

TRENDS IN TRAUMA SURGERY - ANALYSIS OF THE AAST PROGRAM 1939-2012

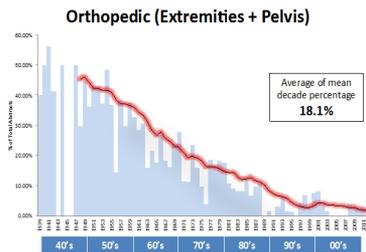
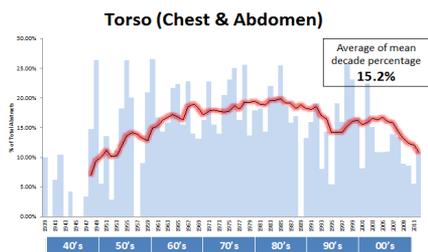
Reuven Rabinovici* MD, Sharon Gautschy Raul Coimbra* MD, Ph.D., Tufts Medical Center

Invited Discussant: Basil Pruitt, MD

Introduction: Major trauma-related clinical and basic science innovations were presented at AAST since its establishment in 1938. Thus, an analysis of all podium presentations at the Annual Meeting of the Association was carried out to identify historical and current trends in trauma surgery.

Methods: All abstract books of the Annual Meetings of AAST from 1939 (first meeting) to 2012 were identified except for 1943 and 1945 (no meeting due to WWII) and 1946 (not found). A master list of abstracts (n=3,637) was generated in Excel. Abstracts were assigned to 14 different categories, and the percentage of each category was tabulated per year. Trend lines were then generated using a mean of 10 zones. Additionally, the year in which major clinical and basic science advancements were first presented was recorded.

Results: Overall, most (20%) AAST presentations were related to the resuscitation, shock, infection, inflammation, immunology, endocrinology, and metabolism category. This was followed by the orthopedic (18%) and the torso (chest and abdomen) trauma categories (15%). The trend for each category over time was identified. Prominent trends included a bell-shaped curve for torso injuries (left figure), a progressive decrease in orthopedic topics (right figure), an increase in critical care topics since the 70's, in resuscitation/infection/shock abstracts since the 80's, and in trauma system presentations since the 90's. 175 first presentations of key topics were identified. Prominent examples include use of penicillin (1941), sepsis (1948), use of plasma (1950), tetanus immunization (1953), trauma education (1954), first controlled clinical trial (1955), iv nutrition (1957), traumatic coagulopathy (1963), hypertonic saline (1966), angiography for trauma (1967), first inflammation study (1968), "wet lungs" (1968), use of PEEP (1971), use of computers in trauma (1971), description of ED thoracotomy (1972), pulmonary capillary wedge pressure (PCWP, 1972), ICP monitoring (1976), splenorrhaphy (1978), H2 blockers (1979), use of CT scan in trauma (1980), selective management of splenic injury (1981), ATLS (1984), use of ultrasound in trauma (1987), damage control laparotomy (1992), laparoscopy (1992), DVT prophylaxis (1995), endovascular stenting (2000), telemedicine (2005), and damage control resuscitation (2007).



Conclusions: Analysis of all oral AAST presentations identified trends and significant milestones in trauma care and research. In 75 years of existence, the AAST Annual Meeting remains the forum in which major developments in trauma care and scientific knowledge are presented and disseminated.

TRENDS IN TRAUMA-RELATED MORTALITY IN THE UNITED STATES FROM 2002-2010

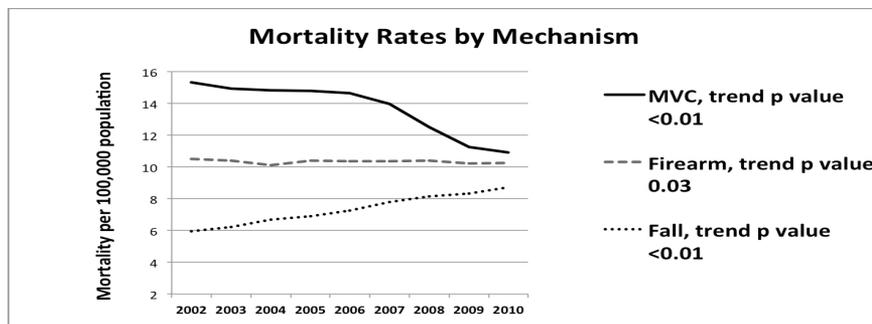
Robert G. Sise MBA, MPH, Richard Y. Calvo MPH, Lakshika Tennakoon MD, David A. Spain* MD, Thomas G. Weiser MD, MPH, Kristan L. Staudenmayer* MD, MS Stanford University

Invited Discussant: Charles C. Baker, MD

Introduction: Epidemiologic trends in trauma-related mortality in the U.S. require updating and characterization. In the past, improvements in trauma care and vehicle safety, as well as changes in population demographics, have led to reduced mortality for the three most common causes of trauma-related deaths: motor vehicle crashes (MVCs), firearms, and falls. We hypothesized that while this trend continues, there have been changes in the proportions of deaths from the different mechanisms.

Methods: Multiple sources were queried for the time period of 2002-2010: the National Trauma Data Bank (NTDB), the National Centers for Disease Control (CDC), the National Highway Traffic Safety Administration (NHTSA), and the U.S. Census Bureau. The incidence of injury and mortality for MVCs, firearms, and falls were determined using CDC data. NHTSA data were used to determine annual vehicle miles traveled (VMT). Injury severity data were derived from the NTDB. Census data were used to determine population rates and demographic changes. Injury Severity Score (ISS) was analyzed between 2002 and 2010 with t-tests. Analysis of mortality trends by year was performed using the Cochran-Armitage test for trend.

Results: From 2002-2010, the total mortality decreased by 6% ($p < 0.01$). However, mortality trends differed by mechanism (Fig.). The large decrease in fatal MVCs was associated with a decrease in the annual number of all MVCs (6.3 to 5.4 million), fewer injuries per MVC (463 to 413 injuries/1000 MVCs), and a decrease in mean ISS per MVC (11.1 to 10.5, $p < 0.01$). The decrease in the number of MVCs was not associated with a decrease in VMT (2.9 to 3.0 billion). Firearm-related mortality decreased slightly despite a 10% increase in firearm-related injuries (31 to 34/100,000 population). In contrast, fall-related mortality increased by 46% (5.95 to 8.70, $p < 0.01$) and was associated with a 2.4 million (9.3%) increase in population over 70 years of age.



Conclusion: MVC mortality rates have decreased over the last decade, due in part to decreases in the number and severity of MVC-related injuries. Improvements in trauma care also likely play a role. Conversely, fall-related mortality is increasing and is projected to exceed both MVC and firearm mortality rates should current trends continue. Trauma systems will need to take account of these changing injury mortality patterns and demographics to best accommodate the needs of the injured population.

TEMPORAL TRENDS OF POSTINJURY MULTIPLE ORGAN FAILURE: STILL RESOURCE-INTENSIVE, MORBID AND LETHAL

Angela Sauaia MD,Ph.D., Ernest E. Moore* MD, Jeffrey Johnson* MD, Theresa Chin MD, Anirban Banerjee Ph.D., Jason L. Sperry MD, Ronald V. Maier* MD, Clay Burlew* MD, Colorado School Of Public Health

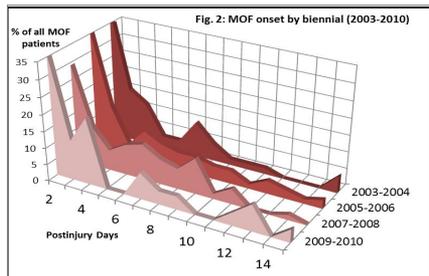
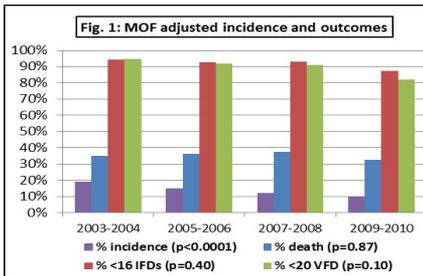
Invited Discussant: H. Gill Cryer, MD, PhD

Introduction: While the incidence of postinjury multiple organ failure (MOF) has declined over the past decade, temporal trends of its morbidity, mortality, presentation patterns and healthcare resources utilization have been inconsistent. The purpose of this study is to describe the evolving epidemiology of postinjury MOF from 2003-2010 in multiple trauma centers sharing standard treatment protocols.

Methods: “Inflammation and Host Response to Injury Collaborative Program” institutions that enrolled >20 eligible patients per biennial during the entire 2003-2010 study period were included. Patients aged 16-90 years, with blunt torso trauma and hemorrhagic shock [systolic blood pressure (SBP) <90 mm Hg, base deficit (BD) \geq 6 mEq/L, blood transfusion /12hrs], without severe head injury were followed for 28 days. ICU free days (IFD) and ventilator free days (VFD), were categorized at their median values (<16 IFD; <20 VFD). All rates were adjusted for temporal trends and admission risk factors [age, sex, BMI, new injury severity score (NISS), SBP, BD] using logistic regression. MOF was defined as a Denver MOF score>3.

Results: 1643 patients from four institutions were evaluated. MOF adjusted incidence decreased over time (Fig. 1) but MOF related death rate ($p=0.87$), IFD ($p=0.40$) and VFD ($p=0.10$) did not improve. Lung and cardiac dysfunctions became less frequent (61% to 53%, $p<0.001$; 22% to 13%, $p=0.004$), but kidney and liver failure rates did not change (11% to 13%, $p=0.10$; 17% to 14%, $p=0.15$). The onset of MOF has retained a multimodal distribution (Fig. 2). Age, BMI, and shock severity upon admission (SBP, BD) increased over time, but not NISS. No changes were detected in 12hrs blood transfusions over time. Infections and non-septic complications (NSC) rates did not decline (Infections: 54% to 58%, $p=0.22$; and NSC: 54% to 57%, $p=0.17$).

Conclusions: Postinjury MOF remains a resource-intensive, morbid, and lethal condition. Lung injury is an enduring challenge and should be a research priority. Lack of outcome improvements suggests that reversing MOF is difficult and prevention is still the best strategy.



A PROSPECTIVE RANDOMIZED TRIAL OF THE EFFICACY OF "TURNING POINT", AN INPATIENT VIOLENCE INTERVENTION PROGRAM

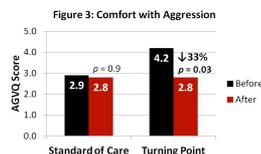
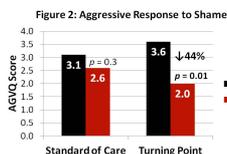
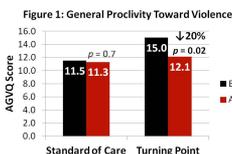
Catherine E. Loveland-Jones MD, Scott Charles MAPP, Lucas Ferrar MD, Andrea VanZandt BA, Thomas A. Santora* MD, Abhijit S. Pathak* MD, Jay E. Dujon* MD, Lars O. Sjöholm* MD, Joseph F. Rappold* MD, William Dubin MD, Amy J. Goldberg* MD, Temple University Hospital

Invited Discussant: Rochelle Dicker, MD

Introduction: From 2002-2011, there were over 17,000 shootings in Philadelphia. "Turning Point (TP)", an inpatient violence intervention program, was established to take advantage of the teachable moment that occurs after violent injury. In addition to receiving social work services, TP patients watch their trauma bay resuscitation video and a movie about violence, meet with a gunshot wound survivor and an outpatient case manager, and also undergo psychiatric assessment. The purpose of this study was to determine the efficacy of TP in changing attitudes toward violence among victims of penetrating trauma.

Methods: An IRB-approved prospective randomized study was conducted at an urban Level 1 trauma center from January-June 2012. Patients ≥ 18 y who sustained a gunshot or stab wound were randomized to standard of care (SOC; social work services), or TP. The validated Attitudes Toward Guns and Violence Questionnaire (AGVQ) was administered at the beginning and end of the hospital stay in order to assess attitudinal change. Analysis was performed with the Wilcoxon signed-rank test. A $p < 0.05$ was significant.

Results: A total of 40/159 subjects were randomized (21 SOC, 19 TP). The most common reason for exclusion was anticipated length of stay < 48 h. Only 9% of eligible patients refused participation. The SOC and TP groups were similar with respect to demographics and injuries except in age (SOC 31y, TP 22y). In comparison to the SOC group, the TP group demonstrated a 20% reduction in General Proclivity toward Violence ($p=0.02$; Figure 1), a 44% reduction in Aggressive Response to Shame ($p=0.01$; Figure 2), and a 33% reduction in Comfort with Aggression ($p=0.03$; Figure 3).



Conclusions: TP is effective in changing attitudes toward violence among victims of penetrating trauma. Continued enrollment and longer follow-up are necessary to determine if this program can truly be a turning point in patients' lives.

UNRELENTING VIOLENCE: AN ANALYSIS OF 6327 GUNSHOT WOUNDS AT LEVEL I TRAUMA CENTER

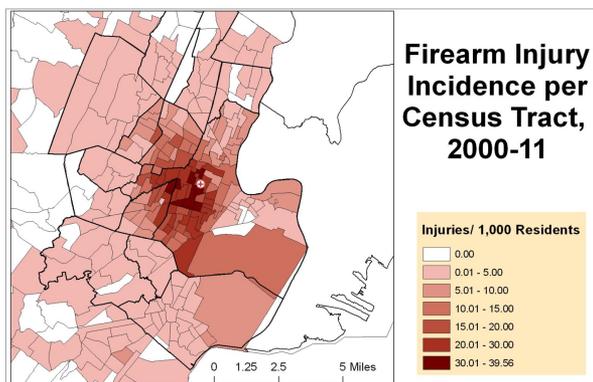
David H. Livingston* MD, Robert F. Lavery MA, Maeve C. Lopreiato MPH,RN, David F. Lavery BS, Marian R. Passannante Ph.D., New Jersey Medical School

Invited Discussant: Demetrios Demetriadas, MD

Introduction: Perceptions of violence are too often driven by individual sensational events yet “routine” gunshot wound (GSW) injuries are largely under reported and hidden to policy makers. Previous studies have mostly focused upon GSW homicides. To illuminate this public health problem we studied the health care burden of interpersonal GSW at a Level I Trauma Center.

Methods: Retrospective analysis of all interpersonal GSW injuries (excluding self inflicted and law enforcement GSW) treated from 1/2000-12/2011. Data collected included: body region injured, # of wounds and mortality. GIS mapping of the incident location and home addresses were determined. Hospital costs were calculated using Medicare cost-charge modifiers.

Results: 6327 patients were treated with a mean of 527/year (range 389 to 640). Of interest 23% of patients mostly with peripheral GSW were never seen by the trauma service. There were significant increases in proportions of patients with ≥ 3 wounds (13% to 22%; $p < 0.0001$) and ≥ 3 body regions injured (6% to 16%; $p < 0.0001$). Mortality increased over the 12 years (9% to 14%; $p < 0.0001$). GIS mapping revealed significant clustering of GSW (figure; + = Trauma Center). 5 cities accounted for 85% of the GSWs. The GSW rate (per 100,000 residents) for these cities ranged from 19-108 compared to a national rate of 20. Only 2% of the census tracts had no GSWs during the time period and 39% of census tracts had at least one GSW/yr for 12 years. 70% of patients were shot in the city where they lived; 25% within 168 meters and 55% within 1600 meters of their home. Total inpatient cost was \$115 million, 75% being unreimbursed. Cost/patient increased three-fold which is in excess of the health care inflation rate over the same time period.



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Conclusions: GSW violence remains a significant public health problem with significant increases in mortality and health costs. Relying on trauma registry data alone will seriously underestimate GSW numbers. In contrast to episodic and random mass casualties which make national news, GIS mapping demonstrates that the majority of “routine” GSW violence is geographically restricted and not random. To combat this problem, policy makers must understand that the determinants of firearm violence reside at the community level.

**BRIEF INTERVENTIONS AS A MEANS TO REDUCE PROBLEMATIC
DRINKING BEHAVIOR AMONG FIRST-TIME DUI ARRESTEES: A
RANDOMIZED TRIAL**

Garth H. Utter* MD, MSc, Jason B. Young MD, PharmD, Daniel Eisenberg Ph.D., Carol R. Schermer* MD, MPH, Leon J. Owens* MD, University of California, Davis

Invited Discussant: Deborah Kuhls, MD

Introduction: In medical settings, a form of counseling based on motivational interviewing known as brief intervention (BI) reduces alcohol-related risk-taking behavior and harm in high-risk populations. Individuals arrested for driving under the influence of alcohol (DUI) are another population at increased risk for future harm from their drinking behavior. We hypothesized that a BI administered shortly after a first DUI arrest might decrease problematic drinking behavior.

Methods: We conducted a single-center randomized trial, enrolling first-time DUI arrestees at a county jail from December, 2010 through April, 2011. Prior to their release, we assessed baseline characteristics, then randomized participants to either a single BI or no discussion. Ninety days later, we administered the Alcohol Use Disorders Identification Test (AUDIT) (range 0-40, higher values indicating more problematic drinking) and assessed whether, independent of court order, subjects sought treatment for their drinking.

Results: We enrolled 200 subjects and 181 (90.5%) completed 90-day follow-up. Mean age was 30 ± 10 years, and 50% were men. Mean blood alcohol concentration upon arrest was $0.14 \pm 0.04\%$. Baseline AUDIT scores were 7.7 ± 6.3 among control subjects and 8.8 ± 5.8 among BI subjects. By 90 days, AUDIT scores decreased by 3.4 ± 5.0 units among control subjects and 4.7 ± 5.1 among BI subjects [difference 1.3 (95% C.I. -0.1 to +2.8)]. The likelihood of subsequent binge drinking [RR 0.95 (95% C.I. 0.46-1.93)], abstinence [RR 1.10 (95% C.I. 0.48-2.52)], alcohol-related injury to self or others [RR 2.2 (95% C.I. 0.4-11.8)], and seeking treatment [RR 1.01 (95% C.I. 0.47-2.17)] did not differ between the arms.

Conclusion: A single BI counseling session shortly after first-time DUI arrest does not reduce 90-day self-reported drinking behavior or increase seeking treatment for drinking beyond that which normally occurs. Further efforts to evaluate motivational interviewing for first-time DUI arrestees should focus on different applications of BIs—e.g., extended counseling or in subgroups more receptive to changing their drinking behavior—and possibly longer follow-up.

THROMBELASTOGRAM GUIDED ENOXAPARIN DOSING LEADS TO INCREASED SERUM ANTI-XA LEVELS, BUT DOES NOT CONFER PROTECTION FROM DVT: A RANDOMIZED CONTROLLED PILOT STUDY

Scott G. Louis MD, Philbert Van MD, Gordon Riha MD, Jeffrey Barton MD, Elizabeth Rick BS, Misa Sato Samantha Underwood MS, Jerome Differding MPH, Enrique Ginzburg* MD, Martin A. Schreiber* MD, Oregon Health & Science University

Invited Discussant: Sandro Rizoli, MD

Introduction: The incidence of DVT remains high in general surgery and trauma patients despite widespread prophylaxis with enoxaparin. A recent observational study demonstrated decreased incidence of DVT if patients on enoxaparin had a change in R time (ΔR) >1 minute when heparinase-activated TEG was compared to normal TEG. We hypothesized using ΔR guided dosing would result in decreased DVT rates

Methods: A prospective, randomized controlled trial was performed at a level 1 trauma center. Both trauma and general surgery patients were included. Upon enrollment demographic data including age, gender, BMI, and APACHE II score were obtained. Enrolled patients were randomized to standard (30mg BID) or TEG-guided dosing. Dose-adjusted patients underwent daily enoxaparin titration to achieve a ΔR of 1-2 minutes. VTE screening was performed per institutional protocol. Antithrombin III (AT-III) and anti-Xa levels were drawn at peak enoxaparin concentrations.

Results: 87 patients were enrolled. There was no difference in demographic data between the groups. No pulmonary emboli were identified. The control group had a DVT rate of 16% while the experimental group had a rate of 14%, $p=NS$. The experimental group's median enoxaparin dose, 40mg BID, was significantly higher than that of the control, $p<0.01$. TEG ΔR was not different between the control and experimental groups. Beginning at day 3, anti-Xa levels were higher in the experimental group ($p<0.05$). There was no difference in AT-III activity between the two groups; 67% of patients demonstrated AT-III deficiency.

Conclusion: TEG adjusted enoxaparin dosing led to significant increases in anti-Xa activity that did not correlate with a decreased DVT rate. Failure to reduce the DVT rate and increase ΔR despite increased dosing and increased anti-Xa activity is consistent with the high rate of AT-III deficiency detected in this study cohort. These findings suggest the need for novel advances in chemoprophylaxis which either increase AT-III directly or are independent of the AT-III pathway.

FINDINGS OF A RANDOMIZED CONTROLLED TRIAL USING LIMITED TRANSTHORACIC ECHOCARDIOGRAM (LTTE) AS A HEMODYNAMIC MONITORING TOOL IN THE TRAUMA BAY.

Paula Ferrada MD, David Evans MD, Luke Wolfe MS, Rahul J. Anand MD, Julie Mayglothling MD, Therese Duane* MD, James Whelan MD, Stephanie Goldberg MD, Ajai Malhotra* MD, Poornima Vanguri MD, Rao R. Ivatury* MD, Michel Aboutanos* MD, Virginia Commonwealth University

Invited Discussant: Heidi Frankel, MD

Introduction: Limited transthoracic echocardiogram (LTTE) has been introduced as a technique to direct resuscitation in trauma patients. We hypothesize that LTTE is a useful tool to guide therapy during the initial phase of resuscitation in trauma patients.

Methods: All highest level alert patients with at least one measurement of systolic blood pressure <100 mmHg, a mean arterial pressure < 60 mmHg, and/or a heart rate >120 bpm who arrived to the trauma bay (TB) at a level 1 center were randomized to have either LTTE performed (LTTEp), or not performed (nonLTTE) as part of their initial evaluation from July 1 to December 31 2012. Images were stored and results were reported regarding contractility (good vs. poor), fluid status (empty inferior vena cava: eIVC [hypovolemic] vs. full inferior vena cava: fIVC [not hypovolemic]), and pericardial effusion (present vs. absent). Time from TB to operating room (OR), intravenous fluid (IVF) administration, blood product requirement, ICU admission, and mortality were examined in both groups.

Results: 240 patients were randomized. 25 patients were excluded since they died upon arrival to the TB, leaving 215 patients in the study. 92 patients were in the LTTEp group with 123 patients in the nonLTTE group. LTTE helped guide resuscitation as patients with eIVC received on average significantly more fluid than patients with fIVC (1.8L vs. 1.0L, $p<0.0001$). The LTTEp and nonLTTE groups were similar in age, (38 vs. 38.8, $p=0.75$), ISS (19.2 vs. 19.0, $p=0.94$), RTS (5.5 vs. 6.0, $p=0.09$), lactate (4.2 vs. 3.6, $p=0.14$) and mechanism of injury, (Blunt 64% vs. 63%, penetrating 28% vs. 33%, burns 7.6% vs. 4%, $p=0.44$). Strikingly, LTTEp had significantly less IVF than nonLTTE patients, (1.5L vs. 2.5L, $p<0.0001$), less time from TB to OR, (35.6 min vs. 79.1 min, $p=0.0006$), higher rate of ICU admission, (80.4% vs. 67.2%, $p=0.04$), and although not statistically significant, a lower mortality rate (11% vs. 19.5%, $p=0.09$). Mortality differences were particularly evident in the traumatic brain injury (TBI) patients, (14.7% in LTTEp vs. 39.5% in nonLTTE, $p=0.03$) as shown in table 1

Table1 TBI Patients

	LTTEp	nonLTTEp	p value
Mean Age	37y	42y	0.32
Mean ISS	21.7	18.8	0.39
Mean IVF	1.04L	2.4L	<0.0001
Blood Transfusion	17.7%	2.6%	0.05
Min to OR	40min	65min	0.15
Mortality	17.7%	39.5%	p0.0336

Conclusion: LTTE is a useful guide for therapy in hypotensive trauma patients during the early phase of resuscitation. In this study, there was an improved outcome in patients where therapy was guided by LTTE findings

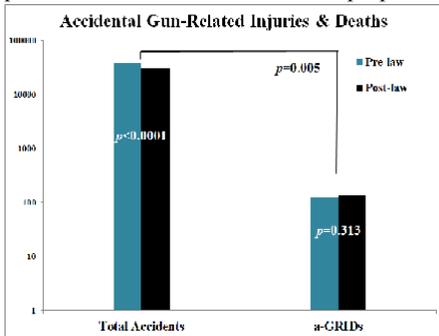
REPEAL OF THE CONCEALED WEAPONS LAW AND ITS IMPACT ON GUN-RELATED INJURIES & DEATHS

Rashna F. Ginwalla MD, Andrew Tang MD, Randall Friese* MD, Donald J. Green MD, Lynn Gries MD, Bellal Joseph MD, Narong Kulvatunyou MD, Dafney Lubin MD, Terence O'Keeffe MB,ChB; MSPH, Gary Vercurysse* MD, Julie L. Wynne MD,MPH, Peter Rhee* MD,MPH, University of Arizona - Tucson

Invited Discussant: Glen Tinkoff, MD

Introduction: SB-1108, enacted on July 29, 2010, allowed citizens over 21 years to carry concealed weapons without a permit or completion of a previously mandatory training course. It is unclear whether the law creates a “deterrent factor” to criminals, or escalates gun-related violence as a result of an increased number of concealed weapons being carried by inexperienced individuals without the proper training. We hypothesized that SB-1108 would result in an increase in gun-related injuries and deaths (GRIDs).

