Session I

Paper 1 7:50 AM

MANAGEMENT OF COLONIC WOUNDS IN THE SETTING OF DAMAGE CONTROL LAPAROTOMY: A CAUTIONARY TALE

Jordan A. Weinberg, MD, Russell L. Griffin, MPH, Jeffrey D. Kerby*, MD PhD, Donald A. Reiff, MD, Richard L. George, MD, Sherry M. Melton*, MD, Loring W. Rue III*, MD.
University of Alabama at Birmingham.

Invited Discussant: Timothy C. Fabian, M.D.

Background: While colonic wounds are commonly treated in the setting of damage control laparotomy (DCL), there is a paucity of reported data to guide management. Small series suggest that delayed colonic anastomosis following DCL is relatively safe. The purpose of this study was to evaluate our own experience with the management of colonic wounds in the context of DCL, using colonic wound outcomes following standard laparotomy (SL) as a benchmark.

Methods: Consecutive patients over a 7-year period with full-thickness and/or devitalizing colon injury were identified from the trauma registry. Early deaths (<48 h) were excluded. Colon-related complications (abscess, anastomotic dehiscence, stomal ischemia) were compared between those managed in the setting of DCL versus SL.

Results: 157 patients met study criteria: 101 had undergone SL and 56 had undergone DCL. Procedure-associated colon-related complications were:

Procedure	DCL (n, % with complication)	SL (n, % with complication)	p
Repair	16 (19)	44 (4)	0.11
Resection/anastomosis*	33 (39)	50 (18)	**0.04**
Resection/colostomy*	7 (14)	7 (14)	0.77

**Anastomosis or colostomy performed in staged fashion in DCL group.*

Resection and delayed anastomosis in the setting of DCL was associated with a significantly greater incidence of complications than SL resection and anastomosis. The incidence of documented anastomotic dehiscence was 12% in the DCL group, compared with 4% in the SL group ($p = 0.21$).

Conclusions: Management of colonic wounds in the setting of DCL is associated with a relatively high incidence of complications. The excessive morbidity associated with delayed anastomosis, however, gives us pause. While stoma construction is not without its own complications in the setting of DCL, it may be the safer alternative.

Session I

Paper 2 8:10 AM

DOES SPLENIC PRESERVATION TREATMENT (EMBOLIZATION, SPLENORRAPHY, PARTIAL SPLENECTMY) IMPROVE IMMUNOLOGIC FUNCTIONS AND LONG-TERM PROGNOSIS OF SPLENIC INJURY?

H. Nakae, MD, T. Shimazu*, MD, H. Miyauchi, MD, J. Morozumi, MD, S. Ohta, MD, Y. Yamaguchi, MD, M. Kitano, MD, H. Ikeuchi, MD, M. Kishikawa*, MD, M. Ueyama, MD, T. Yukioka*, MD, H. Sugimoto*, MD. Kinki Univ.

Invited Discussant: Andrew B. Peitzman, M.D.

Objective: Splenic preservation treatment (PT: splenic embolization, partial splenectomy and splenorrhaphy) is preferred to splenectomy from immunologic considerations. We studied if preservation treatment actually reduces the occurrence of overwhelming postsplenectomy infections (OPSI) and is beneficial in immunologic functions.

Methods: We retrospectively studied long-term prognosis of patients with blunt splenic injury treated at seven tertiary emergency centers in Japan. Blood samples and abdominal CT were taken from patients who agreed to participate in the study to measure immunologic functions and remaining volume of spleen. Splenectomy (SN; n=66, 760 patient?year, max 28 years) and preservation treatment (PT; n=34, 213 patient?year) groups were compared.

Results: There was no patient who had an episode of severe infection. Blood tests made in 58 patients (24 SN vs 34 PT) revealed significant differences in Howell-Jolly body positive rate (SN 91% vs PT 3%, $p<0.05$), WBC, CD3(%), platelet counts and serum Ig-G. There were no significant differences in serum levels of Ig-M, 12 valent anti-pneumococcal Ig-G antibodies, and C3 and C4. Average number of anti-pneumococcal Ig-G serotypes below reference levels was 3 (SN) and 4 (PT), respectively. CT was taken in 30 patients with PT and the volume of remaining spleen (mean 132 ± 61 ml) had no significant correlations with WBC, platelet counts or other indices.

Patients(n)	H-J body positive (%)	WBC (/μL)	Segmented WBC (%)	CD3 (%)	Platelet (/μL)	Ig-G (mg/dL)	Ig-M (mg/dL)
SN (34)	91	6900	40	68	320K	1413	91
PT (24)	3.1	5800	49	73	260K	1202	103

Conclusions: PT did not show discernable advantages over SN in immunological indices including Ig-M and 12 valent anti-pneumococcal antibodies, suggesting prophylactic measures and close follow-up would be necessary after PT as well as SN.

Session I

Paper 3 8:30 AM

THE EFFECTS OF SPLENIC ARTERY EMBOLIZATION ON NON-OPERATIVE MANAGEMENT OF BLUNT SPLENIC INJURY: A 16 YEAR EXPERIENCE

Ashraf A. Sabe, BA, Jeffrey A. Claridge*, MD, David I. Rosenblum, DO, Kevin Lie, MD, Mark A. Malangoni, MD. MetroHealth Medical Center.

Invited Discussant: Naoyuki Kaneko, M.D.

Introduction: Non-operative management (NOM) of blunt splenic injury has become the preferred treatment for hemodynamically stable patients. The utility of splenic artery embolization (SAE) in NOM has been controversial. We hypothesized that incorporation of SAE into a practice protocol for patients at high risk for NOM failure (contrast extravasation or pseudoaneurysm on CT, grade 3 injury with large hemoperitoneum, grade 4 injuries) would improve patient outcomes.

Methods: A retrospective analysis of three continuums of practice was performed: I- SAE not part of practice; II- selective use of SAE; and III- standard use of SAE for patients at high risk for failure. Failure of NOM was defined as the need for operation.

Results: 816 patients with blunt splenic injury were treated at our Level 1 Trauma Center from 1992-2007. Phase I had 222 patients, phase II had 230 patients, and phase III had 364 patients. Data in the table represents NOM and are expressed as mean $\pm$ standard error of the mean.

	I (1992-98)	II (1998-2002)	III (2002-07)
Initial NOM (%)	136 (61.3)	188 (81.7)*	322 (88.7) #
Age (yrs)	34.0 $\pm$ 1.5	36.2 $\pm$ 1.2	37.6 $\pm$ 1.1
Injury Severity Score (ISS)	22.8 + 1.0	20.7 + 0.8	19.6 + 0.7*
Splenic Injury Score (SIS)	2.4 + 0.1	2.5 + 0.1	2.5 + 0.1
SAE total (% of NOM patients)	6 (4.4)	31 (16.5)*	115 (41.5) #
SAE initial (% of SAE)	0 (0)	16 (51.6)*	90 (78.2)*
Mortality (%)	8 (5.8)	1(0.5)*	6 (1.9)
Length of stay (days)	11.0 $\pm$ 1.0	9.7 $\pm$ 0.7	9.4 $\pm$ 0.6
NOM failure (%)	31(22.8)	7(3.7)*	14(4.3)*
*$p < 0.05$ vs. I; #$p < 0.05$ vs. I and II			

Conclusions: The increased use of initial SAE in high risk patients has expanded the utility of NOM, but has not been associated with an incremental improvement in mortality or length of stay.

Session I

Paper 4 8:50 AM

THE REAL RISK OF SPLENECTOMY AFTER DISCHARGE HOME FOLLOWING NON-OPERATIVE MANAGEMENT OF BLUNT SPLENIC INJURY

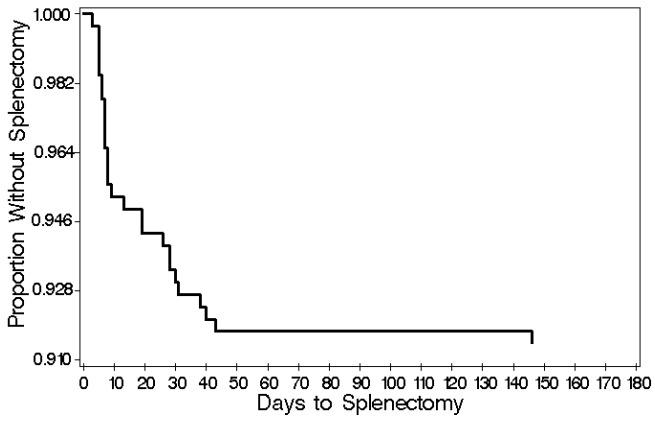
Ben L. Zarzaur*, MD MPH, Satyam Vashi, BS, Louis J. Magnotti, MD, Martin A. Croce*, MD, Timothy C. Fabian*, MD. University of Tennessee Health Science Center.

Invited Discussant: Brian Harbrecht, M.D.

Introduction: The post-discharge natural history of non-operative blunt splenic injury (Non-opBSI) has not been adequately elucidated. As a result, outpatient management is poorly defined. Population based outpatient data would provide clinicians with an estimate of baseline risk of post-discharge splenectomy after Non-opBSI. The purpose of this study was to determine, using population based data, the 180-day risk of splenectomy in a clinically relevant sample.

Methods: A statewide Hospital Discharge Data System containing patient level data was used to construct a prospective cohort of persons 18 or older with Non-opBSI admitted to any hospital in the state from 2000- 2005 and discharged home. Readmission for splenectomy within 180 days from the original injury date was determined.

Results: 4103 persons with BSI were admitted from 2000 – 2005. 2971 (72.4%) were managed non-operatively. 1932 (47.1%) were discharged. 27 of 1932 were readmitted for splenectomy within 180 days. Median time from injury to readmission for splenectomy was 8 days (range 3 -146). The 180-day risk of splenectomy was 1.4% following non-operative management and discharge home. The figure illustrates the time from discharge to readmission for splenectomy.



Conclusions: Non-opBSI results in a 180-day risk of readmission for splenectomy of 1.4% for persons discharged home. A majority of splenectomies occur within 8 days. Explicit patient education and close follow-up are necessary.

Session I

Paper 5 9:10 AM

MAJOR HEPATIC NECROSIS: A COMMON COMPLICATION FOLLOWING ANGIOEMBOLIZATION FOR TREATMENT OF HIGH-GRADE LIVER INJURIES

Danielle N Dabbs*, DO, Deborah M Stein*, MD, MPH, Thomas M Scalea*, MD. R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine.

Invited Discussant: Martin Croce, M.D.

Objective: Angioembolization (AE) is commonly used as adjunctive hemostasis in patients with high grade liver injures. The complication rate of this technique is not well defined, especially that of major hepatic necrosis (MHN).

Methods: Patients with high grade blunt or penetrating liver injuries, (grades III-VI), were retrospectively reviewed from January 2002 to December 2007. Demographic and injury specific data, complications, and admission physiologic variables were collected. Patients who had therapeutic AE, either pre or post-operatively, and went on to develop liver-related complications including MHN were reviewed.

Results: There were 538 high grade liver injuries identified from January 1, 2002 to December 31, 2007. A total of 116 (22%) patients underwent therapeutic AE, of which there were 32 grade III, 68 grade IV, and 16 grade V injuries. 30 patients (26%) went on to develop MHN, which required definitive management. MHN was diagnosed by CT or second look operation. 67% of patients with MHN were grade IV and 73% sustained blunt trauma. The patients with MHN had a higher grade liver injury (4.3 vs.3.7, $p<0.001$) and a longer LOS (34.7 vs. 15.6, $p<0.001$) when compared to those without MHN. ISS (37.4 vs 36.3, $p=0.72$) and hemodynamic parameters on admission (SBP = 119.5 vs. 124.2, $p=0.55$; HR = 106.8 vs. 101.0, $p=0.31$) were no different between the two groups. All patients with MHN underwent damage control laparotomy with hepatic packing pre or post AE. In this group, the overall mortality rate was 6.7%. Other complications in this group included bile leak (33.3%), abscess (26.7%), gall bladder necrosis (13.3%), and rebleeding (6.7%).

Conclusion: A combination of operative and non-operative adjuncts is often needed to manage high grade liver injuries, either due to blunt or penetrating trauma. AE is frequently used in these patients. MHN is a common complication of AE. Factors that may contribute to the development of necrosis after AE include higher grade injuries after blunt trauma and use of hepatic packing as part of damage control laparotomy.

Session I

Paper 6 9:30 AM

TRANSARTERIAL EMBOLIZATION AFFECTS RECOVERY IN NONOPERATIVE MANAGEMENT OF SEVERE BLUNT HEPATIC INJURIES

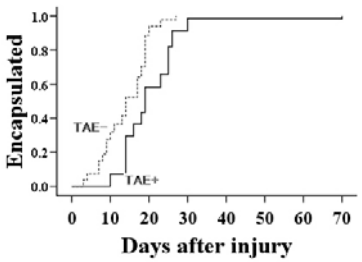
Kazuhiko Sekine, MD, Mitsuhide Kitano, MD, Kikuo Yo, MD, Atsushi Nagashima, MD, Masakazu Doi, MD, Motoyasu Yamazaki, MD, Tomohiro Funabiki, MD, Tomohiro Kurihara, MD, Masayuki Shimizu, MD, Shokei Matsumoto, MD, Hiroshi Yoshii, MD, Naoki Aikawa*, MD DMSc . School of Medicine, Keio University, Tokyo, Japan.

Invited Discussant: George Velmahos, M.D., Ph.D.

Background: Concerning nonoperative management of hemodynamically stable patients with severe blunt hepatic injuries (BHI), it still remains to be investigated what factors would be associated with the time course of healing and the right time to wean from bed rest. Based on weekly CT scans, the BHI patients were advised bed rest until the injuries healed and were encapsulated by a ?5-mm parenchymal wall.

Methods: We reviewed hemodynamically stable patients admitted to our hospitals (over 16 years), who underwent nonoperative management of severe BHI (American Association for the Surgery of Trauma (AAST) - Organ Injury Scale (OIS), grades IV and V). Demographic data and series of CT scans were examined. The severity of hepatic injuries showing laceration was determined using Couinaud's liver segment classification, transarterial embolization (TAE) for active hepatic bleeding, and the amount of hemoperitoneum. Extrahepatic factors were evaluated using the Abbreviated Injury Scale for injuries to the head, face, thorax, and extremities. The time period for the injured segments to encapsulate was obtained individually from the serial CT findings. Cox regression and Kaplan-Meier analyses were used to identify risk factors associated with delayed healing.

Results: All 35 patients (males, 23; females, 12; mean age, 32) were managed nonoperatively. The risk factors were independently and significantly associated with TAE (odds ratio 2.45, 95% confidence interval 1.01–5.92; p = 0.047). No hemorrhagic complications occurred after weaning from bed rest.



Conclusion: Performing TAE for active liver hemorrhage caused delayed recovery of BHI regardless of extrahepatic factors. Healing of the lacerated segments to their encapsulated form can be an indication for the patient to be weaned off bed rest.

Session I

Paper 7 9:50 AM

RENAL GUNSHOT WOUNDS: MANAGEMENT AND CLINICAL OUTCOMES

Bryan B. Voelzke, MD, Jack W. McAninch*, MD. San Francisco General Hospital.

Invited Discussant: Rao R. Ivatury, M.D.

Introduction: To analyze our experience with renal gunshot wounds (GSW).

Methods: We analyzed our prospective trauma database for patients with renal GSW.

Results: 201 patients (206 renal units) with renal GSW were collected from our database. Preoperative imaging (one shot IVP, dedicated IVP, or CT) was performed in 68.7% (n=140). Gross or microscopic (>5 RBC/hpf) hematuria was present in 88.7%. Injury to other organs was present in 96% (193/201), with > 1 organ involved in 74.6%. The liver was the most commonly injured organ. Using the AAST grading system, there were 46 grade 1 (G1), 21 G2, 62 G3, 51 G4, and 26 G5 injuries.

Intervention	G1	G2	G3	G4	G5	*Total*
Observation/Bedrest	31	9	9	2	0	*51*
Exploration Only	15	4	1	0	0	*20*
Repair*	0	8	52	49	26	*135*
Mesh	0	1	10	11	1	*23*
Omental Patch	0	0	23	19	1	*43*
Peritoneal Patch	0	0	2	0	0	*2*
Renorraphy	0	7	25	16	2	*50*
Vascular Repair	0	0	0	14	5	*19*
Partial Nephrectomy	0	0	11	22	0	*33*
Nephrectomy	0	0	4	7	19	*30*

**Multiple repairs were often done on the same kidney*

The trend to observe without renal exploration has not changed significantly over the past three decades (1978-89=26.7%, 1990-99=26.4%, 2000-07=18.6%). 95 renal units (excluding nephrectomy) underwent repair with associated small or large bowel injuries without any known complications, including 14 patients with mesh utilized during renal repair. The renal salvage rate was 85.4% (n=176/206) with two delayed nephrectomies for persistent bleeding after failed embolization and vascular repair. Postoperative imaging was obtained in 32.8% (55/201) patients, and there were no known cases of post-injury hypertension. Overall survival was 96% (n=193), with 2 intraoperative and 6 postoperative deaths. Isolation of renal vessels was obtained in all patients prior to opening Gerota's fascia with no deaths secondary to urologic intervention.

Conclusion: Selective observation and various operative techniques can yield high renal salvage rates approximating 85% after GSW.

Session I

Paper 8 10:10 AM

FAST PERFORMED BY RADIOLOGISTS – CONFIRMING THE TRUTH ABOUT ULTRASOUND IN TRAUMA

Christine Gaarder*, MD PhD, Christian F. Kroepelien, MD, Ruth Loekke, MD, Johan B. Dormagen, MD, Johan Pillgram-Larsen*, MD, Paal A. Naess, MD PhD. Ullevaal University Hospital.

Invited Discussant: Grace Rozycki, M.D., M.B.A.

Objectives: What allows focused assessment with sonography for trauma (FAST) to be useful in trauma evaluation is its ability to identify intraabdominal fluid. However, there is growing evidence in the literature showing that it is not sensitive enough in this regard. Most of the existing literature refers to FAST performed by surgeons or emergency physicians. In most European trauma centres, ultrasound is performed by radiologists. For hemodynamically stable patients the diagnostic accuracy of CT scans remains unmatched. We still need a diagnostic modality for the hemodynamically unstable patient, reliable enough to exclude intraabdominal haemorrhage as the cause of instability. The purpose of this study was to determine the sensitivity and specificity of FAST performed by radiologists for detection of hemoperitoneum in the unstable patient.

Methods: Prospective study at a major European trauma centre. FAST was performed in trauma patients by the radiologist on call who was included in the trauma team. Results were compared with one of the following reference standards: CT scan, DPL, exploratory laparotomy or observation. The study population consisted of the subgroup deemed potentially unstable when admitted as defined by: SBP ? 90 mmHg, pulse rate ? 120 bpm or BD ? 8.

Results: Of the 708 patients subjected to FAST examination during the study period, 115 patients met the inclusion criteria. There were 84 true-negative, 11 false-negative, 16 true-positive and 4 false-positive. Sensitivity and specificity were 59 % and 95%, respectively. Positive and negative predictive values were 80% and 88 %, respectively.

Conclusion: A negative FAST in an unstable patient, even in the hands of radiologists, cannot reliably exclude intraabdominal bleeding. These patients should undergo another diagnostic test to exclude intraperitoneal haemorrhage. The options are CT if stabilized, DPL or exploratory laparotomy if remaining unstable.

Session I

Paper 9 10:30 AM

PULMONARY CONTUSION PRIMES SYSTEMIC INNATE IMMUNITY RESPONSES

R Shayn Martin, MD , BK Yoza, PhD, JD Wells, BS, EM Hiltbold, PhD, JW Meredith*, MD, CE McCall, MD. Wake Forest University Health Sciences.

Invited Discussant: Jeffrey S. Upperman, M.D.

Introduction: Traumatic injury may result in an exaggerated response to subsequent immune stimuli such as nosocomial infection. This "second hit" phenomenon, and molecular mechanism(s) of immune priming by traumatic lung injury, specifically pulmonary contusion, remains unknown. We used an animal model to test the hypothesis that exaggerated immune responses after pulmonary contusion are dependent on systemic priming of the innate immune receptor, TLR4.

Methods: Male, 8-9 wk, C57/BL6 mice underwent blunt chest injury followed by intratracheal administration of the TLR4 agonist, lipopolysaccharide (LPS, 50mcg) 24hrs after injury. Other experimental groups were uninjured, and injury or LPS alone. Mice were euthanized 4hrs after LPS challenge and blood, bronchoalveolar lavage (BAL), and tissue were isolated. One way ANOVA with Bonferroni multiple comparison test for significant differences (*, $p<0.05$).

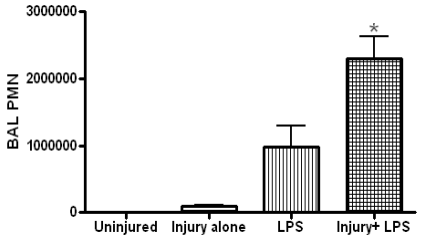


Figure 1.

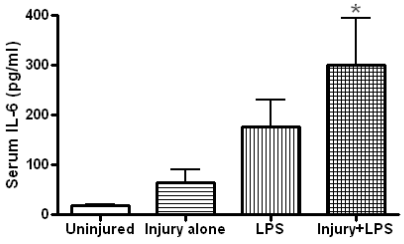


Figure 2.

Results: Histological analysis of alveolar septal edema and neutrophilic infiltrate showed that injury+LPS resulted in a more severe lung injury. BAL neutrophilia (Fig. 1) was significantly increased in injury+LPS animals. Injury+LPS showed significantly elevated levels of IL-6 (Fig. 2) in the serum.

Conclusion: Pulmonary contusion results in an exaggerated response of the innate immune receptor, TLR4. We observed synergistic increases in inflammatory mediator expression in the blood and a more severe lung injury in injured animals challenged with LPS. These results suggest that exaggerated immune responses after pulmonary contusion are dependent, at least in part, on priming of the innate immune receptor TLR4.

Session I

Paper 10 10:50 AM

AN EVALUATION OF MULTI-ROW DETECTOR CT IN DIAGNOSING PANCREATIC INJURY: RESULTS OF AN AAST MULTICENTER STUDY

Herb A. Phelan, MD, George Velmahos*, MD PhD, Gregory J. Jurkovich*, MD, Randall S. Friese, MD, Joseph P. Minei*, MD. UT-Southwestern Medical Center and the AAST Multi Institutional Trials Working Group on Pancreatic Injuries and Multichannel CT Scanners.

Invited Discussant: John J. Fildes, M.D.

Background: Efforts to determine the suitability of low-grade pancreatic injuries for non-operative management have been hindered by the inaccuracy of older CT technology for detecting pancreatic injury. This retrospective, multicenter AAST-sponsored trial examined the sensitivity of newer 16- and 64-row CT for detecting pancreatic injury (PI), and sensitivity/specificity for the identification of pancreatic ductal injury (PDI).

Methods: Patients who received a preop 16- or 64-row CT followed by laparotomy with a documented PI were enrolled. Blinded radiologists re-reviewed pre-op CTs to establish the presence (+) or absence (-) of PI and PDI. Operative notes (OpN) were reviewed and all patients were confirmed as PI(+), and then classified as PDI(+) or (-). As all patients had PI, an analysis of PI specificity was not possible. PI patients formed the pool for further PDI analysis. Multivariate logistic regression was performed utilizing the presence or absence of agreement between CT and OpN findings as an independent variable. Covariates were age, gender, ISS, mechanism, PO contrast, and presence of other abdominal injuries.

CT	PI (n)	PI sensitivity	PI specificity
16	153	60%	NA
64	53	47%	NA
CT	PDI (n)	PDI sensitivity	PDI specificity
16	50	54%	95%
64	21	52%	90%

Results: 20 centers enrolled 206 PI pts, including 71 PDI(+) pts. IV contrast was used in 203 studies; 69 studies used PO contrast. 89% were blunt mechanisms, and 96% of patients were able to have their duct status operatively classified as PDI (+) or (-). Logistic regression showed no covariates were associated with an increased likelihood of detecting PI. For PDI, blunt mechanism was associated with accuracy in 16-row CT (OR: 15.21; 95% CI: 1.15-201.12); younger age was associated with accuracy in detecting PDI for 64-row CT (OR: 0.90; 95% CI: 0.81-1.00).

Conclusion: 16- and 64-row CT have low sensitivity for detecting PI/PDI. Their use as decision-making tools for the non-op management of low-grade PI are therefore limited.

Session III-A

Paper 11 1:00 PM

GENETIC VARIATION IN COMPLEMENT COMPONENT 2 OF THE CLASSICAL COMPLEMENT PATHWAY IS ASSOCIATED WITH INCREASED MORTALITY AND INFECTION: A STUDY OF 627 TRAUMA PATIENTS

John A. Morris Jr*, MD, Cedric Francois, MD PhD, Paul Olson, PhD, Judith M. Jenkins, MSN, Patrick R. Norris, PhD, Jason H. Moore, PhD, Anna E. Williams, Brent S. McNew, Jeffrey A. Canter, MD. Vanderbilt University Medical Center.

Invited Discussant: Vicente H. Gracias, M.D.

Introduction: Trauma is a disease of inflammation. Complement Component 2 (C2) is a protease involved in activation of complement through the *classical* pathway and has been implicated in a variety of chronic inflammatory diseases. We hypothesize that genetic variation in C2 (E318D) identifies a high-risk subgroup of trauma patients reflecting increased mortality and infection (Ventilator associated pneumonia: VAP). Consequently, genetic variation in C2 may stratify patient risk and illuminate underlying mechanisms for therapeutic intervention.

Methods: DNA samples from 627 trauma patients (ISS < 45, 90th percentile) were genotyped for C2 E318D and linked with covariates (age: mean 42.8 years, gender: 74% male, ethnicity: 80% Caucasian, mechanism: 84% blunt, ISS: mean 25.0, admission lactate: mean 3.13 mEq/L), and outcomes: mortality 9.9% (62/627), and VAP: 18.5% (116/627). Patients with ISS ? 45 were excluded, as magnitude of injury overwhelms genetics and covariates in determining outcome. VAP was defined by quantitative broncho-alveolar lavage (>10^4). Multivariate regression determined the relationship of genotype and covariates to risk of death and VAP.

