

TRAJECTORIES TO DEATH IN BURN PATIENTS

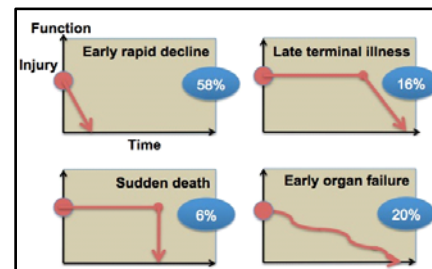
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Introduction. Despite unprecedented survival rates achieved by modern burn care, many severely burned patients still succumb after injury. Prior studies of death trajectories have yielded important epidemiologic findings in multiple fields, including trauma. Yet, patterns of progression toward death remain poorly characterized in burn patients. We hypothesized that burn non-survivors will follow distinct temporal distributions and patterns of decline.

Methods. We retrospectively identified all adult deaths from 1995-2007 in the National Burn Repository (NBR) database (n=5,975), as well as our regional burn center (n=237). We stratified patients by age, and analyzed injury and death characteristics. We used objective criteria to allocate patients at our burn center to one of four trajectories: early rapid decline, late terminal illness, sudden death, or early organ failure.

Results. The greatest concentration of deaths in both samples and age-groups occurred within 72 hours of injury. Histograms show consistent asymptotic distribution as a function of time post-burn in both age groups, with no subsequent mortality peak.

Death was most often due to burn shock within the first week of injury, cardiogenic shock or lung injury in weeks 1-2, and sepsis/multi-organ failure after week 2. Patients commonly followed a trajectory of early rapid decline (58%), followed by early organ failure (20%), late terminal illness (16%), then sudden death (6%) (figure).



Conclusions. The majority of burn deaths follow a pattern of early rapid decline. In addition, a large proportion of late deaths result from early organ failure. These findings indicate that more than three-quarters of burn deaths are attributable to failure or significant decompensation beginning in the resuscitation phase. Future efforts to mitigate deaths in modern burn care should focus on resuscitation.

EARLY USE OF ALBUMIN IMPROVES SURVIVAL AFTER BURN INJURY

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Introduction: The optimal resuscitation algorithm remains elusive for patients with large burn injury. Recent reports from the military support that larger burns who do not respond well to ongoing Ringer’s lactate resuscitation may improve with the use of 5% albumin and vasopressors. We hypothesized that the use of 5% albumin and vasopressors, as needed, would decrease complications of fluid resuscitation and burn mortality.

Methods: Fluid needs during the first 24 hours after burn injury, complications and demographics were collected for all patients 12 years and older with burn size = 20% TBSA admitted from 2003-2010. In 3/2007, we changed our resuscitation to include the use of 5% albumin in the first 24 hours if the estimated fluid needs at 12 hours post burn would lead to a fluid volume of 6cc/kg/% burn at 24 hours. The patients treated prior to this change (PRE) were compared to those after the guideline change (POST).

Results: The two groups were well-matched for age, burn size, and inhalation injury. There was a trend toward lower fluid use in the POST group where the use of albumin was higher but the use of pressors was lower. Ventilator days and mortality were decreased in the POST group. There was not a statistical difference in the number of escharotomies performed or incidence of abdominal compartment syndrome (ACS).

Group N	Age years	TBSA %	Inhalat N(%)	cc/kg/% TBSA	Mortal N(%)	Vent days	LOS days	Pressors N(%)	Albumin N(%)
PRE 95	43±18	39±18	39(41)	4.6±2.3	25(26)	16±29	29±30	42(44)	9(9)
POST 53	43±19	38±18	22(42)	4.2±1.8	6(11)	8±13	31±31	12(23)	17(47)
P value	NS	NS	NS	0.07	<0.05	<0.05	NS	0.01	<0.01

Conclusions: An algorithm incorporating albumin use in the first 24 hours after burn injury was associated with the use of less vasopressor agents and lower mortality. Early albumin use was also associated with shorter duration of mechanical ventilation in burn patients sustaining burns = 20% TBSA.

17-BETA ESTRADIOL REAPPROPRIATES MASS LOST TO THE HYPERMETABOLIC STATE IN THERMALLY INJURED RATS

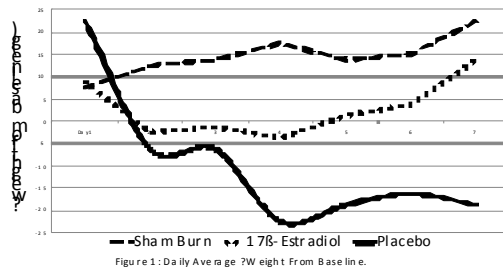
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Introduction: The response to thermal injury is typified by elevations in pro-inflammatory cytokines, accelerated cellular apoptosis, and a marked increase in metabolism. Studies have shown that 17β-estradiol has anti-inflammatory and anti-apoptotic effects in acute injury. We hypothesized that the administration of 17β-estradiol following severe burns would mitigate markers of hypermetabolism in burned rats.

Methods: Adult male Sprague-Dawley rats were maintained in metabolic cages. Animals were blindly randomized to a sham-burn, placebo, or a 0.5mg/kg 17β-estradiol group. 40% TBSA burns were produced by scalding, and animals were resuscitated (4ml/kg/%burn LR) immediately following the injury. A single dose of study drug or placebo was administered 15 minutes following the burn. Measurements were taken daily for the next six days. One-way ANOVA was used to determine statistical significance (p<0.05).

Results: Daily average Δweight from baseline is shown in Figure 1. Statistical significance was demonstrated on Days 1-4 following injury. Table 1 shows an estimate of hypermetabolic activity based on mass differences in intake/output, represented as mass used for other energy (OE±SEM). This value is derived by [food mass intake(g)]-[fecal mass output(g)]-[body weight gain(g)] and represents an estimate of metabolic energy and activity. (Formula Adapted from Izamis, et al, J Burn Care & Res. Nov/Dec 2009).

Conclusion: Placebo-treated rats continued to demonstrate weight loss, presumably due to mass lost to hypermetabolic activity. 17β-estradiol is associated with a reduction of the weight loss and hypermetabolic activity exhibited by placebo-treated burned rats.



	Day1	Day2	Day3	Day4	Day5	Day6
Sham	-1±4	5±6	7±7	0±6	-1±7	-2±8
17β	-5±4	7±1	30±5	8±4	13±10	14±10
Placebo	-22±4	9±4	27±4	25±5	38±6	30±2
p-value	0.007	0.955	0.008	0.003	0.004	0.008

Table 1: Mass Balance results OE±SEM

VALUE OF AUTOMATED CHEST COMPRESSION DEVICE FOR KIDNEY TRANSPLANTATION IN INTENSIVE CARE UNITS.

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Introduction: Transplanting kidneys donated by expanded criteria (ECD) or uncontrolled cardiac death (DCD) donors is a universal challenge in intensive care units (ICU). Such kidneys sometimes require a long ischemic time (IT) because of difficulties with cooling in situ. This study demonstrates the outcomes of kidneys from uncontrolled DCD donors with a long IT in which hemodynamics were maintained using an automated chest compression device (AutoPulse) before procurement.

Methods: After obtaining approval, kidneys from DCD donors in our ICU (2008-2009) and those from brain dead (BD) donors in Tokyo (2008-2009) entered this study.

Results: We identified 8 kidneys from uncontrolled DCD donors those were maintained using the AutoPulse, 16 from standard DCD donors with cooling in situ, and 14 from BD donors. Although IT and delayed graft function were significantly increased in kidneys maintained with the Autopulse, primary non-function was not found in any of them 1 year after transplantation, and 1 kidney each from a BD donor and a standard DCD donor were non-functional. The creatinine concentration in 8 kidneys that had been maintained using the AutoPulse was equal to those of kidneys from standard DCD and BD donors.

Conclusion: Kidneys from uncontrolled DCD donors with a long IT that were maintained using an automated chest compression device had good graft survival and function 1 year after transplantation. Although our study size is small, it is advocated that these kidneys are equivalent to those from standard DCD or BD donors.

Variables	ECD or Uncontrolled	Standard DCD	BD donors
	DCD donors (n=8)	donors (n=16)	(n=14)
Donor age (yrs)	51 ± 9	62 ± 9	52 ± 14
Recipient age (yrs)	52 ± 13	49 ± 12	44 ± 13
Total ischemic time (min)	1099 ± 422 ^{a,b}	459 ± 131	465 ± 133
Non-functional (n) ^c	0	1	1
Creatinine (mg/dL) ^c	1.30 ± 0.43	1.33 ± 0.57	1.52 ± 0.58

^a P < 0.001 vs. standard DCD donors; ^b P < 0.001 vs. BD donors; ^c at one year after transplantation

EARLY PULMONARY EMBOLISM AFTER INJURY: A DIFFERENT ANIMAL?

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Background: Pulmonary embolism (PE) following trauma is a well recognized and potentially fatal complication. Recent work has demonstrated that PE may occur much earlier after acute injury than previously thought. We sought to characterize those PEs occurring early after injury and hypothesized that they may represent a different clinical entity than those occurring later in the post-injury period.

Methods: Data from the trauma registry was examined for patients with a diagnosis of pulmonary embolus over a five-year period (2005 – 2010). Patients whose pulmonary embolus occurred within 72 hours of admission were classified as having “early” PE and were compared with those whose PE occurred later in their hospital course.

Results: Among 6483 trauma patients, there were 54 episodes of PE (0.83%). 19 patients (35%) had an early PE. 5 patients died, all within the later PE group. Patient age, BMI, type of prophylaxis used, blood transfusion during the first 72 hours, presence of spinal cord injury, and presence of pelvic fracture was not significantly different between groups. None of the early PE patients were diagnosed with concurrent DVT, compared with 14 of the later group (40%). The majority of patients had negative lower extremity duplex scans after their PE was diagnosed (84.2% of early PEs, 68.2% of later PEs). Early PE patients had a higher rate of lower extremity fractures (57.9% vs. 11.4%, $p = 0.0003$), a lower mean injury severity score (16.1 vs. 28.7, $p = 0.002$), and a lower average length of stay (17.4 days vs. 29.4 days, $p = 0.01$). Early PE patients had a shorter average time to start of chemical prophylaxis (1.44 days vs. 3.68 days, $p = 0.009$), were less likely to have had a femoral line (0% vs. 17.1%, $p = 0.02$), and less likely to have operative intervention under general anesthesia before the development of their PE (36.8% vs. 71.4%, $p = 0.01$).

Conclusions: Early PE after trauma may occur with different underlying pathophysiology than previously thought. Further study is indicated as this may have implications concerning the prevention of PE in trauma patients.

**POSTINJURY MULTIPLE ORGAN FAILURE:
ADMISSION PLATELET COUNT IS THE LOUDEST SINGING CANARY**

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Background. Postinjury multiple organ failure (MOF) remains a major cause of late trauma deaths and ICU resource consumption. Recent studies documented the change in the epidemiology of MOF (incidence, mortality, severity, age). We hypothesized that the classic independent predictors (age, shock parameters, ISS) for MOF are no longer valid.

Methods. A 48-month prospective cohort study was performed at a Level-1 trauma center. Consecutive ICU trauma admissions (ISS>15, age>18 years, AIS head<3, survived >48 hours) were included. All proven [age, ISS, NISS, base deficit (BD), lactate, blood transfusion, BMI] and potential predictors [demographics, co-morbidities, physiological parameters, interventions, resuscitation data] were collected prospectively. MOF was defined by the Denver Score. Data are presented as %, mean±SEM, *denotes p<0.05.

Results. 123 patients met study criteria, 16 (13%) of these developed MOF. The univariate comparison of demographic, injury severity, physiological and outcome data showed:

	Age	Male	Platelets	NISS	BD	ICUdays	Mortality
MOF n=16	59±6*	64%	185±19*	44±4*	-4.9±1	19±3*	12.5%
Non-MOF n=107	42±2	68%	271±10	34±1	-6.1±1	7±1	2.8%

Multiple logistic regression analysis demonstrated the following predictors of MOF.

	Age	NISS	Admission Platelet count
P value	0.0132	0.0137	0.0062
OR (95% CI)	1.04(1.01, 1.08)	1.07(1.01, 1.14)	0.26 (0.1, 0.68)

None of the other variables were different based on multiple logistic regression including: ISS, gender, serum lactate (12hrs, 24hrs), BD (12hrs, 24hrs), red cell transfusion (12hrs, 24hrs), crystalloid infusion or subsequent serum platelets.

Conclusion. Compared to previous studies MOF patients were older and less likely to die of MOF. Only age and NISS remained significant from the classic predictors. Markers of shock severity and resuscitation parameters are no longer predicting MOF. The admission platelet count below 200 is an early and potentially modifiable predictor that warrants further focused assessment.