Methods: We performed a retrospective, population-based cohort study spanning 24 months before (pre-law) and after (post-law) SB-1108. Death statistics, injury and in-hospital death data, overall crime & accident trends and the number of firearm purchase-related background checks between the two periods was determined. Injured patients were dichotomized into two groups, intentional (i-GRIDs) and accidental gun-related injuries and deaths (a-GRIDs), which were analyzed separately. The primary outcome was any gun-related injury or death (GRID), while gun-related death alone was analyzed as a secondary outcome. Student's t-tests and chi-square analyses were performed to determine means and proportional differences in GRIDs between the two



time periods respectively. Relative risks were calculated for each subgroup.

Results: National and state background checks for firearms purchase increased between the two study periods (national $p=0.0003$; state $p=0.0006$), and were proportionately reflected in a relative increase in state firearm purchase (1.50% pre-law vs 1.59% post-law, $p<0.001$). The proportion of i-GRID to overall city violent crime remained the same over the two periods (9.74% pre-law vs 10.36% post-law, RR 1.06, 95%CI 0.96,1.17).

However, the proportion of gun-related homicides increased in the post-law cohort (1.97% pre-law vs 2.45% post-law, $p=0.058$). Victims of violent crimes had a 24% increased risk of death by firearms after passage of SB-1108 (RR 1.24, 95%CI 1.00-1.54). The proportion of a-GRIDs increased significantly in the post-law cohort such that accident victims were at a 41% increased risk of being injured or killed by firearm (RR 1.41, 95%CI 1.11-1.80).

Conclusion: Both nationally and statewide, there was an increase in firearm sales over the study periods. Although the proportion of intentional GRIDs to overall city violent crime remained constant, there was an increase in homicide by firearm and accidental GRIDs since the institution of SB-1108. Liberalization of gun access has resulted in an increase in fatalities and should be critically assessed.

MORE HARM THAN GOOD: ANTI-SEIZURE PROPHYLAXIS AFTER TRAUMATIC BRAIN INJURY DOES NOT DECREASE SEIZURE RATES BUT MAY INHIBIT FUNCTIONAL RECOVERY

Indermeet Bhullar* MD, Donald Johnson PharmD, David Chesire Ph.D., Eric Frykberg* MD, University of Florida, Jacksonville

Invited Discussant: Kenji Inaba, MD

Introduction: The purpose of this study was to examine the current Brain Trauma Foundation recommendation for anti-seizure prophylaxis with Phenytoin during the first seven days after traumatic brain injury [TBI] in preventing seizures and to determine if this medication affects functional recovery as measured by Glasgow Outcome Score (GOS) at discharge.

Methods: The records of adult (age \geq 18) patients with blunt severe TBI (positive computed tomography [CT] scan of the head and admission Glasgow Coma Score [GCS] of [3-8]) that remained in the hospital at least 7 days after injury at a Level I trauma center were retrospectively reviewed from Jan 2008 to Jan 2010. Seizure rates during the first seven days after injury were compared for two groups based on anti-seizure prophylaxis provided: No prophylaxis (NP) vs. Phenytoin prophylaxis (PP). Phenytoin levels were checked and doses adjusted appropriately to achieve therapeutic levels. The two groups were well matched for demographic characteristics and received identical treatments based on Brain Trauma Foundation Guidelines. Length of stay in the hospital, mortality, seizure rates and functional outcome as determined by GOS were compared for the two groups. Patients with mortality due to other causes outside of brain injury were excluded. Statistical analysis was performed using mean, Fisher's Exact test, and Mann-Whitney test, accepting $p < 0.05$ as significant.

Results: 93 adult patients that met the above criteria were identified (43 [46%] NP group vs. 50 [54%] PP group). The two groups were well matched with no significant differences in age, sex, GCS, and AIS, mechanism of injury, and other demographic characteristics. Contrary to expectation, more seizures occurred in the PP group as compared to the NP group, however, this did not reach significance (PP vs. NP, 2[4%] vs. 0[0%], $p=0.5$). Therapeutic Phenytoin levels were present at the time of the two seizures which occurred at day 5 and 6 after TBI. There was no significant difference in the two groups (PP vs. NP) as far as disposition: mortality due to head injury (4 [8%] vs. 3 [7%], $p=1$); discharge home (16 [32%] vs. 17 [40%], $p=0.7$); and discharge to Rehab (30[60%] vs. 23[53%], $p=0.9$). However, with Phenytoin prophylaxis there was a significantly longer hospital LOS (PP vs. NP, 36 vs. 25 days, $p=0.04$) and significantly worse functional outcome at discharge based on GOS (PP vs. NP, 2.9 vs. 3.4, $p < 0.01$).

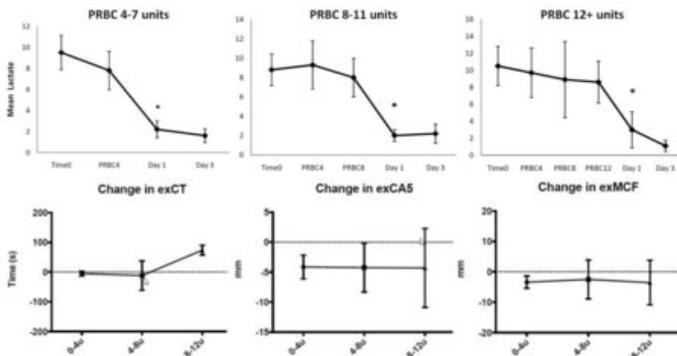
Conclusion: Anti-seizure prophylaxis with Phenytoin may be detrimental after TBI; while providing no benefit in decreasing seizure rates, Phenytoin significantly increased LOS and resulted in worse functional outcome at discharge (lower GOS score). Use of this medication needs to be re-evaluated with current randomized trials that incorporate many of the newer management strategies (such as Diprivan [Propofol] infusion) which were not found in the original landmark study of 1990 by Temkin et al. that helped define the current Brain Trauma Foundation anti-seizure prophylaxis guideline.

HEMOSTATIC RESUSCITATION IS NEITHER HEMOSTATIC NOR RESUSCITATIVE IN TRAUMA HEMORRHAGE

Karim Brohi* MD, Sirat Khan MD, Manik Chana MD, Imran Raza MD, Ross Davenport MD, Christine Gaarder* MD, Ph.D., International Trauma Research Network (INTRN)

Invited Discussant: Yashuhiro Otomo, MD

Introduction: Trauma hemorrhage continues to carry a high mortality rate despite changes in modern practice. Traditional approaches to the massively bleeding patient have been shown to result in persistent coagulopathy, bleeding and poor outcomes. The concept of hemostatic (or damage control) resuscitation has developed from the discovery of acute traumatic coagulopathy and increased recognition of the negative consequences of dilutional coagulopathy. These strategies concentrate on the early delivery of coagulation therapy (plasma and platelet transfusions) combined with permissive hypotension. The efficacy of hemostatic resuscitation in correcting coagulopathy and lactic acidemia during acute hemorrhage has not been studied. **Methods:** This was a prospective study of ROTEM and lactate measurements taken from trauma patients recruited to the multi-center Activation of Coagulation and Inflammation in Trauma (ACIT) study. Patients are enrolled into ACIT immediately on arrival in the emergency department. A blood sample is taken for, among other tests, point of care ROTEM analysis and blood gas measurements. Further blood samples are taken during the acute bleeding phase after administration of every four units of packed red blood cells (PRBC), up to the 12 PRBC units. The quantity of plasma and other coagulation therapy administered within each interval is recorded. For the purposes of this study we selected the first 100 patients who received at least 4 units of PRBCs. **Results:** Of the 100 patients receiving at least 4 units of PRBCs, 33 patients received 8-11 units of PRBCs and 18 received 12 or more PRBC units. On admission, 40% of patients were coagulopathic ($CA5 \leq 35$ mm). This increased to 60% by PRBC 4; 88% by PRBC 8 and 87% at PRBC 12. The average FFP:PRBC ratio between intervals was PRBC 0-4: 0.6; PRBC 4-8: 0.9 and PRBC 8-12: 0.9. There was no improvement in any ROTEM parameter during on-going bleeding. There was no effect of higher ratios of FFP on coagulopathy during acute bleeding. Average admission lactate was 6.2 mEq/l. Patients with a high lactate (>5 mEq/l) on admission did not correct lactate levels until hemorrhage control was achieved and no further PRBC units were required. **Discussion:** While hemostatic resuscitation offers several advantages over historical strategies, it still does not achieve correction of hypoperfusion or coagulopathy during the acute phase of trauma hemorrhage. There are still significant opportunities to improve management and improve outcomes for bleeding trauma patients.



ARE WE LEMMINGS?: NON-SELECTIVE USE OF ANGIOGRAPHY PROVIDES NO BENEFIT IN HIGH-GRADE BLUNT SPLENIC INJURY

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

Invited Discussant: Thomas Scalea, MD

Introduction: The role of angiography (ANGIO) as a diagnostic and therapeutic modality in the management of high-grade (Abbreviated Injury Scale (AIS) ≥ 3) blunt splenic injury (BSI) remains controversial. Studies that show a potential benefit to liberal use of ANGIO are balanced by studies that demonstrate no benefit, increased costs and/or complications, with ANGIO. As a result, some centers have developed liberal protocols using ANGIO as initial therapy while others have more selective criteria or do not utilize ANGIO in the management of BSI. The purpose of this study was to determine if a trauma center's ANGIO utilization rates are associated with delayed splenectomy in BSI following initial non-operative management, as well as to determine factors associated with splenectomy after ANGIO.

Methods: The National Trauma Data Bank was used to identify a cohort of patients 18 – 81 with BSI (AIS ≥ 3) treated at Level I or II trauma centers that admitted at least 10 patients with high-grade BSI from 2007-10. Patients who had early splenectomy (splenectomy < 6 hours from admission) were excluded. Timing of ANGIO and delayed splenectomy (splenectomy ≥ 6 hours from admission) were determined. The rate of ANGIO utilization was determined for each hospital by dividing the number of patients with BSI who received ANGIO by the total number of eligible patients with BSI. Hospitals were stratified based on ANGIO utilization rates into 3 groups: 0% (NO ANGIO); 1-19.9% (LOW ANGIO); $\geq 20\%$ (HIGH ANGIO). Hierarchical logistic regression was used to control for patient clustering at the hospital level and to determine factors associated with delayed splenectomy.

Results: 7412 (Age $\geq 55=16.5\%$; Male=64.6%; Non-White=28%; ISS $\geq 25 = 54\%$) met inclusion criteria. After adjusting for age ≥ 55 , male gender, race, and increasing injury severity, LOW ANGIO (OR=0.89 95%CI=0.66, 1.19) and NO ANGIO (OR=1.22 95%CI=0.67, 2.18) centers showed no difference with regard to delayed splenectomy compared to HIGH ANGIO centers. Among patients who received ANGIO, higher overall injury severity and AIS 5 BSI was positively associated with delayed splenectomy (Table).

Factors Associated with Delayed Splenectomy after ANGIO (*p<0.05)

Conclusions: Trauma centers with NO ANGIO and LOW ANGIO utilization are no different than HIGH ANGIO centers in terms of the odds of delayed splenectomy. Further, more severe spleen injuries and patients with higher injury severity are likely to fail attempted ANGIO. Nonselective protocol driven ANGIO following high-grade BSI does not appear to offer a benefit at the center level. Thus, ANGIO use should be tailored to the individual patient and should not be based solely on BSI grade or other single criterion.

Variables	OR (95%CI)
AIS 5 BSI	2.07 (1.17, 3.67)*
ISS 10-24 vs ISS < 10	2.61 (0.36, 19.15)
ISS ≥ 25 vs ISS < 10	2.01 (1.05, 3.84)*

BLUNT CEREBROVASCULAR INJURY SCREENING WITH 64-CHANNEL MULTIDETECTOR COMPUTED TOMOGRAPHY: MORE SLICES FINALLY CUT IT

Elena M. Paulus MD, Timothy C. Fabian* MD, Martin A. Croce* MD, Vandana Botta BS, Wesley Dutton BS, Stephanie A. Savage* MD, University of Tennessee Health Science Center - Memphis

Invited Discussant: Walter Biffl, MD

Introduction: Aggressive screening to diagnose blunt cerebrovascular injury (BCVI) results in early treatment, leading to improved outcomes and reduced stroke rates. While computed tomographic angiography (CTA) has been widely adopted for BCVI screening, evidence of its diagnostic sensitivity is marginal. Previous work from our institution using 32-channel multidetector CTA in 684 patients demonstrated an inadequate sensitivity of 51% (Ann Surg, 2011). Digital subtraction angiography (DSA) continues to be the reference standard of diagnosis, but has significant drawbacks of invasiveness and resource demands. There have been continued advances in CT technology, and this is the first report of an extensive experience with 64-channel multidetector CTA.

Methods: Patients screened for BCVI using CTA and DSA (reference) at a level one trauma center over the 12 month period ending May 2012 were identified. Results of CTA and DSA, complications, and strokes were retrospectively reviewed and compared.

Results: 594 patients met criteria for BCVI screening and had both CTA and DSA. 128 patients (22% of those screened) had 163 injured vessels: 99 (61%) carotid artery injuries (CAI) and 64 (39%) vertebral artery injuries (VAI). CTA and DSA results are shown in table. The 52 false negatives on CTA were composed of 34 CAI and 18 VAI; 32 (62%) were grade one injuries. Overall, positive predictive value was 36.2% and negative predictive value was 97.5%. Five (1%) procedure related complications occurred with DSA: 3 puncture site hematomas and 2 iatrogenic dissections.

	# vessels	No Injury (DSA-)		Injury (DSA+)		Sensitivity (%)
		(CTA -)	(CTA +)	(CTA -)	(CTA +)	
		True -	False +	False -	True +	
Overall	2376	2017	196	52	111	68
Carotid	1188	979	110	34	65	66
Vertebral	1188	1038	86	18	46	72

Conclusion: 64-channel CTA demonstrated a significantly improved sensitivity of 68% versus the 51% previously reported for the 32-channel CTA ($p=.0075$). 62 percent of the false negatives occurred with low grade injuries. Considering complications, cost, and resource demand associated with DSA, this study suggests 64-channel CTA produces acceptable accuracy to replace DSA as the primary screening tool for BCVI.

MANAGEMENT OF COLONIC INJURIES IN THE SETTING OF DAMAGE CONTROL LAPAROTOMY – ONE SHOT TO GET IT RIGHT.

Devashish J. Anjaria* MD, Timothy M. Ullmann BA, Robert F. Lavery MA, David H. Livingston* MD, UMDNJ - New Jersey Medical School

Invited Discussant: Timothy Fabian, MD

Introduction: Optimal management of colonic injuries in patients requiring damage control laparotomy (DCL) remains controversial. Primary repair, delayed anastomosis or colostomy have all been advocated after DCL, however some evidence suggests that colonic related complications are increased in patients with delayed primary fascial closure. We hypothesized that increased complications associated with colonic repair/anastomosis occurs in those patient undergoing DCL who cannot achieve fascial closure on their initial reoperation.

Methods: A retrospective review of all patients sustaining colonic injury between January 1, 2001 and August 31, 2010 who survived ≥ 4 days. Patients were classified as having management of abdominal injuries during either a single laparotomy (SL), DCL with complete treatment and fascial closure on the initial reoperation (DCL1), or DCL with open abdomen for greater than 2 operations (DCL2). Data was collected on post operative complications and need for intervention. Kruskal-Wallis ANOVA was used to determine differences between groups.

Results: 317 patients were treated with colonic injuries, 70 were excluded due to incomplete charts, leaving 247 patients included in the study. The group was primarily male (93%) with a mean (\pm SD) age of 29 ± 9 years. 92% sustained penetrating injuries. Injury severity scores were similar between groups. Mean time for the DCL1 was 1.2 ± 0.6 days after injury and 4.1 ± 2.8 days for DCL2. Inability to achieve fascial closure by the time of the initial reoperation was associated with significant increase in intraabdominal abscess and anastomotic leaks (Table).

	SL (n = 179)	DCL1 (n = 42)	DCL2 (n = 26)
ISS	18 \pm 10	15 \pm 9	19 \pm 11
Wound infection	6% (11)	14% (6)	12% (3)
Abdominal abscess	17% (30)	31% (13)	50% (13)*
Fistula	1.1% (2)	2.4% (1)	7.7% (2)
Anastomotic leak	2.2% (4)	2.4% (1)	19% (5)*
IR drainage	7% (12)	12% (5)	19% (5)
Unplanned reoperation	15% (27)	31% (13)	---

*p < 0.01 vs. SL

The primary reasons for the unplanned reoperations were intra-abdominal sepsis, peritonitis and/or fascial dehiscence. 19 (73%) patients in DCL2 never achieved complete fascial closure and required split thickness or full thickness skin coverage.

Conclusion: Primary repair or delayed anastomosis after DCL is feasible with complication rates similar to SL when successful fascial closure is completed on the first post-DCL reoperation. However, if fascial closure is not possible on the second operation, patients should be treated with a stoma as there is an 8 fold increase in the incidence of anastomotic leak. We believe that these data indicate that there is a single opportunity for reestablishing colonic continuity after DCL.

Effects of MP4OX, an oxygen therapeutic, on clinical outcomes in trauma patients with hemorrhagic shock: a Phase IIb multi-center randomized placebo-controlled trial

Karim Brohi* MD, Ken Boffard* MD, Dirk Zielske MD, Bruno Riou MD, Queen Mary University Of London

Invited Discussant: Frederick Moore, MD

Introduction: Hemorrhagic shock is associated with a high mortality and morbidity, in part due to end-organ ischaemia. MP4OX is an oxygenated pegylated hemoglobin molecule that has been shown to enhance tissue oxygen delivery in experimental models. We assessed the potential effect of early MP4OX administration on clinical outcomes after trauma hemorrhage.

Methods: This was a multi-center randomized placebo-controlled trial at 38 hospitals in 14 countries. Patients in hemorrhagic shock with blood lactate levels of 5mEq/l or higher and within 2 hours of hospital arrival were eligible for enrolment. Patients were block-randomized by site to receive either 250ml MP4OX or 0.9% normal saline (NS) within 30 minutes of randomization. Patients with continued bleeding could receive additional doses of investigational product up to a maximum of 3 further doses in 12 hours. Patients were followed up for 28 days. The primary end-point was the proportion of patients discharged alive at 28 days. Secondary endpoints included adverse event rates; ventilator, ICU and hospital days; organ failure scores; 48-hour and 28-day mortality.

Results: 329 patients were enrolled between May 2011 and September 2012, 165 to receive MP4OX and 164 NS. After exclusions, 313 patients (153 MP4OX and 160 NS) were randomized and received study drug. The MP4OX and NS groups were well-matched for age, sex, mechanism (49% vs 42% penetrating) and severity of injury (median ISS 20 vs 22); admission physiology and lactate levels. There was no difference in Serious Adverse Events (36% vs 37%) or adverse events between the two groups. Overall mortality in MP4OX group was 11.6% vs 13.9% in control patients. For the primary endpoint, 57% of MP4OX patients were alive and discharged from hospital at Day 28, compared to 50% of NS patients, which did not reach statistical significance. There were further trends towards improved outcomes in the secondary endpoints, with MP4OX patients having more ventilator, ICU and hospital-free days as well as faster times to complete resolution of organ failure, but these were also not statistically significant.

Conclusions: The modified hemoglobin oxygen therapeutic 250ml MP4OX has a good safety profile in trauma patients with severe hemorrhagic shock. While there were promising trends to suggest a potential for improved outcomes, the study was underpowered to confirm the efficacy of MP4OX in trauma hemorrhage.

DAMAGE CONTROL THORACIC SURGERY: MANAGEMENT AND OUTCOMES

James O'Connor MD, Joseph DuBose* MD, Thomas Scalea* MD, R Adams Cowley
Shock Trauma Center

Invited Discussant: J. Wayne Meredith, MD

Introduction: Damage control surgery (DCS) is successfully employed for severe abdominal trauma. Although the DCS principles of early hemorrhage control, subsequent resuscitation and delayed planned definitive surgery are applicable to thoracic trauma, there is a dearth of data on damage control thoracic surgery (DCTS).

Methods: An IRB approved retrospective trauma registry and chart review from January 2002 to December 2012 for thoracic injuries requiring emergency thoracotomy or sternotomy, and temporary closure. Demographics, physiologic and laboratory data, operative procedures and outcomes were abstracted. Data are presents as mean and standard deviation; Student t-test was used with $p < 0.05$ conferring statistically significance.

Results: 44 patients were identified. Mean age 34, 86% were male. ISS 33.2 ± 14.7 , 89% had ISS ≥ 15 and severe chest injury was common (chest AIS $\geq 3 = 93\%$; $\geq 4 = 61\%$, $\geq 5 = 32\%$) with gunshot (48%) and stab wounds (21%) the most common mechanisms. Admission temperature, pH, base deficit and INR were 36 ± 1 C, 7.07 ± 0.13 , -11.1 ± 6.5 , and 1.7 respectively. Operative approaches included unilateral thoracotomy 50%, clamshell 32% and sternotomy 23%. 52% required pulmonary resection (pneumonectomy 3, lobectomy 11, non-anatomic resection 9), 20% had cardiography; the remainder had a variety of vascular injuries. 43% required intra-operative CPR, and 41% left the OR on vasoactives. Mean intra-operative blood requirement was 13 units pRBC's. 42(95%) patients had packing with vacuum assisted closure; the only thoracic compartment syndrome occurred in one to the two who had packing and skin closure. The decision to close the bony thorax was based on normalized physiology, with the time to closure of 3 ± 1 days. At chest closure, echocardiography (TEE) was utilized for patients on vasoactives to assess evidence of tamponade physiology precluding closure. Comparing the physiologic parameters during the initial operation and prior to chest closure; temperature C (34.4 ± 1.3 vs. 37.4 ± 0.8), pH (7.13 ± 0.14 vs. 7.38 ± 0.6) and INR (1.8 ± 0.9 vs. 1.2 ± 0.3), were all statistically significantly ($p < 0.001$). Complications were common, including sepsis (36%), local wound infection (30%), acute renal failure requiring CRRT (30%), ARDS 25% and empyema (23%). Adjunctive salvage ECMO was utilized in 4 patients with 1 survivor. Mean ventilator days, ICU length of stay and hospital length of stay were 19, 20 and 30 days respectively. Overall mortality was 23%. Excluding the 3 ECMO deaths, in-hospital mortality was 16%. Follow-up was available for 73% with a mean duration of 34 months, with all survivors neurologically intact and dialysis free.

Conclusions: Patients with severe chest trauma and marked physiologic derangement can benefit from DCTS. Thoracic packing and temporary vacuum closure avoids thoracic compartment syndrome. Timing of thoracic closure is based on physiology, and TEE is a useful adjunct when closing the thorax of those on vasoactives. While complication were common, mortality is acceptable in this group of these severely injured, metabolically depleted, challenging patients.

TRAUMATIC BRAIN INJURY CAUSES PLATELET ADP AND AA RECEPTOR INHIBITION INDEPENDENT OF HEMORRHAGIC SHOCK IN HUMANS AND RATS

Michael P. Chapman MD, Scott Thomas* MD, Ernest E. Moore* MD, Victoria Ploplis Ph.D., Deborah Donohue MS, Julia Beck BS, Mark Walsh MD, Sagar Patel BS, Joseph Capanari MS, Hanuma S. Chitta MD, Francis Castellino Ph.D., University of Colorado Denver

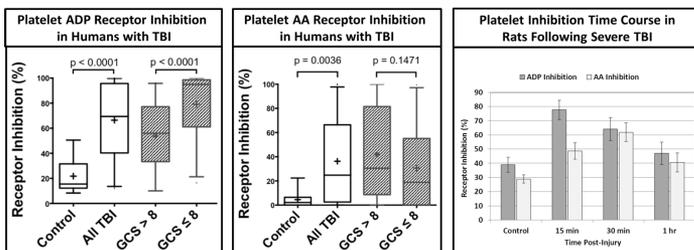
Invited Discussant: Mitchell Cohen, MD

Introduction: Coagulopathy in traumatic brain injury (CTBI) is a well-established phenomenon, but its mechanism is poorly understood. Some studies indicate that CTBI stems from maladaptive protein C activation and hyperfibrinolysis related to the global insult of hemorrhagic shock and multi-system trauma. Conversely, other data implicate overwhelming brain tissue factor release with resultant depletion of platelets and coagulation factors. We hypothesized that the platelet dysfunction of CTBI is, in fact, an intrinsic effect of brain injury and is a distinct phenomenon from the coagulopathy following hemorrhagic shock.

Methods: We first conducted an analysis of field blood from patients with isolated head injury (Abbreviated Injury Score (AIS)-head >3 and AIS-other <2) admitted to our regional trauma center ($n=72$). Thromboelastography (TEG) with platelet mapping was used to measure platelet function and the degree of inhibition of the ADP and arachidonic acid (AA) receptor pathways. Glasgow Coma Score (GCS) was used to quantify the severity of brain injury. Base deficit (BD) and systolic blood pressure (SBP) were used as measures of tissue perfusion. Patients on clopidogrel or aspirin were excluded. Next, we studied the time course of platelet inhibition in a rat model of severe blunt TBI.

