</sup>	1.5 ± 1.3	3.7 ± 5.7
LOS, median (range)	11.0 (0-142) <sup>#</sup>	5.0 (0-1171) <sup>#</sup>	5.0 (0, 737)	5 (0-1171)
Mortality, % (n)	12.6 (19) <sup>§</sup>	8.8 (193) <sup>§</sup>	3.2 (75)	6.2 (287)

\*p < .05 compared to Non-ARDS, intubated, <sup>§</sup>p < 0.05 compared to Neither by X<sup>2</sup> statistic

<sup>#</sup>p < 0.001 compared to Non-ARDS, intubated by Wilcoxon scores test

**Conclusions:** ARDS remains a significant complication in current combat casualty care, and is associated with female gender, higher injury severity and adverse outcomes. ARDS still accounts for death in 0.4% of hospitalized casualties in current military medical care.

**PEDIATRIC ATV TRAUMA: THE EPIDEMIC CONTINUES UNABATED.**

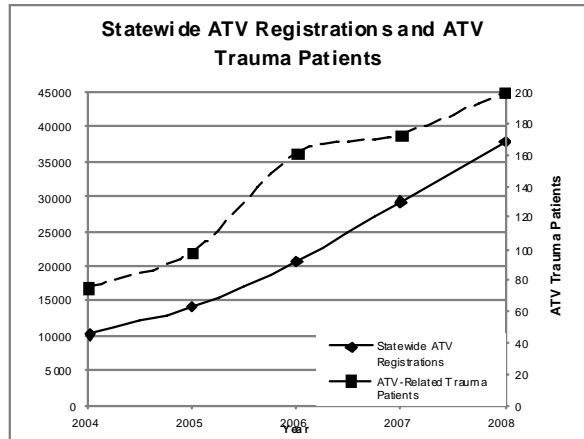
Nathan Blecker, BS, Terence O’Keeffe, MD, Julie Wynne, MD, Randal Friese, MD, Dan Judkins, RN ,MS, MPH, Rifat Latifi, MD\*, Peter Rhee, MD\*, MPH. University of Arizona.

**Introduction:** All-terrain vehicle (ATV) popularity continues to increase but this form of recreation is not as well regulated and can impact children disproportionately.

**Methods:** The trauma registry from a level I trauma center identified all ATV injuries over a five year period (2004-2008). ATV registration data were obtained from the state.

**Results:** There were 720 ATV injuries treated over the five year period and the yearly increases were dramatic rising from 85 in 2004 to 200 in 2008. ATV patients were younger than other mechanized vehicle injuries and over 28% were in patients that were younger than 16 years of age. Children (<16yrs) were four times more likely to be injured due to ATV compared to motorcycles. In addition, only 27.5% of the injured ATV patients were helmeted compared to 47.5% of motorcycle collisions (MCC).

**Conclusion:** ATV injuries have more than doubled over this study period and are becoming a major source of injuries treated. Public education and awareness of the dangers associated with ATV use should be tailored to and targeted towards the parents of children most likely to use ATVs. Legislation to increase helmet use in children and to provide additional resources for trauma centers that treat patients injured while using ATV is necessary for the viability of trauma centers.



Variable	ATV N= 720	MCC N = 1497	MVC N= 8875
Median Age	22	36	28
% <16 yrs	28.1%	3.9%	11.4%
% Helmeted	27.5%	47.4%	N/A
% Mortality	2.3%	4.5%	2.2%
Mean ISS (SD)	8.8 ± 8.6	10.8 ± 11.3	7.3 ± 10.0

Session 4  
Poster # 70

**DATA LINKAGE: COMBINING STATEWIDE TRAFFIC RECORDS AND  
TRAUMA CENTER INJURY DATA FOR PREVENTION OF PEDESTRIAN  
TRAUMA**

Michael A Christensen, RN, MS, Martin Davis, John Sherck, MD\*. Santa Clara Valley Medical Center.

**Background:** The National Highway Safety and Traffic Administration has provided grants to 14 states, not including ours, for Crash Outcome Data Evaluation System (CODES) to link highway safety and crash data with Emergency Medical Systems (EMS) data on medical care and outcomes. Therefore all our traffic crash data and medical injury data are recorded and analyzed separately, preventing any local analysis which could lead to institution of evidence based injury prevention measures. We hypothesized that a computer linkage could be established which would provide sufficient data to assist injury prevention measures for pedestrian injuries, an identified problem in our community.

**Methods:** Local pedestrian injury prevention organizations and personnel were queried for data elements desired. Data were obtained from the Statewide Integrated Traffic Records System (SWITRS) and from the Emergency Medical Services (EMS) Agency trauma registry. A data linkage procedure was designed and implemented for the 2 data sets.

**Results:** Ten years of local SWITRS data, a raw data set of 7,267 pedestrian injuries, was available for analysis, but due to a 2 year delay in data entry, the most recent data was not available. Due to a change in registry, EMS data was available for only the most recent 5 years. Thus 882 injuries met criteria for linkage. For these patients, linkage accuracy was >90%. Specific data obtained for these injuries included exact location, time, weather, lighting, and traffic conditions, and incident specifics including assigned fault. Specific locations and times were identified as high risk. The results were disseminated to interested organizations, city traffic planners, and the county board of supervisors.

**Conclusions:** 1. Retrospective computer linkage of traffic data and injury data can be accomplished, but with loss of much potential data and significant cost and time required. 2. These data are sufficiently accurate to be effectively used in local injury prevention planning. 3. A nation wide crash outcome data evaluation system would provide improved data and would be helpful in crash analysis and injury prevention.

Session 4

Poster # 71

**IMPROVED SURVIVAL TIME WITH COMBINED EARLY BLOOD  
TRANSFUSION AND FLUID ADMINISTRATION IN UNCONTROLLED  
HEMORRHAGIC SHOCK IN RATS**

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Toshihisa Sakamoto, MD. National Defense Medical College, Emergency Medicine.

**Objective:** To test whether early blood administration combined with crystalloid solution infusion may prolong survival in a clinically relevant model of ongoing uncontrolled life-threatening hemorrhage.

**Methods:** Light anesthesia was induced with halothane in 24 rats, and spontaneous breathing was maintained. Uncontrolled hemorrhagic shock (UHS) was induced by withdrawal of blood at 2.5 mL/100g over 15-min period, followed by 75% tail amputation. At 10 min after tail cutting, rats were randomized into 4 groups (n=6 each): Group 1, receiving 3 mL of shed blood followed by 9 mL of lactated Ringer's (LR) solution; Group 2, receiving 9 mL of LR solution followed by 3 mL of shed blood; Group 3, receiving 9 mL of LR solution only; Group 4, receiving neither of shed blood nor LR solution. Rats were then observed until death or a maximum of 180 min.

**Results:** Mean survival time was 138±30 min, 108±22 min, 79±13 min, 55±18 min for Groups 1, 2, 3, and 4, respectively (P<0.01 for Group 1 vs. Group 2, 3, or 4; P<0.01 for Group 2 vs. Group 3 or 4). Additional blood loss from the tail stump did not differ significantly between the three treatment groups.

**Conclusions:** In a model of UHS in rats, a resuscitation regimen using crystalloids agent alone is not ideal, and even brief delay in blood administration worsens survival. Early blood administration combined with crystalloid solution infusion appears ideal.

**THE COST EFFECTIVENESS OF RECOMBINANT FACTOR VIIA IN THE MANAGEMENT OF BLEEDING AFTER BLUNT TRAUMA**

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**Purpose:** Bleeding and transfusion after blunt trauma are associated with increased complications and mortality. Recombinant activated Factor VIIa (rFVIIa) is an intravascular hemostatic agent that reduces the need for blood transfusion after trauma, but high costs limit its use. We sought to determine the cost-effectiveness of the use of rFVIIa to arrest bleeding after blunt trauma.

**Methods:** We developed a cost-effectiveness model using a societal perspective over a lifetime. The model was based on data from a published 30-day international, randomized, placebo-controlled Phase II trial, supplemented by data from outcomes studies on the Acute Respiratory Distress Syndrome (ARDS) as well as complications of rFVIIa treatment. The main outcome measure was the cost per quality-adjusted-life-year (QALY). We performed sensitivity analyses across cost, treatment complications, and utility input variables.

**Results:** In the base case, the lifetime costs after receiving rFVIIa were \$341,000 and total QALYs were 14.34. For placebo-treated patients, total costs were \$285,000 and QALYs were 12.44. The incremental cost effectiveness ratio for rFVIIa was \$29,000/QALY. The incremental cost-effectiveness ratio became less favorable (>50,000/QALY) when the probabilities of death in both the rFVIIa- and placebo-treated groups were equal. Furthermore, rFVIIa became less cost-effective when the incidence of ARDS increased in the rFVIIa treatment arm to the same level as the placebo arm (4% to 16%). Recombinant FVIIa remained cost effective even at prices higher than current wholesale prices.

**Conclusions:** rFVIIa is cost-effective in the management of bleeding after blunt trauma based on findings from a randomized controlled clinical trial. Further data from controlled trials with longer follow-up will substantially improve the understanding of long-term benefits and harms of rFVIIa in blunt trauma.



**MULTI-CENTER VALIDATION OF A SIMPLIFIED SCORE TO PREDICT MASSIVE TRANSFUSION**

Bryan A Cotton,\* MD, MPH, Lesly A Dossett, MD, MPH, Elliott R Haut,\* MD, Shahid Shafi,\* MD, MPH, Timothy C Nunez, MD, Brigham K Au, MD, Patrick Arbogast, PhD, Pampee P Young, MD, PhD. Vanderbilt University, UT-Southwestern, and Johns Hopkins University.

**Background:** Several studies have described predictive models to identify trauma patients who require massive transfusion (MT). Early identification of lethal exsanguination may improve survival in this patient population. The purpose of the current study was to validate a simplified score to predict the need for MT at multiple level 1-trauma centers.

**Methods:** All adult trauma patients treated at three level 1-trauma centers from 07/06-06/07 who (1) were transported directly from the scene, (2) were trauma activations, and (3) received any blood transfusions during admission were included. ABC score developed using the same inclusion criteria for patients admitted to a single trauma center (TC-1A)\* between 07/05-06/06. An ABC score predictive for MT was calculated by assigning a value (0 or 1 for the absence or presence, respectively) to each of the four parameters: penetrating mechanism, positive FAST for fluid, arrival blood pressure <90 mmHg, and arrival pulse >120 beats/minute. ABC Score of 2 was used as “positive” to predict the need for MT. Area under receiver operating characteristic curve (AUROC) was calculated to compare the predictive ability of the score at each institution.

**Results:** The developmental dataset consisted of 586 patients (TC-1A). There were 513 patients at Trauma Center 1 (TC-1B), 372 at Trauma Center 2 (TC-2), and 133 at Trauma Center 3 (TC-3). The MT rate was similar between centers: 14-15%. ABC score was evaluated for its ability to predict MT by 24 hours (Table). The score was also applied to predict MT (>10 U RBC) by 6 hours, with an AUROC of 0.90 (95% C.I. 0.87-0.93).

	N	Sensitivity	Specificity	Correctly classified	AUROC (95% C.I.)
TC-1A*	586	75%	86%	84%	0.86 (0.80-0.92)
TC-1B	513	83%	88%	87%	0.90 (0.86-0.93)
TC-2	372	90%	67%	87%	0.88 (0.81-0.96)
TC-3	133	76%	86%	84%	0.83 (0.77-0.92)

**Conclusions:** The ABC score is a valid instrument to predict the need for MT early in the patient’s care and across various demographically diverse trauma centers. Future research should focus on this score’s ability to prospectively identify patients who will require MT.

**IDENTIFYING LIFE THREATENING SHOCK IN THE OLDER INJURED PATIENT USING AGE X SHOCK INDEX: AN ANALYSIS OF THE NATIONAL TRAUMA DATA BANK**

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

**Objective:** Reliance on traditional vital signs (TVS), particularly in older patients, to identify life-threatening shock after injury may result in slowing time to definitive care and may also lead to lower enrollment in prospective resuscitation studies. Shock index (SI), defined as heart rate (HR) divided by systolic blood pressure (SBP), is easily calculated and may be a better indicator of early shock after injury than TVS. Multiplying age by SI (AGE X SI) may be better in older injured patients. Using the National Trauma Data Bank (NTDB) we explored the hypothesis that (AGE X SI) would be a better predictor of 48-hour mortality (48 MORT) in OLD patients (Age > 55) compared to TVS, while for YOUNG patients (Age ≤ 55), SI would be a better predictor than TVS.

**Methods:** Version 8.1 of the NTDB was queried for incidents of blunt, non-neurologic injury occurring during 2007, to patients aged 18-81. The main outcome was 48 MORT. Areas under the receiver operating characteristic curves (AUC) were compared for TVS, SI and AGE X SI in YOUNG and OLD patients.

**Results:** 189574 incidents were identified. Overall 48 MORT was 1.18% (1.09% in YOUNG and 1.42% in OLD; p <0.0001). For YOUNG patients, there was no difference

	N	ISS	HR	SBP	SI	Age x SI	between SBP (AUC
YOUNG	134381	9.3	91	135	.70	24.4	0.654) and SI
OLD	55193	9.0*	83*	144*	.61*	41.5*	(0.655) for

\*p-value < 0.05 vs Young  
predicting 48 MORT. But, both were better than HR (AUC 0.606 p< 0.0001). For OLD patients, AGE X SI (AUC 0.693) was a better predictor of 48 MORT compared to HR (AUC 0.626 p<0.0001), SBP (AUC 0.657 p<0.0002) or SI (AUC 0.684 p<0.008).

**Conclusion:** TVS are inadequate predictors of shock after non-neurologic blunt injury. Using SI in the YOUNG and AGE X SI in OLD to identify patients at risk for early mortality after blunt injury could result in earlier definitive treatment. Their use as inclusion criteria for prospective resuscitation studies may increase enrollment accuracy.

## TIME-DEPENDENT RELEASE OF BIOACTIVE SUBSTANCES IN STORED BLOOD: DOES LEUKOREDUCTION HELP?

Randall Friese\*, MD, Robert Barber, PhD, Jessica Bender, BS, Terence O'Keefe, MD, Julie Wynne, MD, Rifat Latifi, MD, Peter Rhee\*, MD. University of Arizona College of Medicine.