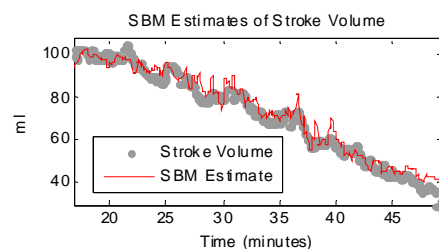
THE ACCURATE ASSESSMENT OF HEMORRHAGE IN THE FIELD USING SIMILARITY BASED MODELING

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Background: Accurate and early assessment of hemorrhage in the field is essential for the initiation of optimal prehospital care. At present this is done using clinical signs and symptoms. Stroke volume (SV) is a primary indicator of the degree of central blood volume, but measurement is not feasible in the field. The purpose of this study was to assess the efficacy of similarity based modeling (SBM) in predicting SV based on data collected from a noninvasive wearable sensing device.

Methods: 10 subjects wore a wearable sensing device during lower body negative pressure (LBNP), an experimental model of hemorrhage used in conscious humans. The device measures: activity, heart rate (HR), HR variability, pulse transit time, respiratory rate, O₂ saturation and tidal volume. A progressive LBNP protocol was applied which produced profound central hypovolemia; LBNP was stopped at the point of cardiovascular collapse (i.e., presyncope). A finger cuff blood pressure monitoring device (Finometer) provided a reference beat-to-beat measurement of SV. SBM was trained using the sensing device data and subsequently to generate off-line estimates of SV. The reference SV measurements were used to assess the accuracy of the SBM model.

Results: SBM estimates of SV were highly correlated with reference SV measurements. The mean and median r^2 values for the SBM estimates were 0.92 and 0.93 respectively (p-values \ll 0.001) and the standard deviation was 10 ml. The figure shows the data for one subject.



Conclusions: SBM-based estimates of SV were highly correlated with reference measurements of SV. SBM-based algorithms could easily be embedded into noninvasive, wearable devices for real-time determination of SV in the field.

**CHANGES IN SYSTEMS-LEVEL COMPLEXITY PRECEDE
DETERIORATION IN TRADITIONAL VITAL SIGNS IN HYPOXIC CARDIAC
ARREST**

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Introduction: Measures of electrocardiogram (EKG)-derived complexity could be used as new vital signs. We propose a new approach for higher, systems-level interpretation of physiologic complexity via calculation of multidimensional entropy in vital sign data.

Objective: Monitor systems-level complexity to identify decompensation. Hypothesis: changes in systems-level complexity precede loss of arterial pulsation (LOAP) in hypoxic cardiac arrest. **Methods:** Eleven anesthetized, intubated, paralyzed and mechanically ventilated swine were instrumented. EKG, systolic blood pressure (SBP); heart rate (HR), pulse oxymetry, end tidal CO₂, electroencephalography Bispectral Index and continuous cardiac output were recorded. After baseline stabilization, the endotracheal tube was clamped and the animals monitored until LOAP. Retrospectively, all available monitoring data was loaded into the OntoSpace software. OntoSpace Complexity (OSC) was calculated and timing of the changes in it was compared to the experimental timeline.

Results: see table. At baseline, OSC was low reflecting deep anesthesia and paralysis. During asphyxia, traditional vital signs remained non-indicative of demise until abrupt occurrence of LOAP. OSC changed 5 min. 24 sec before LOAP (see table, range 1-8 minutes) a critical change (rise) in OSC took place. Data are means. Statistical significance by ANOVA with adjustment for multiple comparisons.

Variable/time point	Baseline	Tube clamped, mean 5. 24 min pre-LOAP	LOAP
(OSC), unitless	10	31 *	27.6 *
HR, beats per minute	113	95 *	86 *
SBP, mm Hg	104	118 *	31 *
CO, L/min	2.7	4.1 *	2.4 *

Conclusions: Changes in systems-level complexity precede deterioration in traditional vital signs during hypoxic cardiac arrest. Prospective studies will be conducted to evaluate the utility of this approach as a real-time decision-support tool.

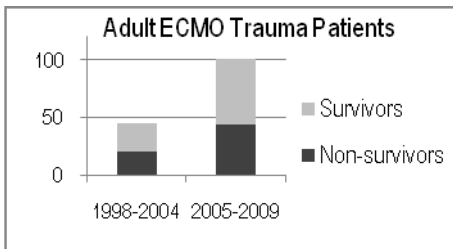
ADULT TRAUMA IN THE MODERN ECMO ERA: A REVIEW OF THE EXTRACORPOREAL LIFE SUPPORT ORGANIZATION DATABASE

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Objective: The use of ECMO for the treatment severe refractory ARDS in trauma patients is increasing. A retrospective analysis of the ELSO registry was performed to identify current outcomes and variables associated with mortality in the adult trauma population from the years of 1998-2009.

Methods: The study population includes patients greater than 16 years of age admitted for penetrating or blunt trauma and requiring ECMO during the course of their hospital admission. A multivariate analysis was performed to determine risk factors for mortality.

Results: Between 1998 and 2009 a total of 146 trauma patients required ECMO. Overall survival was 55.9%. A total of 104 (71.7%) patients were placed on VV ECMO, with 70 (67.3%) survivors. The remaining 42 (28.4%) patients required VA ECMO, of whom 11



(26.8%) survived. Non-survivors demonstrated a significant increase in elevated PIP, increased rates of pre-ECMO arrest, increased rates of requiring VA ECMO and shorter ECMO runs.

The most common complications were clotting of the circuit and bleeding complications. Neither was associated with increased mortality.

Conclusion: In the adult trauma population, overall survival with severe refractory ARDS appears favorable relative to patients managed by conventional ventilation in the absence

of elevated PIP, need for VA ECMO, prior cardiac arrest, or contraindication to anticoagulation.

Covariant of Mortality in the Adult ECMO Trauma Population	Survivors n=82	Non-Survivors n=64	p-value
Need for VA ECMO (%) †	11 (13.6)	30 (46.9)	<0.001
Hours of ECMO ‡	119 (144)	45.5 (173.5)	0.001
Pre-ECMO arrest Y/N (%) †	12 (14.8)	24 (37.5)	0.002
PIP*	41.4 (10.7)	48.3 (14.0)	0.003
Acute renal failure with need for dialysis Y/N (%) †	28 (34.6)	32 (50)	0.06
Bleeding complication Y/N (%) †	23 (28.4)	27 (42.2)	0.08
Age in years ‡	26.6 (21.2)	31.5 (24.4)	0.13
Ventilator hours prior to ECMO ‡	38 (92)	30 (111.5)	0.51
Males (%) †	67 (82.7)	55 (85.9)	0.6
P/F ratio*	63.8 (44.9)	63.5 (42.9)	0.97

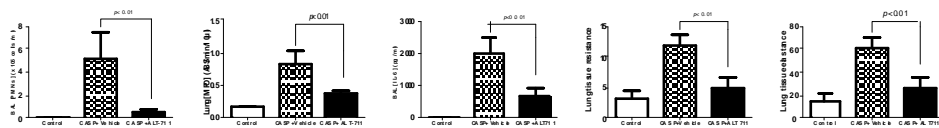
ALAGEBRIUM ATTENUATES ASPIRATION INDUCED PULMONARY INFLAMMATORY RESPONSE AND IMPROVES PULMONARY FUNCTION IN MICE FED HIGH AGE DIET

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Introduction: Our previous study demonstrated that diets high in advanced glycation end products (AGE) exacerbate the pulmonary inflammatory response following gastric aspiration in mice. We designed this study to test our hypothesis that alagebrium (ALT-711), an AGE crosslink breaker, attenuates the pulmonary inflammatory response and improves pulmonary mechanics following an aspiration induced lung injury, a common condition in trauma and ICU.

Methods: Male, 4-wk old CD-1 mice were fed a high AGE (110 ng/g) diet for 4 weeks prior to a gastric aspiration injury induced by intratracheal instillation of a combination of acid and small gastric particles (CASP, pH 1.25, 3.6 mL/kg). Mice received a 6-day course of daily i.p. injection of alagebrium or vehicle (normal saline) starting 6 days prior to injury. Pulmonary mechanical function was measured 5 hr after the aspiration, the animal euthanized, and BAL performed. BAL neutrophil (PMNs) counts, IL-6 levels, and lung homogenate myeloperoxidase (MPO) activity were determined.

Results: Alagebrium pre-treatment significantly decreased the PMNs infiltration and IL-6 levels in BAL, as well as the MPO activity in the lung homogenate. Alagebrium also improved the lung tissue resistance and elastance.



Conclusions: Our study demonstrates that the AGE-enhanced pulmonary inflammatory response and impaired pulmonary function in mice with gastric aspiration can be attenuated by alagebrium. Since AGEs, which are associated with a Western fast-food diet, represent important mediators for the pulmonary inflammatory response after gastric aspiration, utility of AGE-reducing strategies may be useful in the prevention and management of ALI/ARDS after gastric aspiration in trauma and ICU patients.

EARLY TRACHEOSTOMY FOLLOWING TRAUMA REDUCES TOTAL VENTILATOR DAYS

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Introduction: The effect of early tracheostomy (trach) on the duration of post-traumatic respiratory failure is still controversial. While most studies have focused on the time to trach as a variable that can be modified, few have rigorously evaluated the time from trach to liberation from mechanical ventilation. The goal of the study was to determine if timing of tracheostomy or other factors can impact duration of post trach respiratory failure.

Methods: Retrospective series of adult trauma patients requiring trach from 2000-09. Data collected included demographics, ISS, chest injury, total vent days and pneumonia.

Multiple regression was done to analyze variables contributing to post-trach vent days.

Results: 1046 pts underwent trach, mean age 41, 82% male, 25% sustained penetrating injury. 52% sustained severe TBI (AIS =4). The mean ISS was 28. ICU and total length of stay were 21 and 41 days. 66% of pts developed pneumonia. Overall mortality was 11%.

Vent days data stratified by day of trach post-injury is shown.

Post injury Day of trach	1	2	3	4	5	6	7	8	9	=10
# of patients	67	106	103	121	123	87	67	60	48	150
# vent days post trach	10.5	13.1	10.5	9.7	10.6	10.8	12.0	11.8	9.4	12.0
Total vent days	11.5	14.3	12.7	13.1	15.0	16.2	17.5	18.6	17.1	21.6

Patients required a mean 11 days of post-trach ventilator support regardless of the day the trach was performed. Early trachs had less total vent days compared to late trachs (>7days). A regression model including time to trach, Head AIS, Chest AIS, ISS, age, multiple trauma, and pneumonia failed to predict post-trach vent days ($r^2=0.083$).

Conclusions: Following trauma, the time from trach to liberation from mechanical ventilation is relatively constant (9-12 days) and was not affected by patient demographic, type or severity of injury or post injury pneumonia. Since the timing of trach is the only variable that can be modified, early tracheostomy will result in fewer total vent days.

BOTULINUM TOXIN A INJECTION: A NOVEL TECHNIQUE TO IMPROVE THE PRIMARY FASCIAL CLOSURE RATES OF THE OPEN ABDOMEN

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Introduction: Failure to definitively close the open abdomen (OA) after damage control laparotomy leads to considerable morbidity. We hypothesize that botulinum toxin A (BTX), a long term flaccid paralytic, when injected into the lateral abdominal wall musculature, will facilitate delayed primary fascial closure of the OA. **Materials and Methods:** Review of all OA patients (age = 18) from December 2009 - June 2010. Three hundred units of BTX were injected into the external oblique, internal oblique and transversus abdominus muscles, bilaterally, under ultrasound guidance. **Results:** Seventy-seven patients (18 BTX and 59 controls) were included comprising 4% vascular, 11% trauma, and 84% acute general surgical cases. There was no difference in mortality (11% vs 17%, $p=0.54$), morbidity (67% vs 64%, $p=0.86$), fascial dehiscence (11% vs 18%, $p=0.53$), enterocutaneous fistula development (0% vs 7%, $p=0.13$), reintubation (0% vs 11%, $p=0.06$), intra-abdominal abscess (44% vs 25%, $p=0.11$), deep wound infection (33% vs 32%, $p=0.30$), ASA score (3 vs 3, $p=0.28$), APACHE 3 score (77.5 vs 73.5, $p=0.15$) and hospital (23 vs 19 days, $p=0.77$) or ICU duration of stay (9 vs 9 days, $p=0.93$). There was a greater number of serial explorations in the BTX group (4 vs 2, $p=0.01$). The rates of primary fascial closure (83% vs 66%, $p=0.15$), partial fascial closure (6% vs 2%, $p=0.42$) and planned ventral hernia (11% vs 19%, $p=0.44$) were similar. Two patients underwent component separation and primary closure, one in each group. Nine BTX patients were injected within 24 hours of their OA procedure of whom 8 (89%) achieved primary fascial closure and 1 (11%) achieved partial fascial closure. There were no complications related to BTX. **Conclusion:** BTX injection into the abdominal wall musculature is safe and demonstrated a trend toward improved primary fascial closure rates, particularly if performed within 24 hours of the OA procedure. Further study needs to be performed to optimize patient selection and elucidate the effects BTX has on the biomechanical profile of the paralyzed abdominal wall after OA to improve primary fascial closure rates.