Results: Severe TBI patients ($GCS \leq 8$) showed a significant increase in ADP receptor inhibition in their immediate post-injury sample, compared to both mild TBI patients and healthy controls ($p < 0.0001$). Median ADP receptor inhibition was 95.0% (IQR 61.5-98.6%) in the severe TBI cohort, compared to 56.0% (IQR 35-74.6%) in mild TBI and 15.4% (IQR 12.7-30.5%) in controls. No patient had significant hypotension (all SBP ≥ 90) or acidosis (BD: 0.3 ± 3.2). Additionally, non-survivors showed a significant difference in ADP receptor inhibition compared to survivors ($p = 0.04$). In rats with TBI, ADP receptor inhibition peaked at 15 minutes post-injury, at $77.6\% \pm 6.7\%$ versus $39.0\% \pm 5.3\%$ for uninjured controls ($p < 0.0001$; $n=45$). Parallel trends of lesser magnitude were noted in AA receptor inhibition in both humans and rats.

Conclusions: Platelet ADP and AA receptor inhibition is a prominent early feature of CTBI in humans and rats and is linked to severity of brain injury and to poor outcomes in patients with isolated head trauma. This phenomenon is observed in the absence of hemorrhagic shock or multi-system injury. Thus, TBI alone is shown to be sufficient to induce a profound platelet dysfunction equivalent to the use of clopidogrel and aspirin.



IMPACT OF VOLUME OF INFUSION OF FRESH FROZEN PLASMA AND PLATELETS DURING THE FIRST 180 MINUTES OF RESUSCITATION: MINUTE-BY-MINUTE ANALYSIS OF INFUSION RATES ON SURVIVAL BIAS

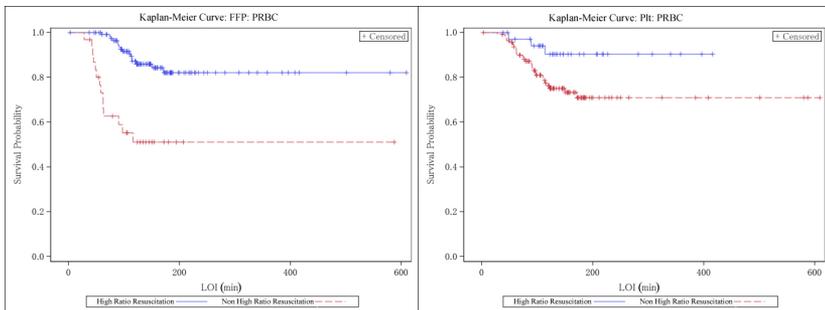
Eric R. Simms MD, Dietric L. Hennings MD, Ibrahim Musa MD, MPH, Kira N. Long MD, Julie Wascom MT, Jiselle Bock-Heaney MD, MPH, John P. Hunt* MD, MPH, Norman E. McSwain* Jr., MD, Peter C. Meade* MD, MPH, Tulane School of Medicine

Invited Discussant: Martin Croce, MD

Introduction: Survival bias is the logical error of focusing on people that "survived" a process while inadvertently overlooking those that did not survive because of their lack of visibility. A now classic example is questioning whether High Ratio Resuscitation (HRR) provides true survival benefit, or if patients received HRR merely because they had longer survival. To date the question of survival bias versus survival advantage with respect to HRR persists. We hypothesize a direct correlation between HRR infusion rates in the first 180 minutes of resuscitation and survival.

Methods: A 24-month retrospective analysis of all adult massively transfused trauma patients surviving >30 minutes and undergoing damage control surgery at an urban Level 1 trauma center. Mean Infusion Rates (MIR: cc/min) of PRBCs, FFP, and Plts were calculated for Length Of Intervention (LOI: ED time + OR time). Patients were grouped into HRR (FFP:PRBC > 0.7, and/or Plts:PRBC >0.7) during the first 180 minutes of resuscitation, versus Low Ratio Resuscitation (LRR). Student's t-tests were performed to analyze the impact of MIR for each blood product on 180-minute survival (180-MS). Kaplan-Meier (KM) survival curves were generated.

Results: 151 patients met inclusion criteria. 120 (79.5%) patients achieved HRR of FFP:PRBC (180-MS= 86.67%) vs. 31 (20.5%) that did not (180-MS = 54.84%), $p < 0.001$. 37 (24.5%) patients achieved HRR of Plt:PRBC ratios (180-MS = 91.89%) vs. 114 (75.5%) with LRR (180-MS = 76.32%), $p < 0.004$. 124 (82.1%) patients achieved HRR of either FFP:PRBC or Plt:PRBC (180-MS = 86.29%) vs. 27 (17.9%) patients that did not (180-MS = 51.85%), $p < 0.0001$. Regarding survival bias analysis: 121 (80.1%) patients survived 180 minutes, (PRBC MIR 71.9 cc/min, FFP MIR 92.0 cc/min, Plt MIR 3.45 cc/min) vs. 30 (19.9%) who did not survive (PRBC MIR 47.3 cc/min, FFP MIR 33.7 cc/min, Plt MIR 1.05 cc/min), $p = 0.43$, $p < 0.0001$, $p < 0.011$.



FFP:PRBC Kaplan-Meier curve

Plt: PRBC Kaplan-Meier curve

Conclusion: To the best of our knowledge this is the first study to analyze the impact of MIRs on survival bias. Minute-by-minute we demonstrated a dose-dependent survival advantage in the first 180 minutes of resuscitation at high MIRs of FFP and Plts. Early use of high MIRs for FFP and Plts conveys a survival advantage in patients with severe hemorrhage.

MORTALITY AFTER GROUND-LEVEL FALL IN THE ELDERLY ANTICOAGULATED PATIENT: A LONG-TERM ANALYSIS OF RISK VS BENEFIT

Tazo S. Inui MD, Ralitzia Parina MPH, David Chang MBA, MPH, Ph.D., Thomas S. Inui MD, MSc, Raul Coimbra* MD, Ph.D., University of California, San Diego

Invited Discussant: Nicholas Namias, MD

Introduction: Elderly patients who suffer ground level falls represent a population at risk for head injury. Previous trauma literature has demonstrated in single-institution settings that the use of oral anticoagulation (OAC) for stroke prevention in patients with cardiac arrhythmias may increase risk of mortality. We conducted an observational study to determine the long-term outcomes of ground-level fall patients on OAC and assess risk factors for mortality due to falls both for short- and long-term timeframes.

Methods: Retrospective analysis of the longitudinal version of the California Office of Statewide Planning and Development database was performed, which included 100% of hospitals for years 1995 to 2009. Inclusion criteria were elderly (age ≥ 65) ground-level fall patients, who had a prior admission diagnosis of atrial fibrillation and a code for chronic OAC use. These patients were stratified by CHA2DS-VASC score and compared to a similarly stratified cohort with no documented history of OAC. Cox proportional hazard was used to evaluate risk for head injury and death. Logistic regression was used to identify risk factors associated with death due to head injury at first admission following a fall. Analysis was performed adjusting for patient demographics, risk factors from which the CHA2DS-VASC model is comprised, and injury severity as measured by ICISS.

Results: A total of 43,169 patients met the inclusion criteria. The mean age was 82 years. Most (68.4%) were female; most (67%) had CHA2DS-VASC scores between 3-5. Patients admitted after a fall had a 20.8% mortality rate in the first admission (n=8986) and had a head injury rate of 9.2% (n=3991). Patients who died with a head injury comprised 10% of all deaths (n=895). The mortality rate of patients sustaining a head injury during the first admission following a fall ranged from 1.4-3.4% and was significantly different from most groups when stratified by CHA2DS-VASC score. Predictors for mortality with head injury on the first admission included male gender (OR 1.9, 95% CI 1.6-2.32), Asian ethnicity (OR 2, 95% CI 1.4-2.9), and a history of previous stroke (OR 4.2, 95% CI 3.3-5.3). Risk of eventual mortality with head injury from a fall significantly exceeded annualized stroke risk for patients with CHA2DS-VASC scores of 0-3 if taken off OAC (p-value $< 0.001-0.015$).

Conclusion: Elderly patients on OAC who fall are at significantly higher risk for mortality than their non-anticoagulated peers. Mortality due to head injury following a single fall substantially exceeds those not taking OAC. However, the risk of death with a head injury from a single fall is not more likely than the annualized risk of stroke for appropriately anticoagulated patients (CHA2DS-VASC ≥ 2). These data suggest that patients with atrial fibrillation who are very high fall risk but who score low on the CHA2DS-VASC scoring system should not take OAC for stroke prevention, as their risk for death outweighs (or is equivalent to) the benefit of stroke prevention.

Table 1. Comparative mortality of OAC and non-OAC users, admitted with head bleed on initial fall.

CHA2DS-VASC score	OAC (% mortality)	No OAC (% mortality)	p-value
0	1(1.4)	12 (1.1)	0.832
1	9 (1.4)	122 (1)	0.309
2	96 (2.2)	456 (0.9)	< 0.001
3	244 (2.2)	760 (0.7)	< 0.001
4	249 (1.8)	657 (0.6)	< 0.001
5	164 (2)	382 (1)	< 0.001
6	93 (3.4)	213 (1.5)	< 0.001
7	34 (3.4)	57 (1.65)	< 0.001
8	4 (2.3)	8 (2.2)	0.981

PLACEMENT OF INTRACRANIAL BOLT MONITORS BY TRAUMA SURGEONS - A 6 YEAR REVIEW.

Sadia Ilyas MD, Jonathan Saxe* MD, Melissa Whitmill MD, Priti Parikh Ph.D., Mary C. McCarthy* MD, Akpofure Peter Ekeh* MD, MPH, Wright State University Boonshoft School of Medicine

Invited Discussant: Alex Valadka, MD

Introduction: Brain Trauma Foundation guidelines advocate for the use of intracranial pressure (ICP) monitoring following traumatic brain injury (TBI) in patients with a GCS > 8 and an abnormal CT scan. The absence of 24 hour in-house Neurosurgery coverage could however negatively impact timely monitor placement. We reviewed our experience with placement of ICP bolts by Trauma Surgeons who had been trained and credentialed in their insertion.

Methods: In 2005, the Trauma surgeons at a Level I Trauma who are always available in-house were trained and credentialed in the placement of ICP bolt monitors by the Neurosurgeons. We subsequently identified all TBI patients who had ICP bolts placed between January 2006 and December 2011 noting demographic information, GCS, ISS, outcome as well as who placed the bolt – Neurosurgeon or Trauma Surgeon. Misplacement, hemorrhage, malfunctions and dislodgement were considered complications. Comparisons were performed by chi-square testing.

Results: Over the 6 year period over 407 ICP bolts were placed for TBI. Mean age was 40.9 ± 18.9 years, 73.2% were male, mean ISS was 27.9 ± 16 , average length of stay 11.6 ± 9.7 days and mortality 35.4%. MVCs and Falls were the most common mechanisms of injury (35.2% & 28.7%) The Trauma surgeons placed 71 % of the all ICP bolts and Neurosurgeons, 27.5%. The Neurosurgeons placed most of their ICP bolts in the operating room during cranial procedures. (71%) The overall complication rate was 2.5% - there was no difference between the Trauma Surgeons and Neurosurgeons (3.1% vs. 0.8%, $p = 0.2951$) Mortality in both groups was similar- Trauma Surgeons 36.9% vs. Neurosurgeons 30.6% ($p = 0.2896$).

Conclusion: After appropriate training, ICP bolt monitors can be safely placed by Trauma Surgeons with minimal adverse effects. With current and expected subspecialty coverage shortages, Acute Care Surgeons can successfully adopt procedures such as ICP bolt placement with minimal complications.

MULTI-CENTER ANALYSIS OF DIAPHRAGM PACING IN SPINAL CORD INJURY: SUCCESSFUL IN NOT ONLY WEANING FROM VENTILATORS BUT IN BRIDGING TO INDEPENDENT RESPIRATION

Joseph Posluszny MD, Raymond Onders MD, Andrew Kerwin* MD, Deborah Stein* MD, Jennifer Knight* MD, Lawrence Lottenberger* MD, Michael Cheatham* MD, Saied Khansarinia MD, Dayal Saraswati* MD, Michael Weinstein* MD, Patricia Byers* MD, Lawrence Diebel* MD, University Hospitals Case Medical Center

Invited Discussant: George Velmahos, MD, PhD

Background: Ventilator dependent spinal cord injured (SCI) patients require significant resources related to ventilator dependence including intensive care unit time for weaning, appropriate rehabilitation and stays in long term ventilator facilities. Diaphragm pacing (DP) has been used successfully to replace mechanical ventilators for tetraplegics with most experience outlining use in chronic spinal cord injury. Early use of DP following SCI has not been described. Here, we report the largest multi-center experience with utilization of DP in the early phase or initial hospitalization after traumatic spinal cord injury in this rare condition. **Methods:** Under IRB approval for a humanitarian use device (HUD), we retrospectively reviewed our multi-center non-randomized interventional protocol (laparoscopic diaphragm motor point mapping with electrode implantation and subsequent diaphragm conditioning and ventilator weaning) for the early implantation of DP in SCI patients. Our primary goal was to determine successful independence of ventilator support. Our secondary goals were to determine time from implantation to ventilator wean and/or independence, delays until surgery, causes of failure to wean, and baseline demographic characteristics of these patients. **Results:** From 2007 to 2013, 245 SCI patients were implanted with DPs. During this time, 28 patients at 11 centers met the criteria of early laparoscopic evaluation and DP implantation. Average age was 31.2 years (range 16-65) with only 2 females. All patients had cervical spinal cord injuries and mechanism of injury included motor vehicles(8), diving (6), gunshot wounds(4), falls (4), athletic injuries(3), bicycles(2) and tree falling on spine(1). Elapsed time from injury to surgery was 49.1 days (range 3-112). Delays until surgery involved attempting and failing standard weaning, securing IRB approval, insurance coverage and transfers to implanting centers. Seven of the 28 patients (25%) who were evaluated for DP placement had non-stimulatable diaphragms from either phrenic nerve damage or infarction of the involved phrenic motor neurons and were not implanted. Two recently implanted patients are still progressing. Only 2 of the remaining 19 patients (10.5%) implanted were unable to be weaned; one went to a long term acute care hospital (LTACH) and subsequently withdrew all support and one patient uses DP with the ventilator by choice. Thus 89% (17 of 19) were completely weaned from ventilator support in an average of 20.2 days (range 1-180 days). In fact, 12 patients who did not proceed to LTACHS were weaned in only 5.7 days. These patients had earlier implantation at 11.1 days post injury. Additionally, 7 patients (33%) had complete recovery of respiration and DP was no longer needed for respiration and underwent easy removal of the percutaneous electrodes. **Conclusion:** DP implantation can successfully wean traumatic SCI patients from ventilator support, precluding the need for long term ventilator use and need for LTACH placement post injury. In fact, 33% of implanted patients had complete recovery of diaphragm function and no longer required DP. In addition, early laparoscopic evaluation is also diagnostic, in that, a non-stimulatable diaphragm is irrefutable evidence of an inability to be weaned; therefore, long term ventilator management can be immediately instituted.

Making the Financial Case for a Surgeon Directed Critical Care Ultrasound Program (CCUP)

Sarah B. Murthi MD, Heidi L. Frankel* MD, Mayur Narayan MD, Matthew Lissauer MD, Thomas M. Scalea* MD, R Adams Cowley Shock Trauma Center

Invited Discussant: Andrew Andrew Kirkpatrick, MD

Objective: We sought to demonstrate that a well-staffed, surgeon-directed CCUP is both financially sustainable and a source of valuable training.

Methods: A CCUP was developed to provide daytime clinical service, educational/training support and infrastructure support for off hours imaging. Thoracic, abdominal, extremity, ocular imaging and echocardiography were provided. We prospectively recorded initial program and annual costs and hospital and professional billing.

Results: Over 36 months, the CCUP covered 4 surgical ICUs (55 beds). A consult service was added to support other areas. Start-up costs included one basic and one cardiovascular unit per 25 beds, and a data storage system linking reports and images to the electronic medical record (total cost \$189,764). Yearly costs include 0.5 FTE sonographer and 0.2 FTE surgeon (\$106,025). There was three-fold increase in billing from year 1-3, with a 17% increase between yrs 2-3 (Table). The CCUP met operating costs at year 2 and broke even overall in year 3. Assuming the same rate of increase, and increased additional costs including fulltime sonographer and increased surgeon support (0.25 FTE), the CCUP remains financially feasible both for physician and hospital billing at 5 years. We have now trained 36 fellows and approximately 300 residents from various departments.

Conclusions: A surgeon-directed CCUP is financially sustainable and provides valuable training. Departments of Surgery should develop these programs before other sub-specialties fill the void.

Current Cost Analysis

Year	Exams	Cost Hospital	Cost MD Salary	Professional Fee	Hospital Fee
1	108	\$ 240,789	\$ 55,000	\$ 22,032	\$ 52,812
2	296	\$ 51,025	\$ 55,000	\$ 60,834	\$ 144,744
3	357	\$ 51,025	\$ 55,000	\$ 72,828	\$ 174,573
Total	761	\$ 342,839	\$ 165,000	\$ 155,694	\$ 372,129

Projected Costs Analysis

4	418	\$ 102,050	\$ 68,750	\$ 85,272	\$ 204,402
5	489	\$ 102,050	\$ 68,750	\$ 99,756	\$ 239,150
Total	1,668	\$ 546,939	\$ 275,000	\$ 340,722	\$ 815,681

POSITIVE CT ANGIOGRAPHY AFTER PELVIC TRAUMA DOES NOT ALWAYS PREDICT NEED FOR ANGIOEMBOLIZATION

Efstathios Karamanos MD, Peep Talving* MD,Ph.D., Stuart Schroff MD, Shelby Resnick MD, Gerard K. Nguyen BS, Lydia Lam* MD, Demetrios Demetriades* MD,Ph.D., Michael D. Katz MD, LAC+USC Medical Center

Invited Discussant: Babak Sarani, MD

Introduction:Computed tomographic angiography (CTA) is a rapid and comprehensive investigation for patients suffering pelvic fractures. We hypothesized that contrast extravasation (CE) seen on CTA early after admission may not accurately predict clinically significant bleeding requiring angioembolization.

Methods:All patients admitted to an urban Level 1 trauma center between 1/2006 and 6/2012 with pelvic injury who underwent pelvic CTA and subsequent emergent catheter-based diagnostic angiography were retrospectively identified. Patient demographics, injury severity indices, and severity of pelvic fractures were collected. Time to CTA, CT findings, demographics and lab values were evaluated as potential predictors for therapeutic angioembolization, using regression models.

Results:Overall, 94 patients were studied, 45 patients underwent emergent therapeutic angioembolization and 49 had only a diagnostic run. After multivariate analysis, a CTA >60 minutes after admission with CE [AOR (95% CI): 6.92 (2.03, 23.58)], large volume of CE (> 4 cm³), sacroiliac joint disruption, pubic symphysis diastasis, splenic injury, and female gender were identified as independent predictors (table). Early positive CTA, number of areas with CE, density and diameter of CE did not predict the need for embolization. CTAs with CE did not require angioembolization if the CE volume was small and singular, and the patient had stable vital signs prior to diagnostic angiography.

Conclusion:An early positive CTA does not accurately predict the clinically significant hemorrhage requiring angioembolization. A single small CE and stable vital signs are associated with non-therapeutic angiography.

Predictors of Therapeutic Angioembolization

Step	Variable Entered	AOR (95% CI)	adj-p	Cumulative R ²
1	Positive CTA in > 60 min after admission	6.92 (2.03, 23.58)	0.002	0.17
2	Large Volume of CE	19.0 (3.72, 96.64)	<0.001	0.35
3	Sacroiliac Joint Disruption	4.74 (1.38, 16.23)	0.013	0.41
4	Diastasis of Pubic Symphysis	0.21 (0.06, 0.77)	0.019	0.45
5	Splenic Injury	15.56 (1.58, 153.17)	0.019	0.50
6	Female Gender	3.45 (1.34, 11.11)	0.036	0.54

COMPLEX PENETRATING DUODENAL INJURIES: LESS IS BETTER

Carlos A. Ordonez* MD, Alberto F. Garcia MD, M.Sc(c), Michael W. Parra MD, David A. Scavo MD, Luis F. Pino MD, Mauricio Millan MD, Marisol Badiel MD, (a)Ph.D, Juan F. Sanjuan MD, (s)M.Sc, Fernando Rodriguez MD, Ricardo Ferrada MD, Juan C. Puyana* MD, Universidad Del Valle

Invited Discussant: David Feliciano, MD

Introduction: The traditional management of complex penetrating duodenal trauma (PDT) has been the utilization of elaborate reconstructive procedures such as the pyloric exclusion (PE) and duodenal diverticulization. Lengthy, detailed procedures in these cases inevitably lead to potentially poor outcomes and significant complications. The aim of the present study was to evaluate a simplified approach to the management of complex PDT injuries, which emphasizes the current trend of organ specific damage control (DC) surgery.

Method: A retrospective review of all consecutive penetrating duodenal injuries from 2003 to 2012 at a Regional Level I Trauma Center.

Results: There were 44 consecutive patients with PDT and 41(93.2%) of them were from gunshot wounds. Seven patients were excluded due to early intra-operative death secondary to associated devastating traumatic injuries. Of the remaining 37 patients, 12(32.4%) had AAST Organ Injury Scale Grade II, 16(43.2%) Grade III, 8(21.6%) Grade IV and 1(2.7%) Grade V. Primary duodenal repair (PDR) was performed as a definitive procedure in 18.9% of cases and as part of DC in 43.2%. The duodenum was over sewn and left in discontinuity (OSLD) in 37.9% of cases. Subsequent duodenal reconstruction was performed in 92.8% of cases of OSLD and in 12.5% of cases that required PDR during their initial DC surgery. Most frequent form of reconstruction was a duodeno-jejunostomy in 7(46.7%), gastro-jejunostomy in Roux en Y in 3(20.0%), duodeno-duodenostomy in 2(13.3%), pyloric exclusion in only 2(13.3%) and a Whipple procedure in 1(6.7%) case. The most common complication was the development of a duodenal fistula in 12/37(32.4%) cases. These leaks were managed by vacuum assisted closure in 3/12(25%) cases, and posterior drainage by lumbotomy in 9/12(75%). The duodenal fistula closed spontaneously in 7/12(58.3%) cases, 2/12(16.6%) required re-intervention, 2/12(16.6%) died and 1/12(8.3%) is still patent. Overall mortality was 13.5%. The PDR group had the lowest mortality of 8.7% followed by 21.4% in the OSLD group.

Conclusion: Application of basic DC techniques for PDT leads to improve survival and a low incidence of complications. Furthermore, the management of possible subsequent complications of initial DC management can be managed with the same philosophy of simplicity with acceptable outcomes.

THE EARLY BIRD GETS THE WORM: PRE TRAUMA CENTER BLOOD TRANSFUSION IS ASSOCIATED WITH REDUCED MORTALITY AND COAGULOPATHY IN SEVERELY INJURED BLUNT TRAUMA PATIENTS

Joshua B. Brown MD, Mitchell J. Cohen* MD, Joseph P. Minei* MD, Ronald V. Maier* MD, Michael A. West* MD, Ph.D., Timothy R. Billiar* MD, Andrew B. Peitzman* MD, Ernest E. Moore* MD, Joseph Cuschieri* MD, Jason L. Sperry* MD, MPH, University of Pittsburgh

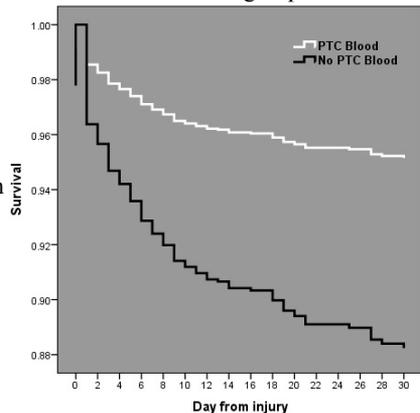
Invited Discussant: Stephanie Savage, MD

Introduction: Hemorrhage and coagulopathy remain major drivers of mortality in injured patients. While significant advances have been made in trauma center based resuscitation, there is little evidence supporting pre-trauma center (PTC) interventions to reduce the mortality associated with early hemorrhage and coagulopathy. Our objective was to evaluate the association of PTC blood transfusion with mortality and coagulopathy in severely injured patients.

Methods: Blunt injured patients in hemorrhagic shock who arrived at a trauma center within 2 hours of injury were included from the Inflammation and Host Response to Injury prospective cohort study. Outcomes included 24 hour mortality, 30 day mortality, and trauma induced coagulopathy (TIC), defined as an admission INR>1.5. Cox proportional hazard regression and logistic regression were used to characterize the risks of these outcomes associated with PTC blood transfusion after controlling for demographics, PTC time, injury and shock severity, early resuscitation, and center level effects.

Results: Of 1415 subjects arriving within 2 hours of injury, 50 received PTC blood. There were no differences in age, gender, or ISS between the PTC blood and No PTC blood groups ($p>0.05$). The PTC blood group was more commonly hypotensive and had a lower base deficit ($p<0.01$), demonstrating a higher overall injury and shock severity as compared to the No PTC blood group. The PTC blood group received a median of 1.3 units of blood in the PTC period and 52% were transported from the scene. In regression analysis, PTC blood was independently associated with a 90% reduction in 24 hour mortality (OR 0.10; 95%CI 0.01-0.95, $p=0.04$), a 60% reduction in 30day mortality (HR 0.40; 95%CI 0.16-0.97, $p=0.04$), and an 86% reduction in TIC (OR 0.14; 95%CI 0.02-0.94, $p=0.04$) after adjusting for confounders. Cox adjusted survival curves showed early separation of the groups with lower survival of the No PTC blood group over the first 30 days (Figure).