Model	Odds Ratio, ED	95% CI	P-value
Mortality	2.65	1.18-5.96	0.02
VAP	2.00	1.03-3.88	0.04

Results: Of 627 patients, 52 patients (8.3%) had the high-risk heterozygous genotype, associated with a significant increase in mortality and VAP.

Conclusion: In 627 trauma patients, 8.3% had a high-risk genetic variation in C2 associated with increased mortality (OR=2.65) and infection (OR=2.00). This variation:

1. Identifies a previously unknown high risk group for infection and mortality.
2. Can be determined on admission.
3. Provides opportunity for early therapeutic intervention.
4. Requires validation in a distinct cohort of patients.

Session III-A

Paper 12 1:20 PM

INTERMITTANT VANCOMYCIN DOSING VERSUS CONTINUOUS VANCOMYCIN INFUSION FOR TREATMENT OF VENTILATOR-ASSOCIATED PNEUMONIA IN TRAUMA PATIENTS.

Thomas M. Schmelzer, MD, A. Britton Christmas, MD, M. Craig Barrett, PharmD, B. Todd Heniford, MD, Ronald F. Sing*, DO. F.H. Sammy Ross, Jr Trauma Center/Carolinas Medical Center.

Invited Discussant: Marie Crandall, M.D.

Introduction: The American Thoracic Society (ATS) guidelines for the treatment of ventilator-associated pneumonia (VAP) recommend vancomycin dosing at 15mg/kg administered twice daily for target concentration level 15-20 mcg/mL. We compared intermittent vancomycon dosing (IVD) to continuous vancomycin infusion (CVI).

Methods: A prospective randomized study in adult trauma patients with suspected VAP. The primary outcome measure was a serum vancomycin level within the target level at 48 hours after initiation of therapy. Secondary outcome measure included development of nephrotoxicity, defined as a rise in serum creatinine of ?50% from baseline. Statistical analysis included Equality of Variances, T-test, and chi square.

Results: Seventy-three patients were enrolled. 18 patients were withdrawn due to failure to draw levels at the appropriate time. There were no differences between treatment groups.

Table 1.	Mean Age	Male/Female	Mean ISS (+SD)	Mean Weight (kg)
IVD (n=27)	41.3 (17.9)	3/24	25.5 (9.9)	87.2 (19.5)
CVD (n=28)	40.3 (16.4)	4/24	26.6 (11.5)	82.8 (21.2)
P value	0.81	0.97	0.70	0.36

Table 2.	Mean Vanc Level	# pts therapeutic range	# pts subtherapeutic	# pts supratherapeutic	Nephrotoxicity
IVD (n=27)	8.9 $\pm$ 3.9	2 (7%)	25 (93%)	0 (0%)	3 (8%)
CVD (n=28)	19.8 $\pm$6.1	16 (57%)	6 (21%)	6 (21%)	1 (3%)
P value	< 0.0001	<0.0001	<0.0001	<0.001	0.36

Conclusion: The ATS recommendations for vancomycin for presumptive VAP treatment are inadequate. Continuous vancomycin infusion should be adopted as the standard dosing strategy.

Session III-A

Paper 13 1:40 PM

SEPSIS DUE TO PERIPELVIC SOFT TISSUE INFECTIONS IN CRITICALLY INJURED MULTIPLE-TRAUMA PATIENTS WITH UNSTABLE PELVIC FRACTURE

Yuichi Kataoka, MD, Hiroaki Minehara, MD, Ken Shimada, MD, and Kazui Soma, MD.
Kitasato University, School of Medicine, Kanagawa, Japan.

Invited Discussant: Mark A. Malangoni, M.D.

Background: In critically injured multiple-trauma patients with unstable pelvic fracture, late mortality almost invariably results from sepsis, which usually arises from soft tissue infections.

Methods: We analyzed clinical features of 11 patients with sepsis caused by soft tissue infections surrounding the fractured pelvis, of 830 patients with pelvic fracture following blunt trauma treated at our level I trauma center over the past 25 years. Soft tissue infection was defined as abscess formation in subcutaneous tissue or muscle diagnosed by CT scan and operation.

Results: Mean injury severity score was 48.2, and mean systolic blood pressure on arrival was 66.7 mm Hg. All the patients had unstable pelvic fractures, multiple concomitant injuries and prolonged haemorrhagic shock. Open pelvic fracture was present in 5 patients. Mean blood transfusion volume within 24 h was 12,438 ml. Intra-aortic balloon occlusion was performed in 4 patients, and transcatheter angiographic embolization (TAE) in 9. Embolic sites of TAE were bilateral internal iliac arteries (n=9), lumbar artery (n=5), median sacral artery (n=2), and circumflex femoral artery (n=2). Infection sites included the gluteal region (n=10), sacral region (n=2), femoral region (n=5), lumbar region (n=5), and the anterior iliac region (n=2). Necrotic changes of infected soft tissue and a high creatine kinase level (> 10,000 IU) were found in all patients. They underwent open drainage and daily debridement with pulsatile irrigation followed by intravenous antibiotics. All patients developed severe sepsis, five of whom subsequently died of multiple organ failure.

Conclusion: Peripelvic soft tissue infections in critically injured patients with unstable pelvic fracture easily become septic. It is nessesary to identify high-risk patients and to perform early diagnosis and treatment.

Session III-A

Paper 14 2:00 PM

MITOCHONDRIAL VARIANT (4216C) IS ASSOCIATED WITH INCREASED RISK FOR SEVERE SEPSIS AND DEATH AFTER TRAUMATIC INJURY.

Ruben Gomez, MD, Ling-Yu Chang, BS, Joseph P Minei*, MD, Robert C Barber, PhD. UT Southwestern Medical Center.

Invited Discussant: Frederick A. Moore, M.D.

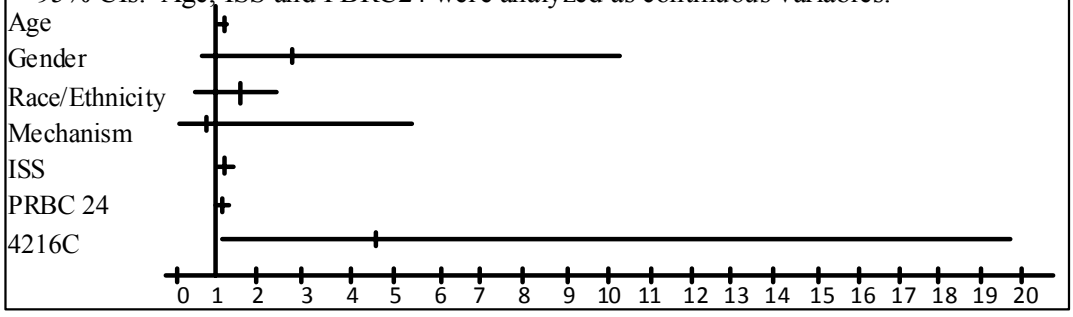
Introduction: Several studies have linked impaired mitochondrial activity to increased risk for clinical complications after injury. A polymorphism (T4216C) in the NADH DH1 gene of the mitochondrial genome has been shown to cause decreased cellular respiration. We have observed previously an association between carriage of the less active 4216C allele and risk for severe sepsis in a cohort of 310 burn patients (data submitted to Shock 2008).

Methods: Association between 4216C and outcome was evaluated in a cohort of 136 patients from Parkland Hospital, Dallas, TX with injury severity scores ?16 who survived >48 hours. Clinical data were collected prospectively and genotypes determined by PCR-RFLP analysis under an IRB-approved protocol.

Results: After adjustment for mechanism and severity of injury, units of packed red blood cells given in the first 24 hours (PRBC24), age, gender and race/ethnicity, carriage of the 4216C-allele had an adjusted odds ratio (aOR) of 4.55 for death (95% CI; 1.06 - 19.43; P=0.041) (Figure). Carriage of 4216C was also associated with increased risk for severe sepsis in this same cohort of patients (aOR = 3.34; 95% CI; 1.09 – 10.26; P=0.035).

Conclusion: Carriage of the 4216C-allele in the mitochondrial NADH DH1 gene appears to decrease mitochondrial function and increase risk for infectious complications after traumatic injury. Although sample size was relatively small in this study, these data replicate an association seen in burn patients, strengthening confidence in their validity.

Adjusted odds ratios for death. Vertical hash marks = aORs. Horizontal lines show 95% CIs. Age, ISS and PBRC24 were analyzed as continuous variables.



Session III-A

Paper 15 2:20 PM

FORMYLATED MITOCHONDRIAL PROTEINS AND THE GENESIS OF SIRS: THE ENEMY WITHIN...

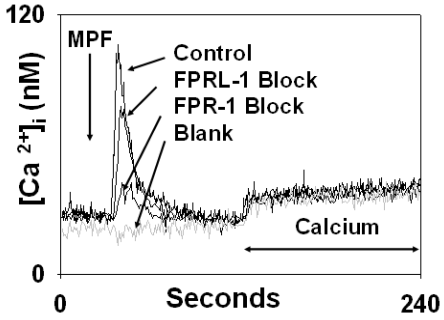
Mustafa Raoof, MD, Qin Zhang, MD, Kiyoshi Itagaki, PhD, Bozena Antoniu, MS, Wolfgang Junger, PhD, Carl J. Hauser*, MD. Beth Israel Deaconess Medical Center, Harvard Medical School.

Invited Discussant: Ronald V. Maier, M.D.

Introduction: Tissue trauma activates innate immunity and can set off the systemic inflammatory response syndrome (SIRS). Clinically, SIRS can mimic sepsis without bacterial infection. Bacteria initiate protein chain synthesis with n-formyl methionine residues whereas eukaryotes do not. Thus n-formylated peptides (FP) like formyl Met-Leu-Phe (fMLP) are seen as foreign by the immune system and leukocytes possess specific, activating FP receptors. Yet since human mitochondria are genetically derived from bacteria they do contain FP. This could be released from traumatized or dead cells. We hypothesized such mitochondrial proteins would activate human neutrophils (PMN).

Methods: Mitochondria were isolated from liver, muscle or cell lines. Soluble mitochondrial protein fractions (MPF) were assayed for their effects on human PMN. Ca^{2+} flux responses were measured in fura-loaded PMN with or without of blockade of formyl peptide receptor 1 (FPR1) or formyl peptide receptor-like 1 (FPRL1) by specific antibodies. PMN chemotaxis to MPF was assayed using trans-well filter plates. Carboxy-H2DCFDA-loaded PMN were stimulated with MPF and assayed for oxidative burst.

Results: MPF caused Ca^{2+} flux similar to that caused by fMLP (Figure, right). This was inhibited by anti-FPR1 antibodies (p=0.004), demonstrating that MPF activates mainly via the G-protein coupled (GPC) FPR1 receptor. MPF acted as a potent chemoattractant with maximal responses twice that of 1nM fMLP. MPF also caused dose-dependent oxidative burst.



Conclusion: Formylated mitochondrial proteins are strong chemoattractants that activate innate immunity via GPC receptors. These findings suggest exposure to mitochondrial peptides from traumatized tissues may be an important event in the genesis of SIRS.

Session III-A

Paper 16 2:40 PM

POST-INJURY NEUTROPHILS EXPRESS T CELL CO-INHIBITORY MOLECULE ILT 5

Paul E Bankey*, MD PhD, Asit De, PhD, Carol Miller-Graziano, PhD, Mita De, MS, Rami Sleem, MD, Yaritza Gandulla, MS. University of Rochester.

Invited Discussant: Ed Childs, M.D.

Introduction: Post-injury neutrophils (PMN) have a well-established role in innate immunity; however, their interactions with T Cells have been largely neglected. Post-injury PMN prolong their lifespan and express T Cell co-signaling molecules that may either promote or suppress T Cell responses. We hypothesize that post-injury PMN express co-inhibitory molecule immunoglobulin like transcript 5 (ILT5) and/or Program death-ligand 1 that may contribute to the inhibition of T Cell responses.

Methods: Human PMN (CD66b+CD16+CD9-) from healthy subjects and trauma ICU patients (Post-injury day 5-10, n=9, ISS >24; age 18-60) were isolated and treated with IFN-γ+GM-CSF. Expression of ILT5 and PD-L1 molecules on viable PMN (7AAR) was measured by flow Cytometry (MFI with isotype control). PMN: T Cell co-cultures were established then labeled with [3H]-thymidine after stimulation with iCD3+sCD28 for 72 hours. T cells were from stored uninjured allogeneic donors. [T cell activation]

Results: Expression of ILT5 (MFI) was found to be over 5-fold significantly increased in trauma patients compared to control subjects. [Table] Expression of PD-L1 (MFI) was also significantly increased compared to control subjects. [Table] Neutrophils directly suppress the proliferative response of T Cells as measured in co-culture. The suppression of T Cell proliferation was greater by trauma patient PMN than by controls. [Table]

Neutrophil Expression of ILT-5 and PD-L1 and PMN: T cell co-culture Proliferation

Marker	ILT-5 (MFI)	PD-L1 (MFI)	T Cell Proliferation (x1000 cpm)
Control Subject	50.0± 28.2	6.5 ± 0.8	105.0 ± 18.5
Trauma Patient	270.2± 68.2#	15.1 ± 4.2 #	53.2 ± 21.3# *

Mean ± SEM # p< 0.05 vs. Control *p<0.05 vs. T cell only (126.0±10.8)

Conclusion: This study demonstrates post-injury PMN expression of T Cell co-inhibitory molecules ILT5 and PD-L1 during PMN directed suppression of T cell proliferative response. These data suggest that post-trauma neutrophils may be activated to a T Cell suppressive phenotype through expression of ILT-5 and PD-L1. Clinically, this immune suppression may translate into a higher incidence of post-injury infection and MODS.

Session III-A

Paper 17 3:00 PM

IMMUNOLOGIC FUNCTION IN THE ELDERLY AFTER INJURY – THE NEUTROPHIL AND INNATE IMMUNITY

Stephanie Valente, DO, William Fallon*, MD, Thomas Alexander, PhD, Ervin R. Tomas, MBA, Olga Pizov, MSN, RN, Steven Schmidt, PhD. Summa Health System, Akron City Hospital.

Invited Discussant: Junichi Sasaki, M.D.

Background: Aging is associated with a decline in immune function. This may contribute to decreased ability of an elderly patient to mount an inflammatory response when injured. This study examined elderly trauma patients to determine if there was a difference in the neutrophil response to injury.

Methods: This prospective, observational, cohort study compared neutrophil function in 24 injured elderly (>65 years) patients admitted to our trauma center; to control groups of non-injured individuals (11 elderly, 17 young). Blood samples were obtained from the non-injured control groups. Blood samples were also taken from the injured elderly group within 48 hrs of trauma and subsequently at two periods during their hospital stay. Neutrophils were analyzed for oxidative burst, apoptosis, IL-10, and CD 18 expression. Results were compared using unpaired t-tests for independent means (alpha 0.05). This study was approved by the IRB.

Results: 24 injured elderly subjects were enrolled: mean ISS 15.3, average age 74.6 years, 92% survival, 100% blunt trauma. The injured elderly had total CD18 % and oxidative burst capability equivalent to the non injured young. The non injured elderly had lower CD18 % and a lower average stimulated oxidative burst level than either the injured elderly or non injured young ($p<0.05$). CD18% in the injured elderly was greater than the non-injured elderly within 24-48h of trauma ($p<0.05$) but normalized > 48h post trauma. IL-10 levels did not differ among groups. Neutrophil apoptosis levels in the injured elderly were lower than levels in the young controls ($p<0.05$).

Conclusion: Some innate immune parameters are decreased in the elderly. Trauma is associated with an increase in innate immune capabilities in elderly individuals however. The clinical significance of this increase is uncertain.

Session III-A

Paper 18 3:20 PM

HUMORAL FACTORS ENHANCE FRACTURE HEALING AND CALLUS FORMATION IN TRAUMATIC BRAIN INJURED PATIENTS

Dieter Cadosch, MD, Oliver P. Gautschi, MD, Matthew Thyer, MD, Swithin Song, MD, Allan Skirving, MD, Luis Filgueira, MD, René Zellweger*, MD. Department of Orthopaedic and Trauma Surgery, Royal Perth Hospital.

Invited Discussant: Kimberly A. Davis, M.D.

Background: Humoral factors derived from the traumatic injured brain are believed to be pivotal for enhanced fracture healing. The underlying pathophysiologic mechanisms remain unknown, as do the responsible soluble factors derived from the injured tissue. The aim of this study was to relate the osteoinductive potential of serum from traumatically brain injured (TBI) patients with a femur shaft fracture to the severity of their brain injury and the clinical and radiological features of fracture healing.

Methods: Patients with (n=16) and without (n=24) TBI and a long bone shaft fracture were recruited. GSC score was determined and x-rays taken of the fracture on admission and at 6 weeks, 3, 6, and 12 months post-surgery. Time-to-union was estimated clinically and radiologically and the callus ratio to shaft diameter calculated. Serum samples were collected at 6, 24, 72 and 168 hours post-trauma, and their osteogenic potential determined by measuring the in vitro proliferation rate of the human fetal osteoblastic cell line hFOB1.19 (hFOB).

Results: TBI patients had a twofold shorter time-to-union ($p<0.001$), a 35-49% increased callus ratio on both x-ray projections ($p<0.001$) and their sera induced a higher proliferation rate in hFOB cells ($p=0.014$). A linear relationship between proliferation rates and the amount of callus formed was revealed ($p<0.05$). GCS was positively correlated with callus ratio on both x-ray projections ($p<0.001$) and the proliferation rate of hFOB cells at 6 hours post-injury ($p=0.038$).

Conclusions: Severely brain injured patients release unknown factors into the humoral circulation that enhance and accelerate bone fracture healing**.** Furthermore, this study shows for the first time, that there is a tight correlation between the extent of the brain damage and the *in vitro* and *in vivo* data investigating the enhanced bone healing potency in TBI patients.

Session III-A

Paper 19 3:40 PM

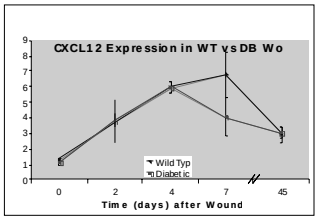
APPLICATION OF THE GENETICALLY ENGINEERED CXCL12 EXPRESSION PLASMID TO DIABETIC MOUSE WOUNDS ACCELERATES HEALING TO NEAR NORMAL VIA STEM CELL TRAFFICKING

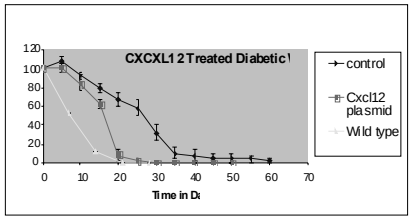
Terry E Restivo, DO MA, Kimberly A Mace, PhD, Alden H Harken, MD, David M Young, MD, Gregory Victorino*, MD (sponsor). UCSF East Bay Department of Surgery.

Invited Discussant: Eric Toschlog, M.D.

Introduction: The chemokine CXCL12 influences survival, production and trafficking of stem cells. We hypothesize that by increasing the level of CXCL12 in the diabetic wound, we will accelerate time to wound closure. This series of experiments aims to: 1) assess the post-wounding expression of the chemokine CXCL12 in both diabetic and wild type mice, 2) create a constitutively expressed CXCL12 plasmid, 3) determine the influence of CXCL12 on the rate of diabetic wound healing, and 4) quantify stem cell recruitment.

Methodology: We performed quantitative real time PCR analysis of CXCL12 mRNA in skin from both Lepr $^{db-/-}$ diabetic and wild type mice at Days 0, 2, 4, 7, and 45 post wounding. Transgene expression of CXCL12 was introduced into wounds by a CMV-driven expression plasmid. CXCL12 or sham plasmids were applied to the wounds of diabetic mice. Wound areas were measured every five days using planimetry imaging. FACS analysis was performed on peripheral blood of treated mice at Days 1,4,7, and 10 post-wounding.





Results: CXCL12 was significantly reduced in Diabetic mice 7 days after wounding ($P < 0.02$). The CXCL12 expression plasmid restored rate of wound healing to near normal (23 days). A 3% increase in circulating stem cells can be seen as early as post wounding Day 1 after application of our plasmid.

Conclusion: Increasing the level of CXCL12 in diabetic wounds accelerates healing to a near normal rate via stem cell recruitment. These results suggest a significant therapeutic potential in the treatment of chronic, diabetic wounds.

Session III-A

Paper 20 4:00 PM

MECHANISMS OF COMMONLY USED ANTISEPTICS ON DELAYED WOUND HEALING

Gregory W. Thomas, BS, Raphael Bar-Or, BS, Leonard T. Rael, MS, Charles W. Mains, MD, Denetta S. Slone, MD, Michael L. Craun*, MD, David Bar-Or, MD. Swedish Medical Center, Trauma Research.

Invited Discussant: Michael R. Bard, M.D.

Introduction: The cytotoxic effects of antiseptics on pivotal cell types of the healing process have been well documented. The purpose of our investigation was to explore the ability of sub-cytotoxic levels of antiseptics to interfere with fibroblast function.

Methods: Cell proliferation assays were performed by culturing primary normal human dermal fibroblasts in the presence of H_2O_2, Povidone Iodine, silver sulfadiazine, and chlorhexadine. Total cell numbers were determined following treatment. Migration was evaluated using scratch assays. Monolayers were "wounded" using sterile pipette tips and cellular movement into the resulting gap was monitored by digital photography.

Results: H_2O_2 and Povidone Iodine reduced both migration and proliferation of fibroblasts in a dose dependent fashion *in vitro*. Silver sulfadiazine and Chlorhexidine both exhibited no significant reductions in proliferation and migration at sub-cytotoxic concentrations.

Conclusion: If indications suggest that debridement of the wound bed will not sufficiently reduce bacterial loads, the care giver maybe faced with no other option than the application of broad spectrum antiseptics. Our data would suggest that H_2O_2 and Iodine are poor choices, potentially retarding the contribution of fibroblasts to the healing process. Silver sulfadiazine and Chlorhexidine, at levels still proven to be bactericidal, had no detrimental effects on fibroblast activity in these assays. The silver sulfadizine may have even increased the proliferative and migratory potential of these cells in culture.

Table 1: Percent inhibition + SE of NHDF proliferation and migration following treatment

Sample	Proliferation	Migration
100 uM H_2O_2 (0.0004%)	36.9 + 5 %	12.8 + 2.9 %
250 uM H_2O_2 (0.001%)	79.27 $\pm$ 20.7 %	23.3 $\pm$ 13.1 %
500 uM H_2O_2 (0.002%)	92.3 + 20.2 %	77.3 + 24 %
0.01% Povidone Iodine	25.7 $\pm$ 3 %	-2.34 $\pm$ 14 %
0.05% Povidone Iodine	35.7 + 2.7 %	15.4 + 3.5 %
0.1% Povidone Iodine	56.5 $\pm$ 11.4 %	48.9 $\pm$ 10.8 %
0.02% Chlorhexadine	10.98 $\pm$ 3 %	7.96 $\pm$ 1.3 %
5 uM Silver sulfadiazine	-17.4 + 3.9%	-37.1 + 2.7 %

Session III-A

Paper 21 4:20 PM

MOBILIZATION OF BONE MARROW CELLS TO THE SITE OF INJURY ARE NECESSARY FOR WOUND HEALING

Salil Shah, MD, Angela Penn, MD, Jason Ulm, MD, Alicia Mohr*, MD, Ziad Sifri, MD, Edwin A. Deitch*, MD, David H. Livingston*, MD. New Jersey Medical School.

Invited Discussant: Carl I. Schulman, M.D.

Introduction: Lung contusion (LC) and hemorrhagic shock (HS) result in early organ failure (lung and bone marrow (BM)) possibly through sequestration of mobilized BM hematopoietic progenitor cells (HPC) into the lung. Post-injury mesenteric lymph has been shown to cause early organ failure thus we hypothesized that diversion of mesenteric would improve organ failure through decreased mobilization of BM HPC to the lung.

Methods: Rats (n=4/group) were subjected to unilateral LC±lymph duct ligation (LDL). Additional groups underwent HS (MAP 35mmHg x 90 mins) ±LC±LDL. Controls were cannulated only. At 3 hrs both lungs and BM were harvested for growth of HPC (BFU-E, CFU-E and CFU-GEMM). Additional rats (n=6) were sacrificed on day 14 and the lungs examined by histology.

Results: LC decreased BM HPC in all cell types and increased their number into the injured lung. BFU-E data shown in table (mean±SD; *$p<0.05$ vs. Control). HS exacerbated these results. LDL decreased BM suppression and the sequestration of cells into the injured lung (¶ $p<0.05$ vs. No LDL). At day 14, all LC rats

BFU-E	Control	LC	LC+LDL	LC+HS	LC+HS+LDL
BM	967±153	620±72*	979±160¶	204±43*	670±31¶
Lung	10±1	22±2*	7±2¶	73±15*	48±18¶

demonstrated healing of their contusion. In contrast all LC+LDL rats had evidence of pneumonia, thickened alveoli and increased numbers of inflammatory cells.

Conclusions: Diversion of the post-injury mesenteric lymph decreased early BM suppression following LC or LC+HS. However, LDL improved BM dysfunction at the expense of impaired lung healing and an increased susceptibility to infection. As we have shown that mobilized BM cells differentiate into pneumocytes following LC, these data indicate that mobilization of BM cells to the site of injury is an adaptive response necessary for successfully wound healing and tissue repair.

Session III-A

Paper 22 4:40 PM

SLEEP DEPRIVATION AFTER SEPTIC INSULT IN A MURINE MODEL INCREASES MORTALITY INDEPENDENT OF AGE

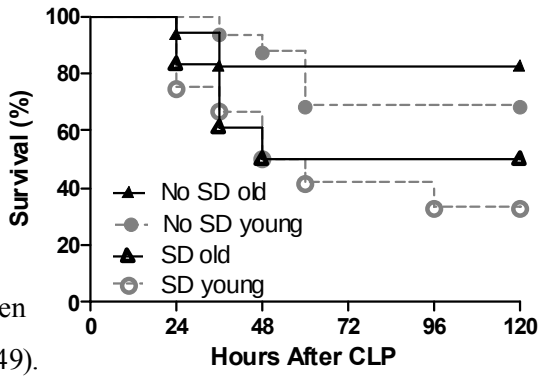
Randall S. Friese*, MD , Brandon R. Bruns, MD, Christopher Sinton, PhD. University of Texas Southwetern Medical Center.