SURGICAL FEEDING TUBES IN THE OPEN ABDOMEN: A RISK WORTH TAKING?

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Introduction: Patients with an open abdomen (OA) after damage control laparotomy present challenges in providing nutritional support. Placement of surgical feeding access in trauma patients without an OA is widely accepted. This practice is controversial, however, in OA patients. We hypothesized that placement of surgical feeding tubes in OA patients does not increase complication rates when compared to placement in patients closed primarily.

Methods: A retrospective review was conducted of patients that required trauma laparotomy and had surgical feeding tubes placed from 2000-2006. Demographics, clinical characteristics and outcomes were collected. Fischer’s exact test and student’s t-test were used to compare variables.

Results: 337 patients underwent trauma laparotomy and surgical feeding tube placement. 237 were closed primarily at the first operation and 100 required an OA.

Overall, OA patients were more severely injured with lower systolic blood pressure, higher ISS, longer ICU stay, and greater number of ventilator days (all

Complication	Primary Closure (n= 237)	Open abdomen (n= 100)	p value
Tube dislodgement	8 (3.3%)	5 (5%)	0.53
Wound infection	21 (8.8%)	15 (15%)	0.12
Fistula	5 (2.1%)	4 (4%)	0.45
Ileus	6 (2.5%)	5 (5%)	0.31
Bowel infarction	4 (1.7%)	5 (5%)	0.13
Bowel leak	5 (2.1%)	2 (2%)	1.00
Bowel obstruction	2 (0.8%)	2 (2%)	0.58

$p < 0.05$). When the groups were compared in terms of feeding tube related complications (see Table), no significant differences were detected (all $p > 0.05$).

Conclusion: Placement of surgical feeding access in patients with an open abdomen does not result in an increased complication rate when compared to placement of access in patients closed primarily. Our results suggest that concerns regarding the placement of surgical feeding tubes in the open abdomen are unwarranted.

DETERMINING INJURIES FROM POSTERIOR STAB WOUNDS USING CT TRACTOGRAPHY

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Introduction: Unlike anterior stab wounds (SW), where local exploration may be helpful in directing management, posterior SW can be challenging to evaluate. Traditional triple contrast CT imaging is cumbersome and technician dependent. The present study examines the role of CT tractography as a strategy to manage select patients with posterior torso SW.

Methods: Hemodynamically stable trauma patients with posterior torso SW were studied. After initial resuscitation, betadine or Visipaque® soaked sterile sponges were inserted into each SW for the estimated depth of the wound. Patients underwent abdominal helical CT scanning, including intravenous contrast, as the sole abdominal imaging study. All images were reviewed by an attending radiologist and trauma surgeon. The tractogram was evaluated to determine SW trajectory and injury to intra- or retroperitoneal organs, bowel, diaphragm, and urinary tract. Patient demographics including age, ISS, length of stay, operative management and injuries were also collected.

Results: Forty-one patients underwent CT tractography. The mean age was 26 ± 10 with a mean systolic blood pressure of 135 ± 18.1 mmHg and a mean ISS of 8.0 ± 8.1 . In 11 patients, tractography detected violation of the intra- or retroperitoneal cavity leading to operative exploration. Injuries detected operatively included: spleen (2), colon (2), kidney (2), diaphragm (2), iliac artery (1). In all patients studied, there were no patients with negative CT findings that failed observation. The mean length of stay was $2 \text{ days} \pm 2.1$.

Conclusions: In this series, CT tractography is a safe, and effective imaging strategy to evaluate posterior torso SW. It is unknown whether CT tractography is superior to other imaging modalities such as a triple contrast CT. Other uses for CT tractography may include determining trajectory from missile wounds and tangential penetrating injuries.

PROSPECTIVE EVALUATION OF SPLENIC PERFUSION PRESSURE CHANGE AFTER PROXIMAL SPLENIC ARTERY EMBOLIZATION: PERFUSION PRESSURE DROP IS DEPENDANT ON ARTERIAL ANATOMY

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Introduction: Splenic artery embolotherapy (SAE) may play an important role in non-operative management (NOM) of blunt splenic injury (BSI). Proximal SAE likely reduces perfusion pressure distally, lowering the risk of delayed bleeding. However, this has not been scientifically examined. Before the role of SAE can be more completely defined, the hemodynamic changes in the splenic artery stump after occlusion must be understood.

Methods: Between 5/24/07 and 2/1/11, Patients referred for angiographic evaluation of BSI underwent aortic and splenic artery stump pressure determination using an embolectomy catheter inflated in the proximal splenic artery. Anatomy of the celiac artery and collaterals as determined by computed tomography was also examined. Celiac stenosis was defined by a diameter reduction of $> 70\%$.

Results: 35 patients undergoing angiography for splenic injury had attempted pressure measurement. Celiac stenosis (atherosclerosis or ligamentous compression) was identified in 8 patients (23%). In 3 of these, splenic artery pressure was not determined as stenosis precluded catheter passage. In the remaining patients, mean pressures before and after occlusion were 96.9 ± 14.5 mmHg and 54.4 ± 19.7 mmHg (mean drop: $44.5\% \pm 17.9\%$). As patients accrued, two distinct patterns of pressure change became apparent. In the 27 with normal arterial anatomy, mean pressure change was $62.2\% \pm 11\%$ compared to a drop of only $26.8\% \pm 24.9\%$ in the 5 with celiac stenosis ($p < .0001$). Significant collateralization contributing to splenic blood flow was seen in all patients with stenosis.

Conclusion: Proximal splenic artery embolization produces substantial pressure decrease in the majority of patients, but in patients with celiac stenosis, perfusion pressure decreased only modestly. This relatively common phenomenon is associated with pre-existing robust collaterals. We speculate this may help explain delayed bleeding after proximal splenic artery embolotherapy leading to NOM failure in some patients.

**SELECTIVE ANGIOGRAPHIC EMBOLIZATION OF BLUNT SPLENIC
TRAUMATIC INJURIES MAY DECREASE FAILURE RATE OF NON-
OPERATIVE MANAGEMENT**

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Objective: To determine if selective use of angio-embolization (AE) in hemodynamically stable adult patients with blunt splenic trauma (BST) at high risk for failure of nonoperative management (NOM) (contrast blush (CB) on computed tomography (CT), high Grade IV-V injuries, or decreasing hemoglobin levels) results in lower failure rates.

Methods: The records of patients with BST from July 1, 2000 to Dec 31, 2010 at a Level I trauma center were retrospectively reviewed using NTRACS. Grade of splenic injury, presence or absence of contrast blush (CB) on initial CT, and indications for AE were all reviewed. Failure of NOM (FNOM) occurred if a patient required splenic surgery after an attempt of NOM. Stepwise logistic regression analysis was used to identify risk factors associated with FNOM.

Results: 1039 patients with documented BST were identified. Excluding 102 that died shortly after arrival and 90 pediatric patients (age<17), 847 remained in the study group. Of these 308 (36%) went directly to the operating room for hemodynamic instability and 539 (64%) hemodynamically stable patients underwent NOM (104 (19%) with AE and 435 (81%) without AE). FNOM for the various groups were: overall NOM group (4%); NOM without AE group (4%) and the NOM with AE group (3%). There were 95 high grade injuries (64 Grade IV and 31 Grade V). Comparing (NO AE) vs. (AE) for Grade I-III, there was no significant difference in FNOM (8%, vs. 0%, $p=0.3$); however, AE significantly reduced FNOM for Grade IV-V injuries: Grade IV (23% vs. 3%, $p=0.04$), and Grade V (63% vs. 9%, $p=0.03$). The only statistically significant ($p<0.05$) independent risk factors for FNOM was grade IV-V injuries.

Conclusions: Routine AE should be considered for the management of hemodynamically stable adult patients with BST and high grade (IV-V) injuries, regardless of CB on CT or decreasing hemoglobin levels.

AN ANALYSIS OF ABDOMINAL CLOSURE TECHNIQUES IN OPEN ABDOMENS WITH LONG TERM FOLLOW UP.

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Objective: We employ either the Wittmann Patch™ (WP) or a negative pressure dressing (NPD) as a temporary abdominal closure (TAC). This study compared these two TAC techniques, and determined long term complications in these trauma patients managed with an open abdomen.

Methods: This IRB approved study was performed in patients that required more than one laparotomy admitted to two level one trauma centers from 1/2000 to 12/2007. Data collected included age, ISS, ventilator days, hospital LOS, mortality, type of TAC (WP or NPD), time to definitive fascial closure (FC), and enterocutaneous fistula (ECF) formation. Long term ventral hernia (VH) rates were determined in patients from one center. Unpaired t-test and Chi square were used to compare groups.

Results: 211 patients required a damage control laparotomy with 74 early (<48h) deaths (34.9%), leaving 137 patients that were managed as an open abdomen at these two institutions.

	Age	ISS	Vent Day	Mortality	LOS	% FC	Day to FC
WP n=69	44.0±1.6	32.4±11.8	27.1±20.8	18.8%	42.2±30	71.0	11.8±6.7
NPD n=68	36.6±20.3	28.7±13.8	13.5±13.5	11.8%	28.2±19	88.2	4.6±4.6
P value	0.009	0.046	<0.001	0.250	<0.001	0.012	<0.001

The WP was placed at a mean of 4.4±3.4 days. 9 (13.0%) ECF occurred in the WP group and 3 (4.4%) ECF occurred in the NPD group (p=0.07). 59 patients were eligible for long term follow-up from one institution; 13 died (22%), 7 (15%) had a skin graft with a planned VH, and 39 (85%) had primary FC without mesh. Long term follow up was determined by office visit (n=9) or chart review (n=30). 10 (26%) patients developed a VH, 4 from the WP and 6 from the NPD group (p=0.493). Mean follow-up time was 42 ± 16.3 months (range 68 to 32).

Conclusion: The WP facilitated FC with an acceptable ECF rate in a very sick group of trauma patients. Overall, 26% of open abdomen patients developed a VH long term. VH formation was not associated with the type of TAC used, i.e., WP or NPD.

SEEKING CLOSURE: A PILOT STUDY OF A NOVEL DYNAMIC FASCIAL CLOSURE TECHNIQUE FOLLOWING DAMAGE CONTROL LAPAROTOMY

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Introduction: Damage control laparotomy (DCL) is an effective operative strategy in the severely injured patient, but has a high rate of incomplete fascial closure. We investigated the impact of a simple method of sequentially placed fascial-based vessel-loops, tightened at subsequent laparotomies, with an overlying abdominal wound vac, on the rate of fascial closure. **Methods:** A retrospective review of patients requiring DCL at our Level 1 center between Jan. 2008 and Dec. 2009 was performed. Patients were divided into two groups, STANDARD (abdominal wound vac) versus DYNAMIC (vessel-loop based tension with vac) and compared using Mann-Whitney tests (*p*-value <0.05 considered significant).

Results: 56 patients underwent DCL and survived. 23 patients (41%) were closed on the first attempt, and were excluded from analysis. All 7 DYNAMIC patients achieved primary fascial closure, whereas only 27% of STANDARD patients achieved fascial closure. DYNAMIC (n=7) and STANDARD (n=26) patients were alike with regards to age, BMI, ISS, APACHE II, ventilator days, ICU LOS and hospital LOS. Patients who closed using the STANDARD technique, however, were younger and had lower ISS and APACHE II scores. **Conclusion:** Our DYNAMIC technique resulted in a significant improvement in fascial closure rate (100% vs 27%), despite higher ISS and APACHE II scores when compared to those who were able to close using STANDARD techniques.

	STANDARD All, n=26	DYNAMIC Closed, n=7	STANDARD Closed, n=7	STANDARD Not Closed, n=19
Age	34 ± 13	41 ± 12	28 ± 6*	37 ± 14
BMI	28 ± 5	29 ± 8	26 ± 1	28 ± 5
ISS	30 ± 14	32 ± 12	24 ± 7*	33 ± 15
APACHE II	22 ± 7	24 ± 12	17 ± 4*	24 ± 7
Ventilator Days	13 ± 11	14 ± 12	5 ± 5*	14 ± 10
ICU LOS (days)	18 ± 12	17 ± 12	8 ± 5*	22 ± 13
Hospital LOS (days)	48 ± 64	34 ± 12	19 ± 6*	59 ± 73
# Operations	5 ± 3	3 ± 1	2 ± 1	6 ± 3
Skin/STSG Closure (days)	20 ± 25	5 ± 2*	5 ± 5*	27 ± 7

IS OCCULT SHOCK A PREDICTOR OF OUTCOME FOLLOWING HEPATIC INJURY?