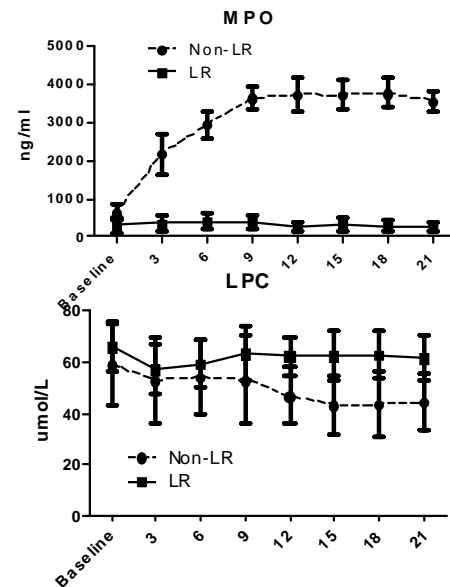
**Background:** Longer storage age of blood (older blood) transfused during resuscitation has been associated with increased post-injury complications and organ dysfunction. Leukocytes within packed red cell products have been postulated to account for these deleterious effects. Time-dependent spontaneous release of leukocyte derived bioactive substances within stored blood, specifically lysophosphatidylcholines (LPTC), has been postulated as a potential mediator. The purpose of this study was to determine the effects of pre-storage leukoreduction (LR) on time-dependent LPTC concentrations in stored human blood.

**Methods:** Nine units of packed red blood cells were obtained from our local blood bank. Five of these units underwent pre-storage LR. All units were received from the blood bank within 48 hours of collection/processing and stored for 21 days according to blood bank protocols. Each unit was sampled at baseline and every three days for 21 days. LPTC and myeloperoxidase (MPO) levels were measured by ELISA at each time point. A sample

from each PRBC unit was sent for culture at 12 and 21 days. Repeated measures ANOVA was used to explore for within group differences in LPTC and MPO levels over time.

**Results:** All cultures had no growth. MPO levels increased over time for non-LR units ( $p < 0.001$ ). MPO levels remained unchanged over time in LR units ( $p = 0.257$ ). LPTC levels were unchanged over time in both LR ( $p = 0.064$ ) and non-LR units ( $p = 0.132$ ). (Figures)

**Conclusions:** Pre-storage LR does not alter time-dependent LPTC concentrations in stored human blood. Leukocytes may not be responsible for the detrimental effects of old blood.



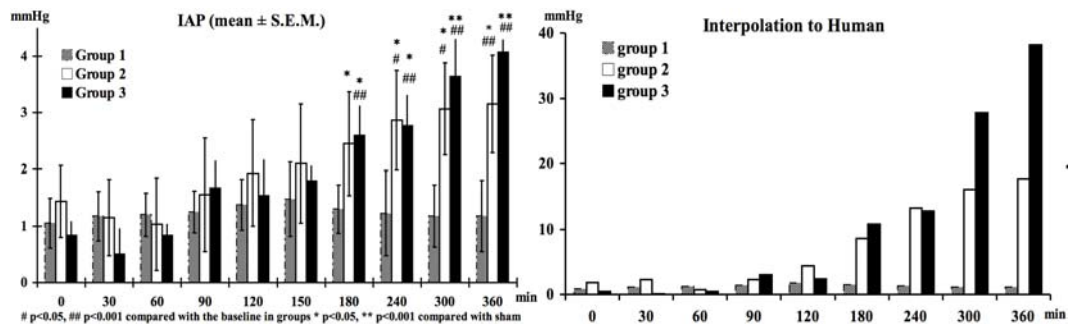
## CLINICALLY RELEVANT MODEL FOR SECONDARY ABDOMINAL COMPARTMENT SYNDROME

Osamu Yoshino, MD, Anthony W Quail, MD, Zsolt J Balogh\*, MD, PhD. Department of Traumatology, John Hunter Hospital, University of Newcastle.

**Introduction:** Secondary abdominal compartment syndrome (SACS) has poor outcome and proven association with the magnitude and quality of early resuscitation. The aims of this study were to quantitate the effect of (1) haemorrhagic shock (HS) and resuscitation (RE) on intra-abdominal pressure (IAP) and (2) timing of blood transfusion on IAP.

**Methods:** NZ rabbits were anaesthetized and instrumented including IAP measurement. Physiological parameters and arterial blood gases were monitored. After a 30-minute equilibration, Group 1 (n=6), served as sham without HS and RE. Group 2 & 3 (both n=6) were bled to induce HS (MAP~30 mmHg for 1 hour) followed by RE with Lactated Ringer (LR) and early (from 60 min) shed blood (SB) in Group 2; and with LR and delayed (from 180 min) SB in Group 3. The abdominal wall compliance of the rabbit was measured and following curve fitting the IAP was interpolated to human by using the mathematical formula ( $\log_{\text{rabbit}}\text{-IAP} = 2.84\log_{\text{human}}\text{-IAP}-0.33$ ). ANOVA and t test were used for statistics.

**Results:** The physiological parameters and IAP were unchanged in the sham group, while Group 2 & 3 were exposed to severe HS with successful RE based on vital signs and blood gases. Group 2 & 3 had significant increases of IAP compared to baseline and Group 1.



**Conclusions:** HS+RE increase IAP in the rabbit to a range that would be considered pathological in the human within 4 hours. SACS can develop without tissue injury. Earlier blood transfusion potentially alleviates the effect of HS on IAP. This model is suitable for research to optimize the resuscitation of severe shock to prevent SACS.

**TRAUMA-INDUCED HYPOTHERMIC COAGULOPATHY: AN EMPIRICAL EVALUATION.**

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**Purpose:** Studies isolating the effect of hypothermia on tissue damage initiated coagulation are lacking. In a controlled environment with minimally altered whole blood in a tissue factor based reaction, we utilized a novel surface contact inhibitor to examine the effect of trauma-induced hypothermia on the blood coagulation process.

**Methods:** Blood samples from six healthy volunteers were analyzed at 27C, 32C, and 37C using thromboelastography (TEG), thrombin-antithrombin complexes (TAT), and clot weights. The surface contact (intrinsic) clotting pathway was inhibited using corn trypsin inhibitor (CTI-0.1mg/ml) and tissue damage was imitated via thrombosis initiation with 5pM tissue factor. Data analyzed with student's *t* test and ANOVA,  $p < 0.05$  significance.

**Results:** Hypothermia leads to significant non-linear impairments in clot formation (R-time), clot momentum (K-time), fibrin deposition (angle), and time to maximum clot formation (TMA). Hypothermia does not appear to affect maximum clot strength (MA), despite decreases in average clot weight. TAT analysis shows decreased onset of thrombin generation (37C-4min, 32C-5min, 27C-7min) and effect on thrombin generation rate.

(Values: Mean $\pm$ SEM)	37C	32C	27C	<i>P</i> -value
<b>R-time (min)</b>	8.2 $\pm$ 0.2	9.7 $\pm$ 0.7	12.1 $\pm$ 1.0	0.008
<b>K-time (min)</b>	4.7 $\pm$ 0.3	5.7 $\pm$ 0.8	8.3 $\pm$ 1.2	0.035
<b>Angle (degrees)</b>	39.6 $\pm$ 1.6	35.2 $\pm$ 3.4	26.7 $\pm$ 2.4	0.007
<b>MA (mm)</b>	55.3 $\pm$ 1.9	57.0 $\pm$ 2.3	54.4 $\pm$ 2.3	0.713
<b>TMA (min)</b>	33.5 $\pm$ 1.3	43.3 $\pm$ 5.5	51.8 $\pm$ 4.4	0.002
<b>Clot Weights</b>	1.18 $\pm$ 0.1	0.88 $\pm$ 0.2	0.82 $\pm$ 0.3	0.001

**Conclusion:** In this study we show that under hypothermic conditions thrombin generation propagation is delayed which results in delayed clot development and altered clot breakdown. Even severe hypothermia does not limit clot potential. These results suggest that the timely re-warming of the hypothermic trauma patient may restore physiologic activity of an otherwise intact coagulation system.

**HIGHER RATIOS OF PLASMA: RBC AND PLATELET: RBC ARE ASSOCIATED WITH A REDUCTION IN MORTALITY AMONG TRAUMA PATIENTS RECEIVING LESS THAN A MASSIVE TRANSFUSION**

Bryan A Cotton,\* MD, MPH, Timothy C Nunez, MD, Brigham K Au, MD, Victor Zaydfudim, MD, MPH, Lesly A Dossett, MD, MPH, Pampee P Young, MD, PhD. Vanderbilt University.

**Background:** Higher plasma and platelet to red blood cell (RBC) ratios have been reported to improve survival among trauma patients receiving massive transfusion. However, transfusion of higher ratios in those not receiving massive transfusions has recently been questioned. The purpose of the current study was to evaluate the impact of higher transfusion ratios among critically injured patients receiving  $\leq 10$  Units (U) RBC intra-operatively.

**Methods:** All patients treated at an adult level 1 trauma center between 02/06-02/08 who (1) underwent immediate operative intervention and (2) received our institution's massive transfusion protocol. Patients receiving  $> 10$  U RBC during the operation were excluded. Patients receiving a ratio of  $\leq 2:3$  plasma: RBC or  $\leq 1:5$  apheresis platelets: RBC were defined as high ratio (HR); those receiving less were classified as low ratio (LR).

Univariate and multivariate analyses examined the effects of transfusion ratios on patient's clinical outcomes, and 30-day mortality.

**Results:** 128 patients met inclusion criteria; 90 in LR plasma group and 48 in HR plasma group. HR plasma patients had higher rate of penetrating injuries (67% vs. 45%,  $p=0.008$ ). However HR plasma patients had fewer cardiovascular complications (19% vs. 38%,  $p=0.021$ ), and less frequent multiple organ failure (21% vs. 43%,  $p=0.045$ ). In addition, the HR plasma group had lower 30-day mortality by univariate (17% vs. 56%,  $p<0.001$ ) and multivariate analyses (OR 0.14,  $p<0.001$ ). These same 128 patients were then examined by platelet ratios with 104 in LR platelet group and 48 in HR platelet group. There were no differences in patient demographics and clinical outcomes between the HR and LR platelet groups. However, HR platelet patients had a lower 30-day mortality by univariate (15% vs. 51%,  $p<0.001$ ) and multivariate analyses (OR 0.15,  $p=0.001$ ).

**Conclusions:** Critically injured patients receiving  $\leq 10$  U RBC intra-operatively may benefit from higher ratios of plasma and platelets to RBC. Patients transfused with HR plasma and HR platelets have an 86% and 85% reduction in 30-day mortality, respectively.

Session 4

Poster # 79

**THE RATIO OF BLOOD PRODUCTS TRANSFUSED REMAINS ASSOCIATED WITH IMPROVED SURVIVAL IN PATIENTS RECEIVING MASSIVE TRANSFUSIONS IN COMBAT OPERATIONS.**

John W Simmons, MD, Christopher E White, MD, Brian J Eastridge\*, MD, Charles E Wade, PhD, Lorne H Blackbourne\*, MD. Brooke Army Medical Center.

**Background:** Improved survival has been shown with high FFP:RBC ratio in military patients who received massive transfusion (MT), at the onset of the present conflicts when medical resources, blood components were limited. Multiple operational and tactical changes have been made since the beginning of the current conflicts to include: body armor, tourniquets, and trauma system improvements. Our objective was to re-evaluate this finding since the battlefield has matured and component therapy is more readily available. Does the advantage of high ratio transfusion persist?

**Methods:** A prospective observational study was performed of US military MT (>10 RBC in 24 hours) patients injured from OCT05 to SEP08. Three groups of patients were created according to the FFP:RBC ratio transfused. Whole blood was counted as 1 unit of RBC and FFP. Mortality rates were compared.

**Results:** 482 MT patients were identified. For the low ratio group the plasma to RBC median ratio was 1:6.7 (IQR, 0:1-1:5.1), for the medium ratio group, 1:2.5 (IQR, 1:2.7-1:2.3), and for the high ratio group, 1:1.3 (IQR, 1:1.5-1:1.1) ( $p < 0.001$ ). Median Injury Severity Score was 23 for all groups (IQR, 16-33). For low, medium, and high FFP:RBC ratios, overall mortality rates were 35%, 25%, and 18% ( $p = 0.027$  for low vs. high).

**Conclusions:** We demonstrated higher plasma to red cell ratios remains associated with improved survival after battlefield injury requiring MT. This analysis will be critical to substantiate evidence-based changes in clinical practice on the battlefield. Our current analysis substantiates earlier analysis of this population of severely wounded combat casualties.

Session 4  
Poster # 80

**THE ROLE OF PREHOSPITAL LACTATE AS A PREDICTOR OF OUTCOME  
IN TRAUMA PATIENTS**

Jose Luis Castillo, MD, Francis X Guyette, MD, MS, MPH, Brian P Suffoletto, MD, Andrew B Peitzman\*, MD, Juan Carlos Puyana\*, MD. Department of Surgery, University of Pittsburgh..

**Background:** Point of Care (POC) lactate has been used as a biomarker of occult hypoperfusion in critically injured patients in the ED and ICU. Recently a method to assess lactate during prehospital transport has become available. Our objective was to determine the role of prehospital lactate as a predictor of outcome in trauma patients.

**Methods:** We measured POC lactate in 399 consecutive adult trauma patients both during critical care air transport (STATLAC) and early in the hospital course (EDLAC) between April and October 2008. We collected demographic and physiologic data from a single air-medical agency and a single, urban Level I trauma center. Lactate values are measured as mmol/L, and presented as median (IQR). We used logistical regression to determine the odds ratio (OR) of increases in STATLAC, EDLAC and the change in lactate (DLAC) on in-hospital mortality, adjusted for initial heart rate, blood pressure, GCS score and age, presented with 95% confidence intervals (95% CI)..

**Results:** In hospital mortality in this cohort of trauma patients is 6% (24/399) with a median ISS of 10 (IQR 5, 18).

VARIABLE	DEAD Median(IQR)	ALIVE Median(IQR)	OR (CI 95%)	Adjusted OR (CI 95%)	ROC Values
STATLAC	4.05(3.45,5.05)	3(1.3,4.1)	1.13(1.01-1.26)	1.24(1.03-1.49)	0.81
EDLAC	3.2(2.2,4.6)	2.1(1.45,3)	1.55(1.21-1.98)	1.71 (1.21-2.45)	0.85
DLAC	0.75(-0.7, 1.8)	1.1(-0.1, 2.2)	0.9 (0.72-1.12)	0.93(0.68-1.26)	0.76

In those patients with STATLAC  $\geq 4$ , there were a higher percentage of patients requiring emergent operation, vasopressors and intubation. This group of patients also had longer a length of ICU and hospital stay.

**Conclusions:** Both prehospital POC lactate and in-hospital lactate predict mortality independently of age, initial vital signs and neurologic presentation in trauma patients. Additionally, Prehospital lactate  $\geq 4$  predicts need for resuscitation and intensive care management.



Session 4

Poster # 81

**LIPID MEDIATORS IN MESENTERIC LYMPH FOLLOWING  
HEMORRHAGIC SHOCK AND THEIR BIOLOGIC ACTIVITIES.**

Koji Morishita, MD, Junichi Aiboshi, MD, Tomohiko Masuno, MD, Kaoru Koike, MD\*,  
Tetsuyuki Kobayashi, PhD, Yasuhiro Otomo, MD. Tokyo Medical and Dental  
University, Nippon Medical School, Kyoto University, Ochanomizu University.