Conclusions: PTC blood administration is independently associated with a lower risk of 24 hour mortality, 30 day mortality, and TIC. Early aggressive resuscitation initiated before arrival at the trauma center incorporating blood transfusion appears to be associated with improved outcomes in severely injured blunt trauma patients, and warrants further prospective study and validation.



COMPLEMENT MEDIATES A PRIMED INFLAMMATORY RESPONSE AFTER TRAUMATIC LUNG INJURY

J. Jason Hoth* MD, Ph.D., Jonathan D. Wells BS, Sarah E. Jones AAS, Barbara K. Yoza Ph.D., Charles E. McCall MD, Wake Forest University School of Medicine

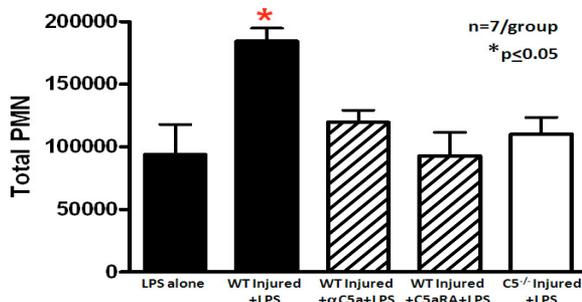
Invited Discussant: Krishnan Raghavendran, MD

Introduction: Pulmonary contusion (PC) is a common, potentially lethal injury that results in priming for exaggerated inflammatory responses to subsequent immune challenge like infection (2nd hit). The molecular mechanism of priming and the 2nd hit phenomenon after PC remain obscure. We hypothesize PC-induced activation of the complement (C) system participates in the priming effect seen after injury.

Methods: Male, 8-9 wk, C57BL/6 mice (WT, C5^{-/-}) underwent blunt chest trauma resulting in PC. The inflammatory response at 3H/24H after injury was quantified by measuring C5a, KC, IL-6 levels in serum/bronchoalveolar lavage (BAL), determining BAL neutrophil/protein levels, and evaluating lung histology. Additionally, mice were treated with the thrombin inhibitor, hirudin, to determine if injury-induced thrombin participated in the activation of C. Injury-primed responses were tested by challenging mice with intratracheal (IT) bacterial endotoxin (LPS) as a 2nd hit at 24H after PC. Inflammatory responses were assessed in the serum, BAL and lung tissue at 4H after LPS challenge. Data were analyzed using one way ANOVA with Bonferroni multiple comparison post-test with significance defined as $p \leq 0.05$. All experimental protocols were approved by the WFUHS Animal Care and Use Committee.

Results: We found significantly increased levels of C5a in the BAL of injured animals as early as 24H, persisting for up to 72H after injury. To determine the molecular mechanism of C activation after injury, we used hirudin-treated mice and found significantly decreased levels of thrombin in the BAL of hirudin treated injured mice that correlated with markedly reduced C5a levels. When challenged with IT LPS, injured mice demonstrated a correlation between increased C5a and increased neutrophils in the BAL and inflammatory mediators in the serum. Conversely, inhibition of C5a or its receptor, C5aR, in WT injured mice prior to LPS challenge correlated with decreased neutrophils in the BAL; C5a deficient mice showed a similar loss of primed response to LPS challenge.

Conclusion: Complement C5a levels in the BAL are increased over several days after PC. Pre-morbid inhibition of thrombin markedly abrogates C5a production after PC, suggesting thrombin-induced C activation is the major pathway of activation after PC. Similarly, inhibition of C5a after PC will diminish the measured priming response to LPS stimulation. Our findings suggest cross-talk between the coagulation and complement systems that induce immune priming after PC.



THE EFFECT OF EPIDURAL PLACEMENT IN PATIENTS AFTER BLUNT THORACIC TRAUMA

Saman Arbabi* MD,MPH, Alexis Gage MD,MPH, Frederick Rivara MD,MPH, Jin Wang Ph.D., Gregory J. Jurkovich* MD, Ronald V. Maier* MD, University Of Washington

Invited Discussant: David Harrington, MD

Introduction: In studies of trauma patients with rib fractures, conclusions on the benefits derived from epidural analgesia versus other analgesic modalities are inconsistent. The purpose of this study was to further evaluate placement and efficacy of epidural analgesia nationwide. We hypothesized that epidural analgesia improves outcomes of blunt trauma patients with 3 or more rib fractures (the cutoff point in previous studies that demonstrated benefit).

Methods: This was a retrospective cohort study of prospectively gathered data from the National Study on Cost and Outcomes of Trauma (NSCOT) database. Patients for this study came from the NSCOT, a multisite prospective cohort study of injured patients aged 18-84 years who were treated in 69 participating hospitals (18 Level I trauma centers and 51 non-trauma centers) across the United States. Our analysis was limited to patients with a blunt mechanism of injury and a thoracic maximum Abbreviated Injury Score (maxAIS) of ≥ 2 . Excluded were patients that were not potential candidates for epidural placement, such as patients with significant head and spine injuries (maxAIS head >2 or maxAIS spine >2), significant neurological impairment (best motor GCS <4), unstable pelvic fractures, coagulopathy, or patients that died within 48 hours. The primary intervention was epidural catheter placement, and primary outcome was death in 30, 90, and 365 days after injury.

Results: The NSCOT database contains 5,043 patients (weighted N=14,477), of which 836 (16.5%) patients were identified as potential candidates for epidural placement. Of patients included in the study, 736 patients (88%) did not receive an epidural catheter, and 100 patients (12%) had epidural catheters placed. The epidural cohort was significantly older (51 \pm 25 versus 44 \pm 28), had higher number of rib fractures, and more likely to have chest tubes (58% versus 39%). There was no significant difference in insurance status, GCS, or thoracotomies (2.2% versus 2.8%). The likelihood of epidural catheter placement was significantly higher in trauma centers as compared to non-trauma centers (adjusted odds ratio 3.06, 95% CI 1.80-5.22). In the epidural group as compared to no epidural cohort, the adjusted odds of death in patients with 3 or more rib fractures at 30, 90, and 365 days was 0.21 (95%CI 0.05-0.94), 0.27 (95% CI 0.07-1.00), and 0.33 (95% CI 0.12-0.91) respectively (propensity score analysis). We adjusted for age, gender, ISS, shock, Charlson Comorbidity Index score, trauma center status, number of rib fractures, chest tube placement, thoracic maxAIS, flail chest, and intubation status (since maxAIS was limited to 2 or lower, it was not a confounder in our model). Limiting the study to patients treated in trauma centers only did not significantly change the results, and epidural placement was associated with significant reduction in mortality.

Conclusion: In this multicenter retrospective cohort study, epidural catheter placement was associated with a significantly decreased risk of dying up to a year post injury in patients with blunt thoracic injury of ≥ 3 rib fractures.

IS IT SAFE? TWICE DAILY DOSING OF ENOXAPARIN IN TRAUMA PATIENTS WITH INDWELLING THORACIC EPIDURAL CATHETER

Shente Hsu MD, Soumojit Ghosh BS, Michael Bottros MD, Douglas Schuerer* MD, Washington University

Invited Discussant: M. Margaret Knudson, MD

Introduction: Thoracic epidural catheters are an effective method used for pain relief of traumatic rib fractures. Trauma patients are commonly given enoxaparin twice daily for deep vein thrombosis (DVT) prophylaxis given its superiority to unfractionated heparin in randomized trials. However, American Society of Regional Anesthesia recommends against twice daily prophylactic enoxaparin in patients with an indwelling epidural catheter, citing concern for risk of epidural hematoma, although rare. DVT and pulmonary embolism (PE) remain common in this population, but there is a paucity of data examining the safety of enoxaparin twice daily in patients with an indwelling epidural catheter.

Methods: We performed a retrospective review of all patients with rib fractures who received a thoracic epidural catheter at our level 1 trauma center from 2005-2012. Data collected included patient demographics, Injury Severity Score, anticoagulant use, presence of significant coagulopathy or thrombocytopenia, difficult epidural placement, and development of epidural hematoma.

Results: We identified 158 patients. There were no epidural hematomas. Patient demographics and other results are in Table 1. Twice daily enoxaparin was given to 83 (52.5%) patients, while 105 (66%) had at least one dose of daily enoxaparin. 17

(10.8%) received no chemical prophylaxis. Significant thrombocytopenia (Plt < 100,000) and coagulopathy (INR > 1.5) developed in 14 (8.9%) and 11 (7.0%) patients, respectively. 8 (5%) patients developed DVT or PE, 5 of whom were on less than twice daily enoxaparin, and only 1 of those had a closed head injury. Patients with PE were noted to have a longer length of stay compared to the whole group (13.0 vs 10.2 days).

Table 1. Patient Demographics and Results

Age	53.4
Male	69% (109)
Female	31% (49)
ISS	18
Closed Head Injury	22.7% (20)
Median Rib fractures/ pt.	6
Hospital day Epidural Placed	2
Epidural duration	5.1 days
DVT/PE	5% (8)
Epidural Hematoma	0

Conclusion: In this largest reported dataset of epidural catheters and concurrent enoxaparin use, there were no epidural hematomas. There is a significantly high rate of DVT and PE in these patients. Even though this study is not powered to detect a small increase in epidural hematomas, given the risk benefit ratio, maintaining appropriate DVT prophylaxis should be favored until a larger multi-center study can be performed.

AGE-RELATED IMPACT ON PRESENTATION AND OUTCOME OF PENETRATING THORACIC TRAUMA IN THE ADULT AND PEDIATRIC PATIENT POPULATIONS

Nathan M. Mollberg DO, Robert Kanard MD, Deborah Tabachnik MD, Thomas K. Varghese MD, Michele Holevar* MD, Gary J. Merlotti MD, Robert Arensman MD, Malek G. Massad MD, Mount Sinai Hospital

Invited Discussant: Mary Fallat, MD

Introduction: Studies reporting on penetrating thoracic trauma in the pediatric population have been limited by small numbers and implied differences with the adult population. Our objective was to report on a large cohort of pediatric patients presenting with penetrating thoracic trauma and to determine age-related impacts on management and outcome through comparison with an adult cohort.

Methods: A Level I trauma center registry was queried between 2006 and 2012. All patients presenting with penetrating thoracic trauma were identified. Patient demographics, injury mechanism, injury severity, admission physiology, and outcome were recorded. Patients were compared and outcomes analyzed based on age at presentation, with those patients ≤ 17 years old defining our pediatric cohort.

Results: 1423 patients with penetrating thoracic trauma were admitted over the study period. 220 (15.5%) patients were pediatric, with 205 being adolescents (13-17) and 15 being children (≤ 12). In terms of management for the pediatric population, tube thoracostomy alone was needed in 32.7% (72/220), whereas operative thoracic exploration was performed in 20.0% (44/220). Overall mortality was 13.6% (30/220). There was no significant difference between the pediatric and adult population regarding need for therapeutic intervention, or outcome (Table 1). Regression analysis failed to identify age as a predictor for the need for either therapeutic intervention or mortality between the two age groups. However, subgroup analysis revealed that age ≤ 12 (odds ratio: 3.84, confidence intervals: 1.29-11.4) was an independent predictor of mortality.

Conclusion:

This series represents the largest to date reporting outcomes for penetrating pediatric thoracic trauma. Management of penetrating thoracic injuries in terms of need for therapeutic intervention, and operative approach were similar between the adult and pediatric populations. Mortality from penetrating thoracic trauma can be predicted based on injury severity, the use of EDT, and admission physiology for both adolescents and adults. Children are at increased risk for poor outcome independent of injury severity.

Table 1. Outcome and management comparison between pediatric and adult patient populations presenting with penetrating thoracic trauma

Parameter n (%)	Pediatric	Adult	p value
	220 (15.5)	1203 (85.5)	
Demographics			
Age, mean \pm standard deviation	15.4 \pm 2.3	28.7 \pm 9.6	<0.001
Gender, male	180 (81.8)	1063 (88.4)	0.011
Injury mechanism			
Stab wound	135 (61.4)	698 (58.0)	0.372
Therapeutic intervention	117 (53.2)	552 (45.9)	0.07
Tube thoracostomy	72 (32.7)	327 (27.2)	0.102
Intrathoracic operation	45 (20.5)	225 (18.7)	0.575
Operative approach			
Thoracotomy	38 (65.6)	162 (55.8)	0.14
Sternotomy	3 (22.6)	23 (34.6)	0.786
Thoracoscopy	3 (3.2)	31 (5.8)	0.345
Clavicular/Axillary	1 (8.6)	9 (5.8)	0.345
Laparotomy	33 (15.0)	160 (13.3)	0.52
Multiple cavity	4 (1.8)	20 (1.4)	0.779
Emergency department thoracotomy	26 (11.8)	131 (10.9)	0.725
Chest abbreviated injury score, mean \pm SD	2.4 \pm 1.5	2.2 \pm 1.5	0.07
Revised Trauma Score, mean \pm SD	7.0 \pm 2.2	7.0 \pm 2.4	1
New Injury Severity Score, mean \pm SD	12.6 \pm 17.3	11.2 \pm 17.0	0.263
Overall mortality	31 (14.1)	139 (11.6)	0.309

COMPUTER VERSUS PAPER ICU SYSTEM FOR RECOGNITION AND MANAGEMENT OF SURGICAL SEPSIS

Chasen A. Croft MD, Frederick A. Moore* MD, Philip A. Efron MD, Peggy S. Marker RN, Andrea Gabrielli MD, Lawrence J. Caruso MD, Fitzgerald J. Casimir MD, Janeen Jordan MD, Lawrence Lottenberg* MD, Lynn S. Westhoff RN, Victoria Klink RN, R. Matthew Sailors BE, Bruce A. McKinley PhD University of Florida - Gainesville

Invited Discussant: Lena Napolitano, MD

Introduction: A system for sepsis management was implemented for acute care surgery ICU patients using a paper system followed by a computerized system. We hypothesized that better outcomes would be associated with the computerized system.

Methods: Using literature and guideline evidence, and local expert consensus, a rule based, data driven system was designed that provides early recognition and guides patient specific management of sepsis including: 1. modified early warning signs–sepsis recognition score (MEWS-SRS; summative point score of ranges of vital signs, mental status, WBC; Q4hr) by bedside RN; 2. suspected site assessment (vascular access, lung, abdomen, urinary tract, soft tissue, other) at bedside by MD or extender; 3. sepsis management protocol (replicable, point of care decisions) at bedside by RN, MD and extender. The system was implemented first using paper forms and then a computerized system. Sepsis severity was defined using standard criteria, and patients were categorized using the 1st sepsis encounter.

Results: In Jan-May 2012 (22wks), a paper system was used to manage 77 consecutive sepsis encounters (3.9±0.5 cases/wk) in 65 patients (77% m; age 53±2). In Jun-Dec 2012 (30wks), a computer system was used to manage 132 consecutive sepsis encounters (4.4±0.4 cases/wk) in 119 patients (63% m; age 58±2). MEWS-SRS elicited 683 site assessments and 201 had sepsis diagnosis and protocol management. Incidence and outcome are summarized.

a,b;1,2 (X ² ,ANOVA) p<0.05	Paper system					Computerized system				
	number	hosp mort rate	ICU free dy	home disp		number	hosp mort rate	ICU free dy	home disp	
severity	total	m (%)	n (%)	m±sem	n (%)	total	m (%)	n (%)	m±sem	n (%)
sepsis	16(25)	81	1(6)	¹ 10±2	4(31)	44(37)	66	^{a,2} 1(2)	^{a,2} 17±1	^a 21(62)
severe sepsis	34(52)	79	¹ 8(24)	13±2	³ 7(54)	21(18)	62	^{b,2} 3(14)	^a 14±2	⁴ 7(21)
septic shock	15(23)	67	¹ 6(40)	13±2	2(15)	54(45)	61	^{b,2} 12(22)	^b 9±1	^b 6(21)
all	65(100)	77	15(23)	13±1	13(20)	119(100)	53	16(14)	13±1	34(34)

Hospital mortality rate for severe sepsis (paper 24 vs computer 14%) and for septic shock (paper 40 vs computer 22%) was greater with the paper than the computer system. With the computer system, ICU stay increased with sepsis severity. For sepsis, disposition to home tended to be more frequent with the computer than the paper system (p=0.06). Septic shock patients (paper 71%; computer 46%) were transferred to ICU from elsewhere.

Conclusions: Sepsis management for acute care surgery patients is a frequent requirement that requires ongoing surveillance and involves a complex care process. A computerized system designed to facilitate early recognition and to prompt individual patient optimized care of sepsis improves outcomes compared with a paper system. Hospital sepsis survival is not associated with disposition to home, but with disposition to ongoing long term care.

Reducing Unnecessary Blood Transfusions In The SICU With A Simple Checklist

Ellen Carraro MD, Naem A. Ali MD, Kay Ashworth RN, Cheryl Newton RN, Jennifer MacDermott RN, Gary Phillips MAS, David Evans MD, Daniel Eiferman MD, Stanislaw Stawicki MD, David Lindsey* MD, Steven Steinberg* MD, Charles H. Cook* MD, The Wexner Medical Center At The Ohio State University

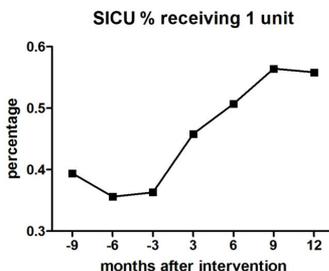
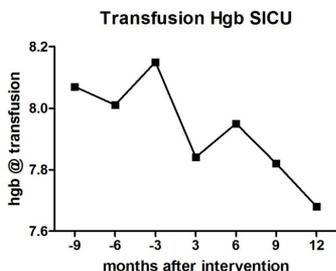
Invited Discussant: Lydia Lam, MD

Introduction: The decades old practice of liberal transfusions in critically ill patients using higher than necessary transfusion thresholds and multiple units of blood continues unabated in many intensive care units (ICU). This occurs despite recent consensus recommendations for more restrictive transfusion practices in critically ill patients. We hypothesized that implementation of a simple 4 step checklist would impact such transfusion practice in a large multispecialty surgical ICU (SICU).

Methods: We retrospectively evaluated transfusion practices for all patients admitted to our SICU for 10 months prior and 15 months after checklist implementation. As a control, we monitored transfusion practice in our medical ICU (MICU, no checklist) during the same time period.

Results: From Jan 2009 to Dec 2010, 3292 and 2550 individual packed red blood cell (prbc) transfusions occurred respectively in our 44 bed SICU and 38 bed MICU (excludes massive transfusion protocol events). For transfusion trigger, random effects linear regression analysis over continuous time shows a statistically significant decrease in the mean hemoglobin (HGB) at time of transfusion in SICU after protocol implementation ($p=0.002$), and without concomitant decrease in the MICU ($p=0.386$). When patients did receive "routine" transfusion, random effects logistic regression analysis shows that SICU patients were 91% more likely to receive 1 prbc (instead of 2) after protocol implementation ($p<0.001$), while MICU patients were only 3% more likely to receive a single unit transfusion ($p=0.003$).

Conclusion: Implementation of a simple 4 step nursing driven transfusion protocol can reduce the transfusion trigger and the number of units transfused in a large SICU.



SURGICAL ICU PATIENTS BOARDING IN OTHER ICUs: GREATER DISTANCES EQUAL MORE FREQUENT COMPLICATIONS

Nicholas W. Blank Daniel H. Holena MD, Matthew Robertson CRNP, Mouhamed Diop Steve R. Allen MD, Niels Martin MD, Carrie Sims* MD, Patrick M. Reilly* MD, Jose L. Pascual MD, Ph.D., University of Pennsylvania

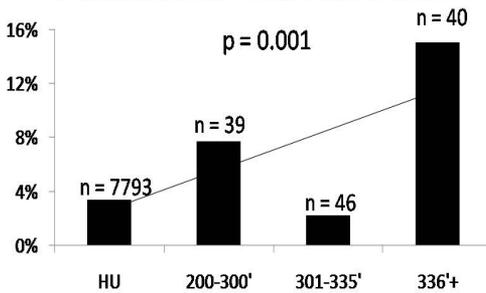
Invited Discussant: Grace Rozycki, MD, MBA

Introduction: Intensive Care Units (ICUs) are frequently at capacity and critically ill patients are often admitted to geographically distinct non-home ICUs. In medical ICU settings, such 'boarding' practices have been associated with increased rates of complications. We hypothesized that surgical ICU patients boarding in a separate neuro ICU but cared for by their 'home team' would suffer a greater number of complications.

Methods: A retrospective review of a prospectively maintained ICU database was performed over a 5-year period ('06/2005-'06/2010). Demographics, diagnosis, APACHE II scores, length of stay and incidence of delirium, pneumonia, ARDS, aspiration, re-intubation and self-extubation were extracted. Distances between the home Surgical ICU (HU) and the non-home neuroICU (NHU) rooms were measured using a surveyor's wheel and divided into 4 groups (HU, 200-300', 331-335', 336'+). Multivariate binomial logistic regression was used to control for age, APACHE II score, and length of stay. A p-value of <0.05 was considered significant.

Results: 7793 patients were admitted to the HU unit and 125 to the NHU unit with similar demographics and from similar surgical services. Incidence of delirium (3.33% vs. 8.00%, $p=0.003$) and reintubation (3.30% vs. 6.40%, $p=0.038$) in the HU was significantly lower than in the NHU. Figures depict the significantly rising incidence of delirium and re-intubation by patient

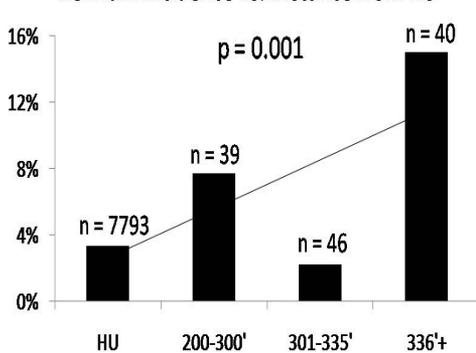
Delirium Incidence vs. Distance from HU



room distance from HU controlling for age, APACHE II and LOS. No significance difference in incidence of other complications were found.

Conclusions: Incidence of delirium and need for reintubation is greater in SICU patients boarding away from the home unit, and this is directly related to physical distance from the HU. Further evaluation of contributing nursing, medical or geographic factors are needed to address the root causes of these findings and improve ICU patient safety.

Delirium Incidence vs. Distance from HU



DETERMINING THE OPTIMAL THRESHOLD FOR GLUCOSE CONTROL IN ORGAN DONORS AFTER NEUROLOGIC DETERMINATION OF DEATH: A PROSPECTIVE ANALYSIS FROM THE UNOS REGION 5 DONOR MANAGEMENT GOALS WORKGROUP

Mitchell B. Sally MD, Tyler Ewing BS, Megan Crutchfield MPH, Madhukar Patel MD, Shariq Raza MD, Darren Malinoski* MD, Portland Veterans Affairs Medical Center

Invited Discussant: Ali Salim, MD

Introduction: A glucose level ≤ 180 mg/dL is currently recommended for the management of patients in the intensive care unit. In organ donors after neurological determination of death (DNDD), guidelines and regional practices target a glucose level ≤ 150 mg/dL, but evidence supporting this practice is lacking. We sought to determine the impact of hyperglycemia on organ transplantation rates and graft outcomes in DNDDs and hypothesized that a glucose target of 180 mg/dL would be effective in optimizing organ transplantation rates and outcomes.

Methods: Donor demographic, critical care endpoints, treatments, organ transplantation rates, and graft outcome data were prospectively collected on all DNDDs in United Network for Organ Sharing Region 5 between July 2010 and December 2012. Critical care endpoints and treatments were assessed at referral for potential organ donation, at the time of consent, 12-18 hours after consent, and prior to organ recovery. The primary outcome measure was having ≥ 4 organs transplanted per donor (OTPD). Univariate analyses were conducted to determine the crude relationship between glucose levels and overall OTPD, individual organ transplantation rates, and recipient graft function. Glucose levels were analyzed as continuous values as well as at the following cutoff points: ≤ 150 , 180, and 200 mg/dL. Crude results were then adjusted for gender, age, extended criteria donor (ECD) status, BMI, diabetes, blood type, and thyroid hormone usage in order to determine independent predictors of ≥ 4 OTPD. Results with a $p < 0.05$ are expressed in the results section.