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Introduction AAST-OIS injury grade has been validated as a predictor of outcome for hepatic injury. Occult shock, defined as admission SBP = 105mm Hg and base deficit (BD) > -4, has not been investigated as a predictor of outcome for hepatic injury. The purpose of this study was to assess if the presence of occult shock on admission is a valid predictor of outcome.

Methods Retrospective ten-year study of all patients sustaining hepatic injuries treated at our institution. Statistical analysis was performed using Z test for proportions. Outcome measure examined was mortality.

Results There were a total of 2223 patients. Initial SBP and BD were available for 1716 (77%). Mean ISS 26±15 and mean RTS 6.94±1.76. Mortality was stratified according to AAST-OIS injury grade and absence of shock (AAST-OIS-NO S), presence of occult shock (AAST-OIS+OS) and presence of clinically apparent shock (AAST-OIS+S).

Injury Grade	AAST-OIS-NO S	AAST-OIS+OS	p value
I	2	14.6	0.012
II	4.3	21.4	<0.001
III	2.6	11	0.007
IV	11.3	29.9	0.012
V	10.5	47.4	0.032

Table 1 Mortality (%) AAST-OIS-NO S vs AAST-OIS+OS

Injury Grade	AAST-OIS+OS	AAST-OIS+S	p value
I	14.6	36.8	0.108
II	21.4	45.3	<0.001
III	11	28	0.016
IV	29.9	39	0.375
V	47.4	51.6	0.985

Table 2 Mortality (%) AAST-OIS+OS vs AAST-OIS+S

Conclusions For all AAST-OIS injury grades for hepatic injury, the presence of occult shock is a significant predictor of mortality. For AAST-OIS injury grades IV-V, occult shock was as lethal as clinically apparent shock.

**THE EFFECTS OF LIVER CIRRHOSIS ON TRAUMA OUTCOMES:
A PROSPECTIVE STUDY**

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Introduction: The adverse effects of liver cirrhosis on outcomes following trauma has been established in retrospective series. In this study, however, we set out to evaluate prospectively the in-hospital outcome measures in this patient population.

Methods: This is a prospective observational study of all patients admitted to the surgical intensive care unit of a level I trauma center from 1/2008 to 12/2010. Cirrhotic trauma cases were matched with non-cirrhotic controls in a 1 to 1 ratio using propensity matching. Matching criteria included age, gender, injury mechanism, vital signs on admission, AIS for all body regions, and ISS. Outcomes included in-hospital morbidity and mortality.

Results: During the 3-year study period, 64 of the 12,102 trauma admissions had liver cirrhosis (0.5%). After propensity matching, no differences with regards to demographic and clinical injury characteristics were observed comparing the cases and controls. The overall morbidity incidence in cases and controls was 21.9% and 7.8%, respectively ($p=0.049$). In-hospital mortality was significantly higher for cirrhotic patients compared to their non-cirrhotic counterparts (20.3% vs. 4.7%; $p=0.002$). Within the cirrhotic group, mortality increased significantly from 5.3% in Child-Pugh class A, to 40.0% in class B, and 50.0% in class C ($p=0.001$). Likewise, mortality was significantly higher for patients with a Model for End-Stage Liver Disease (MELD) score =10 vs. <10 (33.3% vs. 8.8%; $p=0.015$).

Conclusion: This prospective validation concurs with historical retrospective data confirming that liver cirrhosis is associated with adverse outcomes following trauma. Both increasing Child-Pugh and elevated MELD score predicted adverse outcomes in a stepwise fashion.

RIB FRACTURE FIXATION FOR FLAIL CHEST: WHAT'S THE BENEFIT?

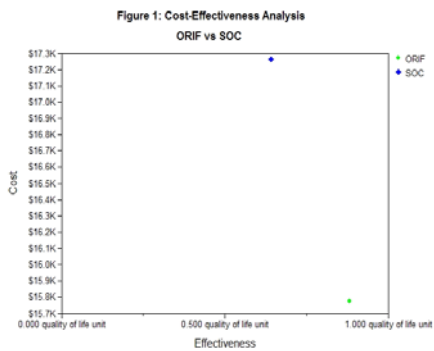
Akash Bhatnagar MS IV, John Mayberry* MD, Ram Nirula* MD MPH. University of Utah.

Background: Recently rib fracture fixation for flail chest has been increasingly employed at both academic and non-academic trauma centers. While a few small non-US studies have demonstrated a clinical benefit it is unclear whether this benefit outweighs the added expense and potential perioperative complications related to the procedure. We therefore sought to determine if open reduction and internal fixation of ribs for flail chest (ORIF-FC) represents a cost-effective means for managing these patients.

Methods: A Markov transition state analysis was performed modeling the outcomes of the standard of care (SOC) or ORIF-FC for flail chest. Probabilities of ventilator-associated pneumonia, tracheostomy, sepsis, prolonged ventilation, DVT, PE, wound infection and post-operative hemorrhage were obtained based upon literature review. Medicare 2010 reimbursement costs were used for diagnoses and procedures. A quality of life improvement factor (QL) ranging from 0 to 15% improvement was used to estimate the improvement in pain and functional outcome related to ORIF-FC. The most cost-effective treatment was then determined ranging the VAP and QL probabilities.

Results: The cost per incremental quality of life unit increase was \$15,269 for ORIF-FC compared to \$16,810 for SOC. Even when the QL factor was set to 0% ORIF-FC remained the most cost-effective strategy. Similarly, ORIF-FC remained the most cost-effective strategy even when the probability of VAP after ORIF was as high as 22%.

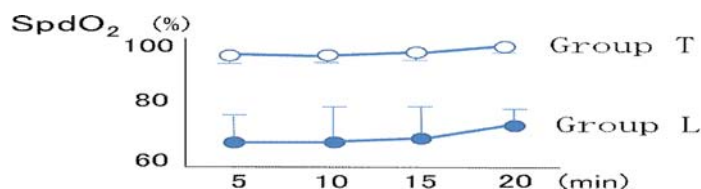
Conclusions: Despite the additional cost of surgery, rib fracture fixation dominates the standard of care and should be considered in the management of appropriate flail chest patients.



NEW METHOD TO MAKE A QUICK AND ACCURATE THERAPEUTIC STRATEGY FOR MASSIVE HEMOTHORAX

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Massive hemothorax (MH) is reported recently to be able to treated non-invasively by interventional radiology (IVR) , when the bleeding is occasionally from thoracic wall injury with intercostal arteries or internal thoracic arteries bleeding. However, MH due to lung injury can not be treated by IVR but by emergency thoracotomy. In the 67th AAST annual meeting, we introduced clinical study concerning gas analysis of blood persistently drained through thoracic catheter (GAB-PDTC) as a quick method to choose accurate strategy for MH. **Purpose :** The aim of this study is to confirm predictive value of GAB-PDTC for planning an initial therapeutic strategy for MH experimentally. **Methods:** Generally anesthetized 8 swine were separated into two groups. Group T (n=4): MH sourced from thoracic wall injury was made by cutting ribs with intercostal arteries and veins. Group L (n=4): MH sourced from lung injury was made by cutting pulmonary arteries and veins. In both groups, FiO_2 was set on 0.21 at the first, and was changed to set on 1.0 after 10 minutes later. Saturated oxy-hemoglobin of GAB-PDTC ($SpdO_2$) was repeatedly sampled every 5 minutes. **Results & Discussions:** In Group T, $SpdO_2$ is constantly high, because intercostal arteries may be main bleeding source in thoracic injuries. In Group L, $SpdO_2$ is constantly low, because both pulmonary arterial and pulmonary venous blood bleeding from the damaged lung area may not be oxygenized. $SpdO_2$ demonstrably represent different value respectively, when the MH bleeding source is thoracic wall and lung injury.



Conclusion: GAB-PDTC can have predictive value to suggest therapeutic strategy for MH.

DO INCLUSIVE TRAUMA SYSTEMS IMPROVE OUTCOMES FOLLOWING RENAL TRAUMA?

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Introduction: Tiered delivery of trauma care (level I-V trauma systems) decreases injury related morbidity and mortality. How this correlates with renal trauma outcomes is unknown. The Healthcare Cost and Utilization Project State Inpatient Database (HCUP-SID) collaborates with states to provide index hospitalization data from participating hospitals. We hypothesize that states with more hospitals participating in a trauma system will have lower nephrectomy and mortality rates.

Methods: We utilized The HCUP-SID to study patients hospitalized with renal injury during 2001, 2004, and 2007. State trauma systems were categorized based on the proportion of all acute care hospitals designated as a trauma center (level I-V), with higher proportions correlating to a more inclusive system (“exclusive” 0-13%, “more inclusive” 14-37% and “most inclusive” 38-100%). Poisson regression for relative risks of inpatient nephrectomy and case fatality were performed adjusting for patient and state level factors.

Results: 14,590 patients were hospitalized secondary to renal trauma in 24 states. Patients in states with the “most inclusive” trauma systems had a 28% lower risk of nephrectomy (RR 0.72, 95% CI 0.58, 0.91) and a 2.6% lower unadjusted inpatient case fatality rate compared to states with “exclusive” trauma systems. Following multivariate analysis, inpatient case fatality risk varied significantly by trauma system inclusiveness. Being treated in states with either a “more inclusive” (RR 0.84, 95% CI 0.73, 0.97) or “most inclusive” (0.74, 95% CI 0.63, 0.86) trauma system was independently associated with a lower inpatient case fatality risk compared to states with “exclusive” systems.

Conclusions: A reduced risk of nephrectomy and a lower inpatient case fatality rate are more common among states that have a higher proportion of acute care hospitals participating as a trauma center (level I-V). As such, further development of statewide inclusive trauma centers may correlate with improved patient outcomes following renal trauma.

GUNSHOT WOUNDS AND BLAST INJURIES IN OPERATION IRAQI FREEDOM

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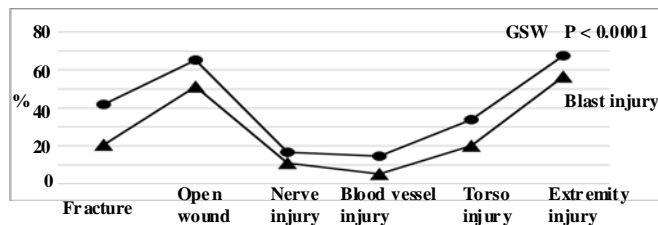
Background: With the current focus on blast injuries, little attention has been given to the clinical characteristics of gunshot wounds (GSW) received during combat in the recent and ongoing conflicts in Iraq and Afghanistan.

Methods: We identified 5,786 U.S. military personnel with combat injuries in Iraq from the CTR Expeditionary Medical Encounter Database. The majority of patients were injured by blast (N = 4,519; 78%), followed by GSW (N = 757; 13%) and another mechanism (N = 510; 9%). The focus of this analysis are the 5,276 patients injured by GSW or blast.

Results: Overall, Injury Severity Score (ISS) was ≥ 16 in 11% (N = 568) of combat injuries. GSW were 3 times more likely than blast injuries to result in injuries with an ISS > 16 (Odds Ratio [OR] = 3.0, $P < 0.0001$); shock and tachycardia were also significantly more frequent (OR = 2.2, OR = 1.3; $P < 0.0001$ and $P = 0.002$ respectively). GSW were associated with higher (3+) Abbreviated Injury Scale (AIS) scores to the head/neck, thorax, abdomen, and extremities (OR = 2.2-3.7, $P < 0.0001$) than blast injuries, and were strongly associated with Glasgow Coma Scale scores < 8 (OR = 3.8, $P < 0.0001$). Analysis of the Barell Injury Diagnosis Matrix reveals several injury types to be more common in GSW than blast injury (Fig. 1). Combat mortality was significantly higher in GSW versus blast injuries (12.7% vs. 3.5%, OR = 4.1, $P < 0.0001$).

Conclusions: GSW are less frequent than blast injuries in the current conflicts but represent more serious wounding patterns. High ISS and AIS scores are strongly associated with GSW, along with shock and higher mortality. Our findings suggest that GSW should continue to be a focus in the improvement of combat casualty care.

Fig. 1. Barell Injury Diagnosis Matrix analysis



**PROSPECTIVE RANDOMIZED STUDY OF IN-VEHICLE VIDEO
MONITORING WITH PARENTAL FEEDBACK: EFFECT ON SUBSEQUENT
TEEN DRIVING BEHAVIORS**

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Objective: Teen drivers are the group with the highest risk for motor vehicle crash involvement. The objective of this study is to determine the influence of an in-vehicle video monitoring system and parental feedback on subsequent teen driving behavior.

Methods: This is a case-crossover prospective study of 16-20 year-old newly licensed drivers. Subjects were randomized into 3 groups depending on interventions by six-month periods: feedback→feedback (n=63), feedback→control (n=68), and control→feedback (n=57). Groups were compared by the number of events during each period. Events were defined as driving behaviors resulting in longitudinal, lateral or combined g-forces over a threshold of 0.50. During parental feedback periods, videos and coaching tips were e-mailed to parents/guardians on a daily basis. Average number of events during feedback and non-feedback periods were compared using Student t-tests ($\alpha=0.05$).