**Introduction:** Intestine exposed to ischemia/reperfusion produces a variety of inflammatory mediators. These mediators enter into the systemic circulation through the mesenteric lymph duct, leading to lung injury. Recent studies have demonstrated that post-hemorrhagic shock mesenteric lymph (PHSML) contains pro-inflammatory mediators, such as cytokines, and biologically active lipids, and activates neutrophils/vascular endothelial cells. The purpose of our study was to determine lipid mediators in PHSML and their biological activities on neutrophils.

**Method:** Male SD rats were anesthetized and cannulated mesenteric lymph duct, femoral artery and vein. In shock group that were subjected to hemorrhagic shock, blood was withdrawn via femoral vein until the mean arterial pressure was reduced to 40mmHg and maintained for 30 minutes. At the end of shock period, animals were resuscitated over 2 hours with shed blood and normal saline (2 x shed blood). Sham group underwent the identical procedures without shock and resuscitation. Lipids in the mesenteric lymph collected during the resuscitation phase were extracted by the Bligh-Dyer method and measured with mass spectrometry. Biological activities (superoxide production, elastase release, and chemotaxis) of lipid mediators on human neutrophils also were tested.

**Result:** Lyso-phosphatidylcholines and lyso-phosphatidylethanolamines were significantly increased in PHSML of shock group. Furthermore, biological activities of these lipids on neutrophils were significantly increased.

**Conclusions:** Mesenteric lymph after hemorrhagic shock contains biologically active lipid mediators. Our results therefore suggest that the lipid mediators may induce multiple organ dysfunction/acute lung injury following trauma and hemorrhagic shock.

**A MATTER OF DOSE? THROMBOEMBOLIC COMPLICATIONS AFTER RECOMBINANT FACTOR VIIA ADMINISTRATION IN TRAUMA PATIENTS**

Erin Reichert, PharmD, Anthony Gerlach, PharmD, Claire Murphy, PharmD, Yalaunda Thomas, MD, Steven Steinberg, MD, David Lindsey, MD, Stanislaw Stawicki, MD, Melissa Whitmill, MD, Charles Cook, MD. The Ohio State University.

**Introduction:** Recombinant factor VIIa (rFVIIa) has been increasingly used to control acute hemorrhage and for emergent reversal of anticoagulation in non-hemophilic patients. Optimal timing and dosage to maximize outcomes and minimize risk of thromboembolic complications (TEC) have not been established.

**Objective:** Determine the incidence of TEC associated with rFVIIa use in trauma patients.

**Methods:** Five-year retrospective review of trauma patients receiving rFVIIa. Diagnosis of TEC was based on cardiac enzymes, electrocardiograms, radiologic or vascular studies.

**Results:** Thirty-five patients received rFVIIa (mean dosage  $3.4 \pm 2.0$  mg). Most had blunt injuries (n=30) and received rFVIIa for hemorrhagic shock (n=17), brain injury (n=13), or warfarin reversal (n=5). Nine patients (25.7%) developed TECs: 8 arterial (4 CVA, 2 MI, 1 CVA/MI, and 1 bowel ischemia) and 1 venous. Mean age, ISS, length of stay, and mortality were similar for the two groups. There was a trend toward higher total dosage ( $93.4$  vs  $50.1$  mcg/kg  $P=0.14$ ) in the TEC group, and TEC patients received significantly more doses ( $2.8$  vs  $1.1$   $P=0.02$ ) than those without TEC.

	TEC (n=9)	No TEC (n=26)	p-value
Mean age $\pm$ SD	$51.7 \pm 27.9$	$43.2 \pm 23.9$	0.39
Mean ISS ( $\pm$ SD)	$23.7 \pm 15.6$	$32 \pm 15.6$	0.19
Total dosage (mcg/kg $\pm$ SD)	$93.4 \pm 138$	$50.1 \pm 33.5$	0.14
Time to rFVIIa (hrs $\pm$ SD)	$9.3 \pm 7.9$	$5.7 \pm 4.6$	0.11
Mean number of doses ( $\pm$ SD)	$2.8 \pm 3.6$	$1.1 \pm 0.3$	<b>0.02</b>
Length of stay (days $\pm$ SD)	$28.4 \pm 20.6$	$15 \pm 19.0$	0.08
Mortality (%)	33.3	61.5	0.24

**Conclusions:** rFVIIa use in trauma patients was associated with an exceptionally high incidence of arterial TEC (26%). These data suggest that either total rFVIIa dose or repeated dosages may be associated with increased risk of TEC, and that when used a single dose should be considered to minimize TEC risk. Further studies are warranted to define the role of rFVIIa in trauma patients.

**THE IMPACT OF SEVERE HEMORRHAGE AND SURGICAL TRAUMA IN A PORCINE HEMORRHAGIC SHOCK MODEL OF HEMODYNAMIC DECOMPENSATION**

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**Introduction:** Various factors determine progression to cardio-circulatory collapse (CCC) and mortality in trauma and hemorrhagic shock (T/HS). We hypothesized that the magnitude of injury and hemorrhage level determines outcome.

**Methods:** We used a pressure-controlled T/HS model to induce CCC by exhausting the physiologic compensatory response. 34 anesthetized female pigs (median wt 28 kg) were bled to a MAP of 30 mmHg. Group A animals (n=20) had neck and groin dissections for hemodynamic instrumentation. Group B animals (n=14) additionally received a thoracotomy. Resuscitation (Hextend) was triggered when CCC occurred (decrease in mean arterial pressure (MAP) <30 mmHg for 10 min or < 20 mmHg for 10 sec or MAP sustained > 30 mmHg for 90 min). Survival was defined 2 hours after resuscitation. Results are provided in median, range, p value and area under the curve (AUC), p value.

**Results:** Groups A and B had 35 and 36% non-survivors (p=0.97); CCC occurred in 80% and 79%, p=0.92; total volume bled/%bled (TVB) was 1005 ml/54% (539 – 1261 ml) vs. 637 ml/30% (392–911), p<0.001; No. of bleedings: 3.5 (1-7) vs. 2 (1-4), p<0.001; total duration of bleeding (TDB): 57 min (27-114) vs. 31 min (9-90), p=0.006; time to CCC: 35 min (6-113) vs. 61 min (12-93), p=0.31; total duration of shock (TDS): 94 min (46 - 178) vs. 99.5 (42 - 159), p=0.55. ROC curve: TVB predicted CCC (AUC=0.82, p 0.009, cut off 25ml/kg); TDB and TDS predicted mortality (AUC=0.88, p=0.011; 0.78, p=0.061 respectively).

**Conclusion:** Greater magnitude of trauma does not increased mortality in our model. Shorter duration of shock and faster initiation of resuscitation may explain similar mortality and CCC rates between groups. This suggest that our model, by dynamically adjusting to the animal's condition, calibrates the overall insult to a similar level of injury independent of the magnitude of trauma or bled volume. It also suggests that a robust determinant of survival is the individual response rather than hemorrhage magnitude.

**EARLY PREDICTORS OF MASSIVE TRANSFUSION IN PATIENTS  
SUSTAINING TORSO GUNSHOT WOUNDS IN A CIVILIAN LEVEL I  
TRAUMA CENTER**

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**Introduction:** Early bedside prediction of the need for massive transfusion (MT) remains difficult, as many models are complex or combine blunt and penetrating trauma populations. The study hypothesis was that massive transfusion protocol (MTP) utilization would improve by identifying markers for MT (> 10 units PRBC in 24 hours) in torso gunshot wounds (GSW) requiring early transfusion and operation.

**Methods:** Data from all MTPs were collected prospectively from 2/1/07-1/31/09.

Demographic, transfusion, anatomic & operative data were analyzed for predictors of MT.

**Results:** Of the 216 MTP activations, 78 (36%) patients sustained torso GSW requiring early transfusion and operation. 5 were moribund and expired prior to receiving MT. Of 73 early survivors, 56 received MT (76%, mean 19 u PRBC) and 17 had early bleeding control (EBC), (24%, mean 5 u PRBC). 12 transpelvic and 13 multicavitary wounds all received MT regardless of initial hemodynamic status (Mean SBP: 96 mmHg, Range 50-169). Of 31 MT patients with low risk trajectories (LRT), 18 (58%) had a SBP < 90 mmHg compared to 3 of 17 (17%) in the EBC group. In these same groups, a base deficit (BD) of < -10 was present in 27 of 31 (92%) MT patients vs. 4 of 17 (23%) EBC patients. The presence of either marker identified 97% of patients with LRT who requiring MT and would have potentially eliminated 11 of 17 EBC patients from MTP activation.

<b>Low Risk Trajectory*</b>	<b>SBP &lt; 90 mmHg</b>	<b>BD &lt; -10</b>	<b>Both</b>	<b>Either</b>
MT Pts (n=31)	18 (58%) #	27 (92%) #	15 (48%) #	30 (97%) #
EBC Pts (n=17)	3 (17%)	4 (23%)	1 (6%)	6 (35%)

\*Low Risk Trajectory = Single cavity and not transpelvic, # p < .01 vs. EBC

**Conclusions:** In patients requiring early operation and transfusion after torso GSW: 1) early initiation of MTP is reasonable for transpelvic and multicavitary trajectories regardless of initial hemodynamic status as multiple or difficult to control bleeding sources are likely and 2) early initiation of MTP in patients with LRT may be guided by a combination of hypotension and acidosis, indicating massive blood loss.

Session 4

Poster # 85

## ROTATIONAL THROMBOELASTOMETRY (ROTEM) CAN DIAGNOSE TRAUMATIC COAGULOPATHY IN 5 MINUTES

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**Background:** Acute Traumatic Coagulopathy (ATC) is present on admission in 25% of severely injured patients. Massive hemorrhage (MH) protocols targeted to correct ATC may improve survival but require early activation for optimal effect. Routine clotting tests are unable to guide ATC-directed protocols. Our aim was to investigate if ATC has a specific RoTEM signature. We hypothesized that RoTEM could rapidly characterize ATC and is related to subsequent transfusion requirements.

**Methods:** Prospective blinded cohort study of adult trauma patients admitted to a single centre. Blood samples were collected within 20 minutes of arrival. All patients requiring immediate trauma team activation were included. Exclusion criteria were >2000ml intravenous fluids prior to blood draw, >5% body surface area burns, pre-existing coagulopathy and presentation to hospital >120 minutes following injury.

**Results:** A total of 167 patients were recruited with median Injury Severity Score 9 (IQR 2-20) and age 32 (23-49). Patients with ATC had prolonged clot formation time and reduced clot amplitude at all time points. The EXTEM Clot Amplitude at 5 minutes (CA5) could discriminate between patients without coagulopathy and those with abnormal PT (CA5 43 vs 30mm,  $p<0.001$ ) and abnormal PTT (CA5 43 vs 35mm,  $p<0.005$ ). A similar pattern was seen with the INTEM curves. A low EXTEM CA5 (<37mm) was associated with the need for red cell transfusion. Average red cell requirement for patients with a low CA5 was 4 units vs 1 unit if normal ( $p<0.001$ ). Patients with low CA5 were significantly more likely to receive fresh frozen plasma (30% vs 3%,  $p<0.001$ ) and more than 6 units of red cells (30% vs 4%,  $p<0.001$ ).

**Conclusions:** ATC has a specific RoTEM signature and can be detected at five minutes. RoTEM diagnosed ATC is associated with increased transfusion requirements. Prospective evaluation is required to assess whether RoTEM can be used to activate MH protocols and guide transfusion therapy.

**1:1 FFP:RBC RATIO IMPROVES SURVIVAL FOR TRAUMA PATIENTS AT RISK FOR MASSIVE TRANSFUSION BASED ON TASH SCORE.**

**Introduction:** This study examines the potential survival benefit of a high ratio of FFP:RBCs for patients (pts) with severe traumatic injury who are predicted to be at risk for massive transfusion (MT) by the Trauma Associated Severe Hemorrhage (TASH) score.

**Methods:** The German Trauma Registry, a large multicenter prospectively populated database, was queried for pts  $\geq$  16 years with severe injury (ISS  $\geq$  9) who were transfused  $\geq$  1 unit pRBC. Pts who died within 1 hour of admission were excluded. MT =  $\geq$  10 RBCs in 24 hrs. A threshold of  $>$  40% prediction of MT (TASH  $\geq$  15) was defined as those at risk for MT. High FFP:RBC ratio is defined as  $\geq$  1:2.

**Results:** There were 659 (27%) pts included who were at risk for MT. 1815 pts were at low risk for MT. For pts at risk of MT, patient age, time to admission, mechanism of injury, ISS, admission vital signs and laboratory values, were similar between pts transfused a high and low ratio of FFP:RBCs, ( $p > 0.05$ ). For pts at risk of MT, those transfused a high vs. low ratio of FFP:RBCs had a reduction in 24 hr and 30 day mortality ( $p < 0.05$ ) without any increase in adverse outcomes (Table 1). The mean FFP:RBC ratio in the high and low ratio groups were of 1:1.05 compared to 1:5.6, respectively. For those pts who were not predicted ( $<$ 40%) to have MT, a high ratio of FFP:RBCs was not associated with improved survival and adverse outcomes were similar (Table 1).

**Conclusions:** A TASH score greater than that associated with a 40% risk of MT may be able to be used to rapidly initiate hemostatic resuscitation principles, which include the use of a high ratio of FFP:RBCs upon admission. This study helps identify the appropriate population for a prospective study of hemostatic resuscitation.

**Table 1**

	n	24 hr mortality	30 day mortality	Sepsis	MOF	Vent-free days (d; mean)
MT+ / High FFP:RBC	422	86 (20.4%)*	145 (34.4%)*	109 (29%)	236 (63.3%)	9.5 (10.9)
MT+ / Low FFP:RBC	237	83 (35%)*	109 (46%)*	40 (23%)	118 (67.8%)	8.4 (10.9)
MT- / High FFP:RBC	925	61 (6.6%)	161 (17.4%)	144 (17%)	398 (47.1%)	14.9 (11.5)
MT- / Low FFP:RBC	890	72 (4.7%)	171 (19%)	133 (16.2%)	314 (38.2%)	16.1 (12)

MT+ =  $\geq$  40% predicted MT or at risk for MT, MT- =  $<$  40% predicted MT or not at risk for MT, \* =  $p < 0.05$

**USE OF FRESH WHOLE BLOOD COMPARED TO CONVENTIONAL COMPONENT THERAPY IN US MILITARY CASUALTIES IS ASSOCIATED WITH DECREASED MORTALITY**

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**Introduction:** The use of fresh whole blood (FWB) in the absence of adequate blood components has been the policy of the US military for over 60 years. Accumulating evidence suggests that this practice is both safe and effective.