Results: There were 1611 DNDDs with a mean age of 38 years, 62% were male, 8% ECDs, and 8% diabetic. Mean glucose was 168 mg/dL overall, 198 mg/dL at referral, 160 mg/dL at consent, 172 mg/dL 12-18 hours after consent, and 151 mg/dL prior to recovery. 537 (33%) hearts, 591 (18%) lungs, 1264 (78%) livers, 251 (16%) pancreata, and 2663 (83%) kidneys were transplanted. Mean OTPD were 3.4 ± 1.7 and 41% had ≥ 4 OTPD. Glucose levels ≤ 150 mg/dL were not associated with differences in organ utilization. However, levels ≤ 180 mg/dL were associated with more OTPD (3.5 vs 3.2) and a higher rate of ≥ 4 OTPD (42% vs 34%) as were levels ≤ 200 mg/dL (3.5 vs 3.3 and 42% vs 32%). After controlling for other factors, a glucose level ≤ 180 mg/dL remained an independent predictor of ≥ 4 OTPD (OR 1.4). In terms of specific organ utilization, mean glucose levels were lower in donors whose hearts and/or kidneys were transplanted (165 vs 170 and 168 vs 175 mg/dL, respectively). Levels ≤ 180 were associated with higher heart (34% vs 28%), pancreas (18% vs 11%), and kidney (85% vs 81%) transplantation rates. Levels ≤ 200 mg/dL were associated with higher heart (34% vs 24%) and kidney (85% vs 78%) transplantation rates. As for graft function, mean glucose levels were lower at 12-18 hours in hearts that were functioning after 9.0 ± 4.8 months of recipient follow-up (162 vs 178 mg/dL). Levels ≤ 150 , 180, and 200 mg/dL were associated with higher kidney graft survival after 10 ± 6.0 months of follow-up (97% vs 95%).

Conclusion: Hyperglycemia is common in DNDDs and is associated with lower organ transplantation rates and worse graft outcomes. Targeting a glucose level ≤ 180 mg/dL appears to preserve outcomes and is consistent with general critical care guidelines.

BETA BLOCKERS FOR ACUTE ATRIAL DYSRHYTHMIAS IN TRAUMA PATIENTS IMPROVES OUTCOMES

Jason P. Farrah MD, Patrick Robinson BS, Christopher Hunter MD, Preston R. Miller* III, MD, Robert S. Martin* MD, Gerald Rebo PharmD, Nathan T. Mowery* MD, Wake Forest University School of Medicine

Invited Discussant: Terence O'Keefe, MD, MPH

Introduction: Acute atrial dysrhythmias (AADs) are a common problem for injured patients. AADs have been identified as independent predictors of mortality in trauma. Treatment of these dysrhythmias are well described in other surgical populations with beta blockers having been shown to improve outcomes. Little is known regarding the optimal treatment of these dysrhythmias in the setting of trauma resulting in inconsistent treatment. We hypothesized that treatment with beta blockers would confer improved outcomes and less recurrence of AADs.

Methods: A retrospective chart review of all patients admitted to our level 1 trauma center over the last ten years was performed. Patients with AADs, defined as atrial fibrillation, atrial flutter, or supraventricular tachycardia were selected for further analysis. Patients were divided into three groups based on initial medical treatment received (beta blockers, calcium channel blockers, or amiodarone) and then compared by univariate and multivariate analysis. Patients with a past medical history of atrial dysrhythmias were excluded from the study.

Results: There were 194 patients included in the study. Patients had a mean age of 64 ± 18 and a mean ISS of 20 ± 13 . 63% of the patients had chest trauma. We constructed a logistic regression analysis for mortality controlling for ISS, age, and shock (admission lactic acid) and found that using beta blockers as the initial treatment of AAD (OR .473, 95% CI .233-.960, $p=.038$) was protective compared to other classes of agents. The recurrence of atrial fibrillation was also significantly higher when comparing beta blockers to calcium channel blockers (21% vs 48%, $p=0.015$) and equivalent when comparing beta blockers to amiodarone (21% vs. 32%, $p=.121$)

	Beta Blocker (n=82)	Calcium Channel Blocker (n=31)	Amiodarone (n=81)	p
ISS	17 (IQR 9-26)	17 (IQR 9-27)	20 (IQR 10-34)	NS
Lactic Acid	2.9 (IQR 1.5-3.4)	2.1 (IQR 1.4-2.6)	2.8 (IQR 1.8-3.9)	NS
Hospital Day AAD Occurred	2 (IQR 1-5)	3 (IQR 0-5)	3(IQR 2-6)	NS
Mortality	21.0%	32.3%	42.0%	<0.05*

NS: all comparisons among groups are non-significant; *comparisons among groups are significant with p-value <0.05

Conclusion: These data suggest that beta blockers should be the initial agent chosen to control AAD in the trauma population. Use of beta blockade is shown to be as effective or better in controlling atrial fibrillation than other agents. The use of beta blocker as the initial agent is associated with a decreased mortality in both univariate and multivariate analysis.

FIBRINOGEN AND PLATELET CONTRIBUTIONS TO CLOT FORMATION: IMPLICATIONS FOR TRAUMA RESUSCITATION AND THROMBOPROPHYLAXIS

Lucy Z. Kornblith MD, Matthew E. Kutcher MD, Brittney J. Redick BA, Ryan F. Vilardi BS, Mary F. Nelson RN, MPA, Mitchell J. Cohen* MD, University Of California San Francisco/San Francisco General Hospital

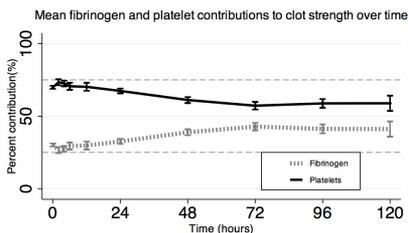
Invited Discussant: Ernest E. Moore, MD

Introduction: Thromboelastography (TEG) is widely used to diagnose the perturbations in clot formation and lysis characteristic of acute traumatic coagulopathy (ATC). With the recent addition of functional fibrinogen testing to standard TEG, relative fibrin- and platelet-based contributions to clot formation can be elucidated. This crucial data can assist in tailoring both early resuscitation and later thromboprophylaxis. We therefore sought to describe the longitudinal relative contributions of fibrinogen and platelets to clot strength after injury, hypothesizing that a low contribution of fibrinogen to clot strength on admission would be associated with coagulopathy, transfusion requirements, and worse outcomes.

Methods: Longitudinal plasma samples were prospectively collected from 165 critically-injured trauma patients at a single Level 1 Trauma Center on arrival and serially for 120h, and matched with demographic and outcomes data. Standard kaolin TEG maximal amplitude (MA), functional fibrinogen (FF) TEG MA, von Clauss fibrinogen, and standard coagulation measures were performed in parallel. Platelet contribution to clot strength was calculated as $MA_{TEG} - MA_{FF} = MA_{platelets}$. Percent contributions of FF (% MA_{FF}) and platelets (% $MA_{platelets}$) were calculated as each respective MA divided by the overall kaolin TEG MA.

Results: 402 FF-TEGs were performed on longitudinal samples from 165 patients. Coagulopathic patients (INR \geq 1.5) had significantly lower admission % MA_{FF} than non-coagulopathic patients (21% vs. 31%, $p<0.05$). In addition, patients requiring plasma transfusion had a significantly lower admission % MA_{FF} (25% vs. 30%, $p<0.05$). Higher admission % MA_{FF} was predictive of reduced mortality (hazard ratio 0.875, $p<0.001$). A 10% increase in admission % MA_{FF} was associated with an INR decrease of 0.12, PTT decrease of 4.22 sec, 24 hour red blood cell transfusion decrease of 3 units, and 24 hour plasma transfusion decrease by 2.2 units (all $p<0.05$). % $MA_{platelets}$ was higher than % MA_{FF} at all time points, decreased over time, and stabilized at 72 hours (70% at 0h, 57% at 72h; Figure). In contrast, % MA_{FF} increased over time and stabilized at 72 hours (30% at 0h, 43% at 72h).

Conclusion: The recent addition of FF testing to standard TEG affords novel differentiation of fibrin- versus platelet-based clot dynamics. Coagulopathy and plasma transfusion were associated with a lower % MA_{FF} , and higher admission % MA_{FF} predicted reduced mortality. Despite the importance of fibrinogen function, we found that platelet function plays a greater role in clot strength at all time points after injury. This finding is the first suggestion that attention to the relative contribution of fibrinogen and platelet function should guide both early resuscitation and later thromboprophylaxis, and that antiplatelet therapy may be of under-recognized importance to adequate thromboprophylaxis after trauma.



COMPARISON OF THE HEMOSTATIC EFFICACY OF LOW VOLUME LYOPHILIZED PLASMA RECONSTITUTED USING STERILE WATER, LACTATED RINGER'S, NORMAL SALINE, AND HEXTEND® SOLUTIONS

Tim H. Lee MD, MS, Sean P. McCully MD, Belinda H. McCully Ph.D., Claire Sands CVT, David A. Hampton MD, Scott G. Louis MD, Jerome Differding MPH, Martin A. Schreiber* MD, Oregon Health & Science University

Invited Discussant: Charles Lucas, MD

Introduction: Optimization of ascorbic acid buffered reconstituted lyophilized plasma (LP) into a low volume solution provides significant logistical advantages, reduces the risks associated with large volume resuscitation, modulates inflammation, and is equally effective for hemostatic resuscitation compared to full volume LP. To further optimize low volume LP, this study compared the physiologic effects of resuscitation using LP reconstituted with sterile water (LP-SW), lactated Ringer's (LP-LR), normal saline (LP-NS), and Hextend® (LP-Hx).

Methods: We performed a prospective, blinded animal study. Plasma was lyophilized following whole blood collection from anesthetized swine. LP was reconstituted to create four test solutions: LP-SW, LP-LR, LP-NS, or LP-Hx. Forty swine were anesthetized and subjected to a validated model of polytrauma and hemorrhagic shock (including a Grade V liver injury), then randomized to resuscitation using one of the four test solutions. Physiologic data were monitored and blood loss, lactate and hematocrit (Hct) were followed. Coagulation status was evaluated using thrombelastography (TEG). Expression of inflammatory mediators was evaluated by RT-PCR.

Results: Forty animals were included in the study (10 animals per fluid group). Baseline vital signs, lactate, and Hct were similar between groups. During the study, there were no differences in vital signs between groups at any time point. Serial serum lactate values were not different between groups. One animal died following LP-Hx resuscitation. There was significantly less blood loss in the groups receiving LP-SW and LP-LR compared to the LP-NS and LP-Hx groups (Figure 1). Differences in TEG parameters between groups were not significant. There was higher expression of the anti-inflammatory cytokine IL-10 mRNA by the LP-SW and LP-LR groups compared to the LP-Hx group (Figure 2).

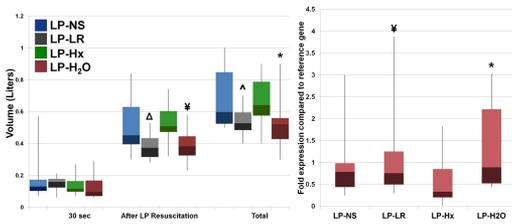


Figure 1. Blood Loss. *LP-H₂O < LP-NS and LP-H₂O < LP-Hx; *LP-LR < LP-Hx; *LP-H₂O < LP-Hx; *LP-LR < LP-NS and LP-LR < LP-Hx. Significance defined as p < 0.05.

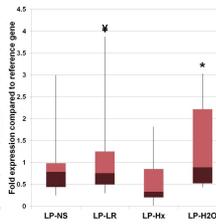


Figure 2. IL-10 mRNA expression. *LP-H₂O > LP-Hx; *LP-LR > LP-Hx. Significance defined as p < 0.05.

Conclusions: Resuscitation using low volume LP-SW and LP-LR buffered with ascorbic acid confers an anti-inflammatory benefit and results in less blood loss in a swine model of polytrauma and severe hemorrhage. Sterile water is a safe, cost effective, and universally available fluid for creating a low volume hemostatic LP resuscitation solution.

PERSISTENT INFLAMMATION IMMUNOSUPPRESSION AND CATABOLISM SYNDROME AFTER SEVERE BLUNT TRAUMA

Erin Vanzant MD, Lori F. Gentile MD, Maria Lopez MBA, Jennifer Lanz RN, Ruth Davis RN, Alex G. Cuenca MD,Ph.D., Henery Baker Ph.D., Frederick Moore* MD, Lyle Moldawer* Ph.D., Philip Efron MD, University of Florida - Gainesville

Invited Discussant: David Hoyt, MD

Introduction: Analysis of the “*Inflammation and Host Response to Injury*” Glue Grant(GG) data base documenting the current epidemiology of severe blunt trauma, identified that the second peak of late multiple organ failure(MOF) has disappeared and that hospital mortality has decreased dramatically over the study period with increasing compliance of standard operating procedures. However, 37% of these patients had a ‘complicated’ clinical course defined by ongoing low level organ dysfunction requiring >14 days ICU care. Based on this, previous published data on chronic critical illness and ongoing observations, a new syndrome was recently described called the persistent inflammation, immunosuppression and catabolism syndrome(PICS). We propose that PICS has replaced late MOF and is the predominant phenotype of chronic critical illness that modern ICUs are producing and can be validated at the genomic level.

Methods: Isolated blood leukocyte(monocytes, PMN and T-cells) microarray data and genome wide expression from 244 severely traumatized patients (ISS >15, no TBI, in shock, requiring blood, age >16) were analyzed. Patients outcomes were identified as ‘complicated’(>14 ICU days,n=68) or ‘uncomplicated’(<5 days n=63). Analysis consisted of identifying gene expression differences, comparison of functional pathways, and individual gene changes(fold changes in magnitude from control; $p < .001$) between groups and healthy subjects(n=21) using IPA. Pathway significance was determined by the use of a z-score, and values of $Z > 2$ (95% CI) were considered significant. Z scores were determined using IPA’s prediction models of known gene relationships in molecular pathways. Epidemiologic data and outcomes were analyzed on admission, and hospital day 7 and 14.

Results: Day 7 and 14, gene expression patterns from PMN and monocytes in complicated patients had significant changes in individual genes that indicate defects in adaptive immunity, decreased MHC expression, and myeloid cell induced lymphocyte T-cell suppression&Th2 skewing. On day 7, only PMNs from uncomplicated patients compared to non-trauma controls had increased expression of functional pathways related to cell movement, chemotaxis, differentiation, homing and cell movement. In monocytes, pathways for chemotaxis involved in inflammation and immune function were significantly up in the uncomplicated vs controls. Clinical analysis showed complicated patients had persistent leukocytosis, lymphopenia, and low albumin concentrations throughout their stay. Of the patients discharged, 28% of the complicated vs 62% uncomplicated were discharged home without rehabilitation.

Conclusion: Isolated leukocyte cell populations from severe blunt trauma patients with a complicated clinical outcome exhibit persistent(>14d) genomic expression changes, with increased inflammation and defects in adaptive immunity. These trends are supported by the failure of complicated patients to demonstrate the same increase in specific immune functional pathways as the uncomplicated. This indicates a defect in the complicated patients’ immune response to severe injury, especially their innate immune system. They also exhibit persistent inflammation, immunosuppression and protein depletion, supporting the genomic changes, as well as the hypothesis that these subjects are exhibiting PICS. Further attempts to delineate why these differences exist are important for future improvements in outcomes in the critically ill.

ASPIRATION OF ACID AND FOOD PARTICLES PRODUCES A SYNERGISTIC PULMONARY EXPRESSION OF sRAGE AND HMGB1 IN MICE.

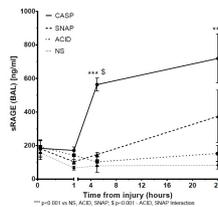
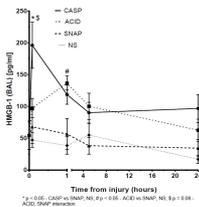
Peter J. Smit MD, MS, Bruce A. Davidson Ph.D., Weidun A. Guo* MD, Ph.D., Jadwiga D. Helinski MS, Barbara A. Mullen MS, Merrill T. Dayton MD, Paul R. Knight MD, Ph.D., Dept of Surgery, SUNY-Buffalo

Invited Discussant: Ronald Maier, MD

Introduction: Trauma patients often aspirate with full stomachs, which can lead to a pulmonary inflammatory response and ARDS. Previous work in our lab has demonstrated that together, the aspirate components (acid and food particles) produce a synergistic (i.e., greater than additive) lung injury. To investigate this mechanism, we hypothesized that there is an associated synergistic expression of the soluble receptor for advanced glycation end-products (sRAGE) and its ligand, high mobility group box 1 (HMGB1) in response to aspiration. Both compounds have been shown to be associated with aspiration-induced acute lung injury.

Methods: Aspiration in CD-1 mice was induced by intratracheal administration of normal saline (NS), hydrochloric acid (ACID), small non-acidified gastric particles (SNAP), or combined acid plus small gastric particles (CASP, i.e., ACID+SNAP). Bronchial alveolar lavage (BAL) was collected at 5 min, 1, 5, or 24 hrs post-injury for sRAGE and HMGB1 assays. In a second experiment, an NF- κ B inhibitor, ethyl pyruvate, was intraperitoneally injected after CASP aspiration and BAL was obtained at 5 hrs post-injury for the same assays. Interaction between ACID and SNAP injuries was assessed by 2-way ANOVA.

Results: Immediately after injury (5 min) HMGB1, but not sRAGE, increased in the CASP group. There was an interaction here between ACID and SNAP on HMGB1 levels trending toward significance ($p=0.08$). At 1 hr post-injury, HMGB1, but not sRAGE, increased in the ACID group ($p<0.05$). At 5 and 24 hrs post-injury, there were no differences between the injury groups with respect to HMGB1, but sRAGE levels were higher after CASP than either ACID or SNAP alone ($p<0.001$). There was an interaction between ACID and SNAP contributing to 22% of the variation in sRAGE levels of CASP-injured mice at 5 hrs ($p<0.001$). Ethyl pyruvate administration reduced HMGB1 ($p<0.05$) and sRAGE levels ($p<0.01$) at 5 hrs post-injury.



Conclusion: Combined acid and food particles are associated with the synergistic expression of HMGB1 and sRAGE, which may contribute to the exaggerated pulmonary inflammatory response and resultant lung injury observed after aspiration. Application of NF- κ B inhibitors, such as ethyl pyruvate, may be useful adjuncts in the prevention and treatment of aspiration-induced ARDS in trauma and ICU patients. Future investigation is necessary to refine our understanding of the interaction between RAGE, HMGB1, and the effector cells of the inflammatory response.

TO SWAB OR NOT TO SWAB: A PROSPECTIVE ANALYSIS OF 341 SICU VRE SCREENS

Douglas Z. Liou MD, Galinos Barmparas MD, Eric J. Ley MD, Ali Salim* MD, Aasin Tareen BS, Tamara Casas BS, Debora Lee BS, Marko Bukur MD, Cedars-Sinai Medical Center

Invited Discussant: Kimberly Davis, MD

Introduction: Vancomycin-resistant *Enterococcus* (VRE) screening is routine practice in many ICUs despite the question of its clinical significance. The value of VRE screening at predicting subsequent VRE or other hospital-acquired infection (HAI) is unknown. The purpose of this investigation was to examine the rate of subsequent VRE HAI in patients undergoing VRE screening.

Methods: This study was conducted in a 24-bed SICU at a Level 1 trauma center. Patients admitted to the SICU between January and August 2011 who had rectal swab for VRE screening within 72 hours were followed prospectively for the development of VRE and other HAI. Demographics, clinical characteristics, and infection rates were compared between VRE+ and VRE- patients. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of VRE screening for predicting subsequent VRE HAI were calculated.

Results: A total of 341 patients had VRE screening within 72 hours of SICU admission, with 32 (9%) VRE+ and 309 (91%) VRE- patients. Patients with VRE+ had a higher incidence of any HAI (78% vs 36%, $p<0.001$) (TABLE). Eight (25%) VRE+ patients developed VRE HAI compared to only 3 (1%) VRE- patients ($p<0.001$). VRE screening had a 73% sensitivity, 93% specificity, 25% PPV, and 99% NPV for determining subsequent VRE HAI.

Conclusion: VRE colonization was present in 9% of SICU patients upon admission. Negative VRE screening had a high specificity and NPV for the development of subsequent VRE HAI. Empiric treatment of VRE infection may be unnecessary in VRE-patients.

	VRE+ (n=32)	VRE- (n=309)	p-value
Age (years), mean \pm SD	62 \pm 17	60 \pm 19	0.52
Male, % (n)	53% (17)	56% (174)	0.73
Trauma, % (n)	19% (6)	22% (67)	0.70
SICU LOS (days), mean \pm SD	4.0 \pm 4.9	4.2 \pm 6.3	0.88
APACHE IV, mean \pm SD	14 \pm 12	18 \pm 19	0.27
HAI within hospital stay, % (n)	78% (25)	36% (111)	<0.001
VRE HAI, % (n)	25% (8)	1% (3)	<0.001

VRE - vancomycin-resistant enterococcus; HAI - hospital-acquired infection

HOW MUCH AND WHAT TYPE...ANALYSIS OF THE FIRST YEAR OF THE ACUTE CARE SURGERY OPERATIVE CASE LOG

Christopher J. Dente* MD, Therese M. Duane* MD, Gregory J. Jurkovich* MD, LD
Britt* MD, MPH, J W. Meredith* MD, John J. Fildes* MD, Emory University

Invited Discussant: James Davis, MD

Introduction: A case log data base was created by the AAST ACS committee to track trainee operative experiences, allowing them to enter their cases in the form of CPT codes or manually, if no CPT code could be established. We hypothesized that the number of cases an ACS trainee performed would be similar to the ACGME expectations of a fifth year general surgery resident. We further hypothesized that the list of Essential and Desired cases (E/D list) created at the inception of the training paradigm would accurately reflect the cases done in an ACS fellowship. **Methods:** The AAST case log database was queried for all cases entered from 7/1/11- 6/30/12. Trainees were classified as those participating in AAST-accredited fellowships (accACS, n = 8) and those who were participating in ACS fellowship not yet accredited (nonaccACS, n = 7). CPT codes were mapped individually to the E/D list and tallied. Cases entered manually were reviewed and assigned a CPT code if possible, or left as “non codable”. To compensate for non-operative rotations and non-compliance with data entry, case numbers were analyzed on a monthly basis and then annualized to estimate average annual case numbers for all trainees. In addition, the operative experience of the fellows was compared to the E/D list. **Results:** 18 accACS and 11 nonacc ACS trainees entered 5630 CPT codes and 409 entries deemed non-codable from a total of 3933 individual cases. 181 non-codable entries were able to be mapped to CPT codes bringing that total to 5811 codes. At least one case was entered in 242 of 348 (70%) potential “fellow-months.” accACS fellows performed 16.5 ± 12.7 cases per month compared to 15.8 ± 14.3 cases for nonaccACS fellows ($p = .71$) When annualized, fellows performed, on average, 195 cases per year (197.5 cases accACS and 189.4 nonaccACS). Actual operative experiences compared to the E/D list are described in the table. Only 77 cases (2.6 cases/fellow) were categorized as pediatric.

Category	% of all Codes	Codes Captured by E/D List (%)
Airway	7%	392/398 (98%)
Chest	13%	437/739 (59%)
Abdomen	50%	1723/2920 (59%)
Extremity	9%	271/524 (52%)
Face	< 1%	9/39 (23%)
Misc	19%	184/1082 (17%)
Neck	2%	8/109 (7%)
Total	100%	3033/5811 (52%)

Conclusions: Acc and nonacc ACS trainees have substantial operative experience averaging nearly 200 major cases during their ACS year. However, high variability exists in the number of essential or desirable cases being performed with about 50% of the fellows’ operative experience falling outside of the E/D list of cases. Modification of the fellows’ operative experience and/or the rotation requirements appears to be needed to provide experience in E/D cases.

DOES RVU-BASED COMPENSATION SHORT-CHANGE THE ACUTE CARE SURGEON?

Diane A. Schwartz MD, Xuan Hui MD, MS, Eric B. Schneider Ph.D., Catherine G. Velopulos MD, Shalini Selvarajah MD, Donald J. Lucas MD, Elliot R. Haut* MD, Nathaniel McQuay* Jr., MD, Timothy M. Pawlik MD, David T. Efron* MD, Adil H. Haider* MD, Bayview Hospital Of Johns Hopkins Medical Center

Invited Discussant: R. Lawrence Reed, MD

Introduction: Emergent operations are known to demand more surgeon attention, time, and resources compared to planned, elective cases, and it remains unclear whether RVU compensation plans effectively capture these differences. Our objective was to determine if RVUs adequately reflect the increased surgeon effort required to treat emergent versus elective patients receiving similar procedures.

Methods: The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) 2011 dataset was queried, and patients undergoing elective or emergent colectomy, hernia repair, or biliary procedures were identified using CPT codes. RVUs, OR time, major/minor complications, and patient length of stay (LOS) were compared across elective and emergent operations. Generalized linear models were employed to assess outcomes, controlling for 12 preoperative risk factors that included demographics and comorbidities. Analyses were then stratified by open versus laparoscopic intervention.

Results: Of the 442,149 patients in NSQIP for the year 2011, there were 27,636 biliary, 28,722 colorectal, and 31,090 hernia procedures. The table displays mean RVUs, LOS, and OR time for elective procedures followed by a column noting the difference off the mean for the emergent counterparts in each category. RVUs are noted to be the same or less for emergencies, excepting hernias, and LOS is longer for all emergent operations. Odds ratios for complications are also higher in emergent procedures as shown below. Major complications are defined as deep incisional surgical site infection, wound complication, unplanned intubation, pulmonary embolus, acute renal failure requiring dialysis, cerebral vascular accident, shock, cardiac arrest, acute myocardial infarction, bleeding requiring transfusion, sepsis, or return to OR. The minor complications comprise superficial infection, pneumonia, progressive renal insufficiency without the need for dialysis, urinary tract infection, and deep vein thrombosis.