Results: 199 cases of the 221 enrolled subjects completed the full year of study. Eleven were excluded from the analysis due to a lack of events. Of the remaining, the median age was 16 and 54% were male. 16,770 events occurred during the study. Males experienced a significantly higher mean number of events compared to females in both non-feedback and feedback settings [116 vs. 51 ($p=0.03$) and 31 vs. 18 ($p=0.019$), respectively]. In the feedback→feedback group, the average number of events was 24 and 23, respectively. In the feedback→control group, the average number of events was 22 and 69 ($p=0.044$), respectively. In the control→feedback group, the average number of events was 106 and 28 ($p<0.0001$), respectively. The number of events during the non-feedback period following the feedback period (69) was not significantly lower than the non-feedback period prior to the feedback period (102) ($p=0.24$).

Conclusions: Video monitoring with parental feedback significantly decreases the frequency of risky driving behavior among newly licensed teen drivers. This positive effect was not significantly sustained after feedback was discontinued.

THE SPECTRUM OF SUBSTANCE ABUSE IN ELDERLY TRAUMA PATIENTS

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Introduction: Alcohol and drug abuse are recognized to be significantly prevalent in trauma patients, and are frequent harbingers of injury. The incidence of substance abuse in elderly trauma patients has however been limitedly examined. We sought to identify the spectrum of positive alcohol & drug toxicology screens in patients = 65yrs admitted to a Level I Trauma Center

Methods: Patients = 65 yr old admitted to an ACS Level I Trauma center over a 60-month period were identified from the trauma registry. Demographic data, blood alcohol content (BAC) and urine drug screens (UDS) results at admission were obtained where available by chart review. Some patients had medially administered opiates prior to arrival. The positive results were compared with individuals below 65 yrs in different substance categories using Fischer’s exact test.

Results: In 5 yr period studied, of the 4139 patients = 65 yrs, 1305 (31.5%) underwent BAC or UDS screening. A Positive BAC was present in 10.7% of these patients and a positive UDS in 48.5%. There was a male preponderance – (72%BAC & 57% UDS) The mean BAC level in those tested was 163g/dL and 71% of patients had a level >80g/dL.

		(= 65)	(< 65)	P value
Positive BAC		140/1305 (10.7%)	1238/2791 (44.4%)	< 0.0001*
Positive UDS	Opiates	217/501 (43.3%)	769/1663 (46.2%)	0.2604
	Marijuana	6/501 (1.2%)	491/1663 (29.5%)	< 0.0001*
	Cocaine	8/501 (1.6%)	195/1663 (11.7%)	< 0.0001*
	Amphetamines	3/501 (0.6%)	23/1663 (1.4%)	0.1647
	Total UDS	243/501 (48.5%)	1239/1663 (74.5%)	< 0.0001*

Conclusion: Alcohol and drug abuse are an issue in patients = 65yrs though not as pervasive a problem as in younger populations. Admission toxicology screens are important as an aid to identify geriatric individuals who may require intervention. Administration of benzodiazepines, opiates and other medications in the course of transfer may confound results and potentially mask prescription and street drug abuse.

FACTORS ASSOCIATED WITH NEURO-TRAUMA IN NON-HELMETED MOTORCYCLIST: A FIVE-YEAR REVIEW.

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Introduction: Neuro-trauma (NT) injuries of the head and spine often result from motorcycle crashes. This study examines the relationship of non-helmet use to specific NT injury patterns, alcohol intoxication and the fiscal implications of caring for these potentially preventable injuries.

Methods: Motorcyclists with NT admitted to our urban, level I trauma center for ≥ 2 days from Jan 2005 – Dec 2009 were included. NT injuries included head injuries (intra-cranial pathology and/or facial/skull fractures) and spine fractures (with or without spinal cord injury). Demographic data, emergency department (ED) physiologic and serum alcohol data, insurance status and accrued hospital charges were analyzed (SAS v 9.2).

Results: Eight hundred motorcyclists were evaluated, with 300 having NT. Seventy-one percent of the cohort (n=212) were non-helmeted (NH). Age (42.3 ± 13.7), ISS (23.8 ± 11.6), mortality (4.3%), rate of ED systolic BP < 90 mmHg (4.7%) and rate of spinal cord injury (0.7%) did not differ statistically between helmeted and NH riders. NH riders had a lower total ED GCS and motor GCS (11.5 ± 4.8 vs. 13.2 ± 4.0 , $p=0.002$; 4.8 ± 2.0 vs. 5.4 ± 1.6 , $p=0.015$). Lack of helmet use was associated with head injuries, alcohol intoxication and self pay insurance status yet protective for spine fractures (Table). The mean hospital

Non-Helmeted Motorcyclist	OR	95 % CI	p value
Head Injury	2.29	1.33-3.94	0.003
Head Injury and Spine Fractures	1.72	0.90-3.30	0.10
Spine Fractures	0.31	0.19-0.53	<0.0001
Alcohol Intoxication	8.17	2.83-23.55	0.0001
Self Pay Insurance Status	3.39	1.29-8.96	0.01

charge for NH riders was $\$102,284 \pm 107,790$ compared to helmeted riders $\$94,560 \pm 122,463$ ($p=0.52$).

Conclusion: NH motorcyclists have a predictable pattern of NT injury, alcohol intoxication and insurance status. In the current environment of health care reform, identification and prevention strategies for reversible injury patterns should be promoted as under or non-funded patients require more financial support from taxpayers.

**ALCOHOL SCREENING AND INTERVENTION FOR TRAUMA PATIENTS
REDUCES ALCOHOL CONSUMPTION AND HIGH-RISK BEHAVIORS**

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Introduction: This study evaluates the impact of the alcohol screening and brief intervention (SBI) program for intoxicated patients at Santa Barbara Cottage Hospital. While SBI has now become the standard of care for trauma centers in the United States, controversy exists over the efficacy of such programs. While some well-designed trials have shown that SBI programs reduce trauma recidivism by as much as 50% (Gentilello et al., 1999), others have recently failed to duplicate these findings (Roudsari et al., 2009).

Methods: We conducted a longitudinal observational study of hospitalized trauma patients who were intoxicated upon admission to our trauma center, and who underwent an SBI. Trauma patients >13 years old with positive blood alcohol concentrations who consented to the study were interviewed during their hospital stay. Follow-up interviews were conducted via telephone at 2 and 8 weeks post-discharge.

Results: A total of 114 patients were included in the study. At 8 weeks, there were significant decreases in all measures of alcohol consumption and high-risk behavior. The number of drinks per week decreased by 8.98 ± 1.18 ($p < 0.001$). The most drinks consumed in one day decreased by 7.57 ± 0.64 ($p < 0.001$). The number of times blacked out per week decreased by 0.24 ± 0.06 ($p < 0.001$). There was a reduction in the amount of times per week that the patients felt they had a problem with alcohol 0.74 ± 0.30 ($p < 0.001$), and the number of times they wanted to stop drinking but couldn't 0.97 ± 0.29 ($p < 0.001$). Ninety-one percent reported avoiding high-risk behaviors while drinking, and 83% indicated that they were influenced in a positive way by the intervention.

Conclusion: Our data demonstrate that the SBI program at Cottage Hospital significantly reduces both alcohol consumption and alcohol related high-risk behaviors. A significant number of patients who are in various stages of alcoholism will present to hospitals with injuries. A program that can alter the behavior of these individuals can significantly reduce the consequences of alcoholism, both for the individuals and for the community.

PEDIATRIC PENETRATING TRAUMA IS ON THE RISE AND IS ACCOMPANIED BY INCREASED LETHAL INTENT: THE SAN FRANCISCO BAY AREA EXPERIENCE.

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Introduction: Pediatric penetrating injuries continue to plague inner cities. Based on our clinical observations, we hypothesized that pediatric penetrating trauma is on the rise and increasingly involves younger children.

Methods: We retrospectively reviewed the trauma databases between 2000 and 2009 of the three major trauma centers in Alameda and San Francisco counties. Penetrating trauma patients aged 16 and under were included. Demographics, injury severity score (ISS), probability of survival (POS), length of hospital stay (LOS) were collected.

Results: We identified 598 pediatric penetrating patients: 444 gunshot wounds (GSW), 135 stabbings (SW), and 19 other. Pediatric penetrating trauma increased 3-fold from 2002 to 2009 ($p = 0.03$). The mean age of the victims was 13.9 ± 0.1 with no change during the study period ($p = 0.12$). Fifty-six children (9.3%) aged = 10 suffered penetrating trauma, 29 were aged = 5. The overall mean LOS was 5.4 ± 0.4 days, and trended down from 4.8 to 3.8 days ($p = 0.20$). The GSW mean LOS was longer than for SW, 5.9 ± 0.6 days vs. 3.5 ± 0.5 days ($p = < 0.02$). The mean ISS for GSWs was 13.4 ± 0.7 , and did not change during the study period. The mean ISS for GSW deaths was 34.1 ± 2.7 . The mortality rate for pediatric penetrating trauma was 9.2%, and trended down from 9.1% to 7.2% during the study period ($p = 0.29$). Mortality rates for GSW and SW were 10.8% and 5.2%, respectively. The overall POS was 88.9% and did not change. The incidence of single GSW to the head increased from 3 to 7% ($p = 0.048$) and carried a 63% mortality rate.

Conclusion: To our knowledge, this is the largest study to date of pediatric penetrating trauma. Pediatric penetrating trauma in the Bay Area increased over the last decade but, contrary to our impression, there was no change in the age of victims. Despite a stable injury severity, the trend in improved survival and decreased LOS suggests improvements in trauma care. An onerous sign is that pediatric single GSWs to the head are increasing, which points to a more deliberate lethality in these attacks.

**PREMATURE TRANSFER OF OLDER TRAUMA PATIENTS FROM THE ICU
INCREASES HOSPITAL LENGTH OF STAY AND MORTALITY**

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Introduction: Intensive Care Unit (ICU) readmissions increase cost, hospital length of stay (LOS) and mortality. To our knowledge, the impact of ICU readmissions has not been evaluated in trauma patients. We investigated the etiology of readmissions to the ICU, risk factors for readmission, and outcomes of these patients.

Methods: Prospectively data was collected on all patients admitted to the ICU in 2009. Patients were divided into readmissions from within our Trauma Center to the ICU versus standard ICU course.

Results: During the study period, 1154 patients were admitted to the ICU. 152 patients died during their initial ICU stay and were excluded. 202 (20%) of the remaining 1002 patients required readmission to the ICU. Patients readmitted to the ICU were older (58 ± 19.5 vs. 46.3 ± 20.2 years; $p < 0.0001$), had a higher GCS (13.6 ± 3.2 vs. 10.9 ± 4.4 ; $p < 0.0001$), and lower ISS (21.1 ± 11.1 vs. 26.3 ± 13.7 ; $p < .0001$). The majority of readmissions were due to respiratory deterioration ($n=103$ or 51%) and unanticipated surgical procedures ($n=46$ or 23%). Patients readmitted to the ICU had more hospital days (18.2 ± 15.1 vs. 14.6 ± 11.8 days; $p=0.0023$) and a significantly greater mortality (12.4% vs. 0.5%; $p < 0.001$).

Conclusion: Trauma patients readmitted to the ICU have increased LOS and a significantly higher mortality. These readmitted patients are significantly older, with readmissions mostly related to respiratory deterioration. Careful attention should be paid to older patients' respiratory status when considering transfer to a step down unit.

**DISABILITY ADJUSTED LIFE YEARS AFTER VIOLENT INJURY:
QUANTIFYING THE HEALTH AND ECONOMIC BURDEN OF
INTERPERSONAL VIOLENCE**

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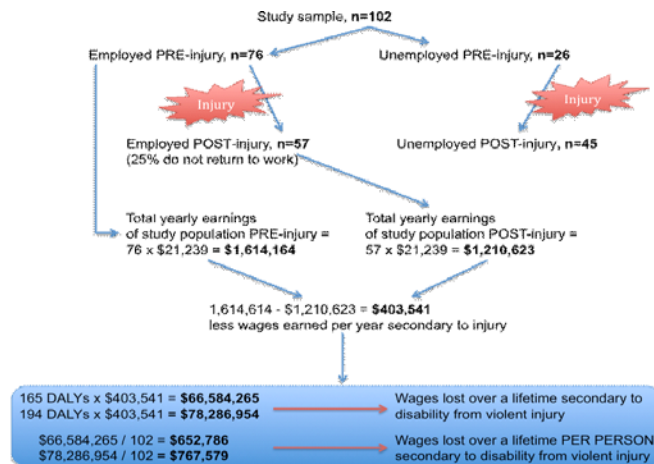
Introduction: Violent injury devastates urban underserved populations, but the impact over a lifetime is not well characterized. The disability-adjusted life year (DALY) measures the burden of disability and is used widely to describe the long-term impact of a particular disease or injury. The objective of this study was to calculate DALYs and lost wages attributable to violence and its consequences on physical and mental health.