**Methods:** We obtained records of 2104 US military casualties receiving any blood product over a 5 years period. We compared adverse outcomes (death and complications) in patients receiving any FWB to those receiving only blood components using propensity-score matching (primary analysis) and multivariable logistic regression.

**Results:** In all, 351 (17%) patients received at least one unit of FWB. Patients administered FWB were more severely injured based on admission variables, as well as GCS and ISS. Using GCS and ISS for propensity-score matching, 302 patients per group were matched. There were no differences in AIS distribution between groups. The FWB group had significantly lower SBP, Hgb, temperature and BD upon admission, while INR and blood component use were greater. 83% of the FWB group had a massive transfusion (? 10 units of PBRC) compared to 29% for components alone. Table: 24 hour mean (median) blood product use (units). \*significant difference between treatments,  $p < 0.01$ .

	PRBC	FWB	Plasma	Platelets	Cryo
Components	8.6 (6)	0 (0)	5.0 (2)	0.6 (0)	0.3 (0)
FWB	15.8* (11)	7.2* (5)	9.5* (7)	0.7 (0)	0.6* (0)

FWB contributed 31% of the total red cell units administered. More patients in the FWB group were administered rFVIIa, 51% vs. 24%. In FWB patients mortality was reduced, 17.2% vs. 24.5% ( $p < 0.03$ ). The increase in survival was associated with an increase in complications 33% vs. 17% ( $p < 0.01$ ), due to greater incidences of ARDS and ARF.

**Conclusion:** FWB demonstrated improved survival compared to blood components alone, in spite of a higher ISS, poorer physiological profile, and increased use of blood products and incidence of complications. The association of reduced mortality with FWB use indicates that continuation of its use is warranted.

**REDEFINING RESUSCITATION TARGETS:UTILIZING TISSUE OXYGEN  
AND FLOW TO DETERMINE RESUSCITATION AFTER INJURY AND  
SHOCK**

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**Background:** We have previously reported on the utility of continuous monitoring of peripheral tissue oxygenation (PmO<sub>2</sub>) to detect occult shock in severely injured patients. However, the relative contribution of oxygen (PmO<sub>2</sub>) and muscle microvascular blood flow (FLOW) to oxygen delivery in this population is unknown. The objective of this study was to define the relationship between FLOW, PmO<sub>2</sub>, and PaO<sub>2</sub> during resuscitation. We hypothesized that low flow would correlate with low PmO<sub>2</sub> in under resuscitated patients.

**Methods:** In this prospective observational study, Licox™ polarographic tissue oxygen monitors (PmO<sub>2</sub>) and Bowman™ thermal diffusion perfusion probes (FLOW) were placed under ultrasound guidance into the uninjured deltoid muscle of severely injured patients. Standard physiologic data was collected at one-minute intervals using a multimodal bioinformatics system. A resuscitated patient was defined as MAP ≥ 70mmHg, Base deficit ≤ -2, and HR ≤ 110. An under-resuscitated patient was defined as Base deficit ≥ -6.

**Results:** As with our prior findings, PmO<sub>2</sub> was higher in resuscitated patients. Interestingly

all $p < .0001$	Flow	PmO <sub>2</sub>	MAP	HR	FIO <sub>2</sub>	Base Deficit
Resuscitated	29.7 ±30.8	39.6 ±29.0	82.7 ±11.8	97.3 ±11.4	47 ±15	-0.88 ±1.14
Under-Resuscitated	59.6 ±33.8	20.3 ±8.4	90.5 ±12.4	74.9 ±28.5	43 ±16	-6.3 ±0.35

FLOW was significantly decreased in resuscitated patients (Table). Stepwise regression indicates that FLOW increases with inspired oxygen, phenylephrine dose, and presence of head injury and is decreased with higher MAP and PmO<sub>2</sub> (all  $p < 0.05$ ).

**Conclusions:** Contrary to our hypothesis, muscle microvascular blood flow was significantly higher in under resuscitated patients and declines as PmO<sub>2</sub> rises. This suggests that tissue oxygen content may be the primary driving force for peripheral perfusion and thus a worthy target to monitor during resuscitation.



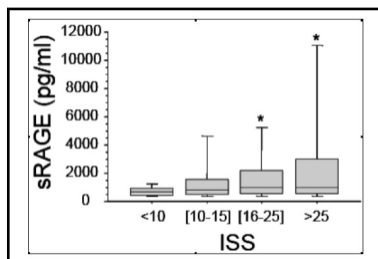
**MODULATING INFLAMMATION AFTER TRAUMA: SRAGE LEVELS ARE ELEVATED IMMEDIATELY FOLLOWING TRAUMA IN HUMANS.**

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**Background:** Soluble Receptor for the Advanced Glycation Endproducts (sRAGE) is a newly identified member of the immunoglobulin superfamily that acts as a multi-ligand receptor for several triggers of sterile inflammation including HMGB1, S100, and other pro inflammatory mediators released after trauma, stress and inflammation. Whether sRAGE levels are affected by trauma and shock and whether such activation would be associated with, inflammation, coagulopathy and poor outcome is not known and constitutes the objective of this study.

**Methods:** We performed a prospective cohort study including 208 patients admitted to a single trauma center. Blood was drawn within 10 minutes of arrival in the ED before the administration of any fluid resuscitation. sRAGE, TNF-a, IL-6, vWF, Ang-2, PT, PTT, PF1+2, sTM, PC, PAI-1, tPA and D-dimer were assayed using elisa, enzyme capture assay and functional coagulation analysis.

**Results:** Plasma levels of sRAGE were increased within 30 minutes after severe trauma in



humans and correlated with the severity of injury and increased base deficit (Figure). This increase in sRAGE was associated with the later development of acute lung injury ( $1646 \pm 2404$  vs  $2968 \pm 440$ pg/ml) acute renal failure ( $1579 \pm 2367$  vs.  $3215 \pm 418$ pg/ml), reduced ventilator free days and greater transfusion requirements (all  $p < 0.05$ ).

sRAGE was also increased with early posttraumatic coagulopathy, hyperfibrinolysis, systemic inflammation and activation of complement (all  $P < 0.05$ ).

**Conclusion:** The results of this study demonstrate for the first time that sRAGE is released into the bloodstream early after severe trauma in humans. The release of sRAGE requires severe injury and tissue hypoperfusion and may function as a modulator of the inflammatory response due to its ability to bind early pro-inflammatory mediators.

Session 4

Poster # 90

## PLATELET INHIBITION TESTS FOR ASPIRIN AND CLOPIDOGREL: ARE THEY USEFUL?

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**Introduction.** As the general population has grown older, the number of patients (pts) on pre-injury antiplatelet (AP) agents has increased. Pre-injury AP agents, such as aspirin (ASA) and clopidogrel (CL), may affect outcome in high risk hemorrhage prone injuries. Platelets can be transfused to counteract these agents and minimize the risk of further bleeding. However, not all pts on these agents demonstrate an AP effect. Studies have shown interindividual variability of plt aggregation that can lead to “CL resistance” or “ASA resistance.” The VerifyNow® P2Y12 assay (VNP) is a reliable, fast and sensitive assay that can be used to monitor plt inhibition (PI) during CL treatment. The Verify-Now® Aspirin assay (VNA) similarly can detect PI due to ASA therapy. We report our 2-year experience with these 2 whole blood assays and their effect on transfusion practices.

**Methods.** Pts on preinjury ASA or CL had VNA or VNP assays performed during their trauma evaluation. Pts with evidence of PI were transfused if the attending surgeon assessed the pt to have a high risk for bleeding. Lab and trauma databases identified cases. Demographics, transfusions, and outcome were obtained from pt medical records.

**Results.** 143 study pts were identified; 61% males, mean age of 74 yrs. Falls were the predominant mechanism (78%); 132 pts (92.3%) had a head injury with mean head-AIS of 2.7. VNA tests were performed on 126 pts with 90 (71%) showing PI; VNP tests were performed on 66 pts with 25 (38%) showing PI. Both tests were performed on 49 pts with 14 (29%) showing PI due to both drugs, 42 (86%) showing PI due at least one drug, and 6 (12%) showing no PI. Pts were transfused in 53 pts; 44 (83%) of which had intracranial injuries by CT scan. There were 15 pts with high risk injuries without evidence of PI by VNA and/or VNP testing that avoided plt transfusions.

**Conclusions.** Trauma pts on pre-injury ASA or CL often do not exhibit PI and those with intracranial or hemorrhage prone injuries may benefit from VNA and/or VNP testing to determine who should have plt transfusions.

Session 4

Poster # 91

## PROFILING TRAUMA CENTRES IN TERMS OF MORTALITY

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**Background:** The performance of trauma centers in terms of patient outcome is generally evaluated using Standardized Mortality Ratios (SMR) based on Trauma Injury Severity Score (TRISS) methodology. However, TRISS SMR have important limitations related to inadequate risk adjustment, use of an inappropriate standard, lack of consideration for inter and intra-hospital variation, and lack of comparability of SMR.

**Objectives:** To develop a method of profiling trauma centers in terms of mortality that addresses the limitations described above.

**Methods:** The study sample was drawn from a trauma registry with mandatory participation of all trauma centers, uniform inclusion criteria, and standardized data collection. Outcome performance was described with regression-adjusted mortality estimates derived from a hierarchical logistic regression model. Risk adjustment was performed with a risk score generated by the Trauma Risk Adjustment Model (TRAM), a term for incoming transfers and an interaction term between the risk score and transfer status. Outliers were identified by comparing each hospital to all remaining hospitals.

**Results:** The study sample comprised 111,091 patients of whom 23,655 (5.4%) died in hospital. Crude mortality varied between 1.3% and 14.3%. Adjusted mortality varied between 2.76% (95%CI 2.4-3.2) and 5.12% (95%CI 4.3-6.1). Four of the 59 trauma centers were identified as statistical outliers.

**Conclusions:** The proposed method of trauma center profiling offers rigorous risk adjustment including consideration of transfer status, is based on comparisons to an internal standard, accounts for inter and intra-hospital variation, and replaces SMR with intuitive estimates of regression-adjusted mortality that can be compared across hospitals. TRAM adjusted mortality estimates can be used to identify trauma centers with unexpectedly high or low mortality, to rank institutions and to initiate the identification of potential explicative factors such as quality of care.

**PROFILING TRAUMA CENTRES: THE TRAUMA RISK ADJUSTMENT MODEL (TRAM) VERSUS THE TRAUMA INJURY SEVERITY SCORE (TRISS)**

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**Background:** The current standard in trauma center profiling is Standardized Mortality Ratios (SMR) based on Trauma Injury Severity Score (TRISS) methodology. A new method based on the Trauma Risk Adjustment Model (TRAM) has recently been proposed. TRAM adjusted mortality addresses the important limitations of TRISS SMR and is likely to improve the validity of trauma center performance evaluations.

**Objectives:** To compare trauma center profiling results generated by the current standard, i.e. TRISS SMR, with those generated by TRAM adjusted mortality estimates.

**Methods:** The study sample was drawn from a regional trauma registry with mandatory participation of all 59 trauma centres, uniform inclusion criteria, and standardized data collection methods. TRAM adjusted mortality estimates were generated with hierarchical logistic regression models. TRISS SMR were generated using both an external standard (the National Trauma Data Bank; NTDB) and an internal standard (population-based). Hospital rankings generated by each method were compared using Spearman's correlation coefficient.

**Results:** TRAM adjusted mortality estimates led to the identification of four outliers out of 59 trauma centers. TRISS SMR calculated with the NTDB as a standard and with a population-based standard led to the identification of 20 and 8 outliers, respectively. The correlation coefficient between ranks generated by TRAM adjusted mortality and TRISS SMR with NTDB standard was 0.58 (95%CI 0.04-0.72). The correlation between ranks generated by TRAM adjusted mortality and TRISS SMR with a population-based standard was 0.64 (95%CI 0.46-0.77).

**Conclusions:** Replacing TRISS SMR with TRAM adjusted mortality for hospital profiling lead to less statistical outliers, more precise estimates of performance and very different hospital ranks. These results suggest that adopting TRAM adjusted mortality over TRISS SMR would improve the validity of trauma center profiling.

## CORRELATION OF PLASMA OXIDATION-REDUCTION POTENTIAL WITH INJURY SEVERITY SCORE AND SERUM AMYLOID A LEVELS IN MULTI-TRAUMA PATIENTS

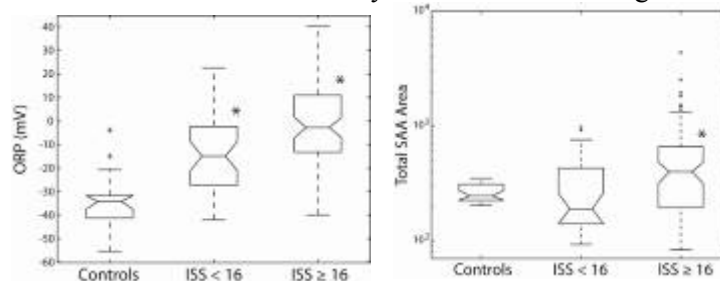
Leonard T Rael, MS, Raphael Bar-Or, BS, Kristin Salottolo, MS, Charles W Mains, MD, Denetta S Slone, MD, Patrick J Offner\*, MD, David Bar-Or, MD. Swedish Medical Center/Trauma Research.

**Introduction:** In critical injury, the occurrence of increased oxidative stress or a reduced antioxidant status has been observed. The purpose of this study was to correlate the degree of oxidative stress, by measuring the oxidation-reduction potential (ORP) of plasma in the critically injured, with injury severity and serum amyloid A (SAA) levels.

**Methods:** A total of 140 subjects were included in this retrospective study comprising 3 groups: healthy volunteers (N=21), mild to moderate trauma (ISS<16, N=41), and severe trauma (ISS≥16, N=78). For the trauma groups, plasma was collected on an almost daily basis during the course of hospitalization and stored frozen at -80°C prior to analysis. ORP analysis was performed using a microelectrode, and ORP maxima were recorded for the trauma groups. SAA, a sensitive marker of inflammation in critical injury, was measured by a liquid chromatography/mass spectrometry method to correlate with ORP.

**Results:** ORP maxima were reached on day 3 ( $\pm 0.4$  SEM) and day 5 ( $\pm 0.5$  SEM) for the ISS<16 and ISS≥16 groups, respectively. ORP maxima were significantly higher in the ISS<16 ( $-14.5\text{mV} \pm 2.5$  SEM) and ISS≥16 groups ( $-1.1\text{mV} \pm 2.3$  SEM) compared to controls ( $-34.2\text{mV} \pm 2.6$  SEM). Also, ORP maxima were significantly different between the trauma groups. SAA was significantly elevated in the ISS≥16 group on the ORP maxima day compared to controls and the ISS<16 group.