Invited Discussant: David H. Livingston, M.D.

Background: Sleep deprivation (SD) is a common problem in the intensive care unit (ICU). Animal models have demonstrated that SD alone is associated with increased mortality. We have previously shown that septic insult with SD results in increased mortality in a murine model. Aging is known to reduce the restorative phases of sleep. The purpose of this study was to evaluate the effect of age on mortality after SD + septic insult.

Methods: C57BL/6J male mice aged 2 (young) or 9 (old) months underwent cecal ligation and puncture (CLP). Animals were randomized to receive SD for 48 hours or standard recovery (no SD). Sham animals underwent laparotomy and cecal manipulation without puncture. SD was achieved by securing animal housing to an orbital shaker set to repeatedly cycle at 30 RPM over 120 seconds (30 on/90 off). This method has been previously validated using electroencephalography. The primary outcome was survival at 5 days post CLP. Kaplan Meier survival analysis with log rank test was used.

Results: Young mice (n=28) had a mortality of 31% with CLP alone increasing to 67% with SD (p=0.03). Old mice (n=35) had a mortality of 18% with CLP alone increasing to 50% with SD (p=0.05). All sham animals survived. There was no difference in survival between young and old mice undergoing SD (p=0.49).



Conclusions: SD after septic insult increases mortality in both young and old mice. However, SD after septic insult does not have a more profound effect on mortality in either age group. These findings suggest that SD experienced in the ICU setting during recovery from critical illness may increase mortality. This effect appears independent of increased age. Further studies evaluating extremes of age are warranted.

Session III-B

Paper 23 1:00 PM

REGIONALIZING EMERGENCY GENERAL SURGERY: THE NEXT STEP FOR ACUTE CARE SURGERY

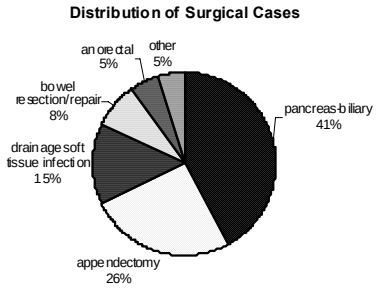
Ernest FJ Block, MD MBA*, Beth Rudloff, RN, Bruce Behn PhD, Charles Noon PhD. Orlando Regional Medical Center.

Invited Discussant: Gregory J. Jurkovich, M.D.

Introduction: There is a national loss of access to surgeons for emergencies. Contributing factors include reduced numbers of practicing general surgeons, superspecialization, reimbursement issues, emphasis on work/life balance and medical liability. Regionalizing acute care surgery, as exists for trauma care, represents a potential solution. The purpose of this study is to assess the financial and resources impact of transferring all non-trauma acute care surgery (ACS) cases from a community hospital (CH) to a trauma center (TC).

Methods: We performed a case mix and financial analysis of patient records with ACS for a rural CH located near an urban Level I TC. ACS patients were analyzed for diagnosis, insurance status, procedures, and length of stay. We estimated physician reimbursement based on evaluation and management codes and procedural CPT codes. Hospital revenues were based on regional DRG rates. All third party remuneration was set at published Medicare rates; self-pay was set at nil.

Results: 990 patients were treated in the CH ED with 188 potential surgical diseases. Acute Care Surgery was necessary in 62 cases; 25.4% were uninsured. Extrapolated to twelve months, 248 patients would generate new TC physician revenue of >$155,000 and hospital profits of > $1.5 million. CH savings for call pay and other variable costs are > $100,000. TC operating room volume would only increase by 1%.



Conclusion: Regionalization of ACS to TC's is a viable option from a business perspective. Access to care is preserved during an approaching crisis in emergency general surgical coverage. The referring hospital is relieved of an unfavorable payer mix and surgeon call problems. The TC receives a new revenue stream with limited impact on resources by absorbing these patients under its fixed costs, saving the CH variable costs.

Session III-B

Paper 24 1:20 PM

WHAT IS THE SAFETY OF NON-EMERGENT OPERATIVE PROCEDURES PERFORMED AT NIGHT? A STUDY OF 10,426 CONSECUTIVE OPERATIONS AT AN ACADEMIC TERTIARY CARE HOSPITAL USING THE NATIONAL SURGICAL QUALITY IMPROVEMENT (NSQIP) DATABASE

Florence E Turrentine, PhD RN , Jeffrey S Young, MD*, Hongkun Wang, PhD, James Forrest Calland, MD. University of Virginia School of Medicine.

Invited Discussant: Juan A. Asensio, M.D.

Introduction: Ever-increasing numbers of in-house acute care surgeons and competition for operating room time during normal daytime business hours has led to an increased frequency of non-emergent general and vascular surgery procedures occurring at night when there are fewer residents, consultants, nurses and support staff available for assistance. This investigation tests the hypothesis that patients undergoing such procedures after-hours are at increased risk for post-operative morbidity and mortality.

Methods: Clinical data for 10,426 consecutive operative procedures performed over a five-year period at a single academic tertiary care hospital were obtained from the NSQIP Database. The prevalence of pre-operative comorbid conditions, post-operative length of stay, morbidity, and mortality was compared between two cohorts of patients: one that underwent non-emergent operative procedures at night and another that underwent similar procedures during the day. Subsequent statistical comparisons utilized Chi-square tests for comparisons of categorical variables and F-tests for continuous variables.

Results: Patients undergoing procedures at night had a greater prevalence of serious preoperative comorbid conditions. Procedure complexity (by RVU) did not differ between groups, but length of stay was longer after night procedures (7.8 vs. 4.3 days, $p < 0.0001$).

	Night (n=193)	Day (n=10,233)	p-value
Pre-op: ASA > 2	53.9%	41.0%	0.0001
Pre-op: DNR Orders	1.6 %	0.3%	0.0056
Pre-op: PVD	9.3%	5.0%	0.006
Pre-op: Ventilator Dependent	3.6%	0.3%	0.0001
Outcome: Mortality (%)	1 (0.5%)	192 (1.9%)	0.73
Outcome: Morbidity	10.9%	10.8%	? 1

Conclusions: Patients undergoing non-emergent general and vascular surgery procedures at night in an academic medical center do not appear to be at increased risk for post-operative morbidity or mortality. Performing non-emergent procedures at night appears to be a safe solution for daytime overcrowding of operating rooms.

Session III-B

Paper 25 1:40 PM

SKELETAL TRACTION VERSUS EXTERNAL FIXATION IN THE INITIAL TEMPORIZATION OF FEMORAL SHAFT FRACTURES IN SEVERELY INJURED PATIENTS.

Michael J. Bosse*, MD, Brian P. Scannell, MD, Norman E. Waldrop, MD, Howell C. Sasser, PhD, Ronald F. Sing*, DO. Carolinas Medical Center.

Invited Discussant: Zsolt J. Balogh, M.D.

Purpose: Treatment of multi-trauma patients with femoral shaft fractures has evolved to damage control (DC) with the use of early external fixation (EF). However, skeletal traction (ST), which is inexpensive and does not require general anesthesia, has long been the gold standard for temporary stabilization of femoral shaft fractures. The aim of this study is to compare the major physiologic clinical outcomes of provisional ST to DC-EF.

Methods: A 5 year retrospective review identified 206 patients sustaining blunt trauma, a femoral shaft fracture, and an Injury Severity Score (ISS) ? 17. Patients were stratified into early (<24 hours) definitive fixation with intramedullary nail (IMN) (N=116), delayed IMN after DC-EF (N=20), or delayed IMN after initial temporary stabilization with ST (N=60). The outcomes of the ST and DC-EF groups such as acute respiratory distress syndrome (ARDS), multi-organ failure (MOF), sepsis, pneumonia, pulmonary embolism (PE), deep vein thrombosis (DVT), Length of Stay (LOS), ICU LOS, days of mechanical ventilation (MV), and mortality were compared.

Results: There were no significant differences between the ST and DC-EF groups in age, mechanism of injury, ISS, GCS on arrival, mean time to definitive fixation (4.1 vs. 4.9 days), or abbreviated injury scale (AIS) for chest. However, the ST group had a higher AIS-head (2.5 vs. 1.1, p=0.0017). There were no significant difference in subsequent rates of ARDS, PE, DVT, pneumonia, MV days, ICU LOS, and death. However, the ST group had a lower rate of MOF (36.7% vs. 65.0%, p=0.0270), sepsis (8.3% vs. 30.0%, p=0.0243), and shorter LOS (26.5 days vs. 35.8 days, p=0.0234) than the DC-EF group.

Conclusion: DC-EF for femur fractures appears to offer no significant advantage in patient clinical outcome. Unless initially subjected to general anesthesia for other DC procedures (i.e., laparotomy), the application of external fixation may not be efficacious. Skeletal traction is a simple, easy technique that can be applied by all trauma surgeons.

Session III-B

Paper 26 2:00 PM

EARLY TOTAL CARE OF BORDERLINE PHYSIOLOGY PATIENTS WITH FEMUR FRACTURE IS SUPERIOR TO DAMAGE CONTROL ORTHOPEDICS

Zsolt Balogh*, MD PhD, Benjamin Nicholas, MD, Laszlo Toth, MD, Karlijn van Wessem, MD, Julie A. Evans, RN, Peter Mackay, RN, Debra McDougall, RN. Deapartment of Traumatology, Division of Surgery, John Hunter Hospital, University of Newcastle.

Invited Discussant: Ronald F. Sing, D.O.

Objective: A recent randomized controlled trial (RCT) favors damage control orthopedics (DCO) over early total care (ETC) in the management of high-energy femur shaft fracture (FSF) patients with borderline physiology. The aim of this study was to compare a Level-1 trauma center's FSF demographics, management and outcomes with those of the RCT.

Methods: A 33-month study of the prospective FSF database was performed. FSF patients were categorized according to the system used in the RCT (stable, borderline, unstable and extremis groups). Stable (S) and borderline (BL) patients were compared to the corresponding groups of the RCT (RCT-S and RCT-BL). Demographics, injury severity and pattern, interventions and outcomes [Acute Lung injury (ALI), SIRS, Pneumonia, sepsis, MOF, ICU LOS, ventilator days and mortality] were compared.

Results: Of 151 FSF identified 102 were high-energy and 79 of those were in S or BL condition. There were 62(78%) S and 17(22%) BL patients in the study group compared with 121(73%) RCT-S and 44(28%) RCT-BL in the RCT.

Table 1. Demographics, methods of treatment, injury severity and transfusions.

Group	N	Age(yrs)	ETC:DCO	New ISS	AIS-chest	24hr Transfusion
S	62	33±17	99%:1%*	18±10*	1±0.2*	32%
RCT-S	121	32±11	50%:50%	27±9	1.75±1.58	23%
BL	17	32±13	88%:12%*	29±10	2.71±0.5	58%
RCT-BL	44	32±12	50%:50%	35±10	2.75±1.59	50%

Table 2. Outcomes

Group	N	ICU(hrs)	Vent(hrs)	SIRS	Sepsis	ALI	ARDS	MOF	Mort
S	62	103±104*	96±79	19%	2%	11%	0%	0%	0%
RCT-S	121	165±187	98±119	31%	9%	19%	8%	0%	0%
BL	17	187±151*	162±156*	41%	6%*	24%	0%*	0%*	0%
RCT-BL	44	438±347	337±305	51%	24%	36%	14%	19%	2%

Conclusion: The incidence of S and BL patients, demographics and injury severity is comparable with the RCT. The examined trauma center's current practice of predominantly ETC among S and BL patients results in shorter ICU and ventilator days, less septic complications and less organ failure than in the RCT with 50% utilization of DCO.

Session III-B

Paper 27 2:20 PM

IMPROVING MORTALITY PREDICTIONS IN TRAUMA PATIENTS UNDERGOING DAMAGE CONTROL STRATEGIES

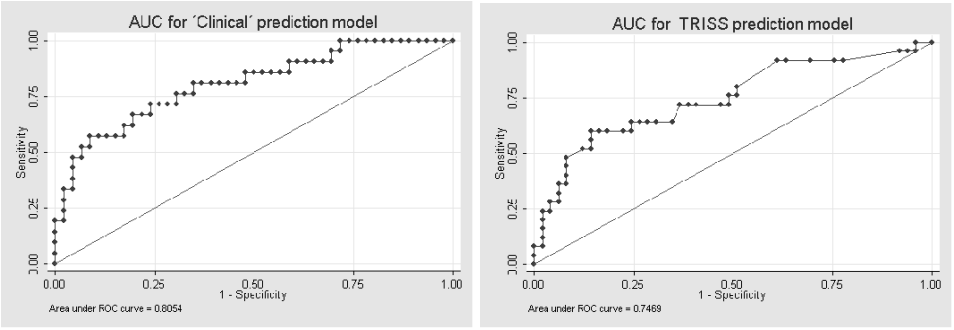
Carlos Ordoñez, MD, Marisol Badiel, MD, Marcela Granados, MD, Alberto García, MD, Gustavo Ospina, MD, María F. Villegas, MD, Gonzalo Blanco, MS, Viviana Parra, MS, María Isabel Gutiérrez, MD PhD, Alvaro Sánchez, MD, Andrew Peitzman, MD, Juan Carlos Puyana*, MD. Universidad del Valle-Colombia.

Invited Discussant: Michael F. Rotondo, M.D.

Objective: The increased use of damage control (DC) surgery in trauma patients requires that accurate prognostic indicators be identified. In order to improve our ability to predict mortality in trauma patients we compared the discriminatory capacity of commonly used trauma and ICU scores in patients undergoing DC.

Methods: Data was prospectively collected from Jan 2000 to Dec 2007, including RTS, ISS, ATI, TRISS, APACHE II as well as several clinical and laboratory parameters. A logistic regression model was used to calculate the area under the ROC curve (AUC) **.**

Results: A total of 83 patients, mean age 32.9±10.6 years, underwent DC surgery. Penetrating trauma ocurred in 80.7%. Mean ISS=28±10.2, ATI = 31.1±17.5, RTS = 7.4±0.9 and APACHE II =15.3±5.9. The overall mortality was 38.5%. The calculated AUC for predictors of 30 day mortality were ISS=0.6420, ATI=0.6409, RTS=0.6984, TRISS= 0.7469 and APACHE II=0.5758. A "clinical" model was constructed using admission pH, hypothermia (≤35 C?) and the number of PRBC transfusions/24 hours. After adjusting for age, this model predicted mortality with an AUC of 0.8054. The discriminatory capacity was superior to that of ISS or ATI (p=0.049) and APACHE II (p=0.0016) and similar to RTS or TRISS (p= 0.4).



Conclusion: A model using the combination of pH, hypothermia, and number of blood transfusions was able to predict mortality following DC surgery with greater accuracy than standard injury/ICU severity scores. These parameters must be considered when evaluating quality control strategies in DC patients.

Session III-B

Paper 28 2:40 PM

FENESTRATED STENT GRAFT FACILITATES EMERGENCY ENDOVASCULAR THERAPY FOR BLUNT AORTIC INJURY

Yoshihiko Kurimoto, MD, Yasufumi Asai*, MD, Satoshi Nara, MD, Kazuhisa Mori, MD, Mamoru Hase, MD, Syunsuke Ohori, MD, Toshiro Ito, MD, Toshio Baba, MD, Nobuyoshi Kawaharada, MD, Tetsuya Higami, MD. Sapporo Medical University, Sapporo, Japan.

Invited Discussant: Aurelio Rodriguez, M.D.

Objective: Endovascular stent-grafting for aortic isthmus injury has been performed intentionally covering the left subclavian artery if necessary. However, simple coverage of the left subclavian artery is not always a safe procedure neurologically and also sometimes not enough to provide a proximal landing zone. We describe our method using a fenestrated stent graft for blunt aortic injury.

Methods: Except for young patients without associated critical injury, blunt aortic injury with mediastinal hematoma has been treated by immediate endovascular stent-grafting, if anatomically applicable. In cases in which aortic injury was located less than 20 mm distal from the left subclavian artery, stent grafts were placed from the aortic arch using a fenestrated stent graft. We evaluated emergency stent-grafting for blunt aortic injury since 2005 when we started to use a fenestrated stent graft.

Results: Between 2005 and 2007, 13 patients with blunt aortic injury underwent immediate endovascular stent-grafting. Among them, 8 (%) were treated using a fenestrated stent graft. Stent grafts were placed distal from the ascending aorta (n=1), the innominate artery (n=5) and the left common carotid artery (n=2) without any concomitant bypass-grafting or transposition of the head vessels. Aortic injury was successfully treated in all cases. Two patients died of brain death due to associated critical brain injury, which means hospital mortality rate is 15.4 %. There was no stent-graft-related perioperative complication. There was no unintentional occlusion of the head vessels by a fenestrated stent graft. One patient underwent open repair at 7 months after stent-grafting because of newly emerged type Ia endoleak.

Conclusion: A fenestrated stent graft was useful to treat blunt aortic injury without any concomitant procedure to provide a sufficient length as a proximal landing zone.

Session III-B

Paper 29 3:00 PM

APPLICATION OF INTERNATIONAL CLASSIFICATION INJURY SEVERITY SCORE (ICISS) TO NATIONAL SURGICAL QUALITY IMPROVEMENT PROGRAM (NSQIP) DEFINES PEDIATRIC TRAUMA PERFORMANCE STANDARDS AND DRIVES PERFORMANCE IMPROVEMENT

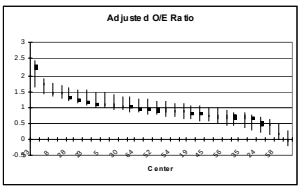
Joseph J. Tepas III*, MD, Brian G. Celso, PhD, Darrell C. Graham, MD, Cynthia L. Leaphart, MD. University of Florida, Jacksonville.

Invited Discussant: Howard R. Champion, F.R.C.S.

Introduction: The ACS NSQIP program is becoming a core methodology to define performance as a ratio of observed to expected events. We hypothesized that application of this using ICISS for individual patient risk stratification to a group of hospitals contributing data to the National Pediatric Trauma Registry (NPTR) would apply objective evidence of actual injuries to define an expected standard, and identify performance outliers.

Methods: Using a blinded code, children entered into Phase III of the NPTR were aggregated by treating hospital. Individual patient ICISS Ps were calculated using survival risk ratios (SRR) derived from the NPTR dataset (n=103,434). For each center, sample size, observed mortality, and ICISS Ps were calculated. Probability of mortality (Pm) was computed as 1 – Ps. Logistic regression was used to develop a predictive model for mortality with logit transformation of Pm to adjust for the skew of minor injury in children by reducing overestimation of low Pm fatalities. Mean Pm was computed for each center and multiplied by its volume to determine expected frequency. O/E ratios and 95% CI were calculated to define expected performance as within CI and outliers above or below CI.

Results: Patients treated at 30 pediatric trauma centers (mean 451 ± 258/ patients per center) were evaluated. O/E distribution is shown with 95% CI (graph). Mean O/E was 0.968, 95% CI = 0.732-1.217. Twelve centers fell within the reference range; 10 centers were defined as above and 8 below expectation. Sample size was unrelated to O/E performance.



Conclusions: Application of ICISS Ps from a national pediatric benchmark population simplifies determination of expected mortality. Cumulative assessment of the ratio of this expected to observed mortality, adjusted by a hospital's volume, defines its performance against peers using the same benchmarks, thereby driving performance improvement based on the objective evidence of injury diagnoses actually encountered.

Session III-B

Paper 30 3:20 PM

UNCOVERING SYSTEMS ERRORS USING A RAPID RESPONSE TEAM: CROSS-COVERAGE CAUGHT IN THE CROSSFIRE

Lewis J Kaplan*, MD, Linda Maerz, MD, Kevin Schuster, MD, Felix Lui, MD, Dirk Johnson, MD, Daniel Roesler, MD, Kimberly A Davis*, MD. Yale University School of Medicine.

Invited Discussant: A. Brent Eastman, M.D.

Introduction: Due to the 80-hour work week, extensive service cross-coverage creates great potential for patient care errors. These patient care emergencies are increasingly managed using a rapid response team (RRT) to reduce patient morbidity. We examine the proximate causes of a surgical RRT activation. We hypothesize that most RRTs would occur during cross-coverage hours and be preventable or potentially preventable.

Methods: All surgical RRTs over a 15 month period were captured using a nursing database and the note from the staffing Intensivist/fellow. RRTs were reviewed for appropriateness (pre-existing criteria), and proximate cause. Proximate causes were further classified as patient disease, team error, nursing error, or system error as well as preventable, potentially preventable or nonpreventable.

Results: Of 98 RRT activations, complete data was available for 82 (84%); 100% met activation criteria and 76 (93%) occurred between 2100-0600. 76 patients were 48-72 hours post-op; 6 had non-operatively managed injuries. The most common reason for activation was impending respiratory failure and acute volume overload (n=72; 88%). Initial RRT therapies included diuretics (n=72), antiarrhythmics (n=48), oxygen (n=82), bronchodilators (n=36); only 2 received blood component therapy. Seventy eight patients (95%) were transferred to higher level of care (61 - SICU , 17 - Step-Down Unit). Only 46% of patients required intubation. Performance improvement review identified 90% of physician related RRTs as preventable/potentially preventable due to errors in judgment or omission. 4 RRTs due to patient disease were unpreventable. Two potentially preventable errors were each ascribed to RN or system concerns.

Conclusions: RRT activations principally result from team based errors of omission, more often occur between 2100 and 0600, and are more often preventable. Careful attention to fluid balance and medical management of comorbid diseases would reduce RRT needs.

Session III-B

Paper 31 3:40 PM

SCOOP AND RUN TO THE TRAUMA CENTER OR STAY AND PLAY AT THE LOCAL HOSPITAL - GLUE GRANT DATA ANALYSIS OF HOSPITAL TRANSFER EFFECT ON MORTALITY

Ram Nirula*, MD MPH, Jason L. Sperry, MD MPH, Ernest E. Moore*, MD, Ronald V. Maier*, MD, Larry M. Gentilello*, MD. University of Utah.

Invited Discussant: Norman E. McSwain, Jr. M.D.

Background: A recent national study of trauma costs and outcome (NSCOT) documented a 20% mortality risk reduction when severely injured patients receive care in a trauma center. Triage attempts to capture this benefit by ensuring that severely injured patients are transported to a high-level trauma facility. However, some patients are triaged to the nearest medical facility for evaluation and decision-making prior to transport to a final destination trauma center (TC). We sought to determine if initial triage of critically injured patients to a non-trauma center is associated with increased mortality.

Methods: A retrospective cohort analysis of the Glue Grant Trauma Database of severely injured patients treated at eight level 1 TCs was performed. Mortality risk for patients who had an intermediate stop at another facility were compared with patients triaged directly from the scene to a level 1 TC. Analyses were performed for all deaths as well as excluding deaths within 24 hours. Patient demographics, time from injury to TC arrival, resuscitation volume, transfusions, head injury, initial SBP, co-morbidities, and injury severity were included as confounders in a multivariate logistic regression model.

Results: There were 1,112 patients of whom 318 (29%) were initially triaged to a non-trauma center. After adjusting for confounders, including time from injury to TC arrival, this was associated with an increase in pre-hospital crystalloids (4.2L vs 1.4L, $p<0.05$) and a twelve-fold increase in need for red cell transfusions (60% vs. 5%, $p<0.001$). Age, ISS, APACHE II score, and time from injury to TC arrival were independent predictors of mortality. The odds of death were 3.8 times greater (95% CI, 1.6-9.0) when patients were initially triaged to a non-trauma facility.

Conclusions: Triaging severely injured patients to hospitals that are incapable of providing definitive care is associated with increased mortality. Attempts at initial stabilization at a non-trauma center may be harmful. These findings are consistent with a need for continued expansion of regional trauma systems.

Session III-B

Paper 32 4:00 PM

WHAT ARE WE MISSING: RESULTS OF A THIRTEEN MONTH ACTIVE FOLLOW-UP PROGRAM

Nancy R Martin, ACNP, Ajai K Malhotra*, MD, Melanie Jacoby, RN, Janie Tarrant, RN, Kelly Guilford, RN, Rao R Ivatury*, MD. VCU Medical Center.

Invited Discussant: Robert L. Coscia, M.D.

Background: Poor follow-up by trauma patients results in a lack of knowledge of post-discharge health related issues. The current study reports on post-discharge health related issues discovered by a program of active post-discharge contact/follow-up.

Methods: All patients discharged home from the trauma service were followed up on in the following manner. Within 4-weeks of discharge, telephonic follow-up was attempted 3 times followed by scanning of electronic records. Failing that, other physicians (specialists and/or primary care) were contacted. Once contact was established, the patient/family member/physician was questioned about the general well being and any specific health related issue and the resolution.

Results: Over the 13-month study period ending September 07, 1353 patients met entry criteria. Contact was established with 692 (51%). Of these 95 (14%) were found to have significant health issues: 1) Infections-31 (Urinary-8, Pulmonary,-6, Blood stream-2, Wound-15); 2) Missed injury-12 (Head bleed resulting in death at home-1, Fractures-8, Soft tissue-3); 3) Venous Thrombo-embolism (VTE)-10; 4) Severe uncontrolled pain-33; and 5) Other-9 (Psychiatric-6, non-traumatic-3). The issues were significant enough for the patients to seek medical care (PCP-59, ED visits-40, hospitalization-20 and specialist care-5) (Table).

Issues identified	PCP	ED	Hospitalization	Specialist	Death
Infections (31)	11	11	8	1	-
VTE (10)	1	3	3	3	-
Missed injury (12)	4	6	-	1	1
Severe uncontrolled pain (33)	13	20	-	-	-
Other (9)	-	-	9	-	-

Conclusion: A significant proportion of trauma patients have moderate to severe health related issues post discharge that are often not found by the trauma team or trauma registry. Active follow-up can identify the nature of the medical issues and help design system changes to reduce/eliminate them.

Session III-B

Paper 33 4:20 PM

COMMITMENT TO COT VERIFICATION IMPROVES PATIENT OUTCOMES AND FINANCIAL PERFORMANCE

Paul M. Maggio, MD MBA, Mary-Anne Purtill, MD, Michael Bellino, MD, Susan I. Brundage*, MD MPH, David A. Spain*, MD. Stanford University.

Invited Discussant: Erwin R. Thal, M.D.