Methods: In this retrospective case series analysis, we conducted an in-depth review of 102 clients in our violence prevention (VP) program. We calculated DALYs using data from our trauma registry and VP program database and disability weights from the WHO. Using data on unemployment and salaries obtained from the Bureau of Labor Statistics, we estimated the earnings lost over a lifetime secondary to disability from violent injury.

Results: The mean age was 20 years. 39% had evidence of PTSD post-injury. Violent injury accounted for 165 years of healthy life lost. Disability weight for mental illness accounted for an 18% DALY increase. See figure for lost wages. When mental illness is included in disability, lost wages increases to \$767,579 per person.

Conclusion: Other studies have shown that in African American

men, violent injury accounts for more DALYs than heart disease. In a population already suffering from high unemployment and high incidence of chronic disease, the physical and mental impact of violent injury creates another threat to this population’s health and economic wellbeing. Violence prevention is necessary to save lives and livelihoods.



A PROSPECTIVE ANALYSIS OF OCCUPATIONAL EXPOSURES TO THE TRAUMA TEAM: IS BEING A TRAUMA SURGEON HAZARDOUS TO YOUR HEALTH?

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Background: Resuscitation and emergent surgical management of critically injured patients frequently exposes health care workers to blood borne pathogens. Despite the known risks, occupational exposures continue to occur. Studies regarding the nature of these exposures are limited. The goal of this study was to identify the type and mechanism of exposures on the trauma service in order to develop preventive strategies.

Methods: From July 1 2009 to June 31, 2010 trauma team members consisting of trauma attendings, residents and medical students at a Level 1 Trauma Center were provided a weekly anonymous questionnaire. Data collection included any mucocutaneous exposures during the preceding week, the level of training, and 15 questions related to the timing, location, procedures, and circumstances surrounding the exposure. Whether the exposure was reported to health services was also documented.

Results: 55 exposures were reported out of 352 responses (15.6%). 32 (58%) exposures were mucocutaneous contamination and 23 (42%) were sharps injuries. 23 (42%) occurred during acute resuscitations, 19 (34%) in the OR, 12 (22%) in the ICU and 1 (2%) on the ward. Most frequently exposed were residents (n=35, 64%, p=0.04) followed by attendings (n=11, 20%) and medical students (n=9, 16%). Barrier precaution use in those exposed were: single gloves, 45 (82%); gown, 32 (58%); eye protection, 32 (58%); mask, 29 (53%); double gloves, 7 (13%). 4 of the 32 (13%) mucocutaneous exposures and 6 of the 23 (26%) sharps injuries were reported to health services.

Conclusion: Exposures to blood borne pathogens occur at a high rate on a trauma service. Preventive strategies should focus beyond the scope of the OR to encompass the resuscitation area and the ICU. Educational programs should be implemented to address the poor compliance rate with barrier precautions and the under-reporting of sharps injuries.

PREDICTORS OF AT RISK OR DEPENDENT DRINKING BEHAVIOR IN 1340 ADULT TRAUMA PATIENTS: A COMPUTERIZED ALCOHOL SCREENING AND INTERVENTION (CASI) STUDY

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Background: Alcohol screening and brief intervention (SBI) is a feasible and effective method for significantly decreasing alcohol consumption, healthcare costs, and injury recidivism in trauma patients. Despite SBI being mandated for all Level I and II trauma centers, concerns regarding cost, logistics, and privacy have led many centers to only conduct SBI on trauma patients with a detectable blood alcohol concentration (BAC). We sought to determine the predictive nature of BAC on at-risk or dependent drinking.

Methods: All adult trauma patients treated at a level-1 trauma center from 9/2009 to 2/2011 had a BAC measured and a SBI attempted prior to discharge from either the ED or inpatient unit. SBI was administered using a bilingual Computerized Alcohol Screening and Intervention (CASI) system with a 10-question Alcohol Use Identification Test (AUDIT) to classify a patient as a non-drinker, not-at-risk drinker, at-risk drinker, or dependent drinker. Data regarding age, gender, and BAC were prospectively collected. BAC was also dichotomized as detectable ($>0\text{mg/dL}$) and over the legal limit ($>80\text{mg/dL}$). Multivariate analyses were performed to identify independent predictors of at-risk or dependent drinking with a p value <0.05 .

Results: Data were complete for 1340 patients with a mean age of 43 ± 20 years and BAC of 41 ± 95 mg/dL. 68% were male, 33% had a detectable BAC, and 16% were legally intoxicated. 19% were classified as at-risk or dependent drinkers. Multivariate analysis identified age (OR 0.975 per year), male gender (OR 3.2), BAC (OR 1.009 per mg/dL), detectable BAC (OR 4.3), and legal intoxication (OR 8.4) as independent predictors of at-risk or dependent drinking. 38% of at-risk or dependent drinkers had no detectable BAC.

Conclusion: Younger age, male gender, and higher BAC are early predictors of at-risk or dependent drinking in adult trauma patients. However, more than a third of at-risk or dependent drinkers do not have a detectable BAC on admission and are not receiving an intervention in centers that screen solely based on BAC.

THE ROLE OF DAMAGE CONTROL RESUSCITATION IN NON-TRAUMA PATIENTS

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Introduction: Damage control resuscitation with plasma and packed red blood cells (PRBC) transfused in a ratio of 1:1 has gained recent favor in trauma patients. The purpose of this study was to determine if 1:1 plasma to PRBC resuscitation is beneficial in non-trauma patients who receive a blood transfusion.

Methods: Five year (2006 – 2010) retrospective study of non-trauma patients (medical and surgical) who underwent blood transfusion of ≥ 6 units of PRBC during a 24-hour period. Amount of plasma and PRBC transfused was collected for each patient and the ratio of plasma:PRBC was calculated. Patients were divided into three subgroups, high ratio group (plasma:PRBC ≥ 1), low ratio group (plasma:PRBC < 1), no plasma group (zero plasma transfused). Primary outcome was mortality.

Results: There were 251 non-trauma patients who received > 6 units PRBC transfusion during a 24-hour period. The population received an average of 6 units of plasma and 8 units of PRBC, with an average plasma:PRBC ratio of 1:1.4. There were 82 (33%) patients in the high ratio group, 119 (47%) patients in the low ratio group, and 50 (20%) patients who received only PRBC and no plasma. Amount of plasma transfused, plasma:PRBC ratio, and mortality for each group shown below:

	High Ratio (n = 82)	Low Ratio (n = 119)	No plasma (n = 50)	P value
Plasma Transfused	10 \pm 4 units	5 \pm 4 units	0 units	< 0.0001
plasma:PRBC	1.3:1	1:1.8	0	< 0.0001
Mortality	23% (n = 19)	17% (n = 20)	6% (n = 3)	0.037

Conclusions: Resuscitation with a plasma:PRBC of 1:1 may not be beneficial for medical and surgical non-trauma patients requiring transfusion and may be associated with an increase in mortality. Further studies are needed to determine the ideal ratio of plasma:PRBC in non-trauma patients requiring transfusion.

**INTENSIVISTS IMPROVE OUTCOMES AND COMPLIANCE WITH
PROCESS MEASURES IN CRITICALLY ILL PATIENTS**

Javariah I Asghar, MD, MPH, Uroghupatei P Iyegha, MD, Elizabeth B Habermann, PhD, MPH, Alain F Broccard, MD, Craig R Weinert, MD, MPH, Gregory J Beilman*, MD. University of Minnesota Dept of Surgery.

Introduction: Specialty-trained intensivist involvement in the care of critically-ill patients has been associated with improved outcomes. However, factors contributing to this observation are still being elucidated. We hypothesized that intensivist-led ICU care would result in decreased mortality, length of stay (LOS) and rate of DVT/PE along with improved compliance with ICU process measures.

Methods: We performed a retrospective review of 847 patients, utilizing the transition at a regional medical center from an open ICU to one where board-certified intensivists assume primary responsibility. Patients were admitted to the ICU over 3-months immediately prior to the transition (June-September 2008) and one year after (June-September 2009). Endpoints included mortality, LOS, DVT/PE rates, and several ICU process measures.

Results: Patients in the post-intensivist cohort experienced decreased hospital LOS and received timely nutrition and DVT prophylaxis more frequently. Although overall mortality was unaffected, patients admitted to the ICU with sepsis demonstrated a marked decrease in mortality (p=0.002). There were no significant demographic differences between the groups.

Conclusion: Intensivist-led ICU care is associated with a shorter hospital stay and timely initiation of nutrition and DVT prophylaxis. While overall in-hospital and ICU mortality, ICU LOS and DVT/PE rates were unaffected, mortality in patients admitted to the ICU with sepsis was dramatically decreased.

	Pre-Intensivist N= 414	Post-Intensivist N= 433
In-hospital mortality %	12.8	9.4
ICU mortality %	6.5	7.2
In-hospital mortality for patients w sepsis %	27.3	7.9*
Hospital LOS (days)	8.7	7.1*
ICU LOS (days)	3.2	3.5
DVT/PE %	0.8	2.3
Antibiotics in 6h %	93.2	97.5
DVT prophylaxis %	28.4	75.7*
GI prophylaxis %	75.2	69.1
Nutrition in 48h %	80.6	87.3*
* p <0.05		

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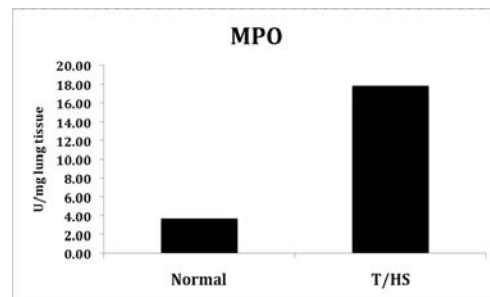
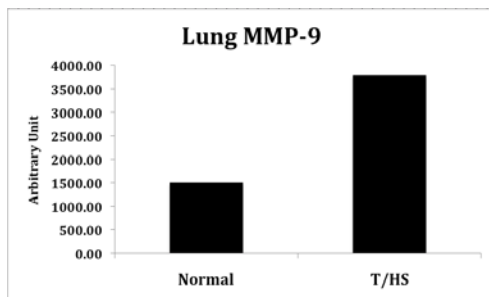
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TRAUMA/HEMORRHAGIC SHOCK INCREASES MATRIX METALLOPROTEINASE-9 IN PULMONARY TISSUE

Wilbert L Jones, MD, Kirk Hansen, PhD, Ernest E Moore, MD*, Monika Dzieciatkowska, PhD, Max Wohlaer, MD, Roopali Shah, BS, Christopher C Silliman, MD, PhD, Anirban Banerjee, PhD. University of Colorado.

Introduction: Matrix Metalloproteinases (MMPs) are known to degrade various collagenase components of the alveolar architecture. Neutrophil (PMN) mediated acute lung injury (ALI) is detected histologically and also by myeloperoxidase (MPO), which are stored in azurophil granules. We hypothesize that MMP-9, a known content of gelatinase granules, would be increased following ALI induced by trauma/hemorrhagic shock (T/HS).

Methods: Briefly, male Sprague-Dawley rats were anesthetized using pentobarbital. Rats were divided into two groups Control and T/HS. Control: anesthesia followed by lung removal with flash freezing in liquid nitrogen. T/HS: underwent cannulation, tracheostomy, and laparotomy and then blood was removed to establish a baseline MAP of 30mmHg x 45mins and the rats were then resuscitated using shed blood and normal saline, lungs were collected 3 hours post-T/HS. The lungs were homogenized in PBS. The supernatant was collected and 10ug of total protein per sample was used for zymography for renaturable gelatinases. MPO was conducted in the standard fashion. Analysis was done using paired t-test. **Results:** Gelatinase activity by proMMP-9 is increased (2.5 fold) in lung tissue post-T/HS in comparison to normal lung ($p=0.01$). In parallel, MPO levels were also elevated (5 fold) in the T/HS rats ($p=0.04$). **Conclusion:** The presence of proMMP-9 correlates with presence of PMN 3 hours post-T/HS, and MMP-9 may play a role in alveolar basement membrane/extracellular matrix degradation seen in ALI.



**POPULATION-BASED EPIDEMIOLOGY OF FEMUR SHAFT FRACTURES:
DAMAGE CONTROL ORTHOPAEDICS OR GERIATRIC FRACTURE CARE?**

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Objective: Femur shaft fracture (FSF) management is often a decision making dilemma [damage control orthopedics (DCO) vs early total care (ETC)], with equivocal evidence. The purpose of this prospective study was to describe the population based epidemiology of FSF with special focus on patient physiology and timing of surgery.

Methods: A 12-month prospective population-based study was performed on consecutive FSF in a 600,000 population area including all ages and prehospital deaths. Patient demographics, mechanism, injury severity score (ISS), shock parameters (SBP, BD and Lactate), transfusion requirements, co-morbidities and outcomes were recorded. Patients were categorized according to the OTA: 'stable, borderline, unstable and in extremis'.