**Conclusion:** The results suggest the presence of an oxidative environment in the plasma of the critically injured as measured by ORP. More importantly, ORP can differentiate the degree of oxidative stress based on the severity of the trauma and degree of inflammation.



## IS THE TRAUMA SURGEON'S CLINICAL JUDGMENT GOOD ENOUGH TO AVOID MISSED INJURIES?

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**Background:** Computed tomography (CT) is frequently used in the evaluation of blunt trauma patients. Resident work hour restrictions, medical-legal ramifications, and advances in imaging technology have led to widespread use of CT scans, resulting in increased costs and radiation exposure. The purpose of this study is to assess the trauma surgeon's clinical ability to predict CT scan results.

**Methods:** This study prospectively enrolled 173 awake, alert patients over a 9-month period. Three trauma surgeons recorded their predictions of CT results based on exam, plain radiographs and ultrasonography. CT scans of the head, chest, abdomen/pelvis and complete spine were studied in all patients. Prior to CT imaging, surgeons predicted whether a CT would be abnormal and recorded their reasons for ordering or not ordering a specific CT. Sensitivity and specificity of predicting injuries were compared to official radiographic interpretations using receiver operating characteristic analysis.

**Results:** The sensitivity of predicting injuries was low, but with high specificity. Sensitivity increased when a CT was ordered based on clinical indications, but with low specificity. Fifteen minor CT injuries out of 147 abnormal CT's would have been missed by omitting the CT scan; no complications were noted.

	CT	Head	Cervical	T & L	Chest	Abd/Pelvis
Trauma MD Predictions	Sensitivity	41.4%	9.1%	29.6%	39.6%	43.8%
	Specificity	87.5%	92.0%	92.5%	88.8%	94.3%
CT Indications	Sensitivity	93.1%	100.0%	92.6%	85.4%	87.5%
	Specificity	20.3%	29.0%	39.0%	32.8%	34.8%

**Conclusions:** While trauma surgeons have a poor sensitivity and high specificity on predicting CT results, the sensitivity markedly improves when there is an indication to order the CT scan. When evaluating alert patients, trauma surgeons are capable of ordering CT's appropriately based on clinical judgment. Selective use of CT's results in fewer tests, less radiation exposure, contrast induced complications and cost.

Session 4

Poster # 95

## THE FUTURE OF TRAUMA SURGERY: RESIDENT AND ATTENDING VIEWS DIFFER

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**Background:** Our study aims to compare the opinions of surgical residents and attending surgeons on trauma characteristics and future directions to gain better understanding of necessary reform.

**Methods:** A 22-item questionnaire was given to general surgery residents registered with the American College of Surgeons, from PGY 1 to 5 levels including recent graduates. This was compared to results from a prior published survey of attending trauma surgeons.

**Results:** Of 6006 resident surveys, we had a 20% response rate while the attending level study included 630 surveys with a 60% response rate. Residents (68%) and attendings (90%) agreed that trauma surgeons are undervalued, while more residents (67%) than existing practitioners (35%) felt that trauma surgery was a viable field. Lifestyle concerns ranked highest as deterrents. Both feel that restructuring should include broader general surgery and that repair of LeFort fractures, open-reduction internal-fixation of the spine, and repair of mandible fractures were non-essential procedures, while repair of cardiac wounds requiring cardio-pulmonary bypass and angioembolization of pelvic fractures were procedures essential for future trauma practitioners. The two groups differed on procedural additions with trauma attendings more open to expanding the scope of practice to include selected neurosurgical and orthopedic procedures while residents did not appear to view this favorably.

**Conclusions:** Both practicing trauma surgeons and surgeons-in-training agree that trauma surgery is in need of change to remain a viable and competitive field. While both agree that more general surgery and outpatient care are welcome additions, residents are more skeptical of expanding the operative scope of the field.

**IMPROVING INTER-FACILITY TRANSPORT: A REGIONAL TRAUMA  
ADVISORY COMMITTEE INITIATIVE**

Toan Huynh\*, MD, Gregg Fleming, RT, Britton A Christmas, MD, Ronald F Sing\*, MD,  
Michael H Thomason\*, MD, David G Jacobs\*, MD. Carolinas Medical Center.

**Introduction:** The Committee on Trauma recommends timely transport of trauma patients to definitive care. Herein, we examined the effect of implementing a Regional Trauma Advisory Committee (RTAC) initiative focused on reducing the time spent at referring hospitals for critically injured patients.

**Methods:** An RTAC coordinator implemented a process improvement (PI) initiative focused on indications for and timing of transport for injured patients. Data were retrospectively collected from January 2004 to September 2008. Patient demographics and time interval at referring hospitals were recorded. Data are presented as mean  $\pm$  SE. Differences among groups were compared by ANOVA with Dunn's Method.

**Results:** During the 5-year study period, there were 6367 patients from 20 counties within a hundred mile radius. Time spent at referring hospitals declined (Table).

	2004	2005	2006	2007	2008
n	1051	1201	1401	1514	1200
Age (yrs)	37.3 $\pm$ 8.2	39.8 $\pm$ 9.3	34.2 $\pm$ 6.4	40.3 $\pm$ 7.5	40.2 $\pm$ 6.7
ISS	11.5 $\pm$ 2.8	12.1 $\pm$ 4.6	17.1 $\pm$ 7.8*	14.7 $\pm$ 8.3	12.7 $\pm$ 3.7
Time (hrs)	2.3 $\pm$ 0.8	2.1 $\pm$ 0.9**	1.9 $\pm$ 0.6**	1.8 $\pm$ 0.8**	1.7 $\pm$ 0.7

\* p<0.01 compared to cohort year; \*\* p<0.05 vs. prior year.

**Conclusions:** Our data showed that implementation of an RTAC initiative focused on improving inter-facility transport led to more timely transfer of trauma patients. Such an initiative can help optimize the care of critically injured patients and comply with the "Golden hour" rule of trauma care.



**RAPID DISCHARGE AFTER TRANSFER OF TRAUMA PATIENTS: HOW OFTEN DOES IT HAPPEN?**

David C Chang, PhD, MPH, MBA, Hayley Osen, Kristin L Chrouser, MD, MPH, David T Efron, MD, Elliott R Haut, MD, Adil H Haider, MD, MPH, Edward E Cornwell, III\*, MD, Fizan Abdullah, MD, PhD. Johns Hopkins School of Medicine, Department of Surgery.

**Introduction:** The phenomenon of discharge to home shortly after transfer from another hospital, also termed ‘secondary overtriage’, is worthy of analysis in trauma patients as it helps to assess the efficiency of triage and transfer criteria. The extent of secondary overtriage and factors associated with it remain largely unknown.

**Methods:** A retrospective analysis of the Nationwide Inpatient Sample from 2000 to 2004. Inclusion criteria were trauma patients (as identified by ICD-9 diagnosis codes of 800-959 in the primary position, excluding codes representing late effects of injury, foreign body, burn, or early complications) who were admitted as transfer from another hospital. Rapid discharge after transfer (“secondary overtriage”) was defined as patients who were discharged alive within 1 day after transfer, and did not receive any surgical procedure.

**Results:** The overall rate of secondary overtriage was 9.1% (4649/51278), with an increasing trend over the years. This rate was significantly higher among patients <18 years old (26.6% vs 6.1%). Patients meeting the definition were more likely to be male (68.7% vs 50.1%), more likely to be blacks or Hispanics (25.9% vs 16.5%), more likely to come from ZIP codes with above-median household incomes (41.0% vs 38.2%), and more likely to be treated at teaching hospitals (74.9% vs 61.1%). The majority of these patients (99.4%) were insured, although the proportion of uninsured patients was significantly higher among secondary overtriage (1.63% vs 0.49%). On multivariate analysis, younger age, uninsured status, and being transferred to a teaching hospital were associated with higher likelihood of rapid discharge after transfer. No association was found with gender, race, and urbanicity.

**Discussion:** Secondary overtriage is more common in pediatric patient than adults, likely due to fear of litigation and the uneven distribution of specialists and resources related to care of pediatric trauma patients. These important topics must be addressed carefully as we identify our nation’s health care spending priorities.

**CHARACTERISTICS OF COMBAT CASUALTY MORTALITY AT LEVEL IV  
MILITARY TREATMENT FACILITY**

Kathleen D Martin, MSN, Sandra M Wanek, MD, Raymond Fang, MD, Diana Monzon, RN, Elizabeth Schell, MSN, Warren C Dorlac, MD, Stephen F Flaherty\*, MD. Landstuhl Regional Medical Center, Germany.

**Background:** Landstuhl Regional Medical Center (LRMC) is the initial US military treatment facility outside the combat zones of Iraq and Afghanistan. This performance improvement review describes the war-related incidence, complications and preventability associated with mortality at LRMC over the three most recent calendar years (CY).

**Methods:** The Joint Theater Trauma Registry was queried for deaths that occurred at LRMC during CY 2006-2008. ISS, NISS, % battle injuries, timing of death, mechanisms of injury, complications, cause of death and preventability were abstracted for analysis.

**Results:** All deaths occurred in patients admitted from the combat theater to the intensive care unit at LRMC.

Table 1. LRMC Admissions

	2006	2007	2008
<b>Total casualties</b>	2,024	2,305	1,230
<b>Battle injuries</b>	1555 (77%)	1770 (77%)	748 (61%)
<b>ICU admits</b>	605 (30%)	589 (26%)	360 (29%)
<b>Mean ICU ISS</b>	12.4	18.8	19.3
<b>Mean ICU LOS</b>	2.4	2.4	2.8

**Conclusion:** Mortality at Level 4 has decreased as the conflict in Iraq and Afghanistan has matured. Deaths have become increasingly non-preventable at this level of care, despite a rising ISS for ICU admissions (12.4 to 19.3). Possible factors

contributing to these changes include improved care at Level 4, improved care in theater and increased lethality in theater. Level II trauma center verification at LRMC between years 1 and 2 of the study may also have contributed to these improvements. Integration of trauma registries, including mortality determinations, across the combat casualty care system is needed to fully characterize factors influencing mortality in combat.

Table 2. Mortality Specific Data

	2006	2007	2008
<b>Total deaths</b>	16	7	3
<b>Mortality rate:</b> all casualties	0.79%	0.30%	0.24%
ICU casualties	2.6%	1.2%	0.83%
<b>Mean ISS</b>	40	34	20
<b>Mean NISS</b>	47	44	24
<b>% battle injuries</b>	88%	71%	66%
<b>Time from injury (days)</b>	5.3	3.6	3.3
<b>Mechanism of injury:</b> blast	63%	43%	33%
penetrating	25%	28%	33%
blunt	6%	14%	33%
<b>Cause of death:</b> brain injury	38%	71%	100%
burn injury	25%	14%	0%
hemorrhage	19%	0%	0%
<b>Complications:</b> renal failure	4	1	1
compartment syndrome	13	1	0
sepsis/bacteremia	5	1	0
ARDS	3	0	0
<b>Preventability:</b> non preventable	63%	88%	100%
potentially preventable	31%	12%	0
preventable	6%	0	0

Session 4

Poster # 99

**EARLY IMMUNE RESPONSE AND ORGAN DAMAGE IN TWO TRAUMA MODELS IN MICE - BILATERAL FEMUR FRACTURE AND PSEUDOFRACTURE**

Christoph L Menzel, BSc, Roop Gill, MD, Sophie S Darwiche, MD, Yoram Vodovotz, PhD, Timothy R Billiar\*, MD, Hans-Christoph Pape, MD. University of Pittsburgh Medical Center.

**Objective:** Comparison of two trauma models, bilateral femur fracture (BFF) and Pseudofracture (PFx), assessing early immune response and early organ damage.

**Methods:** C57/BL6 mice (male, age 7-10 wks) were divided into 4 groups of n=4-7: C: control, S: sham (anesthesia, fixation), BFF: soft tissue injury and fractures, PFx: soft tissue injury and injection of crushed-bone solution. Group C is immediately sacrificed while the other groups are sacrificed after 2, 4 and 6 hours (h). Damage of muscle (AST, CK), lung (MPO activity) and liver (ALT; edema assessment by H<sub>2</sub>O content) and inflammation markers (cytokines, NF- $\kappa$ B-activation, free ssDNA/dsDNA) are measured.

**Results:** Preliminary data analyses (reported as mean  $\pm$  SD) show increased AST-levels [U/l] in the BFF group at 2h (308.6 $\pm$ 106.1 vs S:72.0 $\pm$ 8.6 and C:140.0 $\pm$ 79.4; p<0.05), whereas the AST-level for PFx reaches its high at 6h (457.2 $\pm$ 334.6; not significant vs S and C). CK levels [U/l] for BFF are strongly elevated at 2h (5418.0 $\pm$ 2773.4 vs S:462.0 $\pm$ 248.6 and C:797.0 $\pm$ 729.1; p<0.05) with a downward trend by 4h (4115.1 $\pm$ 555.3 vs S: 1644.0 $\pm$ 2046.5 and C: 797.0 $\pm$ 729.1; p<0.05) and 6h (2153.9 $\pm$ 1115.4; not significant vs S and C). The PFx group shows slight CK-elevations at all timepoints (not significant vs S and C). Pulmonary MPO activity [mg/ml] is elevated after 6h in both BFF (5.8 $\pm$ 1.7) and PFx (5.3 $\pm$ 1.3) groups vs C (2.0 $\pm$ 1.6; p<0.05). ALT levels [U/l] in the BFF group display a rise at 2h (69.1 $\pm$ 22.9 vs S: 41.0 $\pm$ 2.0; ; p<0.05), 4h (66.4 $\pm$ 14.5 vs S:47.3 $\pm$ 6.9 and C:46.0 $\pm$ 7.7; p<0.05) and 6h (79.6 $\pm$ 28.6; not significant vs S and C). The PFx group shows a high at 6h (107.4 $\pm$ 58.9; not significant vs S and C). H<sub>2</sub>O content of the liver exhibits no differences between groups and timepoints. Levels of free ssDNA/dsDNA do not seem to be elevated in either trauma model. Data for cytokines and NF- $\kappa$ B are not available at this point but will still be presented.

**Conclusions:** Both trauma models, BFF and PFx, show similar remote organ damage in the lung, but liver and muscle injury seem to be more severe after BFF.

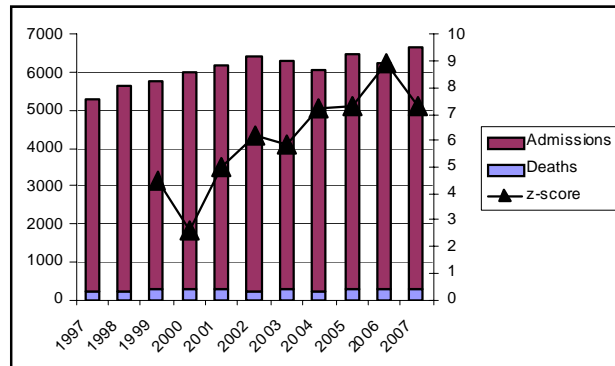
## MORTALITY AFTER TRAUMA: HOW DO WE IMPROVE FROM HERE?