Background: Following an unsuccessful COT visit, our Level I Trauma Center (TC) initiated a Performance Improvement Program that included additional personnel (trauma director and surgeons, nurse coordinator, orthopedic trauma surgeon, and registrar), correcting deficiencies in Trauma QA/PI process and an outreach program. Subsequently, our TC had 2 successful verifications visits. We examined the longitudinal effects of this commitment to COT verification on volume, patient outcomes and financial performance.

Methods: The Trauma Registry was used to derive data for admissions, inter-facility transfers, Injury Severity Scores (ISS), length of stay (LOS) and mortality for 2002-2007. Financial performance was assessed for fiscal years 2002-2007 using hospital data.

Results: Admissions increased 33%, mostly due to a 5x increase in inter-facility transfers. Trauma patients with ISS > 24 increased 39% and ICU LOS decreased 32%. Mortality for ISS > 24 decreased by 45%. There has been a sustained increase in hospital revenue due to trauma (Table) while professional reimbursement for trauma surgeons increased 2.3 fold.

	2002	2003	2004	2005	2006	2007
Mortality ISS > 24	30%	25%	23%	18%	16%	17%
Net Trauma Revenue (Millions)	18.0	22.0	25.2	38.0	26.0	33.8
Contribution to Margin (Millions)	8.5	12.4	12.9	18.7	13.2	17.3

Conclusions: A major hospital commitment to COT verification had several salient outcomes; increased admissions, inter-facility transfers and acuity. Despite more seriously injured patients, there has been a major, sustained reduction in mortality and resource utilization (ICU LOS). This resulted in a substantial increase in contribution to net revenue, contribution to margin, and professional revenues. With a high level of commitment and favorable payer mix, TC verification improves outcomes for both the patients and hospital.

Session III-B

Paper 34 4:40 PM

AN ANALYSIS OF TRAUMA CENTER FINANCIAL PERFORMANCE: TRADING PROFIT FOR LIVES

Michael R Bard, MD, Michael F Rotondo*, MD, Brett H Waibel, MD, Joel Goodwin, MD, Eric A Toschlog, MD, Paul J Schenarts, MD, Claudia E Goettler, MD, Mark A Newell, MD, Scott G Sagraves, MD. East Carolina University.

Invited Discussant: Samir M. Fakhry, M.D.

Introduction: In a previous study, the price of commitment for trauma center development, or investment expense (IE = hospital and academic contributions), was reported at $15.1M and resulted in the benefit of 173 saved lives or $87K/life. However, the effect of IE on contribution margin (CM) and profit/loss (PL) was not considered. This investigation evaluates the overall impact of IE on trauma center financial performance.

Method: Financial records for all patients admitted to our Level 1 University Trauma Center were evaluated for the development period (2001-2005). Total revenue (TR) considered hospital (HR) and physician (PR) reimbursement. Total expense (TE) was calculated from the sum of hospital direct (HDC) and indirect (HIC) cost, and departmental expense (DE). CM and PL were calculated as: CM = TR - (HDC - DE) and PL = TR – TE. CM and PL per patient and the effect of IE on both CM and PL was then determined.

Results: A total of 11,057 patients were admitted during the study period. TR was $169.7M (HR $164.1M, PR $5.6M). TE was $185.1M (HDC $95.8M, HIC $81.4M, and DE $7.9M). CM was $66M or $6K/patient and PL was -$15.4M or -$1.4K/patient. If IE ($15.1M) had not been utilized for development, TE decreased to $170M resulting in a CM/patient increase to $7.3K and a reduction of PL/patient to -$27.

Conclusions: Given the assumption inherent in the financial model, investment expense or trauma center development – aimed at improving patient outcome – turned a break-even operation into a money-losing proposition. Lives were saved at the expense of profit. This work further substantiates the need for alternative funding mechanisms for both the development and sustenance of trauma centers.

Session VI

Paper 35 8:00 AM

OPTIMAL EVALUATION OF INJURY SEVERITY FOR MULTIPLE TRAUMA

T Tarui, MD, S Uno, MD, H Goto, MD, T Matsuda, MD, S Shimazaki*, MD, Y Yamaguchi, MD . Kyorin Univ. Hospital, Tokyo, Japan.

Invited Discussant: Steven R. Shackford, M.D.

Objective: To evaluate the overall severity of injuries for multiple trauma patients is a key for optimizing trauma care. Among the tools for that purpose, Injury severity score (ISS) and New ISS (NISS) are most often used recently. ISS has been reported to ignore the multiple injuries in the same region, whereas NISS has also been criticized to overestimate them. The objective of this study is to find an optimal way for the evaluation of injury severity for multiple trauma patients.

Methods: We conducted a chart review for all trauma patients in our level 1 trauma center in a year of 2007. Using AIS codes set for all injuries of multiple trauma patients, we generated a brand-new ISS, named Optimal ISS (OISS), which consisted of the sum of (the worst AIS)^2 , R x (the second worst AIS)^2 and R x (the third worst AIS)^2. In the equation, the "R" is 1.0 or 0.21, if the second or the third worst injury is in the different or the same region from/with the other regions, respectively. We compared the OISS as a prediction tool for the mortality with ISS or NISS.

Results: In 2007, we treated 124 multiple trauma patients (95 males and 29 females), and their average age was 46.7 years old. Among them, 26 patients were dead during the hospital stay and the mortality rate was 21.0%. The average ISS, NISS, and OISS were 18.7, 25.3, and 19.2, respectively. The area under ROC curve of ISS, NISS, or OISS for the prediction of death was 0.880, 0.863, or 0.887, respectively. OISS was the better method for mortality prediction than the other scores compared, and the sensitivity and specificity were 0.846 and 0.816, respectively, when the cut-off value was fixed to be 19.8.

Conclusion: OISS is found to be an optimal evaluation tool of injury severity for multiple trauma patients, for the score takes into consideration the injury location, whether it is in the same or the different region with/from the others. OISS might be also useful to predict the outcome of trauma patients for optimizing trauma care.

Session VI

Paper 36 8:20 AM

IS IT NECESSARY TO IMAGE THE CERVICAL SPINE IN YOUNG CHILDREN FOLLOWING BLUNT TRAUMA? AN AAST MULTI-CENTER STUDY

Peter T. Masiakos, MS MD, Rafael Pieretti-Vanmarcke, MD, George C. Velmahos*, MD PhD MSEd. PEDSPINE study group, Massachusetts General Hospital for Children.

Invited Discussant: Therese M. Duane, M.D.

Cervical spine injuries (CSI) in children are uncommon but potentially devastating. C-spine clearance in toddlers is complicated by an unreliable clinical examination. The optimal method to evaluate the pediatric c-spine is undefined. Furthermore, concerns about radiation exposure have raised questions about the need to image these rarely injured patients. An international, multi-center AAST-sponsored study sought to establish optimal c-spine clearance guidelines for blunt trauma patients younger than 3 years of age.

Methods: For the period 01/95-01/05, Trauma registry and medical record data from 22 trauma centers were reviewed for children age 0-3 years, who were evaluated for blunt trauma. Data included: demographic variables, injury mechanism and severity, clinical findings, imaging modalities, CSI, and interventions. The outcome measured was clinically significant c-spine injury (CS-CSI), defined as CSI, requiring prolonged immobilization (i.e. hard collar, Halo, operation). Using predictors of CS-CSI determined by univariate and multivariate analysis (significance set at $p<0.05$), an at-risk population was identified.

Results: 9,771 eligible patients were identified. 2,803 (28.7%) underwent c-spine imaging. A CS-CSI was identified in 119 patients (1.2%). By creating a weighted score (WS) based on three simple independent predictors and their statistical significance, 7,679 patients (78.5%) with a score of 0 or 1 could be ruled out for CS-CSI without the need of imaging.

Independent Predictor CS-CSI	WS	Odds Ratio	95% C I	P-value
Glasgow Coma Scale < 14	3	55.95	28.80-108.68	<.0001
Age = 3 years old	2	15.67	8.53 - 28.76	<.0001
Mechanism = MVC or Fall	1	3.77	2.25 - 6.31	<.0001

Only 4 patients with score 0 or 1 had CS-CSI (Negative Predictive Value: 99.95%) but all 4 demonstrated neurologic signs on admission suggestive of CS-CSI.

Conclusions: CS-CSI in children less than 3 years old is very rare. Simple clinical predictors can be used to obviate the need for C-spine imaging in the majority of this patient population.

Session VI

Paper 37 8:40 AM

FOUR YEARS OF THE JAPAN TRAUMA DATA BANK (JTDB): EVALUATION OF THE INTERACIVE WEB-BASED TRAUMA REGISTRY IN TERMS OF QUALITY INDICATORS FEEDBACK

N Aoki, MD, S Ohta, MD, H Tohira, MD, N Morimura, MD, D Saito, MD, K Koseki, MD, J Yokota, MD, T Sakamoto, MD, T Aruga, MD. Center for Health Service, Outcomes Research and Development, Tokyo, Japan.

Invited Discussant: Ernest F.J. Block, M.D., M.B.A.

Purpose: The Japan Trauma Data Bank (JTDB) is a web-based trauma registry with interactive quality indicators (QIs) feedback and anonymous benchmarking. This paper aims to; (1) compare basic JTDB statistics with those of the National Trauma Data Bank (NTDB), (2) validate TRISS methodology in Japanese, and (3) preliminarily evaluate the effect of QIs feedback in quality improvement.

Methods: A total of 13,677 complete clinical data entries were made from 45 trauma centers in 2004 - 2007. The time trend of two pilot QIs (rate of performance) were evaluated: (1) FAST (focused assessment with sonography for trauma) for patients with a shock index ?1.0 (i.e. heart rate ? systolic blood pressure), and (2) Neck color of patients showing somnolence (defined by Japan Coma Scale ? 10) in prehospital settings.

Results: Compared with NTDB, JTDB data has more elderly (43.6% vs. 26.5%), less penetrating trauma (4.8% vs. 11.1%), and more severe (26.1% vs. 9.6% in ISS>24 bracket) patients. Although the area under the ROC curve was 0.963 (95%CI: 0.958 – 0.967), the JTDB population showed a low survival ratio in the 60-70% (58.1%) and 70-80% (68.3%) survival brackets by the TRISS method, respectively. The table demonstrates average QIs in 2004 – 2007; demonstrating an improvement over the period.

QIs	2004	2005	2006	2007
FAST (%)	77.5	79.5	79.7	84.6
Neck Color (%)	50.2	55.4	59.8	58.3

Conclusions: JTDB data demonstrates some differences from NTDB in demographics. Due to these differences, TRISS methodology may need to be calibrated for a Japanese population. Web-based interactive QI feedback showed a potential to improve trauma care performance.

Session VI

Paper 38 9:00 AM

END-TIDAL CO2 IS NOT A RELIABLE MARKER OF VENTILATION STATUS IN THE TRAUMA PATIENT

Keir J. Warner, BS, Joseph Cuschieri*, MD, David J. Carlbom, MD, David Baker, MD, Brandon T. Garland, BS, Gregory J. Jurkovich*, MD, Michael K. Copass, MD, Eileen M. Bulger*, MD.
Harborview Medical Center.

Invited Discussant: Yoshihiro Yamaguchi M.D.

Background: Tightly regulated ventilation in the early management of traumatic brain injury (TBI) is critical. Recent evidence has shown that an arterial CO2 (PaCO2) of 30-39mmHg is the ideal target range for early ventilation in trauma patients; however, this requires serial arterial blood gas (ABG) measurements. End-tidal capnography (EtCO2) may be a surrogate measure of ventilation that would be well-suited to the prehospital setting. While there is good correlation between EtCO2 and PaCO2 in healthy patients, this may not be the case following injury with impaired pulmonary ventilation/perfusion. We hypothesize that EtCO2 directed ventilation will demonstrate a poor correlation with PaCO2 measures of ventilation status in the trauma patient.

Methods: We conducted a prospective observational study on consecutive intubated trauma patients treated in our emergency department over a nine month period. Patients had EtCO2 continuously measured as part of standard treatment. When routine ABG values were sampled, the concomitant EtCO2 level was recorded. Regression analysis was used to determine the strength of correlation among all trauma patients and then stratified based on the admission base deficit (BD) as a marker of shock.

Results: Between 01/01/07 –12/31/07, 185 patients were evaluated. The overall EtCO2-PaCO2 correlation was R^2=0.289, but variedly greatly with admission base deficient: BD --2 to 2 had a correlation of R^2= 0.65; BD 2-6 R2=0.24; and BD > 6 R2=0.26. Patients ventilated in the commonly recommended EtCO2 range of 35-40 were likely to be under ventilated (PaCO2>40mmHg) 80% of the time, and severely under ventilated (PaCO2>45mmHg) 30% of the time.

Conclusion: The use of EtCO2 as a ventilation guide in trauma patients with significant BD has poor correlation. Better strategies for guiding prehospital and emergency department ventilation are needed.

Session VI

Paper 39 9:20 AM

PRE-INJURY WARFARIN WORSENS OUTCOME IN ELDERLY PATIENTS WHO FALL FROM STANDING

Jerry Lee Howard, MD, Mark Cipolle*, MD PhD, Sarah Horvat, BS, Victoria Sabella, RN CCRC, Glen Tinkoff*, MD, Michael Pasquale*, MD. Lehigh Valley Hospital.

Invited Discussant: David T. Efron, M.D.

Introduction: Fall from standing is one of the most common mechanisms of injury for admission to the trauma center in the elderly population. Many of these patients present anticoagulated with warfarin. This two-center study was designed to examine effects warfarin has on outcome in this population.

Methods: A retrospective review of prospectively collected registry data at two Level I trauma centers was conducted from 2003 to 2006. The study population included patients age ?65 admitted to the trauma center after a fall from standing. These centers are close geographically and have similar patient demographics. Data collected included age, ISS, AIS for head, mortality, admission GCS and INR. Patients were divided into two groups based on pre-injury condition of warfarin use. Statistical differences were determined by unpaired t-test for continuous variables and Chi square for dichotomous variables.

Results: Of the 27,812 patients admitted to these two trauma centers over this time period, 2791 (10.0%) were age ?65 admitted after a fall from standing. INR was 2.8±1.1 in warfarin group (+ warf). The number of patients with AIS head 4 and 5 was similar between groups (-warf 22.1%, +warf 25.9%).The tables summarize the data.

Table 1. Demographics and Overall Mortality

	N	Age	ISS	GCS	Mortality
- warf	2254	80.9±7.7	10.4±7.6	14.0±2.3	5.7%
+warf	537	80.8±7.1	10.8±8.6	14.2±2.3	8.6%
P value		0.8	0.3	0.7	0.02

Table 2. Mortality as a Function of Admission GCS and AIS head

	GCS 3-8	GCS 9-13	GCS 14-15	GCS 14-15 and AIS 4-5
-warf	52.6%	18.0%	3.3%	6.4%
+warf	52.4%	25.5%	5.3%	13.5%
P value	1.0	0.4	0.06	0.03

Conclusion: Pre-injury warfarin use has an adverse effect on outcome (mortality) in elderly patients who fall from standing. Importantly, this effect is most prominent in patients admitted awake with significant findings on CT scan. This argues for rapid triage and INR correction in this population.

Session VI

Paper 40 9:40 AM

THE EFFECT OF TRAUMA TRAUMA CENTER DESIGNATION ON OUTCOME IN TRAUMA PATIENTS DEVELOPING VENTILATOR-ASSOCIATED PNEUMONIA

Brad Putty, MD, Joe DuBose, MD, Pedro G.R. Teixeira, MD, Gustavo Recinos, MD, Lydia Lam, MD, Kenji Inaba*, MD, Demetrios Demetriades*, MD PhD, Howard Belzberg, MD. Los Angeles County / University of Southern California Hospital.

Invited Discussant: Lena M. Napolitano, M.D.

Introduction: Previous investigations have established an association between outcomes of severe trauma and American College of Surgeons (ACS) trauma center designation. The association between ventilator associated pneumonia (VAP) and ACS level is less well defined.

Methods: The National Trauma Databank (NTDB, v. 5.0) was queried to identify adult (Age ? 18) trauma patients ventilated ? 48 hours who developed VAP after admission to either ACS level I or level II centers. Transfer and burn patients were excluded. Univariate analysis defined differences between patient cohorts. Logistic regression analysis was utilized to identify independent risk factors for mortality.

Results: A total of 3465 patients were identified, 2274 level I and 1191 level II admissions. Univariate analysis revealed level I patients were more commonly older (age ? 55, 71.5% vs. 66.8%, $p = 0.004$), injured by penetrating mechanisms (6.9% vs. 2.6%, $p < 0.001$) and hypotensive (SBP < 90) on admission (16.2% vs. 13.6%, $p = 0.042$). The populations were otherwise similar. Level I patients were more likely to receive early (? 7 days) tracheostomy (33.1% vs. 29.1%, $p = 0.017$) and achieve discharge to home (20.2% vs. 16.1%, $p < 0.001$). Despite longer mean vent days (18.5 vs. 16.5 days, $p = 0.001$) and hospital LOS (34.2 vs. 29.6 days, $p < 0.001$), level I patients also had decreased mortality rates (10.8% vs. 14.7%, $p = 0.001$). Logistic regression analysis revealed that age > 55, GCS ? 8 and admission to a level II facility were independent risk factors for mortality.

Adjusted odds ratio for mortality after logistic regression

Variable	Adjusted Odds Ratio (95% CI)	*p*-value
Gender	1.23 (0.95 - 1.59)	*0.111*
Mechanism	1.18 (0.67 - 2.05)	*0.569*
ISS > 15	0.78 (0.58 - 1.02)	*0.067*
Hypotension (SBP < 90)	0.82 (0.62 - 1.09)	*0.172*
Age > 55	3.38 (2.70 - 4.22)	*0.000*
GCS <= 8	1.36 (1.09 - 1.69)	*0.007*
ACS Level II	1.34 (1.08 - 1.66)	*0.008*

Conclusion: For adults who develop VAP after trauma, admission to a level I facility is associated with improved survival. Further prospective study is needed to determine the factors responsible for this observation.

Session VI

Paper 41 10:00 AM

THE MISSING DEAD: THE PROBLEM OF CASE ASCERTAINMENT IN THE ASSESSMENT OF TRAUMA CENTER PERFORMANCE

David Gomez, MD, Wei Xiong, BSc MSc, Najma Ahmed*, MD PhD, Avery B Nathens*, MD PhD. St. Michaels Hospital.

Invited Discussant: Frank L. Mitchell, III, M.D.

Introduction*:* Policies and procedures regarding the transportation and care of patients presenting without vital signs in the field or emergency department (ED) vary across regions and institutions. Similar variation occurs with definitions of dead on arrival (DOA) and perceptions of futility and salvagebility. Thus institutions might capture different populations in their local registries, some of whom are unsalvageable. This has implications for the interpretation of hospital performance indicators. We set out to evaluate how this variation might affect the perception of performance.

Methods*:* NTDB (version 7) was used to capture adult patients (n=442,692) across 211 hospitals. Early deaths were those occurring ≤24 h after arrival. We postulated that if centers were similar in their capture of these patients and in their performance, the ratio of early to late deaths (E/L) would be similar across institutions after case mix adjustment. We developed a prediction model to create an adjusted E/L. Hospitals were divided in quartiles based on adjusted E/L: a lower ratio (or lower quartile) means fewer early deaths.

Results*:* Mortality was 5.3%. The mean crude E/L ratio was 1.32. There was marked variation in E/L across centers (range: 0.2-6). Significant variation persisted after adjustment: 0.21-3.81 (Table 1). Case mix among early deaths varied significantly across quartiles: patients were younger, more likely to be male, had greater degrees of injury severity and a higher mortality rate with increasing quartiles. Institutional characteristics significantly associated with higher adjusted E/L were: Level 1 or 2 center, teaching institution; and those stating they included DOA as part of their registry inclusion criteria.

Conclusions*:* There are marked differences in E/L ratios across centers after adjustment, which might be due to differing policies or perceptions of futility. We estimate that as many as 33% of all deaths are “missing” in because of differential case ascertainment suggesting that the missing dead might play an important role in decreasing a center’s reported mortality and improving the perception of hospital performance.

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Session VI

Paper 42 10:20 AM

PREDICTORS OF POST-TRAUMATIC DEEP VEIN THROMBOSIS (DVT) - HOSPITAL PRACTICE VS. PATIENT FACTORS: AN ANALYSIS OF THE NATIONAL TRAUMA DATA BANK (NTDB)

Elliott R. Haut*, MD, David C. Chang, MBA MPH PhD, Charles A. Pierce, MPH, David T. Efron*, MD, Adil H. Haider, MD MPH, Preeti R. John, MD MPH, Peter J. Pronovost, MD PhD, Edward E. Cornwell III*, MD. The Johns Hopkins University School of Medicine.

Invited Discussant: Kevin M. Dwyer, M.D.

Objectives- Trauma centers that perform more duplex ultrasounds report more DVTs. However, it is uncertain if this is due to hospital practices or patient characteristics. We hypothesize that admission to trauma centers that aggressively use duplex, independently predicts DVT reporting for individual patients, controlling for patient-level risk factors.

Methods- We analyzed patients from hospitals reporting at least one vascular ultrasound and one DVT to the NTDB (v6.2). As NTDB contains no data on hospital duplex surveillance practice, we defined "screening" hospitals as those performing ultrasound on over 2% of patients. The primary outcome measure was DVT diagnosis. Multilevel multiple logistic regression was performed, comparing "screening" vs. "non-screening" hospitals, with patient-level risk factor covariates. Sensitivity analysis was performed by varying duplex rate cutoff (5%,10%,15%), outcome (VTE) , and population (LOS>3 days).

Results- Approximately half of 492,496 total patients were admitted to "screening" hospitals. Unadjusted DVT rate was 3-fold higher in "screening" hospital patients (1.18% v. 0.35%, p<0.001). "Screening" hospital admission was independently associated with higher likelihood of having DVT reported (OR 2.16, p=0.03). No qualitative differences were identified on sensitivity analysis (OR range 1.56 to 3.59).

Risk Factors Associated with DVT Identification in Individual Trauma Patients

	Odds Ratio	95% Confidence Interval
"Screening" vs. "Non-Screening" Hospital	2.16	1.07-4.34
Age ? 40 years	2.00	1.74-2.30
Extremity Injury (AIS?3)	1.96	1.68-2.30
Head Injury (AIS?3)	1.53	1.22-1.92
Ventilator Days ? 3	5.14	3.66-7.22
Venous Injury	2.85	1.97-4.13
Major Surgery	4.79	4.08-5.62

Conclusions- Hospital ultrasound practice is an independent predictor of DVT diagnosis, even controlling for patient-level risk factors. This is further evidence that hospital DVT rate is an inadequate quality of care measure after trauma.

Session VI

Paper 43 10:40 AM

DVT SURVEILLANCE PROGRAM IN THE ICU: A COST BENEFIT ANALYSIS

Stephanie R Goldberg, MD, Ajai K Malhotra*, MD, Nancy Martin, RN, Vishal Khiatani, MD, Todd Borchers, NP, Therese Duane* MD, Michel Aboutanos*, MD MPH, Rao Ivatury*, MD.
VCUHS, Medical College of Virginia.

Invited Discussant: Rochelle A. Dicker, M.D.

Objective: Deep venous thrombosis (DVT) and pulmonary embolism (PE) in traumatized patients leads to significant in-hospital mortality and short and long term morbidity. The current study evaluates the effectiveness of a DVT surveillance program in reducing the incidence of PE among traumatized patients admitted to the ICU, and the associated cost.

Methods: All trauma patients admitted to the adult ICU had surveillance (2/week) by lower extremity venous duplex (surveillance period – SP: 2004-07). The rates of DVT and PE were recorded and compared to the rates observed in the pre-surveillance period (PSP: 2001-03). All patients in both periods received mechanical and pharmacologic prophylaxis within 24 hours of admission unless contraindicated. For cost analysis, the average length of ICU stay was used to calculate the average number of examinations per patient. This was compared to the medical and monetary benefit of any reduction in PE rates.

Results: There were a total of 4337 trauma patients admitted (PSP – 1427 and SP – 2910). Number of DVTs were higher in the SP though this was not statistically significant. The number of PEs in the SP was significantly lower ($p<0.05$) (Table).

Period	ICU patients	DVT (p = not significant)	PE (p<0.05)
PSP (2001-03)	1427	12	22
SP (2004-07)	2910	36	25

Based on these data, surveillance resulted in possible prevention of 20 PEs, with diagnosis and treatment cost saving of $300,000 (assuming cost of $15,000/PE) and 1 PE related death (assuming a case fatality rate of 5%). The cost of the surveillance program was $873,000 (mean length of ICU stay of 5 days with mean 1.5 duplex examinations per patient and $200/examination).

Conclusions: Routine surveillance of trauma patients admitted to the ICU has a significant cost, however it results in a decreased rate of pulmonary embolism and possible death.

Session VIII

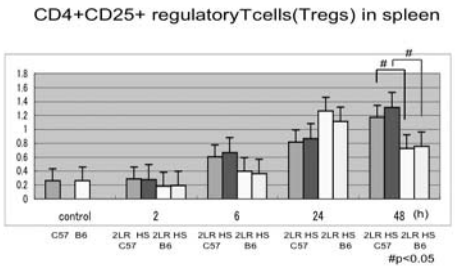
Paper 44 8:20 AM

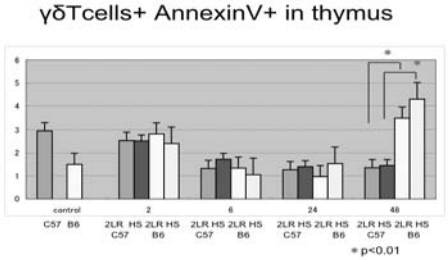
EFFECT OF HYPERTONIC SALINE RESUSCITATION ON CD4+CD25+ REGULATORY GAMMA DELTA T CELLS AND T CELLS AFTER HEMORRGAGIC SHOCK AND RESUSCITATION IN RELATION TO APOPTOSIS AND iNOS

Yoshinori Murao, MD, Kenji Isayama, MS, Fukuki Saito, MD, Akihiko Hirakawa, MD, Toshio Nakatani*, MD PhD. Kansai Medical University, Osaka, Japan.

Invited Discussant: David B. Hoyt, M.D.