Table 4. Estimates of patients by surgery types for the outcomes of LOS, OR time

	Biliary				Colorectal				Hernia			
	Laparoscopic		Open		Laparoscopic		Open		Laparoscopic		Open	
	Mean	Diff	Mean	Diff	Mean	Diff	Mean	Diff	Mean	Diff	Mean	Diff
	elective	emergent	elective	emergent	elective	emergent	elective	emergent	elective	emergent	elective	emergent
RVU	11.86	0.01	17.54	-0.09	27.51	-0.50	26.01	-0.31	9.50	1.93	9.73	0.56
LOS (days)	1.64	1.48	7.36	1.25	6.16	2.36	10.07	3.26	0.58	2.63	1.34	3.16
OR Time (min)	66.36	8.40	131.40	-7.45	172.31	-30.36	184.27	-45.47	71.31	8.77	76.53	4.20
	OR		OR		OR		OR		OR		OR	
major complications	ref.	1.46	ref.	1.60	ref.	1.51	ref.	1.84	ref.	3.08	ref.	1.97
minor complications	ref.	1.30	ref.	1.10	ref.	1.77	ref.	1.19	ref.	2.42	ref.	2.22

*Work Relative Value Unit

*unite-day

*OR time in minutes

Conclusion: Emergent operative management for various procedures is similarly compensated despite longer LOS, more complications, and subsequently increased physician attention. Reevaluating the utility of a modifier that might better capture the additional work involved in emergent patient care may be justified given these findings.

ADJUNCTIVE TREATMENT OF ABDOMINAL CATASTROPHES AND SEPSIS WITH DIRECT PERITONEAL RESUSCITATION (DPR): INDICATIONS FOR USE IN ACUTE CARE SURGERY.

Jason W. Smith* MD,Ph.D., Paul J. Matheson Ph.D., Brian G. Harbrecht* MD, Matthew V. Bennis MD, Glen A. Franklin* MD, Keith R. Miller MD, J D. Richardson* MD, R. N. Garrison* MD, University of Louisville

Invited Discussant: John Holcomb, MD

Introduction: The success of damage-control surgery (DCS) for the treatment of trauma has led to use in other surgical diseases associated with shock states such as abdominal sepsis. Previous studies utilizing direct peritoneal resuscitation (DPR) for the treatment of traumatic injuries have yielded promising preliminary results. We present the initial results of the application of technique to patients suffering abdominal sepsis treated with DCS.

Methods: We enrolled 44 DCS patients over a 5 year period (01/2008 to 12/2012) to undergo DPR in addition to standard resuscitation as part of a prospective case-control study. DPR consisted of peritoneal lavage with 2.5% commercially available peritoneal dialysis solution (Delflex) at a predetermined rate. Temporary abdominal closure was standardized. Patients were propensity score matched to contemporaneous controls for demographics, APACHE II, and cause of abdominal sepsis. Univariate and Multivariate analysis was performed.

Results: There were no differences between the control and experimental group with regard to age, gender, ethnicity, or APACHE II. Indications for damage control included pancreatitis, perforated hollow viscous, bowel obstruction and ischemic enterocolitis. Patients undergoing DPR had both a higher rate of

Application of DPR to General Surgery DCS Patients			
	DPR (n=44)	Control (n=44)	P value
Age (years)	52 ± 12	50 ± 8	0.36
Gender (% male)	59	56	--
Indication for OR (n)			
Pancreatitis	8	8	--
Perforated Viscous	18	17	--
Bowel Obstruction	8	8	--
Ischemia	10	11	--
APACHE II @ OR	25.5 ± 11.4	27.9 ± 13.2	0.36
SOFA @ OR	12.1 ± 5.9	12.9 ± 7.8	0.57
APACHE II @ 48 H	19.3 ± 10	24.7 ± 14.5	0.04
SOFA @ 48 H	8.4 ± 6.1	10.3 ± 5.4	<0.01
Primary Fascial Closure (n)	29 (68%)	19 (43%)	0.03
Time to Closure (days)	5.9 ± 3.2	7.7 ± 4.4	0.02
Abdominal Complication (n)	12 (27%)	21 (47%)	0.038
Mortality (n)	7 (16%)	12 (27%)	0.15

(68% vs. 43%, $p \leq 0.03$) and a shorter time to definitive fascial closure (5.9 ± 3.2 vs. 7.7 ± 4.1 days, $p \leq 0.02$). At 48 hours post-operation, DPR patients had a decreased APACHE II and Sequential Organ Failure Assessment (SOFA) score compared to controls. Additionally, DPR patients had fewer abdominal complications compared to controls (RR 0.57; 0.32-1.01, $p=0.038$). Failure to utilize DPR was a significant predictor of post-operative morbidity in multivariate analysis. Also, inability to definitively close the abdomen following DCS was a predictor of increase post-operative morbidity and increased length of stay in both groups.

Conclusions: DPR shortens the interval to definitive abdominal closure, increases primary fascial closure rate and reduces intra-abdominal complications following DCS for abdominal sepsis. As a result, DPR following DCS may afford better outcomes to patients suffering shock due to severe secondary peritonitis.

OUTPATIENT LAPAROSCOPIC APPENDECTOMY SHOULD BE THE STANDARD OF CARE FOR UNCOMPLICATED APPENDICITIS

Richard Frazee MD, Stephen Abernathy MD, Matthew Davis* MD, Travis Isbell MD, John Hendricks MD, Justin Regner MD, Randall Smith* MD, Texas A&M Health Science Center & Scott and White Hospital

Invited Discussant: Andrew Peitzman, MD

Introduction:

In 2012, a protocol for routine outpatient laparoscopic appendectomy for uncomplicated appendicitis was published reflecting high success, low morbidity, and significant cost savings. In spite of this, national data reflect the majority of laparoscopic appendectomies are done with overnight admission. This study updates our experience with outpatient appendectomy since our initial report, confirming the efficacy of this approach.

Methods:

In July 2010, a prospective protocol for outpatient laparoscopic appendectomy was adopted at our institution. Patients were dismissed from the post-anesthesia recovery room or day surgery if they met predefined criteria for dismissal. Patients admitted to a hospital room as either full admission or observation status were considered failures of outpatient management. An IRB approved retrospective review of patients having laparoscopic appendectomy for uncomplicated appendicitis from July 2010 through December 2012 was performed to analyze success of outpatient management, postoperative morbidity and mortality, and readmission rates.

Results:

Three hundred forty-five patients underwent laparoscopic appendectomy for uncomplicated appendicitis during this time frame. There were 166 men and 179 women with a mean age of 35 years. Three hundred five patients were performed as outpatients for a success rate of 88%. Forty patients (12%) were admitted for pre-existing comorbidities (15 patients), postoperative morbidity (6 patients) or lack of transportation or home support (19 patients). Twenty-three patients (6.6%) experienced postoperative morbidity. There were no mortalities. Four patients (1%) were readmitted for transient fever, nausea/vomiting, partial small bowel obstruction, and deep venous thrombosis. If this outpatient protocol was adopted nationally, there would be a projected health care savings of \$920,000,000 compared to current practice.

Conclusion: Outpatient laparoscopic appendectomy can be performed with a high rate of success, a low morbidity and a low readmission rate. This study reaffirms our original pilot study and should serve as the basis for a change in the standard of care for appendicitis. Adoption of this practice nationally would translate into significant health care savings.

SELF-EXPANDING FOAM FOR PREHOSPITAL TREATMENT OF SEVERE INTRA-ABDOMINAL HEMORRHAGE: DOSE FINDING AND SURVIVAL STUDIES

David R. King MD, Miroslav P. Peev MD, John O. Hwabejire MD, Michael J. Duggan DVM, John Beagle BS, Adam Rago BS, Greg Zugates Ph.D., Rany Busold Ph.D., Toby Freyman Ph.D., Tat F. Ng Ph.D., George Velmahos* MD, Marc A. DeMoya* MD, Upma Sharma Ph.D., Massachusetts General Hospital

Invited Discussant: Peter Rhee, MD, MPH

Introduction: Noncompressible abdominal bleeding is a significant cause of preventable death on the battlefield, with no effective therapies available at point of injury. We previously described the development of a percutaneously-administered, self-expanding, polyurethane foam that improved survival in a lethal Grade V hepatic and portal vein injury model in swine. We hypothesized that survival with foam treatment is dose dependent, and 28 day survival after adequate foam treatment is possible.

Methods: Experiment #1 was a high grade hepato-portal injury created in a closed abdominal cavity resulting in massive noncompressible hemorrhage. After injury, the animals were randomized into five groups. The control group (n=12) was treated only with fluid resuscitation and four foam groups received different volumes (group 1: 64ml, n=6; group 2: 85ml, n=6; group 3: 100ml, n=13; group 4: 120ml, n=10) in addition to fluids. Ten minutes after injury, foam was percutaneously administered, and animals were monitored for 3 hours. Experiment #2 assessed safety with a non-lethal splenic injury model. After splenic injury, animals had fluid resuscitation (control, n=6), or fluids plus foam (dose volumes 100ml, n=6, or 120ml, n=6), were monitored for 3 hours, underwent splenorrhaphy, foam explantation, and recovered for 28 days.

Results: Survival with hepato-portal injury was highest in group 4 (90%; p=0.0007) and decreased in a dose-dependent fashion (group 3: 62%, group 2: 33%, group 1: 17%). All foam groups survived significantly longer than the controls (8.3%). Hemorrhage rate was reduced in all groups, but lowest in group 4 vs. control group (0.34±0.052 vs. 3.0±1.3 ml/kg/min, p=0.005). Increasing foam volume was associated with transient increased peak intra-abdominal pressure (88.2±38.9 in group 4 vs. 9.5±3.2 mmHg in controls, p<0.0001) and increased incidence of focal bowel injuries. Experiment #2 (safety) required between 1 and 9 bowel repairs due to focal injuries after foam removal, but all animals recovered for 28 days without physiologic or histologic abnormalities.

Conclusion: The self-expanding foam improves survival in a dose-dependent fashion in an otherwise lethal injury. Higher doses are associated with better survival, but resulted in increased intra-abdominal pressure and the need for bowel resection. Small bowel repairs were required in the safety model and all animals lived 28 days. Future work will focus on the optimal balance between intra-abdominal pressure and hemostatic efficacy.

TRAUMATIC BRAIN INJURY AND HEMORRHAGE DISRUPTS COAGULATION AND PROTEIN C SYSTEMS, AND RESULTS IN ENDOTHELIAL INJURY AND INFLAMMATION IN A PORCINE MODEL

Martin H. Sillesen MD, Pär I. Johansson MD, DmSc, Lars S. Rasmussen MD, Ph.D., DmSc, Guang Jin MD, Ph.D., Cecilie Jepsen MD, Ayesha Imam MD, John Hwabjere MD, MPH, Jeniffer Lu BS, Michael Duggan DVM, George Velmahos* MD, Ph.D., Marc DeMoya* MD, Hasan Alam* MD, University of Michigan

Invited Discussant: Eileen Bulger, MD

Introduction: Effects of traumatic brain injury (TBI) and hemorrhagic shock (HS) on coagulation and inflammation are poorly defined, which limits our ability to design better interventions, and monitor the response to treatments. We hypothesized that combined TBI and HS would induce coagulation, activate endothelium, and stimulate inflammatory/complement cascades.

Methods: A total of 33 swine were allocated to either TBI+HS (n=27, TBI and volume-controlled 40% blood loss) or controls (n=6, anesthesia and instrumentation). TBI+HS animals were left hypotensive (mean arterial pressure between 30-35mmHg) for 2 hours. Blood samples were drawn at baseline, 3 and 15 minutes post injury, and after 2 hours of shock. In addition to thrombelastography (TEG), markers of coagulation, anticoagulation, endothelial activation/glycocalyx shedding, complement and sympatho-adrenal functions, and inflammation were measured.

Results: TBI+HS group demonstrated an immediate (3 min post-injury) and sustained activation of the coagulation (TEG r-time 3.8min vs. 5.1min, $p<0.01$) and complement (C5a, 2.83ng/ml vs. 2.05ng/ml, $p=0.05$) systems. There was a significant increase in thrombin generation (higher prothrombin fragment 1+2), shedding of the endothelial glycocalyx (Syndecan-1), and protein C activation (figure 1). There was also an increase in endothelial activation (von Willebrand factor, 784 U/l vs. 645 U/l, $p<0.01$), inflammation (TNF alpha, 81.1pg/ml vs. 50.8pg/ml, $p=0.03$) and sympatho-adrenal function (epinephrine 576 ng/ml vs. 463ng/ml, $p=0.01$).

Conclusion: The combination of TBI and shock results in an immediate and sustained activation of the coagulation and complement systems, sympatho-adrenal function, endothelial glycocalyx shedding and activation as well as protein C system activation and inflammation.

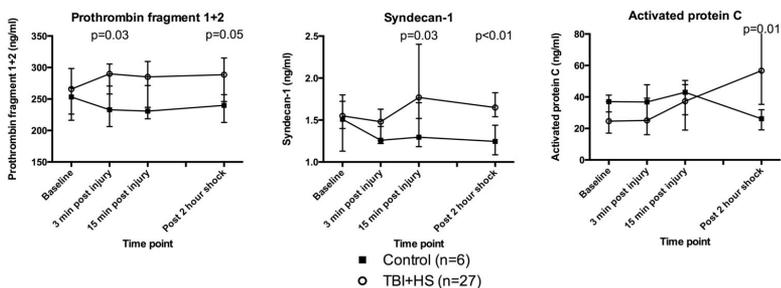


Figure 1: Median prothrombin fragment 1+2 (left), syndecan-1 (middle) and activated protein C (right) at different time points. Error bars indicate interquartile range

VAGAL NERVE STIMULATION MODULATES THE DENDRITIC CELL PROFILE IN POST-HEMORRHAGIC SHOCK MESENTERIC LYMPH

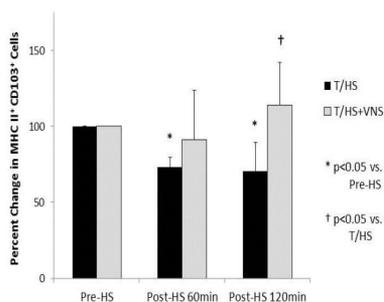
Koji Morishita MD, Todd W. Costantini MD, Brian Eliceiri Ph.D., Vishal Bansal* MD, Raul Coimbra* MD, Ph.D., University of California, San Diego

Invited Discussant: William G. Cioffi, MD

Introduction: Previous studies have established that post-hemorrhagic shock mesenteric lymph (PHSML) contains proinflammatory mediators that may drive the systemic inflammatory response to injury. Although the cellular basis of PHSML is less well characterized in acute models of injury, CD103+MHCII+ dendritic cells (DC) have been identified in the mesenteric lymph in models of chronic gut inflammation suggesting an important role for this cell population in the immune response. We have previously demonstrated the ability of vagal nerve stimulation (VNS) to prevent gut barrier failure after injury, however, the ability of VNS to alter DC trafficking in the gut is unknown. We hypothesized that CD103+MHCII+ DC populations would decrease in mesenteric lymph after trauma and hemorrhagic shock (T/HS) and vagal nerve stimulation (VNS) would prevent injury-induced changes in this population of DCs.

Methods: Male Sprague Dawley rats underwent cannulation of the the femoral artery and vein, and the mesenteric lymph duct prior to HS. The abdomen was opened to simulate trauma. The phases of injury were defined in order as the pre-HS phase (30 min), HS phase (60 min at a mean arterial pressure of 35 mmHg), and post-HS phase (120 min) with resuscitation of shed blood and normal saline. A separate cohort of animals underwent cervical VNS after the HS phase. Gut tissue was harvested at 4 hours after injury for histologic analysis. Mesenteric lymph flow was measured at each phase of the experiment. Mesenteric lymph was harvested to determine cell count and viability. For analysis by flow cytometry, cells were subjected to staining with CD103 and MHCII antibodies, and quantification of this cell population compared in the pre-HS and post-HS phase from the same animal.

Results: T/HS caused histologic gut injury which was prevented in animals treated with VNS. VNS limited the T/HS-induced increase in mesenteric lymph flow at 60 and 120 minutes post-HS. There was no difference in cell count nor cell viability between groups. The percentage of CD103+MHCII+ DC in the PHSML was found to be significantly decreased at 60 and 120 minutes post-HS when compared with that of pre-HS. Performing VNS after T/HS prevented the decrease in CD103+MHCII+ DC population in the PHSML caused by acute injury (see Figure).



Conclusion: T/HS decreases gut DC migration through the mesenteric lymph. VNS alters mesenteric lymph flow and prevents the HS-induced decrease in gut DC migration. VNS modulates intestinal DC trafficking thus altering the gut inflammatory response to injury. Treatments aimed at either directly or pharmacologically stimulating the vagus nerve may represent an ideal strategy to limit the systemic inflammatory response to severe trauma.

THE EFFECT OF TRANEXAMIC ACID IN A PORCINE TRAUMATIC ISCHEMIA REPERFUSION MODEL

Mia Debarros MD, Quinton Hatch MD, Porta Rees MD, Seth Izenberg MD, Joseph DuBose* MD, Matthew Eckert MD, Matthew Martin* MD, Madigan Army Medical Center

Invited Discussant: Martin Schreiber, MD

Introduction: Tranexamic acid (TXA) is an antifibrinolytic with anti-inflammatory properties that is associated with improved outcomes when administered to trauma patients at risk of bleeding, but little is known about its efficacy in an acidotic environment. We evaluated the effect of TXA on hyperfibrinolysis and inflammatory cytokines in a porcine trauma hemorrhage model that reliably induces severe acidosis.

Methods: 10 adult Yorkshire swine underwent a 30% controlled hemorrhage followed by supra-celiac aortic cross-clamping for 50 minutes. 5 control animals received standard resuscitation as well as a 100 mg bolus of rTPA 30 minutes after cross-clamp removal. Experimental animals received standard resuscitation, a 100 mg bolus of rTPA 30 minutes after cross-clamp removal, and a 1000 mg bolus of TXA 5 minutes after the rTPA bolus. ROTEM analysis was performed at baseline, 5 minutes after rTPA dosing, 15 minutes after rTPA dosing, and at 4 hours post cross-clamp removal. Levels of pro-inflammatory cytokines (TNF- α , IL-6, IL-8, IL-1 β) and anti-inflammatory cytokines (IL-10) were assessed at baseline and throughout resuscitation with the use of electrochemiluminescence technology.

Results: Control and experimental animals had similar hemodynamics and routine labs at baseline and throughout the resuscitation phase. At the time of TXA administration the average pH was 7.21. Clot formation time (CFT) was prolonged from baseline at all resuscitation time points in both groups, however there was no difference in CFT between control and experimental groups at any point (59 seconds vs. 69 seconds, $p=0.1$ at 5 minutes; 53 seconds vs. 59 seconds, $p=0.3$ at 15 minutes; 62 seconds vs. 72 seconds, $p=0.1$ at 4 hours). Maximum clot firmness (MCF) was decreased from baseline at all resuscitation time points in both groups, although no difference was observed between control and experimental groups (37 mm vs. 33 mm, $p=0.2$ at 5 minutes; 60 mm vs. 64 mm, $p=0.3$ at 15 minutes; 69 mm vs. 65 mm, $p=0.2$ at 4 hours). Maximum lysis (ML) was increased from baseline at 5 and 15 minutes after rTPA administration in the control group (9% baseline vs. 100% at 5 minutes, $p<0.001$; 9% baseline vs 92% at 15 minutes). In experimental animals, ML was increased from baseline 5 minutes after rTPA (9% vs. 99%, $p<0.001$), but returned to baseline by 10 minutes after administration of TXA (9% vs. 9%, $p=0.8$). There was a dramatic difference in ML between control and experimental animals at 15 minutes (92% vs. 9%, $p=0.001$) after rTPA administration. No fibrinolysis was present in either group at the 4 hour time point. Cytokine analysis is currently pending.

Conclusion: TXA rapidly and fully reverses hyperfibrinolysis despite severe acidemia in a large animal trauma model. While more studies are needed, TXA is a promising adjunct to trauma resuscitation that can be easily administered in the austere or pre-hospital setting.

STEMMING THE TIDE: THE IMPACT OF PLATELET AND DESMOPRESSIN ADMINISTRATION ON EARLY RADIOGRAPHIC PROGRESSION OF TRAUMATIC INTRACRANIAL HEMORRHAGE

Dennis Kim MD, Michael O'Leary MD, Scott Bricker MD, Angela Neville* MD, Frederic Bongard* MD, Brant Putnam* MD, David Plurad* MD, Harbor-UCLA Medical Center

Invited Discussant: Raminder Nirula, MD, MPH

Introduction: Limited data exists regarding the use of hemostatic adjuncts on the progression of post-traumatic intracranial hemorrhage. The objective of this study was to examine the impact of platelet transfusion and desmopressin (DDAVP) administration on hemorrhage progression following TBI. We hypothesized that platelet and DDAVP administration would not result in decreased early hemorrhagic progression.

Methods: A 3-year retrospective analysis of a Level-1 trauma center database of all adult blunt TBI patients. Patients who died within the first 24 hours, required immediate operative intervention, or sustained severe polytrauma were excluded. The primary outcome of interest was early (<24 hours) computerized tomography hemorrhagic progression. Secondary outcomes included quantitative changes in coagulation parameters, the need for delayed operation, complications, and mortality. Subset analysis of patients taking antiplatelets/coagulants was performed in addition to a multiple logistic regression analysis to identify independent predictors for hemorrhage progression.

Results: Of 362 TBI patients meeting the inclusion criteria, 117 (32.3%) received platelets and DDAVP [P/D(+)] and 245 did not [P/D(-)]. Overall, 31% of patients demonstrated early radiographic hemorrhage progression. Patients on antiplatelet agents were more likely to receive platelets and DDAVP ($p < 0.04$). On univariate analysis, there was a statistically significant difference in the incidence of hemorrhage progression (46% [P/D(+)] vs. 24% [P/D(-)], $p < 0.001$). On multivariate analysis, after controlling for age, use of antiplatelet agents, injury severity, and admission platelet count, platelet and DDAVP administration was independently associated with a decreased risk of hemorrhage progression (OR=0.39 [CI=0.23-0.70], $p = 0.001$).

Conclusion: The administration of platelets and DDAVP results in a decreased incidence of hemorrhage progression following TBI. Prospective validation of these findings is warranted.

Predictors of Hemorrhage Progression After Logistic Regression			
Variable	Odds Ratio	95% Confidence Interval	p-value
P/D (+)	0.39	0.23-0.70	0.001
Age \geq 65 years	2.60	1.30-5.20	0.009

Variables in model: age, sex, head AIS, ISS, platelet/DDAVP administration, pre-injury antiplatelet/coagulant use, admission platelet count

TRACHEOSTOMY TIMING IN ISOLATED TRAUMATIC BRAIN INJURY: PROPENSITY-MATCHED COHORT FROM THE AMERICAN COLLEGE OF SURGEONS TRAUMA QUALITY IMPROVEMENT PROGRAM

Aziz Alali MD, Damon Scales MD,Ph.D., Robert Fowler MD, MSc, Todd Mainprize MD, Alexander Kiss Ph.D., Charles De Mestral MD, Avery B. Nathens* MD,MPH,Ph.D., Department Of Surgery, University Of Toronto

Invited Discussant: Charles Adams, Jr., MD

Introduction: Tracheostomy is commonly performed in patients with severe traumatic brain injury (TBI) but its optimal timing is controversial.

Methods: Data on adults with isolated TBI who underwent tracheostomy were derived from 135 centers participating in the American College of Surgeons Trauma Quality Improvement Program (TQIP) over 2009-2011. Patients were divided into two exposure groups: those who received early tracheostomy (ET, ≤ 8 days) vs. late tracheostomy (LT, >8 days). Outcomes were compared between propensity score-matched groups to reduce confounding by indication. Proportional hazards regression treating tracheostomy as a time-dependent exposure was also undertaken as a secondary approach accounting for survivor-treatment bias and censoring of outcomes by mortality.

Results: Females, patients with older age, more comorbid illnesses, history of cardiac disease, fall-related injuries, higher initial motor GCS score, subdural hematoma and non-commercial insurance were more likely to undergo LT. From 1,811 patients, a well-balanced propensity-matched cohort of 1,154 patients was defined. ET was associated with fewer mechanical ventilation days, shorter ICU and hospital stay, lower odds of pneumonia, deep venous thrombosis, pulmonary embolism and decubitus ulcers. Hospital mortality was not significantly different between matched groups. Similar results were noted with the use of proportional hazards regression considering tracheostomy as a time-dependent variable.

Outcome	ET (N=577)	LT (N=577)	Adjusted RR/OR (95% CI)
Median ventilator days (IQR)	10 (7-15)	16 (12-22)	0.70 (0.65-0.75)
Median ICU days (IQR)	13 (9-18)	18 (15-25)	0.69 (0.65-0.74)
Median hospital days (IQR)	20 (15-28)	27 (20-38)	0.79 (0.73-0.85)
Pneumonia-no. (%)	238 (41.3)	313 (54.3)	0.59 (0.47-0.74)
DVT-no. (%)	46 (8.0)	76 (13.2)	0.57 (0.39-0.84)
PE-no. (%)	8 (1.4)	21 (3.6)	0.37 (0.16-0.85)
Decubitus ulcers-no. (%)	22 (3.8)	48 (8.3)	0.44 (0.26-0.73)
Mortality-no. (%)	52 (9.0)	40 (6.9)	1.33 (0.87-2.03)

Conclusion: In this observational study, ET was associated with shorter mechanical ventilation, ICU and overall hospital stay; but, no change in hospital mortality. Early tracheostomy may represent a mechanism to reduce in-hospital morbidity for patients with TBI.