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**Introduction:** Advances in trauma care such as damage control surgery, hemostatic resuscitation, protocol-driven cerebral perfusion pressure management and lung-protective ventilation have promised to improve mortality after major trauma. We performed a longitudinal assessment of injury severity, mortality, and preventability in a mature trauma system to assess the benefits of improved trauma care in the modern era.

**Methods:** Using the institutional trauma registry and the quality management database we determined outcome and cause of death for all primary trauma admissions from 1997-2007. We used the TRISS methodology to benchmark outcomes against injury severity, and the results of contemporaneous peer review to judge preventability.

**Results:** The figure shows admissions, deaths and mean TRISS performance (z-score) for each of the 11 years of study. Annual mortality ranged from 3.9 to 4.9% (n.s.). 52% of patients died of traumatic brain injury, 27% of acute hemorrhage, 12% of multiple organ system failure and 8% of other causes, without significant change from year to year. From 4 to 22 cases each year (2-7%; n.s.) were judged as potentially preventable.



**Conclusion:** Mortality after injury has not changed in the past decade. The fraction of patients dying of TBI, hemorrhage, or organ system failure has not changed. Outcome compared to the early 1990s TRISS baseline has improved steadily, perhaps reflecting similar outcomes achieved in a more seriously injured population. Future improvement of trauma care is more likely to consist of incremental salvage of increasingly injured patients than dramatic reduction in overall mortality.

## INTRACELLULAR ARGININE UPTAKE IS INCREASED IN OLDER STORED PRBC

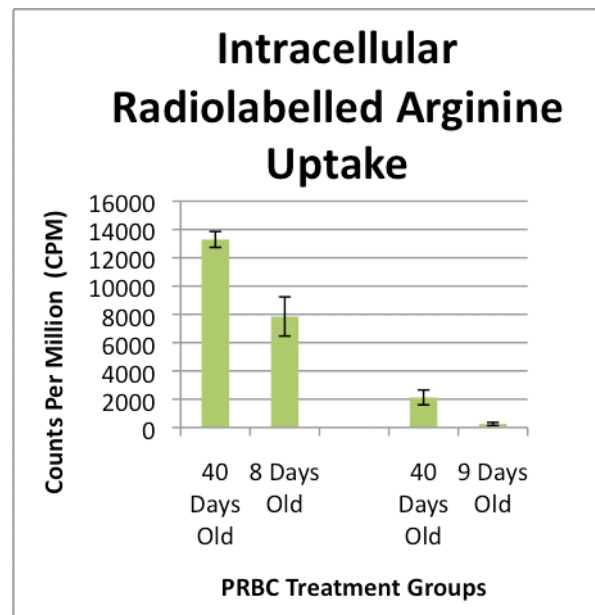
Levi Procter, MD, Cindy Meier, MS, Jerold Woodward, PhD, Patrick McNamara, PhD, Andrew Bernard, MD\*. University of Kentucky College of Medicine.

**Introduction:** Packed red blood cell (PRBC) transfusion carries significant morbidity and mortality, worsened by older PRBC units. Exact mechanisms of transfusion related immunomodulation, TRIM, are unknown. Arginine is depleted in an in-vitro model of PRBC transfusion. Since arginine is essential for normal human T cell function and has been shown to enhance immunity in trauma and surgery patients, arginine depletion by PRBC may mediate TRIM. Arginine is transported into PRBCs via cationic amino acid transporters, the activity of which may change over time. We hypothesize that older PRBC units have higher intracellular arginine uptake compared to younger stored PRBCs.

**Methods:** PRBC were obtained at 1 and 6 weeks of storage and titrated to similar HCTs across a range. Intracellular arginine uptake was determined with radiolabeled arginine (~200  $\mu$ M) after a 5-minute exposure. The reaction was halted, supernatants removed, PRBCs lysed and radioactivity counts measured in a scintillation counter.

**Results:** 6-week-old PRBCs had higher intracellular arginine uptake compared to 1-week-old PRBCs, independent of hematocrit (13295 $\pm$ 796 vs 7850 $\pm$ 2398 for ~5% HCT  $p=0.0593$ ; 2128 $\pm$ 525 vs 250 $\pm$ 110.9 for ~34% HCT;  $p=0.025$ , Figure).

**Conclusions:** TRIM is worse with older PRBCs but the mechanism is unknown. Arginine is essential for T cell function. Older PRBCs take up significantly more arginine than younger PRBCs. Arginine uptake may be a novel mechanism by which older PRBCs worsen T cell function and clinical outcomes.



**ANALYSIS OF HEPATIC GENE EXPRESSION FOLLOWING  
HEMORRHAGIC SHOCK AND RESUSCITATION**

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**Introduction:** Recent data suggest that the type of resuscitation fluid used to treat hemorrhagic shock contributes to cellular dysfunction at the genome level. We studied the differential gene expression in rat liver following hemorrhagic shock followed by resuscitation with lactate Ringer's solution and hypertonic saline.

**Methods:** Male Sprague Dawley rats were hemorrhaged, exposed to hypovolemic shock for 75 minutes and then resuscitated for 1 hour. Treatment animals were randomly assigned as follows: 1) sham resuscitation; 2) lactated Ringer's solution (LR), 80 cc/kg; 3) 7.5% hypertonic saline (HTS) 5.0 cc/kg. After resuscitation, liver samples were collected and cDNA array analysis was performed on the total RNA.

**Results:** The expression of 28,000 genes was analyzed. Resuscitation resulted in at least 1.5-fold altered expression over the sham resuscitation in 879 genes (3%). LR resuscitation modulated the expression of 305 genes and HTS altered the expression of 569 genes. Functional classification of known genes based on gene ontology terms are presented in tables 1 and 2. Real-time polymerase chain reaction confirmed the differential expression for selected genes.

**Table 1. LR resuscitation**

Category	# of genes
binding	37
catalytic activity	23
signal transduction	11
transcription regulator	8
enzyme regulator	4
transporter activity	4

**Table 2. HTS resuscitation**

Category	# of genes
catalytic activity	39
binding	28
transporter activity	13
signal transducer	10
enzyme regulator	5
structural	3
transcription regulator	3

**Conclusion:** The genetic cellular response to hemorrhagic shock and resuscitation is dependent on the type of fluid used for treatment. We identified groups of differentially expressed genes that are involved in various cellular defense pathways.

**THE AFFECT OF 6 HOUR BLOOD PRODUCT RATIOS ON MORTALITY IN PATIENTS WITHOUT SEVERE TRAUMATIC BRAIN INJURY**

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**Background:** The relationship between early blood product ratios, injury location and mortality in traumatic shock has not been examined. Our objective is to determine if these ratios are independently associated with mortality in patients without severe TBI.

**Methods:** A retrospective analysis was performed of a database populated by 16 civilian trauma centers during 2006. We included patients transfused  $\geq 5$  U of RBCs in the first 6 hrs and excluded patients with severe TBI (head AIS  $\geq 3$ ) and those who died within 30 min. Blood product ratios were measured at 6 hrs. A high ratio of FFP:RBC and PLT:RBC was defined as  $\geq 1:2$  units. Multivariate cox regression was performed to determine independent association with 30 day mortality, which was the primary outcome.

**Results:** 609 patients with median age of 35, ISS 25, 54% blunt injury, 78% male, base deficit 10 and INR 1.3 were analyzed. Upon multivariate cox regression, a high FFP:RBC ratio was independently associated with decreased 30 day mortality, hazard ratio 0.51, ( $p < 0.05$ ). A high PLT:RBC ratio or PLT volume was not independently associated with 30 day mortality. Other variables independently associated with increased 30 day mortality were: ISS, hazard ratio, 1.05, ( $p < 0.05$ ); age, 1.03, ( $p < 0.05$ ); and rFVIIa use, 2.7, ( $p < 0.05$ ). 30 day mortality was 16.7 and 29.1% for high and low FFP:RBC groups, ( $p < 0.05$ ). There were no differences between high ( $n=269$ ) and low ( $n=340$ ) FFP:RBC groups for SBP, GCS, temperature, base deficit, ISS, Hb, % blunt injury, RBC units and rFVIIa transfused. INR was increased in the high vs. low ratio group, 1.4 vs 1.3, ( $p < 0.05$ ). Multi-organ failure as cause of death was increased for high FFP:RBC patients, 30 vs. 8%, ( $p < 0.05$ ). Increased truncal hemorrhage as cause of death approached significance in low FFP:RBC patients, 84 vs. 72%, respectively, ( $p=0.09$ ).

**Conclusion:** In patients without severe TBI a high FFP:RBC ratio may decrease mortality whereas a high PLT:RBC ratio may not. Prospective study of blood component ratios in patients with and without severe TBI is required.

**URINE METABOLOMIC ANALYSIS IDENTIFIES BIOMARKERS IN A  
PORCINE MODEL OF HEMORRHAGIC SHOCK AND RESUSCITATION**

Elizabeth R Lusczek, MS, Nancy Witowski, PhD, Kristine E Mulier, MBS, Jeffrey G Chipman, MD\*, Greg J Beilman, MD\*. University of Minnesota.

**Introduction:** Hemorrhagic shock and resuscitation produce physiologic markers of injury called biomarkers. The study of the entire repertoire of small molecules (biomarkers) present in a biologic sample is called metabolomics. We identified the biomarker expression pattern in an animal model of hemorrhagic shock and resuscitation.

**Methods:** Seven pigs were instrumented with arterial, central venous, pulmonary artery and urinary catheters. A splenectomy was performed to reduce autotransfusion. A stabilization period followed; baseline samples were obtained at this point. Blood was then withdrawn to cause 45 minutes of hemorrhagic shock, followed by a period of hypotensive, hypothermic resuscitation (sBP=80 mm Hg, 33°C, to 8 hours) and then normotensive, normothermic resuscitation (sBP=90mm Hg, to 48 hours). Two instrumented but not hemorrhaged animals served as controls. Urine was sampled at time points throughout the experiment. Biomarkers in urine were detected using a 600 MHz Varian NMR spectrometer and identified using Chenomx software. Metabolite concentrations were divided by the combined metabolite concentration to account for variation in urine output.

**Results:** Physiologic measurements were consistent with shock and resuscitation. Thirty-six biomarkers were tracked in the urine of all 9 animals. The following biomarkers showed the same expression pattern, independent of shock or control, at all timepoints: 4-hydroxybenzoate, betaine, citrate, phenylacetylglycine, trigonelline, glutamate, glutamine, glutathione, N-isovalerylglycine, glycine, quinolinate, hypoxanthine, and trimethylamine N-oxide. All returned to baseline levels at 48-hours. The biomarkers 1-methylnicotinamide and niacinamide were only present in experimental animals. Dimethylamine was present in reduced levels after shock as compared to control animals. Lactate was present in elevated levels after shock as compared to controls, but returned to baseline levels at 48 hours.

**Conclusions:** NMR detects biomarker changes in the urine during hemorrhagic shock. Tracking these changes may prove useful to predict outcome.



**DAMAGE CONTROL IMMUNOREGULATION: IS THERE A ROLE FOR LOW VOLUME HYPERTONIC RESUSCITATION IN PATIENTS MANAGED WITH DAMAGE CONTROL SURGERY?**

Juan C Duchesne MD, Bryan Cotton MD\*, Norman E McSwain MD\*. Tulane University School of Medicine.

**Objective:** Hypertonic saline (HTS) is beneficial in the treatment of head-injured patients, due to its potent cytoprotective effects on various cell lines including cardiac myocytes, neuronal cells, and various components of the immune system. We propose that low volume resuscitation with 3% HTS when used after correction of tissue hypoperfusion in Damage Control Surgery (DCS) may improve outcomes when compared to standard resuscitation protocols using Isotonic Crystalloid Solution (ICS).

**Methods:** This study is a 4 year retrospective review of trauma patients managed with DCS at two different institutions. A cohort analysis was made between low volume 3% HTS resuscitation and conventional ICS resuscitation. Univariate analysis of continuous data was done with Students t-test followed by multiple logistic regression.

**Results:** Baseline patient characteristics of age, ISS, % penetrating, BP, hemoglobin, base deficit, and INR were similar between groups.

	<b>3% NS (N=76)</b>	<b>ICS (N=112)</b>	<b>p-value</b>
TICU LOS Mean	10 (8)	16 (15)	<0.01
ARDS Prevalence, %	4.0	13.4	0.02
Prevalence Ratio* (95% CI)	1.00 (ref.)	3.60 (1.09-11.95)	0.04
Sepsis Prevalence, %	6.6	15.2	0.06
Prevalence Ratio* (95% CI)	1.00 (ref.)	2.34 (0.91-6.02)	0.08
Renal failure Prevalence, %	5.3	3.6	0.58
Prevalence Ratio* (95% CI)	1.00 (ref.)	0.61 (0.14-2.69)	0.51
MSOF Prevalence, %	2.6	16.1	<0.01
Prevalence Ratio* (95% CI)	1.00 (ref.)	5.96 (1.42-24.91)	0.01
Death Prevalence, %	5.3	15.2	0.03
Prevalence Ratio* (95% CI)	1.00 (ref.)	3.65 (1.25-10.69)	0.02

\*Adjusted for age, gender, GCS, ISS and systolic blood pressure.

**Conclusions:** Low volume resuscitation with 3% HTS administered after correction of tissue hypoperfusion might convey a protective effect on the homeostasis of a poly-traumatized patient. We believe that this study points to a role for using low volume resuscitation with HTS as a pharmacologic agent to improve outcomes in DCS patients.

**BIAS AND PRECISION OF FIVE EQUATIONS USED TO ESTIMATE  
RESTING ENERGY EXPENDITURE IN MULTIPLE TRAUMA PATIENTS**

Jane Harper, PhD(c), RN, Bonnie Brehm, PhD, RD, Kyra Whitmer, PhD, RN, Paul Succop, PhD, , sponsor but not co-author: Thomas Esposito, MD\*. University of Cincinnati.

**Background:** There is no consensus in the literature regarding the optimal method to predict resting energy expenditure (REE) in seriously injured patients, and no equation exists that was developed or validated solely with this population.

**Study Objective:** To determine which of five well-documented predictive equations provides the most accurate estimate of REE as measured by indirect calorimetry (IC), in a sample made up entirely of seriously injured individuals.

**Design:** Retrospective chart review.

**Setting:** ACS level II trauma center in northern Illinois.

**Participants:** N = 83, with 106 total measurements by IC. Mean ISS was 25. Mechanism of injury was 96.4% blunt, with 49.5% of the total due to motor vehicle collisions.