Results: A total of 125 patients (20.8/100,000/year) with 134 femur fractures. (62% male, age 37±28 years, ISS 20±19, 51% multiple injuries) were identified in two hospitals. 69 patients (55%) sustained a high energy injury (HE) with 16 (23%) of these being polytrauma patients (ISS 28±12, SBP 98±39, BD 6.5±5.8, Lactate 4±2), 15 (94%) required massive transfusion (12±12URBC, 8±5 FFP, 1±0.4 PLT, 13±8 Cryo). The overall LOS was 18±15 days and the ICU LOS was 5±6 days. All HE patients were operated on within 6±13 hours. Of the 125 patients 69% were stable (14.5/100,000/year), 9% borderline (1.8/100,000/year), 4% unstable (0.8/100,000/year) patients and 2% (0.3/100,000/year) were in extremis. All borderline patients received ETC, 60% of the unstable patients and all patients in extremis had DCO. Five deaths occurred due to severe head injury and one due to uncontrolled hemorrhage. 56 patients (45%) sustained a low energy injury (LE) with 85% having multiple co-morbidities. Time to surgery was 25±37 hrs and LOS was 15±11 days.

Conclusion: Most of the FSF are complicated and require specialist care (polytrauma, massive transfusion, elderly with co-morbidities). While the frequently debated DCO is rarely (<10%) indicated (2/100,000/year), the geriatric low energy FSF should deserve more attention due to their high incidence and major resource utilization.

ASSOCIATION BETWEEN PEDIATRIC OBESITY AND LONG BONE FRACTURE SEVERITY-TOUGH BREAKS FOR OBESE KIDS?

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Introduction: Previous studies suggest obese children are at increased risk for extremity fracture; however, the association between body habitus and fracture severity remains unclear. We examined whether obese children with tibia or femur fracture have more severe injuries and higher inpatient morbidity/mortality compared to non-obese children.

Methods: Review of single institution trauma registry for patients 2-15yo, with tibia or femur fracture from Sept.04 to Sept.09. Patients weighing = 95th % for age and gender were classified as obese. Fractures were classified using the Orthopedic Trauma Association (OTA)/AO child and adult fracture classifications where modifiers *B* and *C* and *Ped. severe* indicate > severity. Chi-square/Fisher's Exact test and t-test were used to test significant differences between groups for categorical and continual variables respectively.

Results: The obese group was older (10.4 yrs vs. 8.8 yrs, p=.01) and had a higher mean ISS (22 vs.16 p<0.01). Groups were similar regarding race, gender, extremity Max AIS score, trauma activation level, length of stay, ICU days, days on mechanical ventilation, and proportion of open fractures. Obese patients had a higher proportion of inpatient complications, increased mortality, and OTA B/C type tibia fractures, (See Table).

	Obese (n=42)	Non-obese (n=137)	P-value
Inpatient Comp (%)	9 (21.4)	14 (10.2)	0.06
Mortality (%)	5 (11.9)	3 (2.2)	0.02*
Femur Fx w/X-Ray	Obese (n=36)	Non-obese (n=101)	
OTA B/C (%)	13 (36.1)	41 (40.6)	0.64
OTA Ped severe (%)	12 (33.3)	38 (37.6)	0.65
Tibia Fx w/X-Ray	Obese (n=10)	Non-obese (n=49)	
OTA B/C (%)	7(70.0)	15 (30.6)	0.03*
OTA Ped severe (%)	6(60.0)	14(28.6)	0.07

Conclusion: Obese patients had more severe tibia fractures, greater mortality and approximately a two-fold increase in inpatient complications, though this relation failed to reach statistical significance. Further study is needed to confirm these findings and evaluate etiology.

**OVERCOMING CHALLENGES OF ENDOVASCULAR TREATMENT FOR
COMPLEX SUBCLAVIAN AND AXILLARY ARTERY INJURIES IN
HYPOTENSIVE PATIENTS**

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Matthew J Wall*, Jr, MD. Baylor College of Medicine.

Introduction: Endovascular repair of axillary and subclavian artery injuries is well described, but has been considered contraindicated in the setting of hypotension, complete transection or thrombosis. The purpose of this report is to describe an experience with a unique endovascular approach our service has developed to overcome challenges in treating complex subclavian and axillary artery injuries in hypotensive patients.

Methods: An endovascular technique following universal principles of vascular control, thrombectomy and repair was developed. This technique, formulated to be used in patients with hypotension, complete transection and thrombosis uses a combination of proximal balloon control, endovascular wire snare, stent grafting, and balloon thrombectomy. All procedures were performed in a standard operating room by a multi-disciplinary trauma service equipped with a portable C-arm and fluoroscopic table. Patients were tracked prospectively in a vascular trauma registry.

Results: Seven consecutive patients underwent endovascular repair of complex axillary (4) artery and subclavian (3) artery injuries utilizing our described technique. All injuries were from penetrating trauma and resulted in complete transection or thrombosis. Nearly all (5/7) were hypotensive (SBP<90). Multiple cavity injuries were present in 2 patients. Technical success rate was 100% with zero 30-day mortality. Serial follow-up duplex ultrasound was obtained on all patients. There was one late graft thrombosis however without clinical sequelae.

Conclusion: Endovascular treatment for subclavian and axillary artery injuries is a safe and feasible option even in the setting of complex injury and hypotension. Endovascular techniques can be simplified and modified to conform to standard vascular trauma management principles and as such safely be applied during the acute resuscitation of a trauma patient.

TEMPORARY IVC FILTERS CAN BE SUCCESSFULLY REMOVED IN TRAUMA PATIENTS: THE RESULTS OF A DEDICATED FILTER REGISTRY AND CRITICAL PATHWAY FOR FILTER REMOVAL

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Background: Temporary IVC filters are uniquely suited for trauma patients, in whom the high risk of venous thromboembolism (VTE) is usually only temporarily related to recovery from their injuries. Unfortunately, most “retrievable filters” are not retrieved.

Methods: All permanent and temporary filters were entered prospectively into a dedicated filter registry. Within 60 days of filter placement, all temporary filter patients were contacted by a trauma case manager to evaluate ongoing VTE risk. Low-risk patients were then evaluated by radiology for removal of IVC filter. Radiology then reassessed VTE risk at an office visit. If appropriate, removal of IVC filter was scheduled. Initial contacts with patients were made via a phone call. If unable to obtain initial phone contact – family members, rehabilitation facility, social work were all contacted to obtain most recent phone number and address. A follow-up letter was sent to patient with follow up visit information. Finally, if above contact measures did not work, a certified letter was sent to last known address.

Results:

	2006	2007	2008	2009
Total (Permanent/Temporary)	89 (34/55)	79 (20/59)	108 (30/78)	144 (58/86)
Temporary ⇨ Permanent*	29	22	30	37
Filters Available for Removal (FAR)	26	37	48	49
Unsuccessful Removal (UR)	3	0	3	0
No Show (NS)	3	2	5	12
Unable to Contact or Refused Removal (UC)	2	1	15	12
Expired (E)	1	3	4	9
Retrieval Rate**	68%	91%	47%	70%

*Filter had clot on evaluation or patient met criteria for permanent indication.

**Retrieval Rate = FAR – E – (UR+NS+UC)/FAR – E

Conclusion: A retrieval rate of 59% can be achieved with an explicit process of care. Our rate of retrieval is due to an aggressive process of follow-up.

AUTOTAXIN INHIBITION ATTENUATES OBSERVED INCREASES IN MICROVASCULAR PERMEABILITY IN RAT MESENTERIC VENULES AFTER ISCHEMIA-REPERFUSION INJURY

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Background: Autotaxin (secretory lysophospholipase D), is an enzyme responsible for the production of lysophosphatidic acid (LPA). LPA has been implicated in the pathogenesis of increased microvascular permeability and microvascular dysfunction. We hypothesized that autotaxin inhibition would attenuate increases in permeability observed after anoxia-reoxygenation (AR) *in vitro* and ischemia-reperfusion (IRI) *in vivo*.

Methods: Cultured bovine pulmonary artery endothelial cells (BPAECs) were exposed to anoxia (1 hour) with subsequent reoxygenation (4 hours) (AR group). A biotinylated albumin assay assessed monolayer permeability changes during anoxia-reoxygenation with/without a specific inhibitor of autotaxin (H2L9098) (n=3 each). Next, an intra-vital micro-occlusion technique was used to measure microvascular permeability (L_p) in rat mesenteric post-capillary venules exposed to IRI (45 minutes SMA occlusion, 300 minutes reperfusion, n=6) and in the presence and absence of H2L9098 (n=3 each). Units for L_p are expressed as $\text{cm}\cdot\text{sec}/\text{cm}\cdot\text{H}_2\text{O}\times 10^{-7}$.

Results: AR increased monolayer permeability 4-fold (permeability control vs. AR = 0.09 ± 0.01 vs. 0.4 ± 0.01 $\mu\text{g}/\text{mL}$, $p<0.01$). Both pre- and post-anoxia administration of H2L9098 attenuated this response back to near control levels (permeability AR = 0.4 ± 0.01 , AR+H2L9098(pre) = 0.09 ± 0.01 , AR+H2L9098(post) = 0.1 ± 0.02 $\mu\text{g}/\text{mL}$, $p<0.01$). *In vivo*, IRI increased L_p in a biphasic manner, with a 6-fold increase at 105 min (1st phase) and 8-fold at 270 min (2nd phase). H2L9098 administered after SMA occlusion attenuated L_p by 30% in 1st phase (L_p IRI vs IRI+H2L9098 = 6.0 ± 0.47 vs. 4.7 ± 0.23 , $p<0.01$) and 55% in 2nd phase (L_p IRI vs IRI+H2L9098 = 8.1 ± 0.85 vs. 4.1 ± 0.49 , $p<0.01$).

Conclusion: Autotaxin inhibition attenuates increases in microvascular permeability during AR *in vitro* and IRI *in vivo*. This may be due to decreased LPA production during autotaxin inhibition. Decreasing LPA production through autotaxin inhibition may be a potential therapy in the treatment of IRI.

**TEMPORAL EFFECT OF PH ON PERMEABILITY IN MONOLAYERS OF
BRAIN MICROVASCULAR ENDOTHELIAL CELLS**

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Introduction: Treatment of traumatic brain injury (TBI) using either hyperosmolar therapy or hyperventilation leads to acidosis or alkalosis, respectively. Changes in pH affect the permeability of brain microvascular endothelial cells (HuBrEc), which could ultimately potentiate edema associated with TBI. We have analyzed the temporal changes in permeability, *in vitro*, of HuBrEc in both alkalotic and acidotic conditions in order to evaluate the effects of conventional treatment during specific time frames in the course of TBI treatment on brain vascular permeability.

Methods: The resistance of HuBrEc monolayers was measured using Electric Cell-substrate Impedance Sensing (ECIS), in real-time over 50 hours, under both alkalotic and acidotic conditions (pH 6.5, 7.0, 7.4, and 8.0). The release of both IL-6 and IL-8, cytokines that increase permeability of endothelial cells, were also quantified 24 hrs post treatment using ELISA.

Results: Immediately following treatment, resistance across the HuBrEc monolayer increased in a dose dependent fashion as pH decreased; monolayers at pH 6.5 were least permeable while those at pH 8.0 were most permeable- as measured by ECIS. However, the increased resistance observed in monolayers at pH 6.5 changed such that, by 2.5 hours post-treatment, permeability in this monolayer was higher than any other group. IL-8 expression was increased 50% at pHs 6.5 and 7.0 as compared to pH 7.4. IL-6 expression was unchanged between pH 6.5, 7.0, and 7.4.

Conclusions: Initially, acidotic conditions decrease permeability of HuBrEc monolayers, which may be beneficial in ameliorating edema associated with TBI. However, acidotic conditions lasting longer than 2.5 hours results in increased permeability in HuBrEc monolayers and may actually contribute to edema. Increased expression of IL-8 in response to acidotic conditions indicates that this cytokine may play a role in mediating the response, whereas IL-6 does not.

DIFFERENTIAL INVOLVEMENT OF IKK ALPHA AND IKK BETA IN REGULATING MICROVASCULAR ENDOTHELIAL CELL BARRIER INTEGRITY

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Introduction: β -Catenin, an integral component of the endothelial adherens junctional complex is a key molecule that determines microvascular hyperpermeability in conditions such as hemorrhagic shock (HS). Both β -catenin and nuclear factor κ B (NF- κ B) proteins interact and serve as important regulators of several cellular functions including cell-cell adhesion. Two kinases, IKK α and IKK β , are critical activators of the NF- κ B pathway. The objective of this study was to understand the relationship between β -catenin and IKKs in maintaining barrier integrity.