ARE ALL DEATHS RECORDED EQUALLY? THE IMPACT OF HOSPICE CARE TO RISK ADJUSTED MORTALITY

Rosemary A. Kozar* MD,Ph.D., John B. Holcomb* MD, Wei Xiong MSc, Avery Nathens* MD,Ph.D., University Of Toronto

Invited Discussant: Mike Sise, MD

Introduction: Hospice care can provide dignity and comfort at end of life. However, transfer of care to hospice is not recorded as an in-hospital death in some trauma registries or administrative discharge data. As a result, mortality rates for the purpose of performance improvement or public reporting will be artificially low. The current study sought to determine the impact of discharges to hospice care on risk-adjusted mortality for trauma deaths reported to TQIP (Trauma Quality Improvement Performance).

Methods: Data were derived from TQIP participating centers in 2011. Center performance was evaluated using risk-adjusted mortality and presented as observed to expected (O/E) mortality ratios derived from a logistic regression model adjusting for clinically relevant risk factors. Impact of discharge to hospice care on center performance was measured by determining the changes in performance if hospice cases were treated as survivors rather than deaths. Differences between groups (hospice vs non-hospice deaths) were compared by nonparametric Wilcoxon rank-sum test for skewed distribution data. Odds ratios are presented with their 95% CI.

Results: Data were submitted by 167 centers on 126,259 injured patients. There were 8,862 deaths: 746 (8.4%) of who were discharged to hospice and the remainder captured as in-hospital deaths. Overall, 106 centers (63.5%) reported at least one discharge to hospice care. Across centers, the proportion of deaths recorded as discharged to hospice ranged from zero to 57%. By univariate analysis, hospice patients were older (77.1±16.2 vs 55.9±23.6 years), had lower ISS (19.2±8.4 vs 28.3±13.2) and a lower head AIS (3.1±1.9 vs 3.3±2.1) than patients recorded as in-hospital deaths for centers with hospice deaths. After controlling for age, gender, race, payment status, and comorbidities logistic regression demonstrated that age>70 (OR 4.3, CI 3.5-5.1), male gender (OR 0.7, (CI 0.6-0.8), non-black race (OR 1.9, CI 1.3-2.7), non-commercial insurance (OR 1.4, CI 1.1-1.7) and and co-morbidity >2 (OR 1.3, CI 1.1-1.6) were associated with hospice care. If patients transferred to hospice care were treated as survivors in the estimation of risk adjusted mortality, 30 centers (18%) would have a change in their status (Table, ^ = changed to). Changes would be in both directions for average performing centers, while high performing centers would appear worse and poor performing centers would appear better. For centers that reported hospice deaths, the risk adjusted mortality decreased by 9.3% for every 10% increase in the proportion of deaths recorded as discharged to hospice.

Mortality including in-hospital and hospice deaths				
Mortality (in-hospital)	^ high	^ average	^low	N
High	14	7	0	21
Average	9	107	7	123
Low	0	7	16	23

Conclusion: Public reporting of risk adjusted mortality is appropriately increasing. Given the large variation in proportion of deaths recorded as “discharged to hospice” rather than an in-hospital death, there is the potential for significant distortion of actual performance. Failure to consider this potential will also misguide efforts directing performance improvement activities. Discharges to hospice should be aggregated with in-hospital deaths when reporting risk-adjusted mortality.

Benchmarking Trauma Centers on Mortality Alone Does not reflect Quality of Care: Implications for P4P.

Zain G. Hashmi MBBS, Eric B. Schneider Ph.D., Renan Castillo Ph.D., Elliott R. Haut* MD, Syed N. Zafar MD,MPH, Edward E. Cornwell* III, MD, Ellen MacKenzie Ph.D., Asad Latif MD,MPH, Adil H. Haider* MD,MPH, Johns Hopkins School of Medicine

Invited Discussant: Robert Winchell, MD

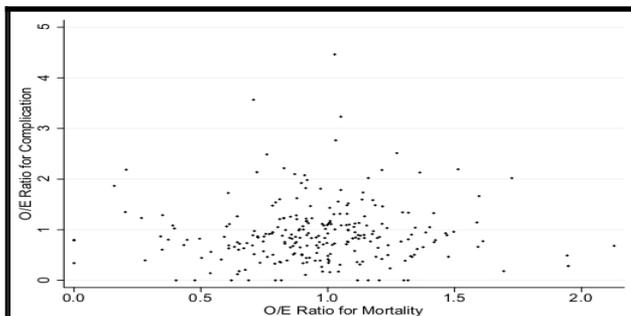
Introduction: Trauma centers are currently benchmarked on mortality outcomes alone. However, pay-for-performance (P4P) measures will allocate funding based on complications. Our objective was to determine if trauma centers were profiled on complications, would the results be similar to the current standard method of mortality based benchmarking.

Methods: Analysis of National Trauma Data Bank 2007-2010. Patients ≥ 16 years, with blunt/penetrating injuries and an Injury Severity Score ≥ 9 were included. Risk adjusted observed-to-expected (O/E) mortality ratios for each center were generated and used to rank each facility as: high, average or low performing. We similarly ranked facilities on O/E morbidity ratios (defined as occurrence of any one of the following complications: pneumonia, deep venous thrombosis, acute respiratory distress syndrome, sepsis, pulmonary embolism, decubitus ulcer, surgical site infection, myocardial infarction, cardiac arrest, unplanned intubation or stroke). Concordance between hospital performance rankings was evaluated using a weighted kappa statistic. Correlation between morbidity and mortality-based O/E ratios were assessed using Pearson's R. Multiple sensitivity analyses were performed to ensure that the competing risk of death did not bias the morbidity analyses.

Results: A total of 449,743 patients from 248 facilities were analyzed. The unadjusted morbidity and mortality rates were 10.0% and 6.9%, respectively. Only 40% centers had similar performance rankings for both mortality and morbidity. Of the 114 high performers for mortality, only 66 were also high performers for morbidity (11 were ranked as average on both and 19 were low performers on both mortality and morbidity rankings). Comparison of hospital performance status using mortality and morbidity outcomes demonstrated poor concordance (weighted kappa=0.03, p=0.30). Additionally, no correlation was found between morbidity and mortality-based O/E ratios ($r=0.03$, $p=0.60$).

Conclusions: Mortality-based external benchmarking does not identify centers with high complication rates. This creates a dichotomy between current trauma center profiling standards and measures used for P4P. A benchmarking mechanism that reflects all measures of quality is needed.

Figure 1. Scatterplot comparing hospital rankings on mortality/morbidity.



EPIDEMIOLOGY AND RISK FACTORS OF MULTIPLE ORGAN FAILURE (MOF) AFTER MULTIPLE TRAUMA: AN ANALYSIS OF 31154 PATIENTS FROM THE TRAUMA REGISTRY OF THE GERMAN TRAUMA SOCIETY

Matthias N. Fröhlich MD, Marco M. Schneider MD, Rolf Lefering Ph.D., Christian Probst MD, Thomas Paffrath MD, Bertil Bouillon* MD, Arasch Wafaisade MD, Department Of Trauma And Orthopedic Surgery , University Of Witten-Herdecke, Cologne-Merheim Medical Center

Invited Discussant: Joseph Cuschieri, MD

Introduction: In severely injured, who survive the early posttraumatic phase, multiple organ failure is considered as the main cause for morbidity and mortality. Current literature describes an increasing incidence of MOF. A reliable prediction of MOF could have an influence on individual monitoring and therapy of severely injured patients. The objectives of this study were 1) to assess the potential changes in the incidence and outcome of MOF after multiple trauma in Germany between 2002 and 2011 and 2) to evaluate independent risk factors for posttraumatic MOF.

Methods: We conducted a retrospective analysis of a nationwide prospective database, the Trauma Registry of the German Society for Trauma Surgery. Patients registered in the Trauma Registry between 2002 and 2011 with complete data sets were analyzed, who presented with a relevant trauma load (Injury Severity Score of ≥ 16) and were admitted to an intensive care unit.

Results: In total, 10201 out of 31154 trauma patients (32.7%) developed a MOF. Patients had a mean age of $45 (\pm 21)$ years, were predominantly male (73%) and had a mean ISS of 28 ± 12 . During the study period mortality of all patients decreased from 18.1% in 2002 to 15.3% in 2011 ($p < 0.001$). Meanwhile MOF occurred significantly more often (24.6% in 2002 vs. 31.5% in 2011; $p < 0.001$). In patients with MOF, mortality decreased over the study period (42.6% vs. 33.3%; $p < 0.001$). Patients who died following a MOF survived two days shorter than non-MOF patients (11 days in 2002 vs. 8.9 days in 2011; $p < 0.001$). Independent risk factors for the development of MOF following severe trauma were: age, ISS, AIS Head ≥ 3 , AIS thorax ≥ 3 , male gender, GCS ≤ 8 , mass transfusion, base excess < -3 , systolic blood pressure < 90 mmHg at admission and coagulopathy.

Conclusion: Over a study period of 10 years an ongoing decrease of mortality after multiple trauma was observed. Concordantly mortality decreased in patients with MOF. However, incidence of MOF in severely injured increased significantly. Therefore, MOF after multiple trauma remains a challenge in critical care. The prediction model from the multivariate analysis could help recognizing the early development of a MOF and preventing fulminant courses in clinical treatment. Furthermore a reliable prediction model is helpful for patient enrolment in trauma studies, in which MOF marks the primary endpoint.

GUIDING THE MANAGEMENT OF INTUBATED PATIENTS WITH PNEUMONIA AND VENTILATOR ASSOCIATED EVENTS USING SERIAL CATHETER-DIRECTED BRONCHO-ALVEOLAR LAVAGE.

Colleen M. Stoeppel MD, Evert A. Eriksson MD, Rafael Diaz-Flores MD, MPH, Pamela Coffie Pharm. D., Jojo Koshy Pharm. D., Cory Kacir Pharm. D., Kenneth Hawkins RRT, Joseph Minei* MD, Christian Minshall* MD, Ph.D., University of Texas Southwestern Medical Center at Dallas

Invited Discussant: Karen Brasel, MD, MPH

Introduction: This is the 6-month analysis of a quality initiative project evaluating the role of serial catheter-directed broncho-alveolar lavage (CDBAL) in the diagnosis and management of pneumonia in ventilated surgical intensive care unit (SICU) patients.

Methods: All intubated patients in the SICU were prospectively evaluated with serial CDBALs from 9/1/12 to 2/27/13 (57% Trauma, 22% Surgery, 19% Neurosurgery and 2% Burn). The initial screening CDBAL was performed 36 to 48 hours after time of intubation. Subsequent CDBALs were performed every four days after the screening-BAL or if the patient developed clinical signs of infection. Pneumonia was diagnosed using clinical pneumonia infection score > 6 and the presence of $> 5 \times 10^4$ colony forming units of pathogenic organisms in the BAL culture. Patients were also evaluated for sustained (>48 hrs) respiratory deterioration requiring increased FiO_2 or PEEP corresponding to the National Health Safety Network (NHSN) definition of ventilator associated event (VAE).

Results: 100 patients underwent screening CDBAL. 41 patients had multiple CDBALs performed per the protocol. 26 patients were diagnosed with pneumonia, and 11 of these patients also met NHSN criteria for VAE. All patients that had sustained respiratory deterioration had a resolution of hypoxia an average of 51 hours after starting antibiotics. 19 of the patients with pneumonia demonstrated no growth of pathogenic bacteria in subsequent CDBAL cultures an average of 4.8 ± 1.2 days after initiation of antibiotics. The duration of antibiotic therapy averaged 9.5 ± 3.6 days in this group, and none of the patients in this group had recurrence of their pneumonia. The remaining 7 patients with pneumonia had repeat positive culture results from the serial CDBALs that were performed while they were undergoing antibiotic therapy. The average duration of treatment in this group was 21.6 ± 7 days. The antibiotic sensitivity data from the serial CDBAL cultures were used to adjust the antibiotic regimen in these patients a median 3 (2, 6) times during treatment.

Conclusion: Serial CDBAL may be a useful tool to guide the duration of antibiotic therapy in patients with pneumonia and VAE. Patients with sustained hypoxia or persistent bacterial growth may require prolonged therapy. Further studies will determine whether patients with improved oxygenation and no growth in CDBAL cultures may be candidates for early elimination of antibiotic therapy.

PROGNOSTIC ABILITY OF A NOVEL QUANTITATIVE PCR METHOD FOR ANALYZING BRONCHOALVEOLAR LAVAGE SAMPLES IN VENTILATED TRAUMA PATIENTS

Alessandro Orlando MPH, Gregory W. Thomas BS, David Bar-Or MD, Swedish Medical Center

Invited Discussant: Michael West, MD, PhD

Introduction: Standard quantitative culture techniques offer results within 2-3 days, precluding targeted and timely antibiotic therapy in ventilated trauma patients. Our real-time quantitative polymerase chain reaction (qPCR) method can detect 25 different bacteria and fungi, gram characteristics and resistance factors, and offers results in as little as 1.5 hours. Our qPCR test has undergone many refinements since its creation, and its 90 primer combinations have been finalized for initial prognostic testing. The objective of this study was to compare the qPCR method to standard quantitative culture techniques.

Methods: This was an observational cohort-study at a Level I Trauma Center from 2009 to 2012. Consecutively-admitted adult trauma patients who were ventilated, had at least one bronchoalveolar lavage (BAL) sample, and quantitative or semi-quantitative culture results were eligible for inclusion. We examined 18 randomly-chosen BAL samples for preliminary prognostic testing. DNA was isolated from the BAL samples and analyzed in 96-well plates using qPCR primers designed to amplify 90 different bacterial, fungal and resistance sequences. Culture findings were obtained from the hospital's microbiology laboratory electronic medical record system. Student's t-tests were used to examine differences in mean qPCR cycle counts, and the qPCR sensitivity was analyzed at both the genus and species level of identification.

Results: The qPCR method detected a total of 104 organisms in the 18 BAL samples, whereas quantitative culture only found 29. At the genus level of identification, the qPCR had an overall sensitivity of 76%; 70% at the species level. When examining sensitivity by individual genera, *Staphylococcus* and *Streptococcus* had the highest sensitivities (92% and 83%). The 7 organisms missed by qPCR at the genus level were *Candida* (n=4), *Pseudomonas* (n=1), *Staphylococcus* (n=1) and *Streptococcus* (n=1). The qPCR method detected 82 organisms that were not detected through quantitative cultures, including various *pneumoniae* and *pneumophila* species. When examining differences in cycle counts between qPCR and quantitative culture methods, we found that those organisms that were only identified through qPCR had significantly less DNA than those identified through both methods (mean cycle count, 28.7 vs. 23.9, $p < 0.001$).

Conclusion: Our qPCR method has shown promising initial prognostic results. In an initial sample of 18 BALs, it was able to correctly identify over 75% of the bacteria cultured through the microbiology laboratory, and achieved higher sensitivities for the most common culprits of pneumonia. Many of the organisms not identified by quantitative culture had large cycle counts, suggesting that the amount of DNA (i.e. number of cells) might have been too low to result in culture identification. This study has provided us with the data necessary to further refine our primer sets. The genus-specific *Candida* primer might require modification because we were not able to detect the 4 *Candida* organisms that were grown through quantitative culture methods; this might also suggest that our institution has a unique *Candida* sequence, different from the standard *Candida* primer. Once refined, our qPCR method has the potential to identify ventilator-associated pneumonia faster and earlier than standard quantitative culture methods, allowing for targeted antibiotic therapy within 1-2 hours.

ENDOVASCULAR SKILLS FOR TRAUMA AND RESUSCITATIVE SURGERY (ESTARS™) COURSE: CURRICULUM DEVELOPMENT, CONTENT VALIDATION AND PROGRAM ASSESSMENT

Carole Y. Villamaria MD, Jonathan L. Eliason* MD, Brent Stansfield Ph.D., Jerry R. Spencer BS, Todd E. Rasmussen* MD, United States Air Force, 59th Medical Deployment Wing

Invited Discussant: Steven Shackford, MD

Introduction: Early definitive treatment of noncompressible torso hemorrhage (NCTH) has potential to significantly improve outcome in civilian and military trauma. Management of NCTH requires early hemostasis and definitive hemorrhage control. A potential adjunct to hemostatic resuscitation in early hemorrhage control is the use of endovascular skills involving resuscitative endovascular balloon occlusion of the aorta (REBOA). ESTARS™ course was developed with the primary goal of providing fundamental endovascular training for trauma surgeons.

Methods: A team of experts developed the content for the ESTARS™ 2-day course, incorporating pre and post-test exams, modular lectures, hands-on endovascular and open vascular instruments exposure, Vascular Intervention System Trainer (VIST) endovascular simulator, and live animal labs for training and testing. Course training was conducted by the same individuals using the same techniques (lecture, discussion, simulation, live animal lab). The curriculum included endovascular techniques for trauma, review of wires, sheaths, catheters, and specific regional vascular injury management (cervical, abdominal, aortic, pelvis, extremity). Live animal labs integrated femoral access, diagnostic aortography, selective angiography, coil embolization, REBOA, control of standardized iliac arterial injury, proximal/distal arterial control, and shunt placement. Participants completed a knowledge test (pre and post-course) and a summative skills assessment. The knowledge test measured participants' knowledge and management of vascular injury defined in the course learning objectives and didactics. Final exams used VIST simulator and live animal lab with standardized injury and resultant hemorrhagic shock. Subjective performance was graded by expert observers utilizing a structured global assessment scale and VIST performance metrics.

Results: Four pilot ESTARS™ courses were completed; 4 participants per course. Participant knowledge and performance significantly improved after ESTARS™, measured by pre/post-test, VIST exam, and animal lab exam. Mean test scores rose from 75.3% to 85.4% after training. All participants significantly improved in performance (10% mean change, $t(7) = 5.39$, $p = 0.001$). The test was unidimensional (Cronbach's = 0.74) and showed no ceiling effect; this suggests the total test score is a reliable and useful measure of participant knowledge. Performer technical skill significantly improved for both endovascular simulation and live animal lab exams. VIST simulator skills assessment included a standardized set of procedures; participants spent a mean of 15:52 min on the task which consisted of recording 4 cine loops. Procedure times ranged from 11:06 to 25:07 min. All participants passed the live animal practical examination.

Conclusions: ESTARS™ course provides optimal endovascular training for trauma utilizing both endovascular simulator training and live animal practicals with standardized injury and ensuing hemorrhagic shock. ESTARS™ was confirmed as a stepwise and hierarchical training curriculum. This course demonstrated measurable improvements in key performance metrics in trauma endovascular techniques for early definitive treatment of NCTH, and should serve as a model for future competency-based structured training in endovascular trauma skills.

IS ROUTINE REPEAT BRAIN CT SCAN NECESSARY IN ALL CHILDREN WITH MILD TRAUMATIC BRAIN INJURY?

Jarett K. Howe MD, Colleen M. Fitzpatrick MD, Lt. Col., USAF, Dana R. LaKam MD, Ana Gleisner MD, Ph.D., Cardinal Glennon Children's Medical Center

Invited Discussant: Denis Bensard, MD

Introduction: The use of CT for the evaluation of pediatric head trauma is common and valuable. Recent evidence suggests up to 1 in 1200 of children undergoing CT will die of a malignancy secondary to radiation exposure from their scans. Guidelines for radiation reduction in children are being developed to minimize exposure in this population. Presently, there is no accepted protocol for surveillance in children with traumatic brain injury (TBI) where repeat CT (rCT) is often performed. We hypothesized that rCT could be avoided in many children with TBI when careful clinical examination was performed. The objective of this study was to evaluate the utility of rCT by comparing the outcomes of similar patients who had a routine rCT with patients followed by clinical exam alone.

Methods: A retrospective cohort review was performed of patients admitted to a level one tertiary pediatric trauma center between July 2004 and July 2012 with a TBI, meeting the inclusion criteria of having both CT evidence of an intracranial hemorrhage (ICH) and a GCS of 14-15. Children were separated into two groups, those who underwent rCT (rCT+) and those who did not (rCT-). Data collected included age, injury severity score (ISS), mechanism of injury (MOI), and type of ICH, and clinical outcome. Patients with coagulopathies, ventriculo-peritoneal shunts, developmental disabilities, concomitant injuries or medical problems resulting in intubation or sedation not attributed to the neurologic insult were excluded.

Results: Of 435 patients admitted with accidental TBI, 120 were included in the study. 106 patients were rCT+, and 14 rCT-. rCT+ children were older (mean age 98.7 ± 7.3 vs 35.3 ± 11.5 months, $p=0.0025$) and more likely to have an epidural hematoma (EDH) (100% rCT with EDH vs 76% rCT all other ICH, $p=0.044$) as the initial CT finding. Mechanism of injury (assault, fall, sports related, motor vehicle collision, motorcycle collision, and auto vs pedestrian, $p=0.557$) and mean ISS (15.2 ± 0.6 vs 13.0 ± 1.1 , $p=0.195$) were not significantly different between the groups. There were no worsening neurological symptoms or need for surgery in rCT- children. rCT identified 7 patients (6.6%) with CT progression of their injury. Five of these had an EDH and 2 a sub arachnoid hemorrhage. Two children underwent operation, both with EDH. Only one child demonstrated a change (decrease) in their physical examination (one of the children with EDH undergoing surgery).

Conclusion: Our study indicates that routine rCT without evidence of clinical deterioration is not indicated in children with an admission GCS of 14-15 and documented ICH on CT scan. Children with EDH appear to have a higher potential for progression of their lesion and rCT appears to be indicated in this sub group.

INHIBITION OF SEPSIS-INDUCED INFLAMMATORY RESPONSE BY BETA1-ADRENERGIC ANTAGONISTS

Irada Ibrahim-zada MD,Ph.D., Christopher T. Gomez BS, Peter Rhee* MD,MPH,
Randall Friese* MD, University of Arizona - Tucson

Invited Discussant: Philip Barie, MD, MBA

Introduction: The use of β 1-selective adrenergic antagonists (β 1AA) in the setting of a pro-inflammatory state is controversial. We have previously described increased survival with β 1AA treatment in an animal model of sepsis. The aim of this study was to examine the signaling pathways associated with β 1AA treatment in septic animals.

Methods: 8-12 week C57BL/6 mice received intra-peritoneal injection of 12.5mg/kg lipopolysaccharide (LPS). Intravenous pumps (Alzet, Cupertino, CA) continuously delivered β 1AA (esmolol; 6.7 μ g/kg/min) or equal volume of saline (control). A total of six animals were sacrificed at 48 hours after LPS to obtain whole blood for microarray analysis (3/group). Molecular profiling was performed on mRNA with Affymetrix Mouse Gene 1.0ST array and analyzed using ANOVA. Genes with at least 1.3-fold change in expression were included for Ingenuity pathway analysis (IPA) to identify signaling pathways associated with β 1AA treatment. Top candidate genes were analyzed *in silico* based on Transfac sequences to identify common functional motifs. Additionally, the GEO database (GSE28750) was queried on 41 patient samples assayed using Human U133 Plus 2.0 Affymetrix GeneChips to compare the expression of our candidate genes between septic patients and healthy volunteers. Gene expression was compared by independent samples t-test. P value <0.05 were accepted as significant.

Results: Microarray expression analysis of mouse blood identified 348 genes differentially expressed between groups. IPA identified immunological disease as well as cell death and survival as the top gene networks significantly associated with improved survival in septic mice treated with esmolol ($p=0.0001-0.036$). The *CAMP* (-2.9), *TNFSF10* (-2.4), *LY6I* (-2.4), *IL18BP* (-1.7), *EDA2R* (-1.7) and *BCL2L14* (-1.7) were among the top 15 genes down-regulated in the esmolol group. Transfac analysis of the gene structure revealed that eight genes shared common promoter activating sequence for NF κ B and/or BRCA1 motifs. There was no change in expression of β 1-adrenoreceptor (*ADRB1*) gene in animals treated with esmolol. Analysis of GEO samples identified down-regulation of *CAMP* ($p=0.032$) and *TNFSF10* ($p=0.001$) genes in septic patients compared to healthy controls.

Gene	Chromosome	p-value	Fold change	Common Motifs
CAMP	3	0.0124	-2.9	NF κ B
TNFSF10	3	0.0099	-2.4	NF κ B/BRCA1
LY6I	15	0.0059	-2.4	BRCA1
TINAGL1	1	0.0361	-2.1	NF κ B/BRCA1
ZBP1	1	0.0360	-1.9	BRCA1
GPR31B	17	0.0295	-1.9	NF κ B
IRGM2	11	0.0126	-1.8	NF κ B/BRCA1
EDA2R	X	0.0362	-1.7	NF κ B/BRCA1
BCL2L14	6	0.0139	-1.7	None
IL18BP	7	0.0420	-1.7	None

Conclusion: Immunomodulation may be a major mechanism of the survival benefit observed with β 1AA treatment in sepsis. β 1AA treatment may lead to normalization of the *TNFSF10* and *CAMP* genes up-regulated by sepsis. Down-regulation of these genes may be explained by activation of NF κ B and BRCA1 which are involved in the immune response and cell repair pathways. Further studies using knock-out models are warranted to investigate downstream inflammation and apoptotic pathways.

PROSPECTIVE EVALUATION OF INTRAVASCULAR VOLUME STATUS IN CRITICALLY ILL PATIENTS: DOES IVC COLLAPSIBILITY CORRELATE WITH CVP?