We examined effects of hypertonic saline resuscitation on $CD4^+CD25^+$ regulatory T cells and γδ T cells after hemorrhagic shock and resuscitation in relation to apoptosis and iNOS in mice. **Methods**: Male C57BL/6J mice 8 to 12 weeks old as wild type and B6.129P2 (NOS2) mice as iNOS gene knock out were used. Mice were anesthetized and blood was withdrawn until a mean arterial pressure of 40±5 mmHg was reached, and maintained for 60 min. Resuscitation was performed as follows: HS+SB; with hypertonic saline (4 ml/Kg of 7.5% NaCl :HS) and shed blood (SB), 2LR+SB; with lactated Ringer's solution (2 times the volume of the shed blood) and SB. Samples of thymus and spleen were harvested at 2, 6, 24 and 48h after resuscitation. $CD4^+CD25^+$ regulatory T cells and γδ T cells were estimated using flow cytometry. Apoptosis was assessed with AnnexinV. **Results:** 1) Hypertonic saline resuscitation did not affect on $CD4^+CD25^+$ regulatory T cells and γδ T cells in wild type and iNOS knock out mice. 2) Regulatory T cells at 48h in spleen in wild type increased compared with iNOS knockout mice. ($P<0.05$). 3) Apoptotic γδ T cells both in spleen and thymus in iNOS knock out mice increased compared with wild type ($P<0.05$). **Discussion:** Immunoenhancing effect of hypertonic saline resuscitation did not correlated with $CD4^+CD25^+$ regulatory T cells and γδ T cells. Immunosuppressive condition after hemorrhagic shock and resuscitation may be related with $CD4^+CD25^+$ regulatory T cells and γδ T cells through iNOS gene.





Session VIII

Paper 45 8:40 AM

HEMOSTATIC RESUSCITATION IN A POLY-TRAUMA MODEL: RESULTS OF A MULTI-INSTITUTIONAL RANDOMIZED PRE-CLINICAL TRIAL

Hasan B Alam*, MD, Jill Sondeen PhD, John Holcomb*, MD, Martin A Schreiber*, MD.
Hemostatic Resuscitation Research Group, Massachusetts General Hospital/Harvard Medical School.

Invited Discussant: Jun Oda, M.D.

Introduction: Trauma induced coagulopathy, acidosis and hypothermia form a "lethal triad" that is difficult to treat, and is associated with extremely high mortality. This study was performed at three academic centers to evaluate whether "Hemostatic Resuscitation" with blood components could reverse the coagulopathy in a complex poly-trauma model.

Methods: Yorkshire swine (40±5 Kg) were subjected to a three phase protocol: "Pre-Hospital" phase= femur fracture, hemorrhage (60% blood volume), and 30 min shock + infusion of saline (3x shed blood) + induction of hypothermia (33^0C); "Early Hospital" phase= grade V liver injury; and "Operative" phase= liver packing. Animals (n=75) were then randomized to the following groups: 1) Sham, 2) control (no treatment), 3) Fresh Whole Blood (FWB), 4) Fresh Frozen Plasma/Packed Red Blood Cells in 1:1 ratio (1:1 FFP/PRBC), 5) FFP alone, 6) 6% hetastarch (Hextend). Treatment volumes were equal to the shed blood. Hemodynamic and physiologic parameters, and coagulation profile [thrombelastography (TEG), PT, PTT. INR, platelets] were monitored during the experiment, and for 4 hours post treatment.

Results: At the end of pre-hospital phase, there was significant acidosis (lactate >6 mmol/L) and coagulopathy (30-80% increase in PT). 30% of the animals died before randomization, and post treatment mortality rates were 75%, 80% and <10% for control, Hextend and blood component groups respectively ($p<0.05$). Hemodynamic parameters and survival rates were similar in groups 3-5. Animals treated with FFP alone had significant anemia compared to the FWB and FFP/PRBC groups, but showed an equivalent correction of coagulopathy, whereas Hextend treatment worsened the coagulopathy.

Conclusions: In this highly reproducible model, we have shown that trauma associated coagulopathy is made worse by hetastarch, but it can be rapidly reversed with the administration of blood components. Impressively, infusion of FFP, even without any red blood cells, can correct the coagulopathy and result in excellent early survival.

Session VIII

Paper 46 9:00 AM

VASOPRESSIN SUPPLEMENTATION: THE MISSING LINK OF TRAUMA EXSANGUINATION PROTOCOLS?

Carrie Sims, MD, Lilias Holmes, MD, Gina Bui, MD, Rebecca Jaffe, MD , Niels Martin, MD , AnnaMarie Horan, PhD, Meredith Bergey, PhD, Yuxia Guan, BS , Mindy Figures, BS, Patrick Reilly*, MD, CW Schwab*, MD. University of Pennsylvania.

Invited Discussant: Jay A. Yelon, M.D.

Introduction: Arginine vasopressin (AVP) is essential for maintaining vasomotor tone during shock. With prolonged hemorrhage, AVP levels may precipitously taper off. Aggressive resuscitation may further depress AVP levels and compromise vasomotor tone. We hypothesize that massive resuscitation is associated with an AVP deficiency that contributes to the vasoplegia seen in late-stage hemorrhagic shock.

Methods: A prospective, observational study was conducted at a large urban Level I trauma center between 3/07-9/07. Patients who were hypotensive (SBP<90 mmHg X 2) or who received blood in the trauma bay (TB) were included (N=22). Hemorrhage control was achieved prior to ICU admission. Serial blood samples were collected (TB? ICU 48hrs). Demographics, injury data, vital signs, lactate, base excess, hemoglobin, transfusion and crystalloid volume were recorded. AVP was measured by EIA post hoc. AVP deficiency (AVP Def) was defined as AVP<10 pg/ml and a MAP≤ 65. Data was analyzed using Mann-Whitney and Fischer's exact tests.

Results: AVP levels were markedly elevated on admission, but decreased rapidly. AVP Def was noted in 11/22 patients. An elevated lactate (TB) and the # of units transfused predicted the development of AVP Def. Vasopressors were required in 7/11 patients with AVP def and in 0/11 patients without AVP Def within 48hrs ($p<0.01$).

	No AVP Def	AVP Def	P-Value[b]
Age	34±14	36±19	0.87
ISS	27±19	27±13	0.76
Lactate-TB	4.3±2.6	9.5±6.2	0.02
Lactate-ICU adm	2.8±1.2	3.5±2.2	0.73
BE-TB	-7.1±3.1	-8.2±5.1	0.48
BE-ICU adm	-2.1±2.0	-1.9±3.4	0.69
Units-ICU adm	2.7±2.0	16.3±11	<0.01
Units-Total/48hr	3.9±2.8	25.5±17.0	<0.01
Fluid-ICU adm	4990±2232	5278±2148	0.73
Fluid-Total/48hr	10700±2803	14712.3±5092	0.11
Hgb-TB	12.1±1.9	11±2.6	0.38
Hgb-ICU adm	11.3±2.4	11.0±3.0	0.90
AVP-TB	64.1±58.8	141.9±194.6	0.62
AVP-ICU adm	19.1±17.9	25.9±35	0.92

Conclusion: Severely injured patients who require massive transfusion are at risk for developing AVP def and a vasopressor requirement within the 48 hours of admission. Future research investigating early vasopressin supplementation for at risk patients is warranted.

Session VIII

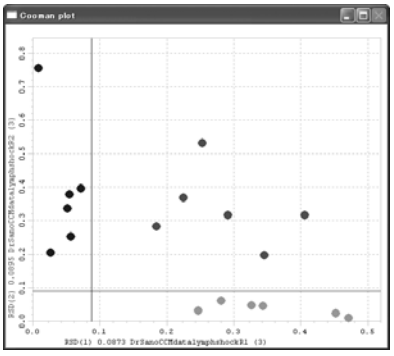
Paper 47 9:20 AM

1H-NMR METABOLOMICS STUDY OF POST-HEMORRHAGIC SHOCK MESENTERIC LYMPH AND LUNG

T Sano, MD, T Masuno, MD, K Hirakawa, PhD, Y Ohno, MD, N Satoh, MD, K Koike, MD, A Katsumi, MD, S Suzaki, MD, H Yokota, MD. Nippon Medical School, Kyoto Univ.

Invited Discussant: Christopher C. Baker, M.D.

Background: Post-hemorrhagic shock (HS) mesenteric lymph (ML) has been shown to contain proinflammatory mediators elaborated from the ischemic gut and cause distant organ injury via neutrophil priming and endothelial cell activation. However, identification of bioactive mediators which trigger distant organ injury remains elusive. Metabolomics is the comprehensive study of metabolites which may allow discovery of biomarkers. The **purpose** of this study was to determine if ^{1}H-Nuclear Magnetic Resonance (NMR) metabolomics could identify the different metabolite profiles in ML and lung with/without ML drainage following HS. **Methods**: Rats underwent HS (MAP 40 mm Hg x 30 min) and then resuscitation with shed blood and normal saline (2x shed blood) over 2 hours. ML was collected hourly up to 2 hours after shock. Lung were harvested after resuscitation. Sham animals were subjected to laparotomy but no hemorrhagic shock. The spectra of metabolites contained in mesenteric lymph and lung were obtained using ^{1}H-NMR spectroscopy, and the data were analyzed by multivariate analysis (Principle Component Analysis and SIMCA method). **Results**: The analysis showed the metabolite patterns of ML during HS, first resuscitation hour, and second resuscitation hour were distributed to each different cluster area. The metabolite pattern of lung with ML drainage differed from that without ML drainage. **Conclusion**: ^{1}H-NMR metabolomics identified the changes in metabolite profiles following hemorrhagic shock in mesenteric lymph and lung. Metabolomics may help to discover the biomarkers and provide insight into the pathogenesis of post-hemorrhagic shock organ injury.



^{1}H-NMR metabolomics
SIMCA of Mesenteric Lymph with Drainage

Session VIII

Paper 48 9:40 AM

PREDEFINED MASSIVE TRANSFUSION PROTOCOLS ARE ASSOCIATED WITH A REDUCTION IN ORGAN FAILURE AND POST-INJURY COMPLICATIONS

Bryan A Cotton*, MD, Brigham K Au, BS, Jay M Isbell, MD, MSCI, Timothy C Nunez, MD, Oliver L Gunter, MD, Pampaee P Young, MD PhD. VANDERBILT UNIVERSITY.

Invited Discussant: Kazuhiko Sekine, M.D.

Introduction: Massive transfusion (MT) protocols have been shown to improve survival in severely injured patients. However, others have noted that these higher FFP: RBC ratios are associated with increased risk of organ failure. The purpose of this study was to determine if MT protocols are associated with increased organ failure and complications.

Methods: Our institution's exsanguination protocol (TEP) involves the immediate and continuous delivery of products in 3:2 ratio of RBC: FFP and 5:1 for RBC: platelets. Patients receiving TEP between 02/2006-01/2008 were compared to a cohort (pre-TEP) of patients from 02/2004-01/2006 that (1) went immediately to the O.R. and (2) received MT (?10 units of RBC in first 24 hours). Organ failure, infectious complications, and abdominal compartment syndrome (ACS) were defined by published guidelines. "Open abdomen" was defined as failure to achieve primary fascial closure by post-injury day 7.

Results: 264 patients met inclusion. Demographics and ISS were similar. TEP received more FFP and platelets intra-op but less in first 24 hours ($p<0.01$). There was no difference in renal failure or SIRS, but pneumonia, pulmonary failure, and ACS were lower in TEP.

	TEP, n=124	pre-TEP, n=140	p-value
Severe sepsis/ septic shock, n (%)	11(9%)	28(20%)	0.011
Ventilator-free days, median	19.9 days	16.1 days	0.001
Open abdomen, n (%)	9(7%)	42 (30%)	<0.001
Multi-organ failure, n (%)	20 (16%)	52 (37%)	<0.001

Conclusions: While MT has been associated with higher organ failure and complication rates, these appear to be reduced when blood products are delivered early as part of a predefined protocol. Our institution's TEP was associated with a reduction in multi-organ failure and infectious complications, as well as an increase in ventilator-free days. Additionally, implementation of this protocol was followed by a dramatic reduction in development of ACS and the incidence of open abdomens.

Session VIII

Paper 49 10:00 AM

FRESH FROZEN PLASMA IS INDEPENDENTLY ASSOCIATED WITH A HIGHER RISK OF MOF AND ARDS

Gregory A. Watson, MD, Jason L. Sperry, MD MPH, Matthew R. Rosengart, MD MPH, Joseph P. Minei*, MD, Brian G. Harbrecht*, MD, Ernest E. Moore*, MD, Joseph Cuschieri*, MD, Ronald V. Maier*, MD, Timothy R. Billiar*, MD, Andrew B. Peitzman*, MD. University of Pittsburgh Medical Center.

Invited Discussant: Nathaniel McQuay, Jr., M.D.

Introduction: Blood transfusion is known to be an independent risk factor for mortality, multiple organ failure (MOF), and nosocomial infection (NI) following injury. Less is known about the risks associated with plasma-rich transfusion components, including fresh frozen plasma (FFP), platelets (PLT) and cryoprecipitate (CRYO).

Methods: Data were obtained from a multi-center prospective cohort study evaluating clinical outcomes in blunt injured adults with hemorrhagic shock. All patients required blood transfusion for enrollment. Patients with isolated TBI and those not surviving beyond 48 hours were excluded. Cox proportional hazard regression models were used to determine outcome risks (per/unit) associated with 24hr plasma-rich transfusion requirements, after controlling for differences in injury severity, resuscitation needs (including 24hr blood requirements and crystalloid), shock and coagulation parameters, and pre-hospital comorbidities.

Results: For the entire study population (n=1,175), 61%, 35% and 28% of patients received FFP, PLT and CRYO transfusions, respectively. Patients were severely injured with a median ISS of 34 [IQR 22,43]. Regression models found no association of plasma-rich transfusion components with mortality or NI. FFP transfusion was independently associated with a significant risk of MOF and ARDS (table, **: $p<0.05$). For every unit of FFP given, the risk of MOF and ARDS increased by 2% and 3%, respectively.

	Mortality	MOF	NI	ARDS
FFP	**0.99(0.96-1.03)**	****1.02(1.00-1.04)**	**1.01(0.99-1.03)**	****1.03(1.01-1.05)**
PLT	**0.95(0.83-1.09)**	**1.02(0.95-1.10)**	**1.01(0.94-1.08)**	**1.08(0.99-1.18)**
CRYO	**1.01(0.96-1.07)**	**0.97(0.94-1.01)**	**0.99(0.96-1.02)**	**1.02(0.99-1.06)**

Conclusions: In patients who survive their initial injury, FFP is independently associated with MOF and ARDS. With the greater use of plasma-rich transfusion components following injury, particularly in massive transfusion practice, further research is required to elucidate the mechanisms responsible for these morbid complications.

Session VIII

Paper 50 10:20 AM

HEMOSTATIC RESUSCITATION DURING SURGERY IMPROVES SURVIVAL IN PATIENTS WITH TRAUMATIC INDUCED COAGULOPATHY

Juan C Duchesne, MD, Tareq M Islam, MD MPH, Jeffrey D Dellavolpe, MD, Georgia Wahl, MD NREMT-P, John P Hunt, MD MPH, James M Barbeau, MD, Yuan Kao, MD, Bruce S Torrance, MD, Patrick Greiffenstein, MD, Alan B Marr, MD, Glen E Steeb, MD, Clifton McGinness, MD, Christopher C Baker*, MD, Norman E McSwain Jr*, MD. Tulane University School of Medicine.

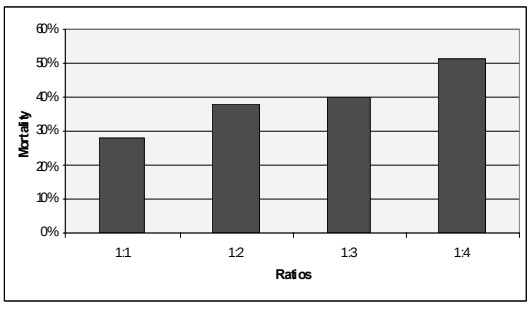
Invited Discussant: Robert A. Cherry, M.D.

Objectives: Hemostatic resuscitation (HR) with 1:1 FFP to PRBC ratio after severe hemorrhage improves survival. Its benefit in patients with traumatic induced coagulopathy (TIC) with requirement of >10 units of PRBC during surgery, has not been elucidated.We hypothesized a survival benefit when HR was used early after injury during surgery.

Methods: Seven year retrospective study of coagulopathic trauma patients with requirement of >10u PRBC in the operating room (OR).TIC was defined as initial emergency department PT>16sec. and/or PTT>50sec.Patients were divided into FFP: PRBC ratios of 1:1, 1:2, 1:3 and 1:4.Patients that received transfusion of both FFP and PRBC during surgery were included. The primary research question was the impact of early FFP: PRBC ratio on mortality. Other variables included patient age, gender, mechanism and ISS.

Results: Four hundred thirty five patients underwent emergency surgery and received FFP with >10u PRBC in the OR; of which 135 (31.0%) had TIC and 53 (39.5%) mortality. Mean operative time 137 minutes SD±49. There was no difference in regards of age, gender, mechanism and ISS between all groups.A significant difference in mortality was found in patients that received >10 units of PRBC (28.2% vs. 51.1%) when FFP: PRBC ratio was 1:1 vs. 1:4 (p: 0.03). Mortality percentage per transfusion ratio illustrated below:

Conclusion: TIC is not unusual and is associated with a high mortality in patients transfused with >10u PRBC during the initial hours after injury. Hemostatic resuscitation during first hours after injury improves survival in patients with traumatic induced coagulopathy.



Session VIII

Paper 51 10:40 AM

HEMOSTATIC RESUSCITATION - SURVIVAL BENEFIT OR SURVIVAL BIAS?

Christopher W Snyder, MD, Jordan A Weinberg, MD, Gerald McGwin Jr, PhD, Sherry M Melton*, MD, Jeffrey D Kerby*, MD PhD, Richard L George, MD, Donald A Reiff, MD, James M Cross, MD, Loring W Rue III*, MD. University of Alabama at Birmingham.

Invited Discussant: Hiroshi Ogura, M.D.

Background: Recent studies have demonstrated that a higher ratio of fresh frozen plasma (FFP) to packed red blood cells (PRBC) administered over 24 hrs is associated with lower mortality, but it remains unclear how the temporal administration of each product may influence this association. We sought to evaluate the temporal relationship between blood product administration and mortality in massively transfused civilian trauma patients.

Methods: Patients requiring massive transfusion ($\geq$10 units of PRBC within 24 hours of admission) between 2005 and 2007 were identified from our trauma registry. Chart review was performed to identify the precise times of relevant events, including trauma bay admission, blood product administration, and death. Patients were divided into low and high plasma ratio groups (<1:2 and $\geq$1:2 FFP:PRBC, respectively), and risk-adjusted mortality was compared. Ratios were calculated both for sequential 6-hr increments of hospitalization and for the first 24 hrs as a whole.

Results: 151 patients (60% blunt, 40% penetrating) were identified. Overall mortality was 49%, with 26% occurring in the first 6 hrs. When the plasma ratio was calculated for the first 24 hrs as a whole, risk-adjusted mortality was 37% in the high plasma ratio group and 60% in the low plasma ratio group (p=0.009). However, when plasma ratios were considered incrementally (every 6 hrs), no significant difference in cumulative mortality risk was observed between groups (Table).

		Time Interval (hrs)			
FFP:PRB	Mortality (%)	0-6	6-12	12-18	18-24
< 1:2	Incremental	37	3	6	0
	Cumulative risk	54*	24*	26*	23*
? 1:2	Incremental	6	12	2	0
*p=NS	Cumulative risk	44*	37*	27*	23*

Conclusion: Lower mortality was observed in patients receiving a higher plasma ratio over the first 24 hours. However, temporal analysis of cumulative mortality using shorter periods of time revealed no survival advantage, likely secondary to crossover between groups and dropout from early deaths. Reduction in mortality associated with higher plasma ratios may represent a survival bias rather than a true survival benefit.

Session IX-A

Paper 52 1:00 PM

ABO NON-IDENTICAL PLASMA COMPONENT TRANSFUSION INCREASES POST-TRAUMA THROMBOCYTOPENIA AND MODS

Andrea Zucchiatti, MD, Lawrence Fialkow, DO, Mark Gestring*, MD, Nicole Stassen*, MD, Julius Cheng*, MD, Edward Piotrowski, MD, Ayodele Sangosanya, MD, Neil Blumberg, MD, Paul Bankey*, MD PhD. University of Rochester.

Invited Discussant: Bruce A. Crookes, M.D.

Introduction: The use of ABO non-identical plasma products (FFP & Platelets) is accepted practice in most blood banks. However, this leads to infusion of antigen and/or antibody that is ABO incompatible with the recipient. This incompatibility results in the formation of immune complexes that activate leukocytes and platelets while also impairing coagulation factor function. Recent transfusion recommendations advocate the increased use of plasma containing components: therefore, we hypothesize that use of ABO identical plasma components may reduce post-injury coagulopathy and multiple organ dysfunction.

Methods: Blood Bank and Trauma Registry databases were reviewed retrospectively for all transfused trauma patients admitted to the ICU who survived over 24 hours and received greater than 6 units of red cells.

Results: Trauma patients transfused with ABO mismatched plasma required more units of PRBC [ABO mismatch: 12.3 vs. ABO match: 8.4, p =0.0011] than similarly injured patients who received only ABO matched components. [Table, ** p<0.05] These patients also had a higher severity of MODS and thrombocytopenia. [Table, ** p<0.05] Age, ISS, RTS, degree of shock, initial INR, plasma units given, and Mortality were similar. [Table, NS]

	ABO Non-Identical		ABO Identical		
Parameter	**Avg**	**StDev**	**Avg**	**StDev**	
Age	44.7	21.9	46.3	23.0	*NS*
ISS	28.3	13.8	29.3	15.1	*NS*
RTS	5.6	1.9	6.0	1.8	*NS*
Base Def	-9.8	3.9	-9.8	4.8	*NS*
FFP + Plt Given	6.4	4.4	5.6	6.3	*NS*
Platelet Count	73.9	48.8	98.5	56.6	**
MODS Score	6.2	4.1	9.5	3.3	**
PRBC Given	12.3	6.9	8.4	9.9	**

Conclusion: We conclude that ABO non-identical plasma transfusion during resuscitation from traumatic hemorrhagic shock is associated with increased thrombocytopenia, RBC transfusion, and more severe MODS. Consideration should be give to utilizing only ABO matched components for trauma massive transfusion guidelines.

Session IX-A

Paper 53 1:20 PM

OVER TRANSFUSION: AN UNRECOGNIZED COMPLICATION OF BLOOD TRANSFUSION

Gustavo Azoubel, MD, Jeannie Calum, MD, Ruxandra Pinto, PhD, Lorraine Tremblay*, MD PhD, Homer Tien, MD MSc, Vanessa Speers, MSc, Sandro Rizoli, MD PhD. University of Toronto.

Invited Discussant: Jay N. Collins, M.D.

Introduction: Transfusion in trauma lack evidence-based guidelines on who and what to transfuse and thus vary widely. Also, transfusion is a major determinant of death in trauma.

Hypothesis: 1) Over transfusion during initial resuscitation is common and increases morbidity & mortality. 2) Over transfused patients have a distinct epidemiological profile.

Methods: Review of all patients admitted to a Level I Trauma Centre from Dec 2000 to Nov 2005. Over transfusion in the first 24h of admission was defined as: pre-transfusion hemoglobin (Hb) <100g/L and post-transfusion Hb>120g/L or transfusion of patients with Hb>100g/L. Data collected: demographics, mechanism injury, ISS, ICU and hospital length of stay (LOS), transfusion, complications and mortality. Non parametric tests were used for continuous variables and univariate analysis for predictors of over transfusion.

Results: Of the 5215 trauma patients admitted, 1525 (29%) received red blood cell (RBC) transfusions in the first 24h. 113 patients (2.2%) were over transfused receiving 1465 RBC units, of which 6% (754 units) were inappropriate. Compared to appropriately transfused, over transfused patients had significantly more complications (75% vs. 57% p=0.002) and longer ICU stay [3 (2-9) vs. 2 (0-6) days, p<0.001). Both groups had similar infection rate and hospital LOS. Independent predictors of over transfusion were ISS (p=0.0005), penetrating injury (p<0.001), amount of fluid (p=0.02), chest/abdominal injuries (p=0.003) and initial Hb (p<0.0001). Over transfusion was not a predictor of mortality. From the univariate analysis the over transfused profile was of females (34% vs. 26% p=0.04), lower initial Hb (108 vs. 132g/L p<0.001), higher ISS (41 vs. 21 p<0.001), requiring more fluid (2.2 vs. 1.1L p<0.001) and with penetrating injuries (29% vs. 17% p=0.003).

Conclusions: Over transfusion is uncommon, 2.2% of all patients, but consumes a large proportion of all the blood in trauma (6%). Over transfusion is associated with significant increases in complication and length of stay. Strategies to prevent over transfusion should be identified and tested to minimize adverse outcomes after major trauma.

Session IX-A

Paper 54 1:40 PM

ABNORMAL ROUTINE COAGULATION TESTS ARE ASSOCIATED WITH PROGRESSION OF TRAUMATIC INTRACRANIAL HEMORRHAGE

CB Allard, Shawn Rhind, PhD, Pang Shek, PhD, Homer Tien, MD MSc, Lorraine Tremblay*, MD PhD, Sandro Rizoli, MD PhD. University of Toronto.

Invited Discussant: Robert D. Barraco, M.D.

Objective: 1) To investigate whether abnormal coagulation tests INR, PTT, platelet count (plat) are associated with progression of traumatic intracerebral hemorrhage (ICH) and mortality. 2) To investigate potential underlying causes of coagulopathy in traumatic brain injury (TBI): soluble tissue factor (TF) and D-dimer (surrogate marker for fibrinolysis).

Methods: Subgroup analysis of severe blunt TBI (GCS<9) adult patients admitted within 4h of injury who were enrolled in a randomized controlled trial (RCT). We analyzed only those with admission and follow up head CT done within 48h. Abnormal coagulation tests were defined as INR? 1.3; PTT?35 or plat<$100x10^9$/L any time between admission and follow up CT. Soluble TF and D-dimer were measured in a random subset of 48 patients. ICH progression was any increase in size or any new ICH within 48h of admission.