**Interventions:** None as part of the study. Measured REE and parameters for estimation were retrieved from the medical record. The equations used were the Harris-Benedict, Mifflin-St. Jeor, Ireton-Jones 1992, Ireton-Jones 2002, and Penn State.

**Key Results:** Using the Bland-Altman method, bias and limits of agreement were calculated, along with the percentage predicted within 10% or within 500 kcal/day. Best performer was Harris-Benedict, with bias of -248.1 kcal, 39.6% predicted within 10% and 70.5% within 500 kcal/day. Worst performer was Ireton-Jones 1992 with bias of 1428.3 kcal, 1.9% within 10% and 3.8% within 500 kcal. In addition, a one-way analysis of variance was carried out to see whether differences in bias were significant. The omnibus F test produced  $F(4, 328) = 603.77, p < 0.0001$ . Post-hoc analysis using the Scheffé correction demonstrated all pairwise comparisons significant at  $p < 0.001$ .

**Conclusions:** This study of 83 multiple trauma patients found the most accurate equation for predicting REE to be the Harris-Benedict without multipliers for activity/illness. Four other tested equations were significantly less accurate.

**BLOODSTREAM INFECTIONS IN PATIENTS RECEIVING  
MANUFACTURED PREMIX PARENTERAL NUTRITION WITH AND  
WITHOUT LIPIDS: ARE THE NEW NUTRITION SUPPORT GUIDELINES  
APPROPRIATE?**

LA Scherer MD,\* RS Turpin PhD, K Williams MPH, R Stephen MBBS, CR Schermer MD MPH\*. Baxter Healthcare.

**Background** Based on a single randomized study of 57 trauma patients, joint SCCM/ASPEN guidelines recommend avoiding the use of lipids with parenteral nutrition (PN) in the first week of hospitalization due to infection risk. The purpose of the current study was to examine the impact of co-administration of soy based lipids with PN (PNL) on blood stream infection (BSI) rates in patients receiving manufactured premix PN.

**Methods** BSI rates were determined using the Premier multi-hospital claims database for hospitalized patients  $\geq 18$ , receiving PN 1/05–12/07. PN for both groups was a premix dual chamber bag with amino acids, dextrose, and electrolytes. PN without lipid was given to 2049 patients and PNL was given to 2643. Chi-square analysis and logistic regression examined the impact of hospital (teaching, location, size) and patient characteristics (demographic, comorbidities, ICU stay, severity of illness) on BSI rates.

**Results** The PNL group was more likely to be classified as major/extreme severity of illness (76.0 vs 67.3%), to be located in the ICU (43.0 vs 36.4%), receive more days of PN (6.7 vs 3.4), have a longer hospital length of stay (17.3 vs 11.9 days), and a longer ICU stay (3.9 vs 2.6 days); all  $p < 0.01$ . Crude and adjusted BSI rates are shown in the table.

	PNL (n=2643)	PN (no lipid) (n=2049)
Unadjusted BSI rates	19.3%*	14.9%
Adjusted BSI Rates	15.1%*	18.6%
* Significantly different from no lipid group $p < 0.01$		

After adjustment for hospital and patient characteristics, patients in the PN group were more likely to develop BSI than those in the PNL group (OR=1.35; 95% CI=1.09, 1.67).

**Conclusions** Although crude BSI rates appear higher in the PNL group, multivariate analysis demonstrates that lipids do not adversely impact BSI rates and may decrease rates for patients receiving manufactured pre-mix PN. Given these new data, recent guidelines should be re-evaluated.

**IS AGGRESSIVE GLUCOSE CONTROL (80-120 MG/DL) BETTER THAN MODERATELY AGGRESSIVE GLUCOSE CONTROL (100-150 MG/DL) IN CRITICALLY INJURED TRAUMA PATIENTS?**

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**Objectives:** Determine whether early (first week) aggressive glucose control (AGC or glucose target range of 80-120 mg/dL) is more effective than moderate glucose control (MGC or glucose target range of 100-150 mg/dL) in critically injured trauma patients.

**Methods:** A prospective quasi-experimental interrupted time-series design was used to evaluate the impact MGC (12 month pre-intervention phase) vs. AGC 12 month post-intervention phase. Patients admitted <48 hours and transfers were excluded. Patients were stratified by serum glucose level on days 1-7 (low = 80-120 mg/dL, medium 121-180 mg/dL, and high = >180 mg/dL), age, gender and injury severity. Patients were further stratified by pattern of glucose control (all low, all medium, all high, improving, worsening, highly variable). Outcome was measured by ventilator days, infection, hospital (HLOS) and ICU (ILOS) length of stay and mortality.

**Results:** 758 patients were evaluated in the pre-intervention phase as compared to 703 patients in the post-intervention phase. There were no significant differences in mechanism (84% vs. 83% blunt), gender (75% vs. 78% male), age (44 vs. 42 years), ISS (26 vs.28) and APACHE score (12 vs. 12). The AGC group was more likely to be in the all low pattern of glucose control ( $p<0.0001$ ). The incidence of infection significantly decreased (over the first 2 weeks) from 21% to 17%,  $p=0.04$  as did ILOS (16 vs. 13.6 days  $p=0.03$ ), ventilator days (15 vs. 10 days,  $p<0.001$ ) and HLOS (20 vs. 15.6 days,  $p<0.001$ ) in the AGC group. This held true when adjusted for age, ISS, gender, and APACHE score (ventilator days [OR =5.1, 1.8, 6.2], ILOS [OR = 2.3, 1.9, 7.5] and HLOS [OR = 5.9, 2.5, 11] ( $p<0.01$ ). There was no difference in mortality (MGC= 14.5%, AGC= 13.9%). However, when controlling for a higher hypoglycemia rate in the AGC group (15% vs. 10%),  $p=0.004$ ) there was a mortality benefit in the AGC group (OR = 1.1, 1-3.8),  $p<0.05$ ).  
**Conclusion:** Patients can only benefit from AGC if hypoglycemia is avoided. Methods to safely implement and maintain AGC are critical and desperately needed.

## HYPOGLYCEMIA IN THE SURGICAL INTENSIVE CARE UNIT

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**Introduction:** The occurrence of hypoglycemic events in an adult Surgical Intensive Care Unit (SICU) at an academic ACS-verified level I trauma center was characterized.

**Methods:** Consecutive hypoglycemic events (blood glucose level 50 or less) over a 7 month period were analyzed in a prospective manner with respect to patient characteristics, number of events per patient, and proximate inciting factors. All subjects were managed with strict glyceemic control, target glucose range 80-110 mg/dL. Eighty-five percent of the subjects were maintained on regular insulin infusions; the remainder were managed with SQ insulin glargine, SQ regular insulin, a combination thereof, or no insulin. Chi-square analysis and stepwise logistic regression were used to analyze the data.

**Results:** 112 hypoglycemic events occurred in 48 subjects (46% male, 29% known diabetics, 37.5% trauma). Fifty-six percent experienced only one event; 44% experienced more than one event (range 2-11) at a mean blood glucose of  $43.2 \text{ mg/dL} \pm 6.4$ . Eighty-five percent were mechanically ventilated; 6% underwent renal replacement therapy; 67% received systemic antibiotics; 8% required vasopressor medications; 14.6% had traumatic brain injuries; and 33.3% had received blood products in the prior 24 hours. The groups experiencing one event versus multiple events were compared; there was no difference with respect to gender, premorbid diabetic status, trauma versus postoperative status and the six clinical characteristics listed. Forty percent of the total events were associated with a proximate inciting event, a change in character or quantity of glucose source and/or change in character or quantity of insulin source. When patients with these inciting events were eliminated, the remainder were compared with respect to those experiencing one event versus multiple events; again, no differences were identified.

**Conclusions:** Neither initial nor recurrent hypoglycemia appeared to be linked to the patient characteristics studied. Rather, 40% of the episodes were associated with proximate inciting events characterized by changes in glucose and insulin administration.

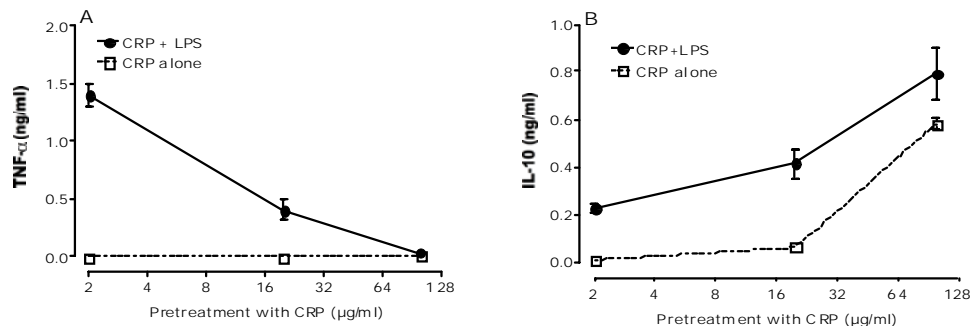
## ACUTE PHASE LEVELS OF C-REACTIVE PROTEIN ARE ASSOCIATED WITH MONOCYTE DEACTIVATION

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**Introduction:** The inflammatory response to severe trauma results in a release of pro-inflammatory and anti-inflammatory mediators. This innate immune response is accompanied by an acute phase reaction characterized by a dramatic increase in C-reactive protein (CRP) levels. We hypothesize that acute phase levels of CRP contribute to monocyte deactivation in the host resulting in a relatively immunodeficient state that may predispose the severely injured trauma patient to secondary infectious insults and sepsis. Suppression of peripheral blood monocyte (PBMC) function has been associated with increased mortality in both septic and severely injured trauma patients.

**Methods:** Human PBMC were separated and incubated with acute phase concentrations of CRP for 22 hours, followed by LPS for 4 hours. We measured the TNF- $\alpha$  response to LPS, as a marker of monocyte suppression. In addition, we measured IL-10 levels and the heme-degrading enzyme, HO-1, since these anti-inflammatory mediators may play a role in monocyte suppression.

**Results:** CRP suppressed the TNF- $\alpha$  response to LPS (Figure A). CRP pretreatment increased the intracellular HO-1 in permeabilized cells as measured by flow cytometry (not shown) and increased IL-10 levels as measured by ELISA (Figure B).



**Conclusion:** These results suggest the upregulation of IL-10 and HO-1 may mediate the monocyte deactivation associated with acute phase levels of CRP.

## CONTRAST NEPHROPATHY IN ELDERLY TRAUMA PATIENTS

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**Background:** Computed tomography (CT) is the gold standard for identifying truncal injuries following trauma, but the intravenous (IV) contrast used is potentially nephrotoxic. Elderly patients have diminished renal function secondary to aging, which would potentially be exacerbated by contrast administration, and compounded by post-trauma hypovolemia. We sought to determine whether the administration of IV contrast was associated with the development of nephropathy in elderly trauma patients.

**Methods:** Medical records of all trauma patients age 55 or over evaluated at an urban, level-one trauma center between 1/03 and 7/08 were reviewed. Data abstracted included age, comorbidities, resuscitation volume, baseline and serial serum creatinine levels, injury severity score, blood pressure, and whether IV contrast was administered. Exclusion criteria included end stage renal disease, contrast allergy, renal trauma, nephrotoxic medications, and death within 48 hours. Contrast was nonionic and isosmolar. Contrast induced nephropathy (CIN) was defined as a 25% relative or 0.5mg/dl absolute increase in creatinine within 72 hrs of contrast administration.

**Results:** Over the study period 1,371 trauma patients over age 55 were evaluated and 1,116 met our inclusion criteria. CT was performed on 1071 patients and 71% of this group received IV contrast. At baseline, the contrast and non-contrast groups were similar. Of all patients, 2.4% met the criteria for CIN (1.9% in the contrast group vs. 4.0% in the non-contrast group). CIN was a risk factor for in-hospital mortality (OR 3.1; 95% CI 1.7 – 5.8;  $p=0.041$ ) and prolonged length of stay ( $p<0.001$ ).

**Conclusions:** IV contrast media in elderly patients is not associated with an increased risk of nephropathy following trauma. Increasing creatinine is a risk factor for mortality and increased length of stay in elderly trauma patients.

**NON OPERATIVE MANAGEMENT OF BLUNT RENAL INJURIES:  
OUTCOME MAY NOT BE AS GOOD AS WE THINK.**

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**Objective:** Non operative management (NOM) of solid organ injury after blunt trauma is now standard. Recently, angioembolization (AE) has been used to extend NOM. Little data exists evaluating NOM in blunt renal injuries (BRI). We sought to determine the overall efficacy of NOM as well as outcome of AE in patients with BRI.

**Methods:** The trauma registry was used to identify all patients with BRI between January 2002 and December 2008. Medical records were reviewed for demographics, grade of injury, the use of angiographic intervention and outcome.

**Results:** 434 patients with BRI were identified. 417 had planned NOM. 339 (81%) patients were successfully observed; none required operation or angiography. 78(18.7%) patients had angiography. 31 (39.7%) had evidence of active vascular extravasation (AVE) on admission CT scan. 47 angiograms were performed for high grade injury or perirenal blood. 22/78 (28.2%) patients had AE, 6 (27.2%) of these failed 1.2(±0.84) days after AE. 54 angiograms were negative. 2 others did not have AE due to technical inability to

	All NOM n=417	NOM Success n=405	NOM Fail n=12	p value
Age (years)	33.6 ±16.8	33.7 ±17.0	28.6 ±11.1	ns
Male	295 (70.1%)	287 (70.9%)	8 (66.7%)	ns
Admission SBP	130.7 ±30.5	130.8 ±30.7	127.2 ±26.2	ns
Admitting HR	98.5 ±23.9	98.4 ±24.0	99.8 ±23.5	ns
ISS	28.2 ±14.1	28.2 ±14.2	28.1 ±10.7	ns
TRISS	0.85 ±0.24	0.84 ±0.25	0.90 ±0.15	ns
Renal Injury (AAST-OIS)				
Grade 1	47	47	0	
Grade 2	225	224	1	
Grade 3	40	38	2	
Grade 4	104	96	8	
Grade 5	1	0	1	
Average	2.5 ±1.0	2.4 ±1.0	3.7 ±0.7	<0.0001
LOS (days)	9.4 ±12.6	9.3 ±12.7	12.2 ±9.8	ns
ICU-LOS (days)	5.4 ±11.5	5.3 ±11.5	8.2 ±9.2	ns
Total Deaths	32 (7.7%)	31 (7.7%)	1 (8.3%)	ns

perform AE. 6 of 56 (10.7%) not embolized failed 2.2(±1.8) days after angiography.

Thus, of patients having angiography, 12/78(15.4%) required laparotomy to treat BRI. 9/31(29%) of patients with AVE failed NOM, but only 3/47(6.4%) without AVE failed ( $p=0.008$ ). Overall failure rate of NOM was 12/417 (2.9%).