Stanislaw P. Stawicki MD, Eric J. Adkins MD, Naeem A. Ali MD, Chinedu Njoku Ph.D.,RN, David C. Evans MD, David E. Lindsey* MD, Charles H. Cook* MD, Daniel S. Eiferman MD, Jayaraj M. Balakrishnan MD, Sebastian Valiyaveedan MD, Sagar Galwankar MD,MPH, Creagh T. Boulger MD, Andrew Springer MD, David P. Bahner MD, RDMS The Ohio State University College Of Medicine

Invited Discussant: Jay Doucet, MD

Introduction: Intravascular fluid status assessment continues to pose a challenge in the intensive care unit (ICU). We performed a prospective study comparing the sonographic inferior vena cava collapsibility index (IVC-CI) and the traditional central venous pressure (CVP). Our primary goal was to determine the behavior of quantized CVP across commonly employed IVC-CI ranges in a large set of measurement pairs.

Methods: A prospective, multinational, observational study was performed in a sample of surgical and medical ICU patients between Oct 2009-Feb 2013. Study participants underwent scheduled, repeated sonographic evaluations of IVC-CI. Demographics, illness severity, ventilatory support status and vital signs were collected. Correlations were made between CVP ranges (<7, 7-12, 12-18, 19+) and IVC-CI ranges (<25, 25-49, 50-74, 75+). Quantized comparison of CVP (2-unit quanta) and IVC-CI (5-unit quanta) was made. Finally, we examined patterns of IVC-CI behavior with unitary CVP changes (Δ IVC-CI/ Δ CVP). Of note, IVC-CI was measured using standard sonographic windows and was defined as $[(IVC_{max}-IVC_{min})/IVC_{max}] \times 100\%$.

Results: Fifty-nine patients with CVP/IVC-CI measurement pairs were included (mean age 55.6 ± 17.8 , 23 women and 36 men. Mean APACHE II 11.2 ± 6.52). We analyzed 226 IVC-CI/CVP measurement pairs (mean, 3.8/patient). 83% of measurements were collected in ventilated patients. Results (**Figure 1A**, left) show that high collapsibility was associated with low CVP (<7). Specifically, CVP <7 was noted in <10% of patients with IVC-CI <25% while >80% of patients in the highest collapsibility ($\geq 75\%$) group had CVP <7. **Figure 1B** (right) shows the behavior of 5-unit IVC-CI quanta versus 2-unit CVP quanta. The mean Δ IVC-CI per unit CVP was 4.86 ± 4.84 (median 3.13) percent collapsibility.

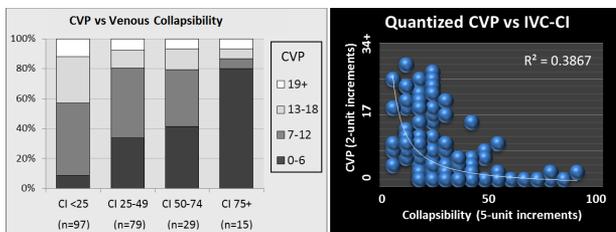


Figure 1. (A, left) Vertical bar show the proportion of patients within given CVP ranges grouped by the collapsibility index (horizontal axis); (B, right) Relationship between quantized (2-unit) CVP measurements versus quantized (5-unit) IVC-CI measurements.

Conclusion: We observed an inverse relationship between IVC-CI and CVP, with each unit of CVP corresponding to a median difference of 3.1% venous collapsibility. Our data support the contention that low collapsibility is consistent with either euvoemia or hypervolemia while high collapsibility suggests intravascular volume depletion. The behavior of the relationship between IVC-CI and CVP across the middle ranges is likely reflective of the role of the vena cava as a capacitance vessel, meant to “preserve” venous return across a broad variety of hemodynamic conditions.

A COMPARISON OF THE INJURY SEVERITY SCORE AND THE TRAUMA MORTALITY PREDICTION MODEL: SHALL THE ISS GO GENTLE INTO THAT GOOD NIGHT?

Alan Cook MD, Jo Weddle MD, Turner Osler* MD, MSc (Biostatistics), Laurent Glance MD, David Hosmer Ph.D., Susan Baker MPH, Baylor University Medical Center

Invited Discussant: Howard Champion, FRCS

Introduction: Performance benchmarking requires accurate injury severity measurement. Despite known shortcomings, the ISS has remained the industry standard for 40 years. TPM uses AIS or ICD-9 lexicons and may capture injury severity better than ISS. We compared TPM to ISS and other popular injury severity measures.

Methods: We used years 2009 and 2010 of the NTDB and extracted 337,359 patient records from 146 centers with injuries reliably described in both AIS and ICD-9 lexicons. Five measures (ISS, Max AIS, NISS, ICISS, TPM) were computed using either AIS or ICD-9 codes. The models were compared using statistical measures of performance (ROC, AIC, Brier score) as well as calibration plots. The 95% CIs were based on 1,000 bootstrapped models.

Results:

	Area Under ROC Curve		Akaike Information Criterion		Brier Mean Probability Score	
	Median	95% CI	Mean	95% CI	Median	95% CI
AIS						
ISS	0.85	(0.848 - 0.853)	82107	(81270 - 83046)	0.031	(0.03 - 0.031)
Maximum AIS	0.85	(0.852 - 0.857)	75992	(75055 - 76873)	0.028	(0.028 - 0.029)
NISS	0.86	(0.853 - 0.859)	75352	(74475 - 76292)	0.028	(0.027 - 0.028)
TPM for AIS	0.89	(0.886 - 0.891)	68174	(67303 - 68965)	0.025	(0.025 - 0.026)
ICD-9						
ISS for ICD-9	0.83	(0.828 - 0.833)	88545	(87718 - 89352)	0.033	(0.032 - 0.033)
NISS for ICD-9	0.83	(0.830 - 0.837)	78048	(76918 - 79286)	0.028	(0.028 - 0.029)
ICISS	0.84	(0.835 - 0.841)	75784	(74743 - 76653)	0.026	(0.026 - 0.027)
TPM for ICD-9	0.87	(0.869 - 0.874)	75580	(74690 - 76295)	0.029	(0.028 - 0.029)

Conclusion: NISS proved superior to the ISS in both lexicons, and is far simpler to compute. NISS should replace ISS for a quick estimate of injury severity. TPM demonstrated superior mortality prediction compared to the ISS and other popular models using AIS or ICD-9 lexicons. The non-monotonic nature of ISS may undermine its performance. AIS captures injury severity more reliably than the ICD-9 lexicon. Regardless of lexicon, TPM provides significantly better outcome prediction than any other model.

IMPLEMENTATION OF CLOUD-BASED IMAGE SHARING TECHNOLOGY SIGNIFICANTLY REDUCED REPEAT CT IMAGING IN A REGIONAL TRAUMA SYSTEM

Aman Banerjee MD, David Bronson MD, Deborah Allen RN, Patricia Wilczewski RN, Robert Ferguson MD, Jeffrey A. Claridge* MD, MS MetroHealth Medical Center - Cleveland

Invited Discussant: Reuven Rabinovici, MD

Introduction: The practice of repeating computed tomography (re-CT) is common among trauma patients transferred between hospitals incurring additional cost and radiation exposure. This study sought to evaluate the effectiveness of implementing modern cloud-based technology (lifeIMAGE®) across a regional trauma system to reduce the incidence of re-CT imaging.

Methods: This is a prospective interventional study to evaluate outcomes after implementation of lifeIMAGE® in January 2012. Key outcomes were rates of CT imaging, including the rates and costs of re-CT from January 2009 through December 2012.

Results: There were 1082 trauma patients transferred from participating hospitals during the study period (657 patients before and 425 patients after implementation) with the overall re-CT rate of 20.5%. Rates of any CT imaging at referring hospitals decreased (62% vs. 55%, $p < 0.05$) and also decreased at the accepting regional level 1 center (58% vs. 52%, $p < 0.05$) following system implementation. There were 639 (59%) patients who had CT imaging performed prior to transfer (404 patients before and 235 patients after implementation). Of these patients the overall re-CT rate decreased from 38.4% to 28.1% ($p = 0.01$). Rates of re-CT head (21% vs. 11%, $p < 0.001$), chest (7% vs. 3%, $p = 0.05$), and abdomen and pelvis (12% vs. 5%, $p < 0.001$) were significantly reduced following system implementation. The cost of repeat imaging per patient was significantly lower following system implementation (mean charges of \$1,046 vs. \$589, $p < 0.001$). These results were more pronounced in a subgroup of patients with an ISS > 14 with a reduction in overall re-CT from 51% to 30% ($p = 0.03$).

Conclusion: The implementation of modern cloud-based technology across the regional trauma system resulted in significant reductions in re-CT imaging and cost.

UNREGULATED PROLIFERATION OF TRAUMA CENTERS UNDERMINES COST EFFICIENCY OF POPULATION BASED INJURY CONTROL

Joseph J. J. Tepas, III* MD, Andrew J. Kerwin* MD, Jin H. Ra MD, University of Florida, Jacksonville

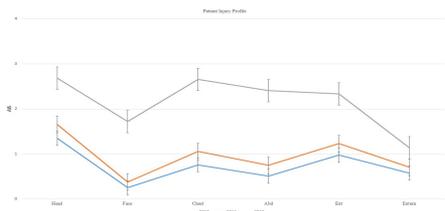
Invited Discussant: Michael Rotondo, MD

When creating your abstract, the only section headers to be used in the abstract and they need to be in this format:

Introduction: Our State trauma system includes Level I (L1) and II(L2) centers for adult care. Both levels require the same commitment of resources and clinical personnel. We evaluated the impact on coverage and regional cost of trauma care produced by activation of a LII center with no preceding needs analysis in an established trauma region with a LI center.

Methods: Patient de-identified trauma registry data for years 2010, 2011, and 2012 were analyzed to assess the effect on trauma service volume over a period at the midpoint of which the LII center was activated. Trends for each year were evaluated by patient volume, mechanism, resource utilization as reflected in transfer to ICU and ICU stay, patient severity as defined by ISS, and patient injury profile determined by mean body region AIS.

Results: Between 2010 and 2011, during which the L2 opened, overall volume at the LI



center dropped 3.7% and blunt volume remained unchanged. From 2011 to 2012 overall LI volume dropped 9.4%, and blunt injury fell by 14%. Proportions requiring immediate OR or ICU care did not change. ISS distribution at the LI center across the years was similar,

however injury severity as indicated by proportion requiring >4 days of ICU significantly increased from 42%, 2011, to 77%, 2012 (Chi Square $p < .0001$). Injury severity increased occurred across all body regions (figure). For 2012 the new center publically reported treating 1100 patients.

Conclusion: Addition of a second trauma center in a stable region in which injury incidence was actually decreasing, doubled the cost of the most expensive component of the trauma system. These added systems costs were incurred while changing coverage for <10% of patients and adding access for the equivalent of another 20%. As evidenced by the significant increase in severely injured patients requiring >4 days of ICU care, the net effect of this was selection of less severe injury away from the established LI center, thereby concentrating its exposure to the most complex and costly components of injury care. Trauma system expansion must be based on needs assessment which assures system survival and controls societal cost.

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EVIDENCE-BASED PROTOCOL FOR PROPHYLACTIC ANTIBIOTICS IN OPEN FRACTURES: IMPROVED ANTIBIOTIC STEWARDSHIP WITH NO INCREASE IN INFECTION RATES

Lauren Rodriguez BA, Hee Soo Jung MD, James A. Goulet MD, Lena M. Napolitano* MD, University of Michigan

Invited Discussant: Hans-Christoph Pape, MD

Introduction: Evidence-based guidelines for prophylactic antibiotic use in open fractures recommend short-course, narrow spectrum antibiotics for Gustilo Grade I or II open fractures and broader gram-negative coverage for Grade III open fractures. There is concern that narrow spectrum activity and decreased duration of antimicrobial prophylaxis could result in higher rates of skin and soft tissue infection after open fracture. No studies to date have assessed the impact of these guidelines on infection rates in open fractures. Infection rates before and after new protocol implementation were examined.

Methods: A new open fracture protocol was implemented; including antibiotic prophylaxis based on Gustilo Grade of open fracture, early orthopedic consultation, standardized wound inspection and dressing application to limit exposure/contamination, and tetanus prophylaxis. By protocol, Grade I and II fractures were to receive cefazolin for 48 hours or clindamycin if there was an allergy. Grade III fractures were to receive ceftriaxone for 48 hours or clindamycin and aztreonam if there was an allergy. Aminoglycosides, vancomycin, and penicillin were removed from the algorithm. Data for 174 femur and tibia/fibula open fractures (101 pre-protocol and 73 post-protocol) were retrospectively collected and analyzed. Patients who were moribund or were managed at another institution for greater than 24 hours were excluded. The National Healthcare Safety Network (NHSN) risk index was used to provide risk adjustment of surgical site infections rates. The NHSN risk index is comprised of 3 variables: ASA score (3, 4, or 5), wound classification (contaminated, dirty), and procedure duration in minutes (>75th percentile). Each factor represents 1 point with a risk index range of 0 (low risk) to 3 (high risk).

Results: No significant differences in the study cohorts (pre- and post-protocol) were identified for demographics (age: 37.2 ± 14.8 vs 40.0 ± 17.9 ; male: 71.3% vs 79.5%), mechanism of injury (MVC: 67.3% vs 64.4%; other blunt: 28.7% vs 32.9%; penetrating: 4.0% vs 2.8%), or disposition (home: 46.0% vs 45.2%, care facility: 49.5% vs 50.7%, transfer: 2.0% vs 1.4%, death: 2.0% vs 2.7%). After protocol implementation, the use of aminoglycoside and glycopeptide antibiotics was significantly reduced (53.5% vs 16.4%, $p=0.0001$). The skin and soft tissue infection rate per fracture event was 20.8% pre- and 24.7% post-protocol ($p=0.58$). There was no statistically significant change after stratification for fracture grade (I: 29.4% vs 6.7%, $p=0.18$; II: 8% vs 20%, $p=0.38$; III: 29.7% vs 40%, $p=0.56$; no category: 13.6% vs 27.8%, $p=0.43$), NHSN Risk Index (0: 0% vs 0%, $p=n/a$; 1: 0% vs 0%, $p=1$; 2: 13.3% vs 28.2%, $p=0.07$; 3: 21.7% vs 11.8%, $p=0.68$, not scored: 47.1% vs 35.7%, $p=0.72$), or fracture site (tibia/fibula: 22.0% vs 25%, $p=0.68$, femur: 15.8% vs 23.8%, $p=0.70$). The rate per fracture event of resistant gram-positive and gram-negative organisms (defined by culture and antibiotic use) was not different (15.8% vs 17.8%, $p=0.84$). The MRSA rate per fracture event was also not different (2.0% vs 4.1%, $p=0.65$).

Conclusion: Implementation of an evidence-based protocol (short course of narrow spectrum antibiotics, excluding glycopeptides and aminoglycosides) for open fractures antibiotic prophylaxis resulted in significantly decreased use of aminoglycoside and glycopeptide antibiotics with no increase in skin and soft tissue infection rates.

**POSITIVE EFFECTS OF A COMMUNITY PROGRAM AND LEVEL II
TRAUMA CENTER, ON DECREASING GANG WARFARE IN SOUTHERN
CALIFORNIA BEACH CITIES**

Thomas K. Duncan DO, Javier Romero* MD, Ventura County Medical Center

Invited Discussant: Edward Cornwell, MD

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Introduction: Creating a change in the mindset of youth/young adults re: perception towards gangs, in the aim to decrease homicides and assaults can be challenging.

Study design: A retrospective analysis of the gang related homicides and assaults in three cities in Ventura County, California was conducted. The study evaluated data pre- and post institution of a community outreach gang violence reduction program – Operation PeaceWorks, spanning a ten year period (2002 – 2012). The program targeted gang members from 12 – 24 years of age. It involves a collaboration of previous gang members dissuading gang activity, peace building between community and gang members, as well as call-in meetings which involve: representatives of an adult level II Trauma Center, Police Department, Parents of Murdered Children, District Attorney, Probation Agency, Clergy, and City Corps. Attendees of the meetings are mentored and counseled, so that they are placed in job training/civic responsibility program, and have the opportunity to further their education, or eventually secure a permanent job. The significance of change was tested by Chi Squared analysis.

Results: The average number of participants was 40 per month; while the total number of interactions was 3,430 meetings. There was a reduction in the number of serious gang assaults over a 4 year period by 24% ($p < .05$) and by 29% over a 10 year period ($p < .01$). There was also a reduction in the average number of gang related homicides by 70% per year over a 4 year period ($p < .01$), and 75% per year over a 10 year period ($p < .01$). The average reduction in total gang related assaults was 41%, and assaults involving firearms was 60%.

Conclusion: Institution of a community gang warfare reduction program was associated with a highly significant decrease in the number of injuries related to gang activity. We believe that Trauma Center participation was an essential component of the program's success.

DO SPEED CAMERAS IMPACT TRAUMA CENTERS?

Jeff J. Skubic MD, Steven Vanhoy Chengcheng Hu Ph.D., Steven B. Johnson* MD,
Chris K. Salvino* MD, Banner Good Samaritan Medical Center

Invited Discussant: Jack Sava, MD

Introduction: While studies, mostly from Europe and Australia, have examined the effect of speed cameras on motor vehicle collisions (MVC), little data exists regarding their impact on charges and number of patients taken to Level 1 trauma centers (LITCs). Because of conflicting perceptions and data on their value, speed cameras were implemented along select Arizona highways in 2008 but then removed in 2010. The hypotheses of our study were two-fold: 1) Speed cameras reduce admissions to LITCs and 2) Speed cameras reduce crash kinetic energy resulting in lower injury severity score (ISS), mortality, hospital costs and length of stay.

Methods: A retrospective review was performed of all patients admitted to LITCs that were injured in motor vehicle crashes along a 26 mile segment of interstate I-10 in urban and suburban Phoenix. Patients were identified using both the Arizona State Trauma Registry and the Arizona Department of Transportation collision data for 2009-2011. This specific 26 mile segment of I-10 was selected because it contained at least one speed camera within one mile along its entire length from October 2008 to October 2010. Two time frames were evaluated: January 1 – December 31, 2009 when cameras were in place (2009 cameras group) and January 1 – December 31, 2011 when no cameras were in place (2011 no cameras group). Variables analyzed included number of injured persons sent to the LITC, age, injury severity score (ISS), mortality, total hospital charges and hospital days. Mann-Whitney rank-sum and Fischer's exact test were used.

Results: The number of injured patients taken to Level 1 trauma centers increased significantly during the time frame after cameras were removed (20 vs 51, $p < 0.0001$). Similarly total hospital charges (1,173,184 vs 1,989,693, $p < 0.0001$) and total hospital days (47 vs 126, $p < 0.001$) were increased. There were no significant differences between the two time frames for age, ISS, mortality, mean charges per patient and mean length of stay per patient (See Table). In comparison, there was an overall 3% reduction in crashes in Arizona between 2009 and 2011.

	2009 (Cameras)	2011 (No Cameras)	Difference	p value
Admissions	20	51	31(+155%)	0.0001
ISS	5.5	4.5	1.0 (-18%)	NS
Age	31.8	35.6	3.8 (+12%)	NS
Mortality (%)	1 (5%)	1 (2%)	0	NS
Total Hosp Charges	\$1,173,184	\$1,989,693	\$816,509 (+70%)	<0.0001
Total Hosp Days	47	126	79 (+168%)	<0.0001
Mean Charges	\$58,659	\$39,014	\$19,645 (-33%)	NS
Mean LOS	2.35	2.46	0.11 (+5%)	NS

Conclusion: In this study, removal of speed cameras from a 26 mile segment of interstate resulted in a 155% increase in injured persons taken to LITC and a 70% increase in total hospital charges associated with a 168% increase in total hospital days. Speed cameras did not appear to impact severity of injuries. Based on this study, installing speed camera along the entire 47,000 miles of U.S. interstate highway might save nearly three billion dollars in hospital charges annually.

THE EFFECTIVENESS OF A STATEWIDE TRAUMA CALL CENTER IN REDUCING TIME TO DEFINITIVE CARE FOR SEVERELY INJURED PATIENTS

Austin Porter MPH, Deidre Wyrick MD, Stephen Bowman Ph.D., Jeff Tabor
NREMT-P/I Arkansas Department Of Health

Invited Discussant: Jeffrey Salomone, MD

Introduction: The State of Arkansas developed and implemented its trauma system in July 2010. The Arkansas Trauma Call Center (ATCC) was a critical component in the system and was designed to navigate trauma patients, from the scene of injury or in intra-facility transfer to the appropriate trauma center based on their needs. The ATCC began operations on January 3, 2011, and at that time was not uniformly utilized by transferring facilities. The first 18 months of operations were examined to evaluate the relationship between ATCC utilization and emergency department length of stay (ED LOS) at sending facilities for patients who require urgent care.

Methods: ATCC data were linked to the Arkansas Trauma Registry (ATR) using unique identifiers; linked records were determined to have used the call center. Patients with significant injury, requiring transfer from one hospital in the system to another were the cohort of the study. This cohort was then stratified by use of the call center. Patients with significant injury were defined as those with hypotension (SBP < 90 mm Hg) or Glasgow Coma Scale (GCS) < 9 at the sending facility or Injury Severity Score (ISS) \geq 16 at the definitive care facility. Patients under the age of 15 years of age were excluded from the analysis. patients who require urgent care.

Results: The study population who met the inclusion criteria was 834; 615 (74%) of which utilized the call center and 219 (26%) that did not utilize the call center to facilitate patient transfers. There were no statistically significant differences between the two groups (those that utilized the call center and those that did not) in terms of ISS, SBP, and GCS. The mean and median ED LOS at the sending facility for transfers in which the call center was utilized was 161 and 143 minutes compared to 181 and 160 minutes in which the call center was not utilized ($p=0.03$). The results of a linear regression model showed that call center utilization accounted for a 19 minute reduction in the ED LOS at the sending facility when controlling for age, SBP, GCS, ISS, and gender ($p=0.01$). The results of a t-test indicated that there were no statistically significant difference in the ED LOS at the sending facility for severely injured patients in which the call center was not utilized when compared to patients who were not severely injured but the call center was utilized ($p=0.6$).

Conclusion: In the first eighteen (18) months following inception, a state implemented centralized call center has been effective in expediting the transfer process, and thus reducing the time to definitive care for severely injured patients. Call center utilization has improved since inception and is now a contract deliverable for trauma hospitals based on these early results.

ENTERAL ALBUTEROL DECREASES THE NEED FOR CHRONOTROPIC AGENTS IN PATIENTS WITH CERVICAL SPINAL CORD INJURY (CSCI) INDUCED BRADYCARDIA

Charity H. Evans MD, Jeremiah J. DUBY PharmD, Andrew Berry PharmD, Carol R. Schermer* MD, Christine S. Cocanour* MD, University Of California, Davis Medical Center

Invited Discussant: Deborah Stein, MD, MPH

Introduction: Cervical spinal cord injury (CSCI) is often complicated by autonomic instability and life-threatening bradycardia requiring rescue treatment with chronotropic agents or pacemaker implantation. β -adrenergic receptors offer a potential target for modulating cardiac vagal activity and heart rate. Enteral albuterol may mitigate symptomatic bradycardia in CSCI patients. The purpose of this study is to examine the effect of enteral albuterol on the frequency of symptomatic bradycardia and the need for rescue therapy in CSCI patients.

Methods: The charts of CSCI patients admitted to a level I trauma center from Feb 2008 through Mar 2012 were reviewed for demographics, episodes of symptomatic bradycardia (defined as heart rate <60 and systolic blood pressure <90), use of enteral albuterol, hospital days requiring chronotropic use, and total atropine administered. In the Albuterol group, patients received scheduled enteral albuterol after experiencing symptomatic bradycardia, with chronotropic agents used as needed for rescue treatment. In the No Albuterol group, only chronotropic agents were used as needed for rescue treatment. The Albuterol and No Albuterol groups were compared using Independent-Samples Kruskal-Wallis test for total number of bradycardic episodes, hospital days requiring chronotropic use, and total atropine administered.

Results: 18 patients with CSCI-induced bradycardia were identified. Eight patients received treatment with enteral albuterol and 10 patients did not receive enteral albuterol. 22% were female, 78% were male. The median age did not differ significantly between the 2 groups (Albuterol median age 49, IQR 28-52.5, No Albuterol median age 51, IQR 43.5-65.5). However, the median ISS was higher in the Albuterol group (median ISS 36.5, IQR 35-66.5 vs median ISS 26, IQR 27-37.25 in No Albuterol group). Patients receiving albuterol experienced 1.8 symptomatic bradycardic episodes vs 4.3 episodes in those patients not receiving albuterol ($p=0.08$). Hospital days on chronotropic agents were significantly less in the Albuterol group vs the No Albuterol group (1.8 vs 8.6; $p=0.01$). The median total atropine given was 1 mg in the No Albuterol group vs 0 mg in the Albuterol group. One patient, in the No Albuterol group, required pacemaker placement. Four patients died in each group, but no death was related to bradycardia.

Conclusions: Enteral albuterol may reduce the frequency of symptomatic bradycardia in patients with CSCI, resulting in less rescue therapy using chronotropic agents. Although this is a small study, it provides a compelling argument for the study of prophylactic enteral albuterol for CSCI-induced bradycardia.