Results: 116 patients entered the RCT and 72 had admission and follow-up CT. 37/72 patients (51.4%) had ICH progression, of whom 25 (2/3) had at least one abnormal test. ICH progressed in 80% of all patients with any abnormal test vs. only 36% with all normal tests (p=0.0004). Abnormal INR (OR=4.1 95%CI [13,132], p=0.016) or plat (OR=12.8, 95% CI [15,108.5], p=0.019) were significantly linked to ICH progression. ICH progressed in all patients with abnormal PTT, which was never elevated in isolation. ICH progression was a major determinant of death (OR=4.8; 95% CI [1.22-18.9], p=.025), 32% died vs. only 9% of those without progression. INR and D-dimer were both linked to death as well. TF and D-dimer had no significant association with coagulopathy (any abnormal test). D-dimer was elevated in all patients but significantly higher (18,000; IQR [10,000-20,000]) in those that died compared to survivors (4,434; IQR [2408, 9824]) (p=0.002).

Conclusion: 1) Any isolated increase in INR or drop in platelet count early after TBI is associated with ICH progression and higher mortality. We speculate that their timely correction may improve outcome. 2) While hyperfibrinolysis appears to be common, there was no evidence linking Tissue Factor to coagulopathy in patients with severe head injury.

Session IX-A

Paper 55 2:00 PM

THE IN VIVO EFFECT OF PROPRANOLOL ON CEREBRAL PERFUSION AND HYPOXIA AFTER TRAUMATIC BRAIN INJURY

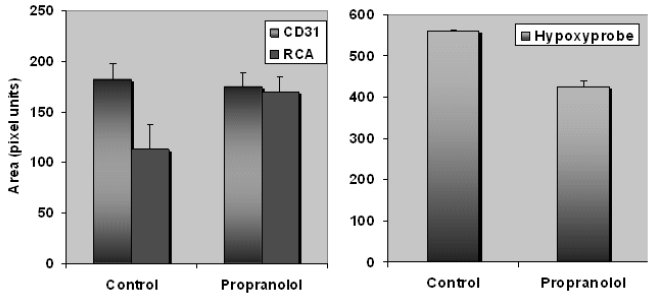
Eric J Ley, MD, Jeff Schenet, MS, Ali Salim*, MD. Cedars-Sinai Medical Center.

Invited Discussant: Yasumitsu Mizobata, M.D.

Introduction: Recent epidemiological evidence has identified beta-blockade as independently associated with improved survival in patients with isolated traumatic brain injury. Reduced sympathetic discharge and catecholamine release may improve circulation in the injured areas and influence delayed demise. The purpose of this study was to determine the effect of beta-blockade on cerebral perfusion and hypoxia in a murine TBI model.

Methods: Six 12-week old BALB-C mice underwent TBI as in a previously described model. Mice were randomized to receive intraperitoneal injections of 200µm PBS alone or 200µm of PBS with propranolol (10mg/kg) 15 minutes and 24 hours after injury, in a blinded fashion. After 25 hours, mice were sacrificed and cerebral tissue was fresh frozen, embedded in OCT, and later sectioned at 5µm. Immunofluorescent images were obtained for vessel density (CD31), vessel perfusion (RCA-Lectin) and cerebral hypoxia (hypoxyprobe-1) and compared with digital quantification.

Results: CD31 staining was colocalized to RCA-Lectin to better demonstrate areas of perfusion. Propranolol treatment increased cerebral perfusion by 33% on digital quantification. Hypoxyprobe-1 analysis demonstrated propranolol treatment decreased areas of hypoxia by 24%. Differences in perfusion and hypoxia were more pronounced near the area of initial cerebral injury.



Conclusion: Propranolol treatment in vivo increased cerebral perfusion and decreased cerebral hypoxia. This research demonstrates beta-blockade may prevent additional brain damage after traumatic insult and should be the focus of future clinical investigations.

Session IX-A

Paper 56 2:20 PM

STATIC CEREBRAL PRESSURE AUTOREGULATION IS INTACT IN PATIENTS WITH SEVERE TRAUMATIC BRAIN INJURY

Eric C. Peterson, MD MS, Randall M. Chesnut*, MD. Harborview Medical Center.

Invited Discussant: Adrian W. Ong, M.D.

Introduction: The management of severe traumatic brain injury (sTBI) patients with and without intact cerebrovascular autoregulation (CPA) varies markedly. Recent studies, analyzing beat-to-beat interactions between intracranial pressure (ICP) and systolic blood pressure (SBP), or transcranial Doppler (TCD) velocity changes during a rapid drop in CPP, suggest that CPA is disrupted after sTBI. We use CT perfusion (CTP) to guide blood pressure manipulation in sTBI and have found CPA results that differ with this literature. We present these results here and suggest modifying our basic concepts of CPA disruption.

Methods: We tested CPA in 24 consecutive sTBI patients using CTP. ICP was monitored intraparenchymally, blood pressure with an arterial line. After a CTP study at baseline, a phenylephrine infusion was used to raise the CPP by 20 mmHg and a second CTP was done immediately thereafter. Quantitative analysis of cerebral blood flow (CBF) was done off-line. CPA was considered intact if CBF was unchanged despite the increase in CPP and disrupted if CBF rose after CPP manipulation.

Results: The mean CPP elevation was 19.3 mmHg. The mean ICP increase was 2.5 mmHg. CPA was intact in 18/24 (75%) of patients and disrupted in 6/24 (25%).

Conclusions: Using direct measurement of CBF in response to a CPP challenge, we found CPA disruption to be much less common than reported in similar groups of sTBI patients. This difference reflects potentially important separate aspects of CPA. We suggest that CPA measurement using beat-to-beat interactions and TCD measurements reflect dynamic CPA processes (“dynamic autoregulation) whereas our method reflects steady-state conditions (“static autoregulation”). If the major disruption of CPA after sTBI involves dynamic vascular responsiveness, perhaps we need more focus on this aspect and less on static CPP manipulation in terms of pathophysiology and treatment.

Session IX-A

Paper 57 2:40 PM

CRANIOPLASTY FOLLOWING POST-TRAUMATIC DECOMPRESSIVE CRANIECTOMY:IS TIMING OF THE ESSENCE?

Kathryn Beauchamp,MD, Jeffry L.Kashuk*,MD, Ernest E.Moore*,MD, Craig Rabb,MD, Joshua Seinfeld,MD, Jennifer Kang,MD, Oszkar Szentirmai,MD, Gene Bolles, MD, Angela Sauaia,MD PhD. Denver Health Medical Center and University of Colorado Health Sciences Center.

Invited Discussant: Peter B. Letarte, M.D.

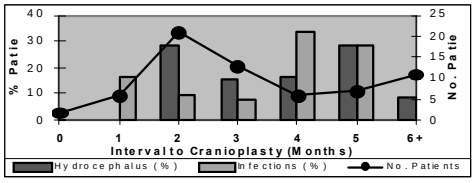
Introduction: The appropriate timing of cranioplasty after decompressive craniectomy for trauma is unknown. Potential benefits of delayed intervention (> 6 wks) for reducing the risk of infection must be balanced by persistent altered CSF dynamics leading to hydrocephalus. We reviewed our recent 6 year experience in an effort to improve patient throughput and develop a rational decision making plan.

Methods: A 6 year query (2003-2007) of our Level 1 Neuro-trauma data base. From 2,400 head injuries and 350 craniotomies, 69 patients qualified with post-traumatic cranioplasty. Timing of surgery, cranioplasty material, post-operative infection and incidence of hydrocephalus were evaluated with logistic regression (LR) to study potential associations between complications and timing, adjusted for risk factors.

Results: No specific time frame was predictive of hydrocephalus or infection, (figure) and LR failed to identify significant predictors among the collected variables. Bivariate analysis showed:

Variable	Hydrocephalus		Infection	
	yes	no	yes	no
N (total=69)	14	55	13	56
ISS: median,(IQR)	35(25-43)	26(25-34)	34(25-37)	26,25-34)
Age: median, (IQR)	42(20-51)	30(21-43)	44(30-51) +	26(20-42)+
Craniectomy /Hematoma vs. Htn	13(93%)	50(91%)	12 (92%)	51(91%)
Autograph (vs. Synthetic)	13(93%)*	44(80%)*	8 (61%)	49(87%)
Mechanism=Blunt	14(100%)	49(89%)	11(85%)	52(93%)
TTC (days): median,(IQR)	87(58-142)	80(58-142)	138(67-186)^	80(58-123)^
LOS-ICU (days): median,(IQR)	19,(12-26)#	28(15-41)#	17(10-24)	20(14-29)

*$\chi 2, p<0.05$; + Wilcoxon p=0.07; # Wilcoxon p=0.08; ^Wilcoxon p=0.12



Conclusion: Delayed cranioplasty to reduce infection or the need for CSF diversion is not justified. With CT confirmation of adequate decompression, our current policy emphasizes early (<6 wks) reconstruction.

Session IX-A

Paper 58 3:00 PM

EARLY MAGNETIC RESONANCE IMAGING IS UNNECESSARY IN PATIENTS WITH TRAUMATIC BRAIN INJURY

Dimitra Manolakaki, MD, George C Velmahos*, MD PhD, Konstantinos Spaniolas, MD, Malek Tabbara, MD, Umar M Butt, MD, Marc M De Moya, MD, Elizabeth A Sailhamer, MD, Hasan B Alam*, MD. Massachusetts General Hospital.

Invited Discussant: Pauline K. Park, M.D.

Introduction: Computed Tomography (CT) is routinely performed in traumatic brain injury (TBI). Magnetic resonance imaging (MRI) is considered more sensitive than CT for subtle abnormalities. Because CT does not always explain the post-traumatic neurologic exam, MRI is performed with increasing frequency. Although MRI at a later stage may be of significant prognostic value, the role of early MRI is questionable. Our objective is to evaluate the role of early MRI in the initial management of patients with TBI.

Methods: This is a 3-year prospective study (Jan.2005 – Dec.2007) of adult TBI patients who, in addition to CT, had MRI of the head within 48 hours of admission to the hospital. The findings from the two imaging studies were compared. The outcome was any change in management based on MRI findings.

Results: We identified 123 trauma patients who had MRI within 18±14.5 hours of CT (median=12 hours, less than 6 hours in 24%). In 82 (67%) patients the findings of CT and MRI were identical. In the remaining 41 patients, a difference between CT and MRI in the location and size of the lesion was found (35) or a minor brain lesion was detected exclusively by MRI (6).

Variables	Identical CT and MRI (n=82)	Different CT and MRI (n=41)	p-value
AIS head >3	40 (50%)	33 (80.5%)	<0.01
GCS <8	23 (28%)	24 (58.5%)	<0.01
BP <100mmHg	5 (6%)	8(20%)	0.03
Intubated	29 (35%)	28 (68%)	<0.01

Following CT, 78 (63%) patients received TBI-related interventions: 8 craniotomies, 12 intracranial pressure monitoring, 14 mannitol, and 72 antiepileptic medications. All patients were monitored intensively. There was no change in treatment after MRI.

Conclusion: Early MRI may be superior to CT in describing subtle TBI findings but the information does not affect management. Head CT is the only imaging test necessary in the first 48 hours after TBI.

Session IX-A

Paper 59 3:20 PM

HEAD INJURY PATTERN IN CHILDREN DIFFERENTIATES ACCIDENTAL FROM NON-ACCIDENTAL TRAUMA

Jonathan P Roach, MD, David A Partrick, MD, Denis D Bensard, MD, Andrew P Sirotnak, MD, Michael H Handler, MD, Charles C Wilkinson, MD, Frederick M Karrer, MD, Moritz M Ziegler, MD, Ernest E Moore*, MD (sponsor). The Childrens Hospital, University of Colorado.

Invited Discussant: Joseph J. Tepas III, M.D.

Introduction: Child abuse represents a significant mechanism of head injury in younger children, but the incidence, outcome, and injury pattern are not well defined. The purpose of this study is to define the incidence and mortality of non-accidental head injury (NAHI) compared to children with accidental head injury (AHI) and determine the anatomic classification of their injuries. We hypothesized that children with NAHI would have a higher mortality rate and that the injury pattern would differentiate a non-accidental from accidental mechanism.

Methods: Our trauma registry was queried for all children ? 5 years of age presenting with traumatic head injury over a 10 year period (1996–2005). Demographic clinical data and in-hospital mortality were recorded. The type of head injury was interpreted from radiographic findings. Data are presented as mean ± SEM (* = $p < 0.05$).

Results: 1430 children with traumatic head injury were identified. 1076 (75%) were defined as AHI and 354 (25%) as NAHI. Children with NAHI were younger (9.9 ± 0.5 vs. 24.9 ± 0.6 months*), more severely injured (ISS 22.2 ± 0.4 vs. 13.4 ± 0.3*), and had a higher mortality rate (13% vs. 4%*). NAHI children had more subdural hematomas (SDH) (81% vs. 29%*) and cerebral edema/diffuse axonal injury (DAI) (22% vs. 7%*) compared to AHI. Conversely, children with NAHI had fewer epidural hematomas (EDH) (1% vs. 10%*) and skull fractures (22% vs. 60%*). In order to adjust for age differences we also examined the subset of children ? 24 months of age (563 AHI children [8.3 ± 0.2 months] vs. 322 NAHI children [6.7 ± 0.2 months]) and the same mortality (11% NAHI vs. 4% AHI*) and injury pattern differences remained.

Conclusions: Traumatic head injury is caused by a non-accidental mechanism in up to 25% of children (36% if less than 2 years old) and leads to a higher mortality compared to AHI. Recognizing the different head injury patterns in NAHI vs. AHI will support an appropriate higher level of suspicion by the trauma surgeon to investigate child abuse.

Session IX-A

Paper 60 3:40 PM

EVALUATION OF POSTTRAUMATIC VENOUS SINUS OCCLUSION WITH CT VENOGRAPHY

Yoshiyuki Fujii, MD, Osamu Tasaki*, MD, Kazuhisa Yoshiya, MD, Tadahiko Shiozaki, MD, Hiroshi Ogura*, MD, Yasuyuki Kuwagata, MD, Hisashi Sugimoto*, MD, Yuka Sumi, MD.
Osaka University Medical School.

Invited Discussant: Elliot R. Haut M.D.

Backgrounds: Although it has been reported that cerebral venous sinus occlusion (CVSO) is associated with intracranial hypertension, its incidence or significance in head trauma is not clarified yet. The purpose of this study is to investigate with CT venography , the incidence of posttraumatic CVSO, clinical course, and the relation to intracranial hypertension.

Patients and methods: Eighty-two consecutive patients were included in this study, who were admitted to our Trauma Center from 2002 through 2008 with skull fracture crossing a dural sinus or petrous portion of the temporal bone. CVSO was examined with CT venography. The patients with CVSO were followed with CT venography or MRI. The relations of CVSO to their outcome and the incidence of 'Talk and Deteriorate' were also investigated. 'Talk and Deteriorate' was defined as the case in which Glasgow coma scale score more than 9 on admission, but craniotomy was performed due to deteriorated consciousness.

Results: CVSO was observed in 16 of 82 cases (19.5%). The sites of occlusion were superior sagittal sinus (n=1), transverse sinus (n=11), and sigmoid sinus (n=4). The recanalization occurred by 6 months in 7 of 10 cases (70%), in which follow-up was possible. Although there was no difference in Glasgow outcome scale on discharge between the cases with CVSO and without CVSO, the incidence of 'Talk and Deteriorate' was significantly higher in cases with CVSO (33%(3/9) vs 5%(2/40),$p<0.05$).

Conclusion: The incidence of CVSO after head injury was much higher than ever thought. It was associated with 'Talk and Deteriorate', so that CVSO may induce acute increase in intracranial pressure in some cases. Early recognition of CVSO may be very important to predict deterioration after admission and start the treatment immediately. CT venography was very useful for screening of CVSO.

Session IX-A

Paper 61 4:00 PM

SOCIOECONOMIC FACTORS EFFECT OUTCOME IN TRAUMATIC BRAIN INJURY.

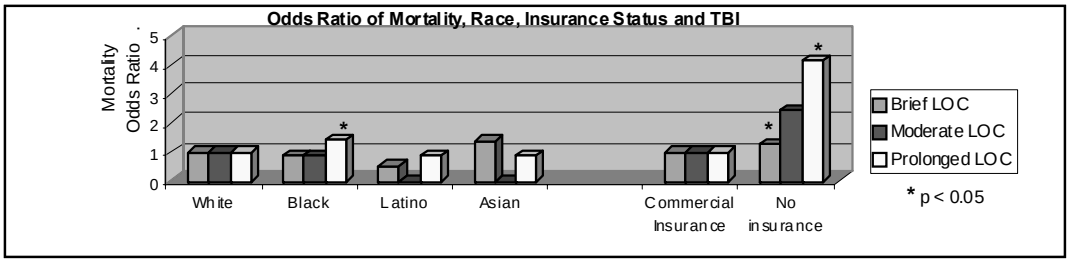
Suresh Agarwal*, MD, Mathew Geltzeiler, Wei Huang, Wayne Lamorte, MD PhD MPH, Fred Millham*, MD, Peter Burke*, MD, Lawrence Chin, MD, Erwin Hirsch*, MD. Boston University School of Medicine.

Invited Discussant: Areti Tillou, M.D.

Objectives: To evaluate whether insurance status and race have an impact upon the outcome of patients with traumatic brain injury (TBI).

Methods: The National Trauma Data Base version 6.0 was retrospectively examined over a five year time period. Patients with ICD-9 diagnostic codes consistent with non-penetrating TBI due to fall or motor vehicle crash were assessed by race, age, length of loss of consciousness (LOC), insurance status, and ICISS. Patients with penetrating injuries, and injuries as a result of assault were excluded. Multivariate analysis was utilized to compare mortality and length of hospital stay with the covariates.

Results: After stratifying 55,098 patients, a correlation between mortality and race demonstrated that age and ICISS were strong predictors across all lengths of LOC. Black race had a statistically significant increase in odds-ratio of mortality for individuals with prolonged LOC. Lack of insurance had a statistically significant increase in odds-ratio of mortality for individuals with brief and prolonged LOC (see table).



Lack of insurance in patients with prolonged LOC also predicted increased length of stay. Lack of insurance predicted a decreased length of stay in patients with brief LOC. Gender was not contributory to mortality and length of stay.

Conclusions: Age, ICISS, and insurance status have a profound impact upon outcome of TBI when assessing for mortality and length of hospitalization. Race may be of influence, particularly in severely head injured patients. The etiologies of the differences have to be further examined.

Session IX-A

Paper 62 4:20 PM

THROMBELASTOGRAPHY VS ANTI-FACTOR XA LEVELS IN THE ASSESSMENT OF PROPHYLACTIC-DOSE ENOXAPARIN IN CRITICALLY ILL PATIENTS

Sungeyun David Cho, MD, Melanie S Morris, MD, Samantha A Underwood, MS, Jennifer M Watters, MD, Martin A Schreiber*, MD. Oregon Health and Science University.

Invited Discussant: Raul Coimbra, M.D., Ph.D.

Background: A standard dose of enoxaparin is frequently used for deep venous thrombosis (DVT) prophylaxis. Evidence suggests inconsistent bioavailability in ICU patients. Anti-factor Xa activity (anti-Xa) has been used to monitor enoxaparin dosing but its accuracy and availability are problematic. Thrombelastography (TEG) is used to evaluate coagulation in diverse settings. The purpose of this study was to determine if TEG could be used to predict enoxaparin-treated patients at risk for developing DVT.

Methods: 261 simultaneous enoxaparin-active (active) and enoxaparin-neutralized (neutral) TEGs were performed in 61 surgical ICU patients over 4 consecutive days. Patient characteristics and anti-Xa were collected. DVT screening was per ICU protocol.

Results: Mean (± SEM) age was 54 (±2.3) years and APACHE II score was 17 (±0.7). There were 31 trauma and 30 general surgery patients (69% male). The DVT rate was 28%. Time to clot formation (R) and percent lysis at 30 minutes (LY30) were different between active vs neutralized blood ($p<0.001$). R time was 1.5 minutes shorter in patients with DVT vs those without ($p<0.001$) indicating hypercoagulability in DVT patients.

Values are mean ± SEM * = $p<0.001$	**R (min) All patients**	**LY30 (%) All patients**	**R (min) DVT**	**R (min) No DVT**
Enoxaparin active	7.1 ± 0.2*	12.2 ± 1.2*	6.1 ± 0.2*	7.6 ± 0.2*
Enoxaparin neutralized	6.6 ± 0.2*	7.8 ±0.8*	N/A	N/A

Anti Xa levels were similar in patients with (0.135±0.012) and without (0.135±0.007) DVT ($p=0.97$). There was a modest correlation between R value and anti-Xa of 0.23 ($p=0.001$). There were no differences in age, BMI, creatinine, APACHE II score, or trauma status between DVT and non-DVT groups.

Conclusion: TEG demonstrates differences between enoxaparin-neutralized and enoxaparin-active blood in ICU patients that may be used to guide dosing. TEG differentiates enoxaparin-treated patients who subsequently develop DVT while anti Xa levels do not. TEG demonstrates an enoxaparin-related increase in fibrinolysis.

Session IX-A

Paper 63 4:40 PM

EARLY INTUBATION IN THE MANAGEMENT OF TRAUMA: INDICATIONS AND OUTCOMES IN 1,000 CONSECUTIVE PATIENTS

Michael J. Sise*, MD, Steven R. Shackford*, MD, Daniel I. Sack, BA, Gabrielle M. Paci, BA, Kimberly A. Peck, MD, Valerie C. Norton, MD, C. Beth Sise, JD, RN, MSN, Benjamin R. Huebner. Scripps Mercy Hospital.

Invited Discussant: Satoshi Ishihara, M.D.

Background*:* The *EAST Practice Management Guidelines* identify indications (EI) for early intubation. However, EI have not been clinically validated. Many intubations are done for other discretionary indications (DI). We evaluated early intubation to assess the incidence and outcomes of those performed for DI and EI.

Methods*:* 1,000 consecutive intubations performed in the first two hours after arrival at our Level I trauma center were reviewed. Indications, outcomes, and trauma surgeon (TS) intubation rates were evaluated.

Results*:* During a 56-month period, 1,000 (9.9%) of 10,065 trauma patients were intubated within two hours of arrival. DI were present in 444 (44.4%) and EI in 556 (55.6%). DI were combativeness or altered mental status in 375 (84%), airway or respiratory problems in 21 (5%), and preoperative management in 48 (11%). Mean ISS was 14.6 in DI patients and 22.8 in EI patients ($p<0.001$). Head AIS $\geq$ 3 occurred in 33.0% with DI and 51.8% with EI ($p<0.001$). Predicted vs. observed survival was 96.6% vs. 95.9% in DI patients and 74.9% vs. 74.6% in EI patients ($p<0.001$). Extubation and discharge within 24 hours occurred in 30 (6.8%) patients after DI and 17 (3.1%) patients after EI ($p<0.01$). Only seven (0.7%) surgical airways were performed and only one for DI (0.2%). There were no significant complications related to intubation for either DI or EI. Early intubation after leaving the trauma room was required in 65 (6.5%) patients and 41 (63.1%) were for combativeness, neurologic deterioration, or respiratory distress/airway problems. TS intubation rates varied from 7.6% to 15.4% ($p<0.001$), and rates of DI ranged from 34.8% to 49.1% ($p<0.05$). TS with higher DI rates were less likely to need to perform delayed intubation ($p<0.01$).

Conclusion*:* Discretionary early intubation was safe and effective. One-third of DI patients had significant head injury. Surgical airways were rarely needed. More frequent use of DI reduced the need for delayed intubation. The *EAST Guidelines* may not identify all patients who would benefit from early intubation after injury.

Session IX-B

Paper 64 1:00 PM

A PROSPECTIVE VALIDATION OF A CURRENT PRACTICE: THE DETECTION OF EXTREMITY VASCULAR INJURY WITH CT ANGIOGRAPHY

Mark J Seamon, MD, Denise Torres, MD, David Smoger, MD, Abhijit S Pathak*, MD, Thomas A Santora*, MD, Paola G Pieri, MD, Kevin M Bradley, MD, Gary Cohen, MD, Amy J Goldberg*, MD. Temple University Hospital.

Invited Discussant: David V. Feliciano, M.D.

Introduction: Arteriography is the current "gold standard" for extremity vascular injury detection. Less invasive than operative exploration (OE), conventional arteriography (CA) still has a 2-3% risk of morbidity and may delay definitive repair. Previous reports have compared these two modalities but were either retrospective, do not reflect current management guidelines, or lack a consistent study control arm for valid comparison. We hypothesized that CT angiography (CTA) provides equivalent injury detection compared to the more invasive CA, but is more rapidly completed and more cost-effective.

Methods: A prospective evaluation of patients, ages 18-50, with potential extremity vascular injuries was performed during 2006-2007. Ankle-brachial indices (ABI) of injured extremities were measured upon presentation in all patients without hard signs of vascular injury. Patients whose injured extremity ABI was <0.9 were enrolled and underwent CTA followed by either CA or OE if CTA findings were limb-threatening. Interventionalists were blinded to CTA findings before performing and reading CAs.

Results: Twenty-one patients (mean age, 26.1±7.1 years) had 22 extremity CTAs after gunshot (82%), stab (9%), or pedstruck (9%) injuries to either upper (32%) or lower (68%) extremities. Twenty-one of 22 (96%) CTAs were diagnostic and all CTAs were confirmed by either CA (n=20) or OE (n=2). Diagnostic CTAs had 100% sensitivity and specificity for clinically relevant vascular injury detection. Unlike rapidly obtained CTA, CA required 131±61 minutes (mean±SD) to complete. In our center, CTA saves $12,922 in patient charges and $1,166 in hospital costs per extremity when compared to CA.

Findings	CTA (n=22)	CA (n=20)	OE (n=2)
Injuries	9	7	2
No Injuries	11	9	0
Vasospasm	1	4	0
Nondiagnostic	1	0	0

Conclusions: With acceptable injury detection, rapid availability, and a favorable cost profile, our results suggest that CTA should replace CA as the diagnostic study of choice for extremity vascular injury detection in most clinical scenarios.

Session IX-B

Paper 65 1:20 PM

VALIDATION OF A SCREENING TOOL FOR THE EARLY IDENTIFICATION OF SEPSIS

Laura J Moore, MD, Krista L Turner, MD, S Rob Todd, MD, Laura Kreiner, BS, Stephen L Jones, MD, Joseph F Sucher, MD, Bruce McKinley, PhD, Frederick A Moore*, MD. The Methodist Hospital.