**Conclusion:** NOM of BRI is safe and effective with an overall failure rate of 2.9%.

However, angiography with or without AE has substantial failure rates. Patients with higher grade injury and AVE on admission CT scan also fail NOM regardless of therapy. Close observation and/or early laparotomy are wise for these high risk patients.



**EFFECT OF STEROID PULSE THERAPY ON INCREASED  
EXTRAVASCULAR LUNG WATER AND PULMONARY VASCULAR  
PERMEABILITY INDUCED BY ACUTE LUNG INJURY**

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**Introduction/ Objective:** Methylprednisolone pulse therapy (MPPT) is known to improve oxygenation in patients with early phase progressive acute lung injury (ALI). However, this mechanism is not completely elucidated. The objective of this study is to investigate whether improved oxygenation is caused by decreased vascular permeability of the lung.

**Methods:** We evaluated the effect of MPPT on extravascular lung water index (EVLWI) and pulmonary vascular permeability index (PVPI) measured by pulse index continuous cardiac output (PiCCO) monitoring for early phase ALI patients. Twenty-two patients were divided into two groups: Group A patients underwent MPPT (n=14). Group B patients did not undergo MPPT (n=8). MPPT was methylprednisolone 1g/day for 3 days.

**Results:** Cause of ALI was pneumonia (n= 9), extrapulmonary sepsis (n=6), and other factors (n= 7). Student's T-test was used to calculate statistical significance. Data are shown as the mean  $\pm$  SD.

	Group A		Group B	
	day 0	day 3	day 0	day 3
PaO <sub>2</sub> /FiO <sub>2</sub> ratio	153.0 $\pm$ 73.2	216.6 $\pm$ 108.0*	196.5 $\pm$ 70.1	219.0 $\pm$ 138.7
PVPI	3.7 $\pm$ 1.0	2.4 $\pm$ 0.9*	2.7 $\pm$ 1.1	3.1 $\pm$ 1.8
ELWI (mL/kg)	20.3 $\pm$ 9.2	14.1 $\pm$ 5.6**	15.5 $\pm$ 7.8	18.6 $\pm$ 11.7

\*p < 0.01 vs. day 0, \*\*p < 0.05 vs. day 0

There was no significant difference in PaO<sub>2</sub>/FiO<sub>2</sub> ratio between two groups on day 0. In Group A patients, PaO<sub>2</sub>/FiO<sub>2</sub> ratio improved, and PVPI and ELWI decreased during the study period. However, there were no significant changes in PaO<sub>2</sub>/FiO<sub>2</sub> ratio, PVPI, or ELWI in Group B patients.

**Conclusion:** This study suggests that MPPT may improve oxygenation by decreasing pulmonary vascular permeability and extravascular lung water in ALI patients.

Session 4  
Poster # 114

**ADHERENCE TO VAP BUNDLE DECREASES INCIDENCE OF VENTILATOR-ASSOCIATED PNEUMONIA IN THE TRAUMA INTENSIVE CARE UNIT**

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**Introduction:** Ventilator-associated pneumonia (VAP) remains a dangerous source of morbidity, mortality and cost. The Institute for Healthcare Improvement (IHI) claims adherence to a "VAP bundle" will decrease VAP in the ICU. We examined the impact of the IHI "VAP bundle" on our trauma ICU.

**Methods:** Prospectively collected data was retrospectively examined in our trauma registry and the Infection Control Committee surveillance of ICU patients. Adherence to "VAP bundle" was acknowledged if all five criteria as delineated by the IHI were met. Incidence of VAP in the trauma ICU was then examined over an 18 month period. Cost of VAP was estimated to add \$30,000 to each patient stay.

**Results:** Prior to initiation of the VAP bundle, the VAP was seen at a rate of 10.4 per 1000 ventilator days. Compliance with the ventilator bundle increased over the 18 month period. VAP decreased to a rate of 4.5 per 1000 ventilator days. A cost savings of \$480,000 dollars was seen.

**Conclusion:** VAP "bundle" initiation is associated with a significantly reduced incidence of VAP in trauma patients in the intensive care unit. Initiation of a VAP bundle protocol is an easy, effective, and inexpensive method for VAP reduction when optimal compliance is maintained.

Session 4

Poster # 115

**PHASE IV CLINICAL TRIAL OF THE RIBLOC RIB FRACTURE REPAIR  
PLATING SYSTEM**

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Richard Mullins, MD\*. Oregon Health & Science University.

**Introduction:** The RibLoc™ fracture plating system was developed to provide durable rib fracture fixation with reduced length compared to standard systems. We monitored safety and efficacy of this novel, FDA-approved plating system in a Phase IV human clinical trial.

**Methods:** IRB-approved clinical trial with 6 month follow-up (NCT00556543). Adverse events were documented and serial chest radiographs were obtained at a minimum of 1 and 6 months. The RAND 36 Health Survey and the McGill Pain Questionnaire (MPQ) were administered pre-operatively and at 2 month intervals.

**Results:** 23 RibLoc™ plates and 92 screws were implanted in 10 patients. 6 patients had acute rib fractures and 4 patients had chronic non-unions repaired. Serial radiographs detected 3 asymptomatic plating system events in 3 patients with non-union repairs: 1 minimal screw backout, 1 complete screw backout, and 1 plate breakage. None of these events required reoperation. No plating system events occurred in acute fracture repairs. RAND 36 scores showed sustained improvement in the physical functioning and bodily pain measures and delayed improvement in the vitality measure. MPQ scores showed sustained improvement in the Pain Rating Index and the Present Pain Intensity score.

**Conclusions:** The RibLoc™ system is clinically safe and efficacious for acute rib fracture repair. Chronic non-union repairs were prone to plating system events, but none affected clinical outcomes negatively.

**PERCENT OF PULMONARY CONTUSION PREDICTS DEVELOPMENT OF ARDS**

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**Introduction:** Pulmonary Contusion (PC) is a significant cause of morbidity and mortality. The relationship between PC size and outcome is not fully understood. We hypothesized that the volume of PC quantified by a computed tomography (CT) based semi-automated analytic method can predict subsequent development of acute lung injury (ALI) and acute respiratory distress syndrome (ARDS).

**Methods:** Patients with PC were retrospectively identified from a Level 1 Trauma Center registry. Admission chest CT scans were analyzed for percent of lung contused. ALI and ARDS were identified by P to F ratios of < 300 and < 200, respectively. Logistic regression and ROC curve analyses were used to correlate contusion size with ALI and ARDS.

**Results:** 44 patients with pulmonary contusion were included in the study. Logistic regression identified percent PC as associated with ALI (OR=1.38, 95% CI 1.05-1.81, p=0.021) and ARDS (OR=1.17, 95% CI 1.10-1.43, p=0.034) (Tables 1&2). ROC curve analysis identified a PC volume threshold of 16% which maximized sensitivity and specificity for identifying ARDS (AUC=0.79).

**Conclusion:** In this dataset, PC volume identified by a CT based semi-automated analytic method was associated with ALI and ARDS. A PC volume of 16% was identified by ROC curve as most indicative of ARDS. This information can be used to identify patients at risk for adverse outcomes who may benefit from early aggressive intervention.

**Table 1: Logistic Regression -ALI**

	OR	95% CI	p
<b>Percent PC</b>	<b>1.38</b>	<b>1.05-1.22</b>	<b>0.02</b>
<b>ISS</b>	<b>1.1</b>	<b>0.98-1.23</b>	<b>0.10</b>
<b>Age</b>	<b>1.08</b>	<b>0.95-1.22</b>	<b>0.25</b>
<b>Lactate</b>	<b>1.63</b>	<b>0.51-5.26</b>	<b>0.41</b>

**Table 2: Logistic Regression -ARDS**

	OR	95% CI	p
<b>Percent PC</b>	<b>1.17</b>	<b>1.01-1.34</b>	<b>0.034</b>
<b>GCS Motor</b>	<b>0.35</b>	<b>0.11-1.08</b>	<b>0.07</b>
<b>ISS</b>	<b>1.12</b>	<b>0.98-1.27</b>	<b>0.09</b>
<b>Age</b>	<b>1.09</b>	<b>0.98-1.20</b>	<b>0.10</b>

**SERUM SUPPORTS THE PROLIFERATION AND OSSIFICATION OF  
SKELETAL MUSCLE CELLS AFTER TRAUMATIC BRAIN INJURY**

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**Introduction:** Traumatic brain injury (TBI) is associated with an increased rate of heterotopic ossification within skeletal muscle, possibly due to humoral factors. However, the pathophysiological mechanism of heterotopic ossification after TBI is still not fully understood. This study investigated whether cells from skeletal muscle adopt an osteoblastic phenotype in response to serum from patients with TBI.

**Methods:** Blood was collected from 17 patients with severe TBI as well as ten control subjects. Primary skeletal muscle cell cultures were isolated from orthopedic surgery patients and characterized using immunohistochemical techniques. Proliferation and osteoblastic differentiation were assessed using commercial cell assays, Western blotting (for osterix protein) and the Villanueva bone stain.

**Results:** All serum-treated cell populations expressed osterix after one week. Cells treated with serum from both study groups in mineralization medium had increased ALP activity and mineralized nodules within the mesenchymal cell subpopulation after three weeks. Serum from patients with TBI induced a significant increase in the rate of proliferation of these cells compared to the controls ( $p < 0.05$ ).

**Conclusion:** Human serum supports the osteoblastic differentiation of cells derived from human skeletal muscle and, furthermore, serum from patients with severe TBI accelerates their proliferation. This suggests the early presence of humoral factors following TBI that stimulate the expansion of mesenchymal cells and osteoprogenitors within skeletal muscle.

**DROP THE SCOPE: IS SELECTIVE IMAGING FOR GUNSHOT WOUNDS TO THE NECK ENOUGH?**

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**Background:** Gunshot wounds to the neck cause injury to multiple zones of the neck. Non-operative management of neck stab wounds has become more widely employed. This review examines the extension of non-operative management principles to gunshot wounds to the neck without “hard” physical exam findings.

**Methods:** Retrospective review of a level I trauma center database over a 10 year period of patients with gunshot wounds to the neck initially evaluated with radiographic studies (plain films, CT, and CTA). Anatomic injury (vascular, aerodigestive, spine, neurologic), adjuvant studies (angiography, esophagoscopy (EGD), bronchoscopy), operative findings, and complications were reviewed.

**Results:** Of 42 patients identified, 30 sustained single zone involvement (I-14%, II-21%, III-36%), and 12(28%) had multiple zone involvement. Overall, 29(69%) patients had an anatomic injury (vascular-17(40%), spine-18(43%), neurologic-10(24%)). The most frequent initial imaging study was CT (86%). CTA was the sole diagnostic study in an additional 7%. In the remaining 7% of patients, plain films alone were used to confirm clinical suspicion of superficial injury. Overall, 76% of patients received a contrast enhanced study (CT, CTA, or angiogram). Thirty patients (71%) were evaluated with more than one radiographic modality. Based on radiographic studies, neck exploration was undertaken in 5(12%) patients and identified one vascular, one esophageal, and three upper airway injuries. Only 4(10%) patients had bronchoscopy and EGD. Of these, only one EGD was abnormal and was performed in a patient with significant mediastinal air on initial CT scan. There were no missed injuries in the 37 patients that did not require neck exploration. In patients who had neck exploration there were no unanticipated findings.

**Conclusions:** Selective use of radiographic imaging in gunshot wounds to the neck did not result in any missed injuries. This data questions the additional benefit of further invasive diagnostic tests (bronchoscopy, EGD) or mandatory operative exploration.

**RE-DEFINING SHOCK IN THE ELDERLY: NORMOTENSION IS NOT REASSURING**

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**Introduction:** There is recent debate on the most appropriate definition of hypotension. Some have advocated raising the threshold to 110mmHg, while others favor 80mmHg. We hypothesize that the optimal definition of hypotension differs by age groups.

**Methods:** An analysis of trauma victims aged 18 and older in the National Trauma Data Bank (NTDB, version 7) was performed excluding burn patients and those with incomplete data. Four groups were identified for analysis: all patients, patients 18-35 years, 36-64 years and  $\geq 65$  years. A series of 101 multiple logistic regression analyses were performed for each population. For each analysis, hypotension was sequentially defined as ED systolic blood pressure (EDSBP) of 50mmHg through 150mmHg to see which model best predicted mortality, adjusting for demographic and injury covariates. The discriminatory power of each model was measured by c-statistics. Optimally defined hypotension was identified as the model with the best c-statistics.

**Results:** A total of 472,848 patients were analyzed, with mean (median) age in years of 42.1 (39), and 33.5% were female. Overall mortality rate was 4.4%. The optimal cut-off for hypotension for all patients was at 90mmHg (c-statistics 0.9445); patients 18-35 years, 82mmHg (c-statistics 0.9730); patients 36-64 years, 90mmHg (c-statistics 0.9467) and elderly patients, 117mmHg (c-statistics 0.8655).

**Conclusion:** For patients younger than 65 years, the classical definition of hypotension as EDSBP less than 90mmHg mark remains the optimal cut-off point. For elderly patients, however, it may be appropriate to consider elevating the systolic BP that defines hypotension.

**IS IT US OR THEM: WHO FAILS AT FOLLOW-UP**

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**Background:** Our previous study showed that trauma patients are poor in following up at the trauma center (Podium AAST 2008). In the current study we hypothesize that institutional factors act as significant barriers for patient follow-up at the trauma center.

**Methods:** All patients discharged home from the trauma service had telephonic follow-up attempted 3 times within 4-weeks of discharge to: 1. evaluate the general well being of the patient; 2. enquire about follow-up; and 3. question if the patient had experienced any difficulty following up at the trauma center (TC).

**Results:** Over the 12-month study period, 940 patients met entry criteria. Contact was established with 755 (80%). From the details of the injury, follow-up was deemed important in 744. Among these, 123 (16%) chose to follow-up outside of the TC, 588 (79%) followed up at the TC, and 33 (5%) chose not to follow-up at all. 147/744 (20%) of the patients reported some barrier to follow-up at the TC (Table). Among these 147 reporting barrier, 20 had significant medical issues requiring follow-up (casts-2; sutures-6; hard collar-12).

Table Barrier	Contact + FU important (n=744)		
	Non TC FU (n=123)	TC FU (n=588)	Refused (n=33)
Language barrier (n=36)	1	30	5
Poor discharge instructions (n=52)	8	35	9
Call center difficulty (n=52)	10	40	2
Affordability (n=4)	-	-	4
Other (n=3)	1	-	2
<b>Total (n=147)</b>	<b>20</b>	<b>105</b>	<b>22</b>

**Conclusions:** Institutional barriers at the TC play a significant role in poor follow-up by trauma patients. These barriers need to be addressed to provide optimal care post-discharge.