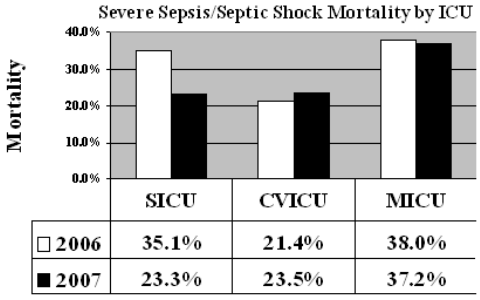
Invited Discussant: Takeshi Shimazu, M.D.

Aim: To assess the efficacy of a sepsis screening tool.

Background: Sepsis is the leading cause of mortality in non-coronary intensive care units (ICUs). The Surviving Sepsis Campaign Guidelines outline strategies for the management of sepsis. Recent studies have shown that early implementation of these guidelines improves survival. We developed an extensive logic-based sepsis management protocol; however, we found that early recognition of sepsis was a major obstacle to protocol implementation. To improve this, we developed a sepsis screening tool. We hypothesized that aggressive screening for sepsis would improve early recognition of sepsis & decrease sepsis related mortality by insuring early appropriate interventions.

Methods: Patients admitted to the Surgical ICU were screened twice daily by our nursing staff. The initial screen assesses the systemic inflammatory response syndrome parameters (heart rate, temperature, white blood cell count, & respiratory rate) & assigns a numeric score (0 to 3) for each. Patients with a score of ? 4 screened positive & went to the 2nd step of the tool which attempts to identify the source of infection. If both screens were positive, the intensivist was notified & our sepsis protocol was instituted.

Results: Over 5 months, 4,991 screens were completed on 927 patients. The prevalence of sepsis was 12.2%. The screening tool yielded a sensitivity of 96.5%, specificity of 96.7%, a positive predictive value of 80.2%, & a negative predictive value of 99.5%. In addition, sepsis related mortality decreased from 35.1% to 23.3%.



	SICU	CVICU	MICU
□ 2006	35.1%	21.4%	38.0%
■ 2007	23.3%	23.5%	37.2%

Conclusion: The two-step sepsis screening tool is a valid method for the early identification of sepsis. Implementation of the tool & our logic-based protocol decreased sepsis related mortality by one third which is consistent with recent studies mentioned above.

Session IX-B

Paper 66 1:40 PM

IS THE USE OF PAN-CT FOR BLUNT TRAUMA JUSTIFIED? A PROSPECTIVE EVALUATION

Areti Tillou*, MD MSEd, Malkeet Gupta, MD, Larry Baraff, MD, David Schriger, MD, Jerome Hoffman, MD, Jonathan Hiatt, MD, Henry Cryer*, MD PhD. David Geffen School of Medicine at UCLA.

Invited Discussant: Kaoru Koike, M.D., Ph.D.

Objective: Many trauma centers utilize pan-CT scan (head, neck, chest, abdomen/pelvis) for evaluation of blunt trauma. This prospective observational study was undertaken to determine if a more selective approach could be justified.

Methods: We evaluated injuries in blunt trauma victims receiving a pan-CT scan at a Level 1 trauma center. The primary outcome was injury needing immediate intervention. Secondary outcome was any injury. The perceived need for each scan was independently recorded by the emergency physician (EP) and trauma surgeon (TS) **before** patients went to CT. A scan was unsupported if at least one of the physicians deemed it unnecessary.

Results: Between 7/1/07 and 12/28/07, 284 blunt trauma patients (average ISS= 11) underwent pan-CT after the survey form was completed. CT scans judged to be unnecessary included 61 head, 50 neck, 116 chest and 82 abdomen. Of the 284 patients, 52 (18%) had injuries that would have been missed if the scans were not performed, including 5 of 61 head scans (8%), 2 of 50 neck scans (4%), 33 of 116 chest scans (28%), and 12 of 82 abdominal scans (15%). These missed injuries represent 5 of the 60 closed head injuries (8%) in the series, 2 of the 17 C-spine injuries (12%), 33 of the 110 chest injuries (30%), and 12 of the 69 abdominal injuries (17%). In 24 patients, none of the 4 CT scans was supported; 10 of these had an injury identified, and 10 were admitted to the hospital (2 to the ICU). Injuries that would have been missed included intraventricular and intracerebral hemorrhage (4), subarachnoid hemorrhage (2), C1 fracture (1), spinous and transverse process fractures (3), vertebral fracture (1), lung lacerations (1), lung contusions (13), small pneumothoraces (7), grade 1-3 liver and splenic lacerations (6), and perinephric or mesenteric hematomas (2). None of the 52 patients required an immediate intervention.

Summary: In this small sample, physicians were willing to omit 27% of scans. If this were done, no injuries requiring immediate actions would have been missed; however, potentially dangerous injuries would not have been identified in 18% of patients.

Session IX-B

Paper 67 2:00 PM

A FATE WORSE THAN DEATH?: LONG TERM OUTCOME OF TRAUMA ICU SURVIVORS

David H. Livingston*, MD, Tovah Tripp, BS, Carina Biggs, MD, Roberty F. Lavery, MA. New Jersey Medical School.

Invited Discussant: M. Margaret Knudson, M.D

Background: Trauma centers successfully save lives of severely injured patients who would have formerly died. However survivors often have multiple complications and morbidities associated with prolonged ICU stays. Since the reintegration of patients into society to lead an active and productive life is the ultimate goal of trauma center care we questioned whether our "success" may condemn these patients to a fate worse than death?

Methods: Charts on all patients ?18 years with ICU stay ?10 days, discharged alive between 8/2002 to 7/2005 were reviewed. Patients with spinal cord injuries were excluded. Demographics, ISS, presence of severe traumatic brain injury (TBI) (AIS 4 or 5), discharge disposition were collected. Patients were contacted by phone to determine general health and work status and a modified FIM score (range 3-12) was calculated.

Results: 257 pts met inclusion criteria; 19 died post-discharge and 107 (45%) participated and form the study group. Mean and median follow-up was 3.5 years from discharge. 82% were male; mean age 41; mean and median ISS 29. Severe TBI was present in 53 (50%). At follow-up, 98 were living at home, 9 in a nursing home. FIM scores ranged from 6-12. 25% of pts scored ?10 and 10% had locomotion scores of ?2 (very dependent). 70% considered themselves to be less active. 81 of the 107 were working pre-injury with only 39 (48%) returning back to work or school. Severe TBI patients were less likely to return to work 40% vs. 69% ($p<0.007$) but TBI had no effect on self-reported level of activity. There was no difference in mean age and ISS in patients who did or did not return to work.

Conclusions: These data demonstrate that ICU survivors >3 years after severe injury have significant impairments including ability to return to work and regain previous levels of activity and that the goal of reintegrating patients back into society is not being met. Further studies better defining the limitations and barriers to improved quality of life are necessary. Survival, while important, is no longer a sufficient outcome to measure trauma center success.

Session IX-B

Paper 68 2:20 PM

REDEFINING RENAL DYSFUNCTION IN TRAUMA: IMPLEMENTATION OF THE ACUTE KIDNEY INJURY NETWORK (AKIN) STAGING SYSTEM

Vishal Bansal, MD, Todd W. Costantini, MD, Gustavo Fraga, MD PhD, Dale Fortlage, BA, Andrea Fraga, MD, Jeanne Lee, MD, Jay Doucet*, MD, Raul Coimbra*, MD PhD. University of California- San Diego.

Invited Discussant: Christopher J. Dente, M.D.

Introduction: Acute Renal Failure (ARF) in critically ill trauma patients is associated with high mortality rates. There is no consensus definition for renal failure, however, the ACS-COT defines ARF as a serum creatinine? 3.5, BUN>100, or dialysis. We hypothesize that by using the Acute Kidney Injury Network (AKIN) staging system we would identify smaller changes in renal function that may impact outcome, and may serve as a marker for other organ dysfunction such as acute respiratory distress syndrome (ARDS).

Methods: We retrospectively identified all patients admitted to the Surgical Intensive Care Unit for greater than 48 hours over a 2 year period ending December 2006. Hourly urine output, serum creatinine, demographic data, trauma scores, admission vital signs, ICU and hospital length of stay (LOS), need for dialysis, organ failure, and death were collected. Patients admitted to the SICU who did not develop renal insufficiency were used as controls.

Results: A total of 392 patients were studied. Of those, only 10 patients (2.6%) were classified as having ARF by the ACS-COT criteria, whereas 92 (27%) had kidney injury using the AKIN criteria (80 Grade 1, 7 Grade 2, 5 Grade 3). Compared to controls, patients meeting AKIN criteria had longer hospital and ICU LOS ($p<0.05$). Patients with Grade 2 and Grade 3 AKI had an increased incidence of dialysis, ARDS, and a 10-fold increase in mortality compared to control ($p<0.05$). *, $p<0.05$ vs. control

	Control	AKI (Total)	Grade 1	Grade 2 + 3	ACS Criteria
Patients	300	92	80	12	10
ISS	20.2 ± 10.5	21.9 ± 12.3	21.9 ± 12.3	21.5 ± 13.2	20.9 ± 15.5
Dialysis	0	8 (8.7%)	1 (1.2%)	7 (58.3%)	8 (80%)
ARDS	9 (3.0%)	6 (6.5%)	4 (5.0%)	2 (16.7%)	1 (10%)
Death	17 (5.7%)	13 (14.1%)*	7 (8.8%)	6 (50%)*	3 (30%)

Conclusion: Stratification using the AKIN criteria for acute kidney injury identifies an increased number of patients with renal dysfunction compared to the current ACS-COT criteria. Importantly, these patients have an increased risk of ARDS and death.

Session IX-B

Paper 69 2:40 PM

CREATING A NATIONALLY REPRESENTATIVE SAMPLE OF TRAUMA CENTERS IN THE US.

Sandra M. Goble, MS, Melanie Neal, MS, John Fildes*, MD, David E. Clark*, MD MPH, Richard W. Sattin, MD, J. Lee Annest, PhD, Mark Faul, PhD, N. Clay Mann, PhD MS, Avery B. Nathens*, MD PhD, Lei Li, PhD, Paul S Levy, ScD, Karen Guice, MD, Laura D. Cassidy, MS PhD. American College of Surgeons.

Invited Discussant: Robert C. Mackersie, M.D.

Purpose: The National Trauma Data Bank (NTDB) was developed as a convenience sample of registry data from contributing trauma centers (TCs), thus inferences about trauma patients may not be valid at the national level. In collaboration with the National Center for Injury Prevention and Control, the American College of Surgeons Committee on Trauma therefore conducted a National Sample Project (NSP) to obtain nationally representative estimates of trauma patients treated in U.S. Level I and II TCs.

Methods: Level I and II TCs in the Trauma Information Exchange Program (TIEP) were identified and a random sample of 100 TCs was selected, stratified by trauma level, geographic region, and prior NTDB participation. A probability-proportional-to-size method was used to randomly select TCs and calculate the weights, where the size measure was the annual number of emergency room visits. NSP estimates from 2003-2005 were compared to raw NTDB data, and to a subset of TCs in the Nationwide Inpatient Sample (NIS), a population-based dataset drawn from community hospitals.

Results: Estimates drawn from the NSP suggest 520,000 trauma incidents occur annually. Weighted estimates of NSP show that the raw NTDB data overestimate the proportion of younger (0-15) and older (>76 years) patients, and underestimate the proportion of injuries with injury severity score <9. Few TCs in TIEP are included in NIS, but estimates based on this subset indicate a higher proportion of older patients (age ? 65 year: 21.0% vs. 14.5%) and a lower mortality rate (3.5% vs. 5.0%) compared with NSP.

Conclusion: Although nationally representative data regarding trauma patients are available in other population-based samples, they do not represent TCs patients and lack the specificity of NSP data, which contains detailed information on injury mechanisms, diagnoses, and hospital treatment. The differences found between the NSP and the NIS are understandable since the NIS includes data from all types of hospitals whereas the NSP contains data only from Level I and Level II TCs.

Session IX-B

Paper 70 3:00 PM

EMERGENCY RESPONSE TO SUICIDE CLUSTERS USING EMERGENCY MANAGEMENT CONCEPTS

Betty Hastings, MSW, David Boyd*, MD. Dept. of Health And Human Services/Indian Health Service.

Invited Discussant: Michael J. Sise, M.D.

Introduction: Suicide is the second leading cause of death for all American Indian Alaska Native (AI/AN) people, ages 10 to 34 (CDC, Leading Causes of Death Report). AI/AN Communities experience unusually high rates of multiple event suicides also referred to as "suicide clusters". This *Emergency Response to Suicide Model* proposes that an organized public health, emergency response by skilled, crisis trained; mental health clinicians and public health professionals can mitigate suicide deaths, reduce suicidal behaviors and stabilize communities in crisis.

Methods: This model has been utilized in two rural communities experiencing suicide clusters and one community experiencing a suicide epidemic. Over an 18-month period, in Community #1, 25 suicides were committed, and in Community #2, 14 suicides were committed. In Community #3, 15 completed suicides have occurred over the past 14 months. A rapid emergency assessment was conducted and an "Emergency Plan of Action" was activated for all three events. In Communities #1, #2 and #3, clinicians and/or public health professionals were deployed over a 90-day period for two-week rotations. Community #1 received eight clinicians, Community #2 received 14 clinicians and Community #3 has received 15 clinicians, thus far. Additionally, community-based outreach and prevention and awareness services were provided.

Results: Since March 2006, Community #1 has experienced one suicide completion. Since December 2006, Community #2 has experienced one suicide completion. In Community #3, which had been experiencing an average of one suicide per month over the last 14 months and where the deployment is still ongoing, there have been no completed suicides.

Conclusions: Cluster suicide is a shared psychiatric and public health problem of major concern. Using an emergency management approach, which provides immediate help to persons who are at risk of suicide and communities in crisis, appears to exert a significant mitigation and preventive influence.

Session IX-B

Paper 71 3:20 PM

SUICIDAL IDEATION AMONG YOUNG MOTHERS: INTERDEPENDENT RISK FACTORS, CONCERNING OUTCOMES

Marie Crandall*, MD MPH, Carol Schermer*, MD MPH. Northwestern University.

Invited Discussant: M. Margaret Knudson, M.D

Introduction: Suicide is the 2nd leading cause of death (LCOD) among 25-34 year olds and the 3rd LCOD among 15-24 year olds. Suicidal ideation (SI) among young mothers out of the context of post-partum depression has been incompletely described. Our hypothesis was that modifiable societal risk factors would contribute to suicidal ideation and that this would affect maternal and infant well-being.

Methods: The Fragile Families and Child Wellbeing Study is a prospectively gathered, longitudinal cohort of families across the United States which deliberately oversamples children born to unwed parents. Bivariate and multivariate regression analyses were used to identify independent risk factors for suicidal ideation and subsequent outcomes.

Results: Of the 4898 women who were surveyed, 880 (18%) reported feeling depressed for more than two weeks in the previous year. Of these, 492 (56%) reported SI. Mothers with SI were more likely to have ended a relationship with the father due to substance abuse or violence (p-values<0.05). Maternal SI was significantly associated with the child's father being in jail, particularly for drug offenses (p-values<0.05). Women who reported having ever been injured by the father were three times more likely to suffer SI (p=0.002). Mothers with SI were twice as likely to smoke, drink alcohol, or use illicit drugs as mothers without SI (p-values<0.05). Children of mothers with SI were nearly twice as likely to have been hospitalized (p<0.05), but the hospitalizations were not more likely to be injury-related (p=0.49). Multivariate regression demonstrated significant interactions between the violence and drug-related variables, and increased SI.

Conclusions: Suicidal ideation among high-risk young mothers was surprisingly common. The association of SI with other social problems underscores the interdependent nature of risk factors in vulnerable communities. Trauma centers routinely screen for substance use; screening for violence and SI as well may help lessen societal morbidities among these high risk families.

Session IX-B

Paper 72 3:40 PM

NOISE SENSITIVITY AS A PREDICTOR OF LONG-TERM SEQUELAE OF MILD TBI

Gabriel Ryb*, MD MPH, Patricia Dischinger, PhD, Joseph Kufera, MA, Kim Auman, MA.
National Study Center for Trauma & EMS.

Invited Discussant: Yasufumi Asai, M.D.

Purpose: The purpose of this analysis was to determine the relative importance of noise sensitivity (NS) as a predictor of persistent post-concussive syndrome (PCS) following mild traumatic brain injury (MTBI).

Methods: 180 MTBI patients admitted to a Level I trauma center were enrolled in a prospective study and 110 followed for 3 months. MTBI was defined as a GCS of 13-15 with a transient LOC and/ or report of being dazed or confused. PCS was defined as the persistence of four or more symptoms long-term. Patients were screened on admission and at 7-10 days and 3 months. Symptom checklists were administered to ascertain the presence of symptoms (cognitive, emotional, and physical) following concussion. For a subset of patients that were physically able, balance tests were also conducted. Logistic regression was used to identify which symptoms best predicted PCS.

Results*:* The mean age of the subjects was 35, and 65% were male. Physical symptoms were the most prevalent in the 7-10 days post-injury, with most declining thereafter to baseline levels. Emotional and cognitive symptoms were less prevalent but more likely to remain elevated at 3 months; 41.8% of subjects reported PCS at 3 months. The strongest individual symptoms that predicted long-term PCS included NS, reported by 26.8% of the subjects at 3-10 days, and irritability, reported by 63.4%. Of those reporting NS at 3-10 days, 93% also reported cognitive symptoms (memory problems, difficulty concentrating, trouble thinking). In regressions including age, gender, educational level and pre-injury depression, only age and NS remained significant; patients who reported NS had an odds ratio of 3.2 for PCS at 3 months (p=.02).

Conclusions: NS following MTBI is an important predictor of PCS, despite the fact that other symptoms, such as headache, were significantly more prevalent in the week post-injury. Balance problems at the 3-month follow-up visit were also significantly associated with NS.

Session IX-B

Paper 73 4:00 PM

MIDINFRARED SPECTROSCOPY IS AN ACCURATE METHOD OF GLUCOSE MEASUREMENT IN CRITICALLY INJURED TRAUMA PATIENTS.

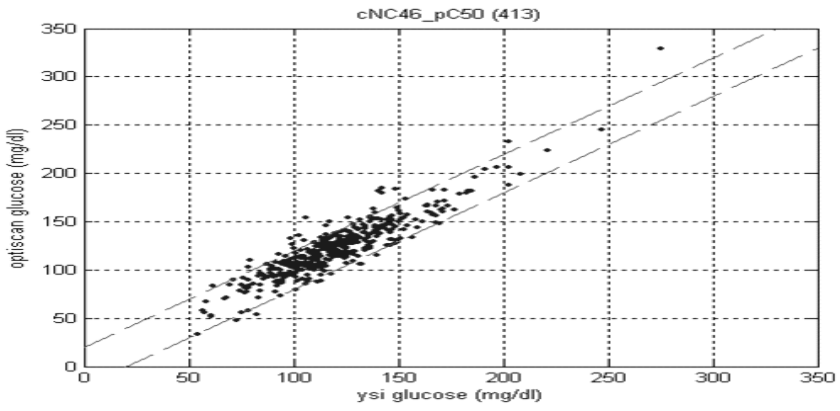
Grant Bochicchio, MD MPH, Kelly Bochicchio, RN MS, Kelly Lettich, BSN, Anthony Herrera, MS, Patricia Lambert, BSN, Kim Lumpkins, MD, Thomas Scalea*, MD. University of Maryland.

Invited Discussant: William Browder, M.D.

Introduction: Recent data have clearly demonstrated that point of care meters are extremely inaccurate (20-40% standard error) in measuring glucose especially in anemic trauma patients. Our objective was to evaluate a new point of care technology (mid infrared spectroscopy or MIS) which also performs continuous glucose measurement.

Methods: A prospective IRB approved consent study was conducted on 50 critically injured trauma patients in whom a total of 413 independent samples were measured. All samples were evaluated using both the gold standard YSI glucose analyzer and MIS. Data including demographics, severity of injury as well as concomitant medication administration were collected.

Results: 88% of patients enrolled in this study were admitted for blunt trauma with a mean age of 40 years, ISS of 28 and APACHE score of 22. Midinfrared spectroscopic plasma glucose measurement had a high correlation, (Rsq = 0.87) and low standard error (STD = 12.5 mg/dL) relative to the YSI gold standard instrument. These results were obtained despite significant anemia, extracorporeal support, CVVHD and >100 potentially interfering drugs encountered in the subjects tested.



Conclusion: This cutting edge technology offers a potential alternative for accurate implementation of tight glycemic control even in an extremely high acuity environment.

Session IX-B

Paper 74 4:20 PM

AN ANALYSIS OF INNER-CITY STUDENTS' ATTITUDES TOWARDS VIOLENCE BEFORE AND AFTER PARTICIPATION IN THE "CRADLE TO GRAVE" PROGRAM

Julia M Toto, MD, Heather R Kulp, BSN MPH, Mark J Seamon, MD, Scott Charles, BS, Michael Lloyd, MS, John Gaughan, PhD, Amy J Goldberg*, MD. Temple University Hospital.

Invited Discussant: David G. Jacobs, M.D.

Introduction: The "Cradle to Grave" (C2G) program, a hospital-based violence prevention program, brings inner-city youth into an urban Level I trauma center to follow the path of an adolescent gunshot victim from trauma bay to morgue. We hypothesized that the C2G program alters student attitudes towards gun violence.

Methods: Forty-three urban public school adolescents (14 to 18 years old) were prospectively enrolled during 2006-2007. After obtaining parental and student consent students completed the Attitudes Towards Guns and Violence Questionnaire (AGVQ), a previously validated and reliable social science assessment tool. Two weeks later, the students participated in C2G. The survey was re-administered four weeks after C2G participation. AGVQ results are reported both as a total score and as a breakdown of the four component subscales (Aggressive Response to Shame, Comfort with Aggression, Excitement and Power/Safety). Higher AGVQ scores indicate proclivity towards violence. ANOVA compared scores with respect to demographic data and type of school.

Results: The 43 participants were primarily eighth grade students (96%, mean age 13.5 years) comprised of 43% males and 57% females. C2G altered adolescent attitudes towards guns and violence. One month after program completion, total scores decreased 13% (p=0.02). These findings indicate a lasting effectiveness of the C2G program in reducing students' propensity towards violence. The greatest attitudinal change occurred in Subscale 1, "Aggressive Response to Shame" (24%, $p<0.01$).

AGVQ Survey Responses Before and After C2G

	Pre C2G	**Post C2G**	**% Change**	***p***
Subscale 1	6.67	5.07	(-) 24%	<0.01
Subscale 2	3.14	2.93	(-) 7%	0.54
Subscale 3	0.81	0.93	(+) 15%	0.61
Subscale 4	5.45	5.05	(-) 7%	0.25
Total	**16.63**	**14.47**	**(-) 13%**	**0.02**

Conclusions: This hospital-based program is capable of positively impacting adolescents' attitudes towards guns and violence. Our results suggest that hospitals offer a unique opportunity to address the public health crisis posed by inner-city firearm violence.

Session IX-B

Paper 75 4:40 PM

JULY - AS GOOD A TIME AS ANY TO BE INJURED

R Grant Highstead, MD, James H Street III, MD, Christine T Trankiem-Ecenbarger, MD, James C Jeng*, MD, Jack A Sava, MD. Washington Hospital Center.

Invited Discussant: Mary C. McCarthy, M.D.

Background. Recent studies have suggested worse outcomes for hospitalized patients during the beginning of the academic calendar, though these findings have not been reproduced among trauma patients. This study compares outcomes of injured patients during the beginning of the academic year, when trainees are fresh and inexperienced, with those at the end of the academic year.

Methods. Retrospective analysis of the trauma registry of a large urban Level One trauma center. Patients admitted during April/May (ENDYEAR group) or July/August (FRESH group) between 1998 and 2007 were included. Demographic and injury parameters were recorded, and outcomes compared including crude mortality (Mx), complication rate (Cx), length of stay (LOS), and ICU length of stay (ICU-LOS). Proportions were compared using chi-squared test, and means were compared with student's t-test. Additionally, TRISS methodology was used to evaluate risk-adjusted performance.

Results. 3967 patients were included in the FRESH group, and 3626 in the ENDYEAR group. The groups were similar in age (36.07±0.28 years and 36.40±0.29 years, p=0.39) and mean ISS (8.36±0.18 and 8.38±0.18, p=0.93). There was no difference in hospital length of stay (4.57±0.15 days vs. 4.45±0.16 days, p=0.58), or LOS-ICU (5.61±0.18 days vs. 5.28±0.17 days, p=0.63). Complication rates for the FRESH and ENDYEAR groups were 6.10% and 6.45% (p=0.53), and crude mortality was 6.91% and 6.01% (p=0.11). FRESH and ENDYEAR groups had similar W-Statistics (1.03 and 1.22) and positive, significant Z-scores (3.52 and 4.41).

Conclusion. Outcomes were similar between patients injured at the beginning of the academic year compared with the end of the academic year. Our data does not support the concept of a July Effect in Level One trauma centers.

Session XI

Paper 76 8:20 AM

COMPARISON OF NEW HEMOSTATIC AGENTS WITH CURRENTLY DEPLOYED PRODUCTS TO CONTROL A LETHAL ARTERIAL HEMORRHAGE IN SWINE

Bijan S. Kheirabadi, PhD, Jason W. Edens, MD, Irasema B. Terrazas, MS, J. Scot Estep, DVM, Harold G. Klemcke, PhD, Michael A. Dubick, PhD , John B. Holcomb*, MD. US Army Institute of Surgical Research.

Invited Discussant: Peter Rhee, M.D. M.P.H.

Objective: Chitosan dressing (CD) and zeolite granules (QC) have been deployed for the past 5 years for treating external hemorrhage in combat casualties. We evaluated three new hemostatic agents for their efficacy and initial safety in an arterial hemorrhage model that was 100% fatal with Army standard gauze treatment.

Methods: Anesthetized pigs (37 kg, n=46) were instrumented, splenectomized, and their femoral arteries were isolated and injured (6 mm arteriotomy). Following 45 seconds free bleeding, a test agent [WoundStat (WS), Super QR (SQR), Celox (CX)] or a control product [CD, QC bags (ACS^+)] was applied to the wounds and compressed with a large gauze for 2 min. Fluid resuscitation was given and titrated to a mean pressure of 65 mmHg. Animals were observed for 180 min or until death. CT angiography was performed on survivors and tissue samples were collected for histology. Data (means ± SD) included duration of hemostasis (DH), blood loss (BL), survival, and wound temperature (T°).

Results: No differences in baseline. ACS^+ testing was halted after 6 failed experiments; other agents are shown in the table. [*P<0.05 vs. CD; °P<0.05 vs. CX; $^+$P<0.05 vs. others]

	CD, n=10	CX, n=10	SQR, n=10	WS, n=10	*p* value
DH, min	25.4 ± 56.8	108.6 ± 92.2*	125.5 ± 74.4*	166.0 ± 23.8*	< 0.01
BL, ml/kg	85.6 ± 31.6	40.0 ± 52.4*	34.5 ± 51.4*	9.5 ± 16.5*	<0.05
% Survival	10	60	70*	100*	< 0.01
Survival, min	83.3 ± 38.1	138.1 ± 56.0*	164.0 ± 25.8*	180*°	<0.001
T?max	36.1 ± 1.1	36.6 ± 0.9	53.5 ± 5.9$^+$	36.7 ± 0.7	< 0.001

CT images showed no blood flow in treated vessels. Histological evidence indicated least tissue damage with CD, moderate damage with WS and CX, and most injury with SQR.

Conclusion: The new hemostatic agents are significantly more effective in treating arterial hemorrhage than currently deployed products. Among them, WS granules appear to be most efficacious, followed by SQR and CX powders. The clinical significance of tissue damage caused by these agents and any potential risk of embolism with procoagulant granular/powder products are unknown and warrant survival studies.

Session XI

Paper 77 8:40 AM

OUTCOMES OF PRIMARY REPAIR IN WAR-RELATED COLON INJURIES

Amy Vertrees, MD, Matthew Wakefield, MD , Chris Pickett, MD, Lauren Greer, BA, Abralena Wilson, DO, Sue Gillern, MD, Jeffery Nelson, MD, Jayson Aydelotte*, MD , Alexander Stojadinovic, MD, Craig Shriver, MD, Martin Schreiber (sponsor). Walter Reed Army Medical Center.

Invited Discussant: Donald D. Trunkey, M.D.

Introduction: The role of primary repair of modern day war-related colon injuries remains controversial.

Methods: Retrospective review of medical records of combat-wounded soldiers with colon injuries sustained from March 2003 to August 2006 was conducted.

Results: Seventy-seven soldiers returned to Walter Reed Army Medical Center (WRAMC) with colon injuries. Twelve patients with minor colon injuries were excluded. The remaining 65 patients (mean age 28 years) sustained 67 colon injuries from secondary blast (n=38); gunshot (n=27); motor vehicle crash (MVC, n=1) and crush injury (n=1). Patients arrived at WRAMC 5 days (range 2-16 days) after injury, and were hospitalized for a median of 22 days (range 1-306 days). Primary repair was attempted in right (n=18, 60%), transverse (n=11, 85%), and left (n=9, 38%) sided colon injuries. Delayed definitive treatment of colon injuries occurred in 42% of patients. Failure of repair occurred in 16% of patients, and was more likely with concomitant pancreatic, stomach, splenic, diaphragm and renal injuries ($p<0.04$). Failures were associated with loss of abdominal domain (83% vs 28% without failure), and one death. Ostomy takedown complications included hernia (n=3, 19%), superficial wound infection (n=5, 38%) and enterocutaneous fistula and stricture (n=1; 8%). Overall morbidity for ostomy takedown was (48%). Follow up averaged 311 days (median 198 days).

Conclusions: Diversion of colon injuries is more common compared to civilian injured patients. Delayed anastomosis can often be performed after damage control operations once the patient stabilizes. Failure of primary repair occurred in 16% of patients, and was most common with concurrent intraabdominal injuries.

Session XI

Paper 78 9:00 AM

TOPICAL NANOEMULSION THERAPY REDUCES BACTERIAL WOUND INFECTION AND INFLAMMATION FOLLOWING BURN INJURY

Mark R. Hemmila*, MD, Aladdein Mattar, MD, Saman Arbabi*, MD MPH, Tarek Hamouda, MD Ph D, Michael A. Taddonio, BS, Stewart C. Wang*, MD PhD, James R. Baker Jr, MD.
University of Michigan.

Invited Discussant: Tina L. Palmieri, M.D.

Objective: We previously demonstrated that topical agents can modulate dermal inflammatory signaling following burn injury. Nanoemulsions are oil-in-water emulsions containing nanometer-sized droplets with active surfactants at their oil-water interface that have broad antimicrobial properties. We hypothesize that topical application of a nanoemulsion compound (NB-201) can attenuate burn wound infection and inflammation following thermal injury.

Methods: Male Sprague-Dawley rats underwent 30% TBSA scald burn to create a partial thickness burn injury. Animals were resuscitated with Ringer's lactate 4 mL/kg and the wound covered with an occlusive dressing. Eight hours after injury, the burn wound was inoculated with $1x10^6$ CFU of *Pseudomonas aeruginosa.* NB-201 or 0.9% saline (Control) was sprayed onto the wound at 16 and 24 hrs following burn injury. Skin was harvested 32 hrs post-burn for quantitative wound culture and determination of inflammatory mediators in tissue homogenates.

Results: NB-201 reduced bacterial growth in the burn wounds by 3 logs, with only one animal having *P. aeruginosa* counts greater than 10^5 CFU/g tissue (Table). Treatment with NB-201 reduced neutrophil sequestration in the treatment group as measured by myeloperoxidase assay (MPO) and significantly reduced levels of proinflammatory cytokines IL-1β and IL-6 in skin homogenates when compared to saline-treated controls.

Treatment	Average CFU/g tissue	No. rats w/ CFU/g >1x10^5	IL-1β (pg/mL)	IL-6 (pg/mL)	TNFα (pg/mL)	MPO (µg/mL)
Control	1.7x10^7	12/15	7647±2558	2217±676	168±48	0.47±0.07
NB-201	1.1x10^4	1/14	613±227	164±31	88±28	0.13±0.04
p-value	0.03	0.0001	0.01	0.007	0.2	0.0005

Conclusion: Topical NB-201 substantially reduced bacterial growth in a partial thickness burn model. The nanoemulsion therapy also attenuated the local dermal inflammatory response and reduced neutrophil sequestration. NB-201 represents a novel potent antimicrobial and antiinflammatory treatment for use in burn wounds.

Session XI

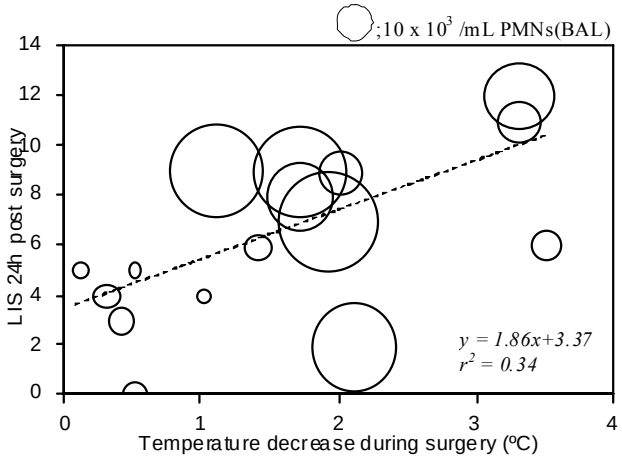
Paper 79 9:20 AM

HYPOTHERMIA DURING BURN SURGERY AND POSTOPERATIVE ACUTE LUNG INJURY IN EXTENSIVELY BURNED PATIENTS

Jun Oda*, MD, Kosuke Kasai, MD, Mitsuhiro Noborio, MD, Masashi Ueyama, MD, and Tetsuo Yukioka*, MD. Chukyo Hospital, Nagoya, Japan.

Invited Discussant: William G. Cioffi, M.D.

Background: Respiratory dysfunction remains one of the major complications after burn surgery in extensively burned patients. We evaluated the relationship between invasiveness of burn surgery and acute lung injury. **Methods**: Patients admitted to our burn unit between 2006 and 2007 with burns greater than or equal to 30 percent of the total body surface area (TBSA) without severe inhalation injury were entered into this study. Of sixteen patients (mean age 49.4±19.3 years old, TBSA 46.0±14.9%) who underwent burn surgery (3-6 days postburn), vital signs, hemodynamic parameters, blood gas analysis and peak inspiratory pressure (PIP) were recorded. Lung injury score (LIS) was serially determined. Bronchoalveolar lavage (BAL) was performed before and 24h postoperatively **Results**: Body temperature and LIS preoperatively (baseline) were 37.1±0.9 ºC and 3.8±2.2, respectively. LIS increased with increased polymorphonuclear neutrophil (PMN) in BAL 24h postoperatively in 7 of 10 patients with intraoperative temperature decreasing more than 1 degree. Extent of excision (20.3±6.7%), transfusion (4.3±3.0 units), or duration of surgery (147±49 minutes) alone did not show significant correlation with the development of acute lung injury postoperatively. **Conclusion**: In patients with severe burn injury, hypothermia during surgery despite aggressive intraoperative warming is significantly correlated with the development of acute lung injury with increased PMN in BAL, and may reflect the severity of invasiveness.



Session XI

Paper 80 9:40 AM

PREVENTABLE PEDIATRIC TRAUMA DEATHS IN ONTARIO: A COMPARATIVE POPULATION BASED STUDY.

Ivan R Diamond, MD, Patricia C Parkin, MD, Paul W Wales, MD, Desmond Bohn, MD, Margaret Kreller, CHIM, Evelyn Dykes, MBChB, Barry A McLellan, MD, David E Wesson*, MD. The Hospital for Sick Children.

Invited Discussant: Arthur Cooper, M.D.

Introduction: In a previous study (1985-7) we found that 21% of pediatric (0-15 years) trauma deaths in the Province of Ontario were potentially preventable. Since then many trauma system changes have occurred including field triage, designation of trauma centers and improved injury prevention. This study aims to re-examine the preventable trauma death rate in our system using identical methodology to our previous study.

Method: The records of all children (0 – 15 years) who died in Ontario (total pop. 11 million) from 2001 through 2003 following blunt or penetrating trauma were obtained from the Chief Coroner and compared to the those in our previous report. In both series we excluded cases where care was not sought (mainly homicides and suicides), and all deaths due to asphyxia and drowning. Deaths were considered preventable if the Injury Severity Score (ISS), based on AIS 1985, was < or = 59; all others were deemed unpreventable.

Results: There has been a substantial reduction in both the number of pediatric trauma deaths and the proportion that were preventable [Relative Risk Reduction for preventable death: 69% (95% Confidence Interval: 43 – 83%); Number Needed to Treat: 7].

	2001-03	**1985-87**
Number of Deaths	211	378
Number of Cases with sufficient data to calculate ISS	168	317
Preventable deaths	11	67
Number of pre-hospital/in-hospital preventable deaths	7 / 4	34 / 33
Number of pre-hospital/in-hospital unpreventable deaths	113 / 44	140 / 110
Preventable death rate	7%	21%

Conclusion: Aside from a marked decline in the overall number of pediatric trauma deaths in Ontario, there has been a 3-fold decline in the proportion of deaths from salvageable injuries (i.e., preventable deaths). It is highly likely that better primary and secondary prevention **and** improvements in trauma care contributed to these declines. We estimate that, for every 7 deaths from fatal injuries, system changes between the two study periods eliminated one preventable death.

Session XI

Paper 81 10:00 AM

REVERSAL OF COAGULOPATHY IN PATIENTS WITH TRAUMATIC BRAIN INJURY: RECOMBINANT FACTOR VIIA IS MORE COST EFFECTIVE THAN PLASMA

Deborah M Stein, MD MPH, Richard P Dutton*, MD MBA, Mary E Kramer, RN, Thomas M Scalea*, MD. R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine.

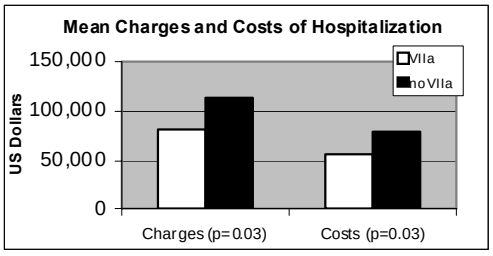
Invited Discussant: Alex B. Valadka, M.D.

Objective: Rapid normalization of coagulopathy in patients with severe traumatic brain injury (TBI) allows for safe neurosurgical intervention and may prevent progression of intracranial hemorrhage. Coagulopathy is typically reversed with plasma. Off-label recombinant factor VIIa (rFVIIa) is also used. rFVIIa use is limited by expense, making cost effectiveness an important consideration.

Methods: We used the trauma registry to identify coagulopathic patients with isolated severe TBI (Head AIS>3, admitted to the ICU, no other body region AIS>3, INR>1.3) admitted between 1/02 and 6/07. Non-survivable TBI was excluded. Demographics, laboratory data, rFVIIa use, and financial data were recorded. Patients receiving rFVIIa were compared to those treated with plasma alone.

Results: Of 306 coagulopathic patients with isolated severe TBI, 105 patients met inclusion criteria. 52 patients who received rFVIIa (median dose of 1.2 mg) were compared against 53 patients who were reversed with plasma alone. Mean age, admission GCS, and ISS were the same between the two groups. Head AIS, admission INR, and pre-injury warfarin use were greater in the rVIIa group. Despite this, length of stay was shorter in the rFVIIa group and overall hospital costs and charges were significantly lower.

	VIIa (n=52)	no VIIa (n=53)	*p value*
Age (years)	60.0 ±25.0	52.0 ±22.6	*0.09*
Male	36 (69.2%)	34 (64.1%)	*0.58*
Head AIS	**4.6 ±0.5**	**4.4 ±0.5**	***0.04***
Adm GCS	9.8 ±4.4	8.1 ±4.7	*0.06*
Adm INR	**2.4 ±1.3**	**1.9 ±0.8**	***0.01***
Pre-Injury warfarin	**32 (61.5%)**	**17 (32.1%)**	***0.003***
ISS	26.8 ±7.9	26.0 ±16.2	*0.62*
LOS	**14.5 ±10.1**	**20.1 ±16.2**	***0.04***
ICU LOS	13.3 ±9.9	17.8 ±16.0	*0.09*
Mortality	13 (25.0%)	14 (26.4%)	*0.94*



Conclusion: The use of low dose rFVIIa for emergent reversal of coagulopathy in severe TBI patients was associated with a decreased LOS and total hospital costs. Prospective study in this population is strongly indicated.

Session XI

Paper 82 10:20 AM

DISSEMINATED INTRAVASCULAR COAGULOPATHY IN SEVERE HEAD INJURY: A PROSPECTIVE STUDY

Peep Talving, MD PhD, Rodd Benfield, MD, Pantelis Hadjizacharia, MD, Kenji Inaba*, MD, Linda S Chan, PhD, Demetrios Demetriades*, MD PhD. University of Southern California.

Invited Discussant: Richard P. Dutton, M.D.

Background: The present study evaluates the incidence and risk factors for disseminated intravascular coagulation (DIC) following severe head injury and the effect of this complication on outcomes.

Methods: Prospective study of all patients admitted to the surgical ICU of a Level I trauma center from June 2005 to May 2007 with severe head injury [head abbreviated injury score (AIS) >3]. Criteria for DIC included a clinical condition consistent with DIC, platelet count <100,000 and elevated PT/aPTT. The following potential risk factors with $p<0.2$ on bivariate analysis were included in a stepwise logistic regression to identify independent risk factors for DIC and its association with mortality: age, mechanism of injury [blunt (B) or penetrating (P)], blood pressure on admission, Injury Severity Score (ISS), Glasgow Coma Scale (GCS), head and other body area AIS, diffuse axonal injury, cerebral edema, intracranial hemorrhage (intraventricular, parenchymal, subarachnoid, or subdural), pneumocephaly, and presence of midline shift.

Results: There were 436 patients (393 blunt, 44 penetrating). 387 patients had isolated severe head injury. DIC occurred in 36% of all patients (33% in blunt and 55% in penetrating trauma; $p<0.007$) and in 34% of patients with isolated head injury (32% in blunt and 54% in penetrating trauma; $p=0.006$). The presence of major extracranial injuries (AIS>3) did not influence the incidence of DIC. Independent risk factors for DIC in isolated severe head injuries were found to include GCS<=8, ISS>=16, presence of diffuse cerebral edema, subarachnoid hemorrhage, intraventricular hemorrhage, and hypotension on admission. DIC was an independent risk factor for mortality [adjusted odds ratio (95%CI) 9.61 (4.06, 25.0) <0.0001].

Conclusion: The incidence of DIC in SHI is high, especially in penetrating injuries. Independent risk factors for DIC include GCS<=8, presence of cerebral edema, subarachnoid hemorrhage, intraventricular hemorrhage, ISS >=16,and hypotension. DIC increased mortality by nearly 10 times.

Session XI

Paper 83 10:40 AM

PHOSPHODIESTERASE INHIBITION MODULATES INTESTINAL TIGHT JUNCTION SIGNALING AFTER BURN INJURY: EFFECTS ON MYOSIN LIGHT CHAIN KINASE

Todd W. Costantini, MD, William Loomis, BS, Dana Drusinsky, Sunghyuk Choi, MD, James G. Putnam, BS, Brian Eliceiri, PhD, Andrew Baird, PhD, Vishal Bansal, MD, Raul Coimbra*, MD PhD. University of California- San Diego.

Invited Discussant: William G. Cioffi, M.D.

Introduction: Burn injury can result in loss of intestinal barrier function, leading to systemic inflammatory response syndrome and multi-organ failure. Myosin Light Chain Kinase (MLCK), a tight junction protein involved in the regulation of barrier function, increases intestinal epithelial permeability when activated. Prior studies in intestinal epithelia have shown that Tumor Necrosis Factor- alpha (TNF-α) activates MLCK, in part through a Nuclear Factor Kappa B (NF-κB) dependent pathway. We have previously shown that phosphodiesterase inhibition decreases both TNF-α synthesis and NF-κB activation in models of shock. Therefore, we postulate that phosphodiesterase inhibition will attenuate activation of the tight junction protein MLCK, which may decrease intestinal tight junction permeability after severe burn.

Methods: Male balb/c mice undergoing a 30% total body surface area steam burn were randomized to resuscitation with normal saline (NS) or NS + Pentoxifylline (PTX, 12.5mg/kg). Intestinal TNF-α levels were evaluated using ELISA. Gut extracts were obtained to assess Myosin Light Chain Kinase (MLCK), phosphorylated IkBα, and phosphorylated NF-κB p65 levels by immunoblotting.

Results: Burn injury increased intestinal MLCK protein levels 3-fold ($p<0.05$ vs sham) in animals resuscitated with NS, while those receiving PTX had MLCK levels similar to control ($P<0.005$ vs. NS). Compared to animals receiving NS, treatment with PTX decreased intestinal TNF-α levels by 59% ($p<.002$). PTX attenuated cytoplasmic IkBα phosphorylation and nuclear NF-κB translocation to sham levels ($p<0.05$ vs. NS).

Conclusion: Treatment with phosphodiesterase inhibition attenuates activation of the tight junction protein MLCK, likely through its ability to decrease local TNF-α synthesis and NF-κB activation after burn. Phosphodiesterase inhibition modulates intestinal tight junction signaling after burn injury and could be considered as an adjunct to standard resuscitation.

Session XI

Paper 84 11:00 AM

PHASE I/II CLINICAL EVALUATION OF STRATAGRAFT: A NOVEL BACTERIOSTATIC HUMAN SKIN TISSUE

Michael J. Schurr*, MD, Kevin F. Foster, MD, Lee D. Faucher*, MD, Angela L. Gibson, PhD, John M. Centanni, MS, Allen R. Comer, PhD, B. Lynn Allen-Hoffmann, PhD. University of Wisconsin.

Invited Discussant: Basil A. Pruitt, Jr., M.D.

Introduction: Trauma and burn wounds often require temporary allograft placement to prevent infection and dehydration until permanent wound closure is feasible. We developed and clinically tested a novel skin substitute (StrataGraft™) with bacteriostatic properties *in vitro.* StrataGraft™ is produced from a consistent source of adventitious agent-free, long-lived, keratinocyte progenitor cells that recapitulate human skin.

Methods: Whole genome microarray analysis was used to identify differences in gene expression between StrataGraft™ and bioengineered tissue generated with strain BC-1Ep keratinocytes, and was confirmed by qPCR. To assess antimicrobial activity *in vitro,* bacterial growth assays were performed and significance was determined using one-way ANOVA with Dunnett's multiple comparisons. A Phase I/II, FDA approved, randomized, safety and dose escalation trial was performed to assess autograft take and infection in 15 patients two weeks after coverage with cadaver skin or StrataGraft™.

Results: Microarray analysis of StrataGraft™ revealed an increase in expression of human β defensin-3 (HBD-3) and cell type-specific proteases involved in post translational processing of host defense peptides. qPCR showed that StrataGraft™ HBD-3 mRNA levels were 8-fold greater than tissue generated with BC-1Ep keratinocytes. *In vitro* microbial growth (S. *carnosus*) was attenuated 50% by exposure to StrataGraft™ relative to tissue generated with other strains of keratinocytes. Analysis of primary endpoints in the clinical study showed no difference in autograft take after pretreatment with either StrataGraft™ or cadaver skin. StrataGraft™ was comparable to cadaver skin in ability to be meshed (1:1 ratio, Brennan Medical, Saint Paul, MN).

Conclusions: StrataGraft™ is a pathogen-free human skin substitute tissue that is ideal for the temporary management of severe skin wounds prior to autografting. StrataGraft™ skin tissue may offer additional protection to the wound bed through bacteriostatic properties and has been shown to be safe and effective in this Phase I/II clinical trial.

Session XI

Paper 85 11:20 AM

IMPACT OF DECOMPRESSIVE CRANIECTOMY ON FUNCTIONAL OUTCOME FOLLOWING SEVERE TRAUMATIC BRAIN INJURY

Regan F Williams, MD, Louis J Magnotti, MD, Martin A Croce*, MD, Brinson Hargraves, MD, Thomas J Schroeppel, MD, Micheal S Muhlbauer, MD, Shelly D Timmons, MD, Peter E Fischer, MD, Timothy C Fabian*, MD. University of Tennessee Health Science Center.

Invited Discussant: Blaine L. Enderson M.D.

Introduction: The beneficial effect of decompressive craniectomy (DC) in the treatment of traumatic brain injury (TBI) remains controversial. In many centers, it is utilized as a salvage procedure for uncontrollable intracranial pressure (ICP). It is our contention that DC represents a viable early option for head trauma patients. The purpose of this study was to evaluate the efficacy of DC on functional outcome following severe TBI in the largest single institutional series reported in the literature.

Methods: Patients with severe TBI (AIS 4-5) treated with DC over a 3-year period were identified from the trauma registry. Functional outcome was measured 1-3 years post injury using the Glasgow Outcome Score-Extended (GOSE) via telephone interview, and classified as good (GOSE 5 to 8) or poor (GOSE 1 to 4, including death). Outcomes were compared using Wilcoxon rank-sum and chi-square tests where appropriate.

Results: 112 patients were identified: 90 (80%) men and 22 (20%) women. Overall mortality (all in-hospital) was 35% (head-related = 24%). Of the 73 survivors, follow-up was obtained in all but 3. Good outcome was achieved in 63 patients (58% overall, 90% of survivors). Those with good outcome were younger (25 years vs. 40 years, $p = .02$) and experienced a greater change in pre- to post-decompression ICP (ICP reduced by 24 mmHg vs. 10 mmHg, $p = .0021$). Not surprisingly, unchanged ICP (pre- to post-decompression) was associated with poor outcome ($p = .0005$). There was no difference in immediate pre-decompression ICP between survivors vs. non-survivors. However, immediate pre-decompression GCS was significantly higher in survivors compared to non-survivors (7 vs. 5, $p = .007$).

Conclusions: DC resulted in good functional outcome in >50% of patients with severe TBI. The greatest benefit was observed in younger patients with a demonstrable reduction in ICP following decompression. The prospect of improved functional outcome offered by this procedure in the treatment of severe TBI warrants prospective investigation.

Session XI

Paper 86 11:40 AM

ACUTE CARE SURGEONS: NOT JUST A TITLE - IMPROVED SURVIVAL IN ELDERLY PATIENTS REQUIRING OPERATIVE INTERVENTION

Stepheny D Berry, MD, Casey J Thomas, DO, Joe H Patton*, MD, Anthony J Falvo, DO, Jennifer Ritz, RN, Jack Jordan, Ilan Rubinfield, MD. Henry Ford Hospital.

Invited Discussant: Michael E. Lekawa, M.D.

Introduction: As the general population ages, there is an increasing number of operations being performed on patients 80 years of age and older. Mortality in the elderly population varies in the literature from 7% in predominately elective surgery to 31% for emergent procedures, with an average overall mortality of 21%. The advent of the Acute Care Surgeon provides continuous coverage as well as a specialist experienced in complex surgical issues such as those specific to this age group. We evaluated the outcomes of our facility's Acute Care Surgery Division (ACSD) regarding elderly surgical patients.

Methods: We completed a retrospective analysis of patients, age 80 or older, who required an operation by a member of the ACSD between 07/00 and 11/06 at an urban tertiary care facility. Information regarding patient age, ASA score, gender, length of operation, type of operation, and mortality was abstracted from the medical record.

Results: 286 patients were identified from the database. 56.8% of the patients were female and 44.2% were male. 76% of these patients underwent major abdominal surgery. 67% of patients underwent emergent operative intervention. Overall 30 day mortality was 11.8%. Mortality for emergent procedures was 15.1%. Predictors of mortality using a logistic regression model were age, ASA score, and female gender ($p<0.001$). There was no increase in mortality in patients who required "off hours" surgery. Neither length of operation nor designation as an emergent procedure was a predictor of mortality.

Conclusion: Literature suggests that age and ASA score are predictors of mortality. Our data support these conclusions. However, our patients appear to have a lower mortality rate than cited in the literature when complexity of operation and designation as an emergent procedure are considered. This improved survival is likely multi-factorial in origin, and further analysis is needed for clarification. It has been shown that when dealing with complex surgical issues, high-volume centers have better results than those at low-volume institutions. We suspect the acute care surgery population is no different.