Methods: HS was achieved in Sprague-Dawley rats by withdrawing blood to reduce MAP to 40 mmHg followed by resuscitation. Hyperpermeability of mesenteric post-capillary venules was studied using FITC-albumin under an intravital microscope. To evaluate the role of IKKs, the rats were given IKK inhibitor X prior to HS. Rat lung microvascular endothelial cells (RLMEC) were transfected with IKK α or IKK β siRNAs followed by β -catenin immunofluorescence. The role of IKKs in the nuclear translocation of β -catenin was studied by transfecting RLMEC with IKK α or IKK β siRNAs and TOPflash (or FOPflash as a control) reporter constructs followed by luciferase assay.

Results: IKK inhibitor X (2 mg/kg) attenuated HS-induced hyperpermeability ($p < 0.05$). In RLMEC, the adherens junctions showed strong β -catenin immunofluorescence. IKK α siRNA transfected cells showed preservation of β -catenin and the adherens junctions whereas IKK β siRNA transfected cells showed disruption of the adherens junctions. IKK α siRNA transfection did not induce β -catenin nuclear translocation whereas IKK β siRNAs did ($p < 0.05$).

Conclusion: Differential involvement of IKK α and IKK β may in part be responsible for regulating β -catenin localization in the adherens junctions and barrier integrity. Inhibition of IKK α may be a mechanism by which the IKK inhibitor provided protection against HS-induced hyperpermeability.

HYPOTHERMIA REDUCES RESUSCITATION FLUID VOLUMES REQUIRED TO MAINTAIN BLOOD PRESSURE IN A RAT HEMORRHAGIC SHOCK MODEL

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Objective: To examine the hypothesis that resuscitative hypothermia would: (1) reduce fluid requirements and reactive oxygen species production during a period of resuscitation; and (2) improve survival after hemorrhagic shock (HS) in rats.

Methods: Sixteen rats underwent: an HS phase (phase I; from 0–75 min), with pressure-controlled HS at a mean arterial pressure (MAP) of 30 ± 5 mmHg; a resuscitation phase (phase II; from 75–150 min), with fluid resuscitation to maintain MAP =75 mmHg; and an observation phase (phase III; from 150 min to 72 h). During phase II, eight rats were randomized into a normothermia group (group 1, control, 38°C) or a hypothermia group (group 2, 34°C). Rats were anesthetized during phases I and II, and were awake during phase III. Fluid requirements during phase II and survival at 72 h were compared between groups. Plasma levels of vitamin E and the redox status of coenzyme Q9 (%CoQ9) were also assessed.

Results: The fluid requirement during resuscitation in phase II was 8.2 ± 1.4 mL/100 g in group 1 vs. 2.1 ± 0.7 mL/100 g in group 2 ($p < 0.01$). Vitamin E level decreased to 10.8 ± 1.8 μ M/L during HS in all rats. After resuscitation, it was restored to a baseline level of 15.9 ± 3.1 μ M in group 2 but remained at 10.2 ± 0.8 μ M in group 1 ($p < 0.05$). %CoQ9 did not differ significantly between the groups. At 72 h, six of eight rats in group 1, and all rats in group 2 survived (NS).

Conclusion: In a rat HS model, hypothermia during resuscitation from HS reduces resuscitation fluid volume required to maintain blood pressure and restores vitamin E to the baseline level, and appears to have no adverse impact on long survival after HS.

IS LIMITED PREHOSPITAL RESUSCITATION WITH PLASMA OR ALBUMIN MORE ADVANTAGEOUS THAN HEXTEND, THE STANDARD RESUSCITATION FLUID ON THE BATTLEFIELD?

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Introduction: Recent reports of survival benefits of early transfusion of plasma with red cells (1:1 ratio) in trauma patients suggest that plasma may be a good alternative fluid to Hextend for battlefield resuscitation. We studied possible advantages of initial resuscitation with plasma as compared to Hextend or albumin in a model of uncontrolled hemorrhage.

Methods: Male NZW rabbits (3.3±0.1 kg) were anesthetized, instrumented and subjected to a standard splenic injury with uncontrolled bleeding into the open abdomen. Ten min after injury (MAP < 40 mmHg), rabbits were resuscitated with a limited volume (15 ml/kg) of Hextend (H, n=10), rabbit plasma (P, n=10), or 5% human albumin (A, n=9), given in two bolus injections (15 min apart) to a systolic target pressure of ~90 mmHg, as done on the battlefield. Animals were monitored for 2.5 hrs or until death. Arterial blood samples were collected at different time points and analyzed for ABG, CBC, and coagulation tests.

Results: There were no differences in baseline measures among groups. PT (6%) and aPTT (20%) were increased 30-min post-resuscitation with no overall differences among groups. Hematocrit, fibrinogen, BD and TEG values were significantly different at that time point (table). Survival times were 131±7 (H), 124±9 (P) and 147±3 (A) min (P=0.07).

gp	Hct %	Fibrinogen mg/dL	MAP mmHg	BD mM	TEG α(deg)	TEG MA	Total Bld loss(ml/kg)	Survival rate
H	22±1.2	118±12	41.7±5.3	5.9±1.3	55±2	53±2	27.2±1.8	4/10
P	25±0.9	167±14*	39.5±4.8	3.7±0.9	58±4	69±1*	23.3±2.4	4/10
A	26±1.1*	133±7	51.9±4.6	2.2±1.0*	66±2*	65±1*	23.8±1.8	8/9*

Data (mean± SEM) analyzed by Kruskal-Wallis, and Chi-square tests; *P<0.05 vs. H

Conclusion: Limited resuscitation with plasma or albumin better preserved coagulation function than did with Hextend. However, despite these hemostatic improvements, plasma resuscitation did not affect the overall blood loss or survival of the injured but non-coagulopathic rabbits. Albumin infusion appeared to improve survival here possibly by sustaining higher blood pressure and better tissue perfusion and oxygen delivery.

THE PREVALENCE OF THROMBOGRAM-BASED APC RESISTANT PHENOTYPES AMONG FFP DONORS

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Background: Severe injury and hemorrhagic shock often results in the acute coagulopathy of trauma (ACoT) and transfusion of blood products including fresh frozen plasma (FFP). While the mechanisms of ACoT are incompletely defined, increased activation of Protein C (APC) has been implicated in its pathogenesis. The hemostatic efficacy of transfused FFP in mitigating ACoT may depend on its sensitivity to APC. Changes in APC sensitivity result in different thrombin generation profiles and hemostatic potential. The aim of this study was to define the prevalence of APC phenotypes among FFP donors.

Methods: Sensitivity of the plasma to APC was evaluated with a global test of hemostasis which quantifies the endogenous thrombin potential (ETP). The APC ratio (APCr) is defined as ETP in the presence of APC divided by the ETP in the absence of APC. The APC-resistant phenotype value was set at = the 75th percentile of the normal/APC-sensitive APCr values. Other measurements included an aPTT-based APCr, residual platelet count (PLT), PLT factor 4 (PF4), PLT microparticles (PMP), coagulation factors and inhibitors.

Results: FFP from 39 single donor commercial units had a median APCr of 0.13 (IQR 0.09 - 0.28). APC-resistant phenotype (APCr = 0.28, $p < 0.0001$) was identified in 28% (11/39) of FFP units. With the aPTT-based assay APC-resistant units had significantly decreased APCr (2.63 ± 0.12 vs. 2.87 ± 0.41 , $p < 0.03$). The APC-resistant FFP was more likely to be female (11/25 vs. 0/14, $p < 0.002$), had higher PLTs (27 vs. $6 \times 10^9/L$, $p < 0.03$), and FXII (129 vs. 98%, $p < 0.05$), and a lower free Protein S (74 vs. 96%, $p < 0.0002$), compared to the APC-sensitive phenotype. The APCr showed strong correlation with free Protein S ($R = 0.95$), and FXI ($R = 0.68$), and less with PLT, PF4, and PMP.

Conclusion: We found a high prevalence of the APC-resistant phenotypes among FFP donors. As ACoT is associated with increased PC activation, transfusing APC-resistant FFP might be more effective in mitigating ACoT compared to FFP with the APC-sensitive phenotype.

**AN EMERGENCY DEPARTMENT THAWED PLASMA (TP) PROTOCOL
DECREASES BLOOD COMPONENT UTILIZATION AND IMPROVES
SURVIVAL IN SEVERELY INJURED PATIENTS**

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Background: Hemorrhagic shock resuscitation strategies have increasingly focused on earlier plasma transfusion. However, while crystalloids and uncross-matched RBCs are available in most EDs, plasma is traditionally kept in the blood bank. We have had thawed plasma (TP) stored in the blood bank (TP-BB) for years. However, to expedite delivery and transfusion of plasma, we recently implemented an emergency department (TP-ED) protocol. We hypothesized that having TP in the ED would not only reduce time to 1st plasma transfusion but 24-hour blood product use and mortality.

Methods: TP-ED protocol initiated 02/01/10. We evaluated all trauma patients admitted 8 months before and after implementing TP location change. Patients included if they (1) were major trauma activation, (2) were direct scene transports, and (3) received at least one unit of RBC and one unit of plasma in the 1st 6 hours. Primary outcome: time to 1st unit of plasma. Secondary outcomes: 24-hour blood use and 30-day mortality.

Results: 254 patients met study criteria (103 TP-BB, 151 TP-ED). Demographics were similar. Compared to TP-BB, TP-ED had higher injury score (median ISS 25 vs. 22, $p=0.02$) and physiological instability (median w-RTS 3.83 vs. 6.59, $p=0.02$). TP-ED had shorter time to 1st plasma transfusion (42 min vs. 83 min, $p<0.001$). 25% TP-ED patients received 1st plasma <20 min after arrival (vs. 1% in TP-BB, $p<0.001$). Controlling for anatomic (ISS), physiologic (w-RTS), and metabolic injury (base deficit), TP-ED reduced 24-hour transfusions of RBC ($p=0.016$), plasma ($p=0.035$), cryoprecipitate ($p=0.003$), and platelets ($p<0.001$). TP-ED had lower massive transfusion rate (27% vs. 39%, $p=0.045$). Controlling for ISS, w-RTS, base deficit, and mechanism, logistic regression identified TP-ED as an independent predictor of increased 30-day survival (OR 1.6, $p=0.038$).

Conclusions: We demonstrated that implementation of a TP protocol in the ED expedites transfusion of plasma to severely injured patients. This approach is associated with a reduction in overall blood product use and a 60% increase in odds of 30-day survival.

THE IMPACT OF DAMAGE CONTROL RESUSCITATION (DCR) ON OUTCOME IN PATIENTS WITH ABDOMINAL GUNSHOT WOUNDS

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Introduction: DCR strategies have become more standardized and widely applied over the last 5 years. In order to assess the impact on mortality in patients with severe abdominal gunshot wounds (AGWs) managed with DCR, we compared outcomes in a group of AGWS patients admitted from 2003 to 2006 (period 1-P1) with a group from 2007 to 2010 (period 2-P2) in a level one trauma center.

Methods: We identified 162 AGSWs patients managed with DCR in our ICU data registry and analyzed transfusion practices, crystalloid administration and mortality.

Results: RTS = Revised Trauma Score; PATI = Penetrating abdominal trauma index; NISS=New Injury Severity Score; PRC=Packed Red Cells; FFP=Fresh Frozen plasma

Table 1	Period 1 (n=83)	Period 2 (n=79)	P value
RTS, Me, IQR	7.55 (5.96 – 7.84)	6.9 (5.19- 7.84)	0.06
PATI, mean±SD	34 ± 15	34.9 ± 17.6	0.35
ISS, Me, IQR	25 (16 – 34)	25 (18 – 34)	0.7
NISS, Me, IQR	34 (34-44)	43 (34-50)	0.21
% patients SBP< 90	30.1	48.1	0.016
Total PRC U/24 h	9 (6-17)	8 (6-11)	0.8
Platelets U/24 h	11 (6-17)	12 (9-23.5)	0.01
FFP U/24h	9 (5-15)	10 (6-16)	0.7
Cryoprecipitate U/24 h	8 (6-12)	8 (6-12)	0.6
% pts PRC/FFP/plt 1:1:1	45.6	76	p<0.0001
Cell saver use %	1.3	15	0.001
Total Intra-Operative bleeding, Median IQR, ml	3350 (1950-5000)	2150 (1500-3500)	<0.001
Total crystalloids infused 24 h, ml	9100 (6900-12362)	6400 (4700-8700)	<0.001
Mortality/ 24 h, % (n)	24.1 (20)	7.6 (6)	0.0042
28 day Mortality, % (n)	28.9 (24)	11.4 (9)	0.006

Conclusion: The number of patients undergoing DCR strategies has significantly increased in this severely injured population. More aggressive use of blood products and reduced use of crystalloids resulted in a decrease in intra-operative bleeding. The combined effect of DCR interventions has had a significant impact on mortality in AGWs patients.

ACCOUNTING FOR DIFFERENCES IN TRANSFUSION VOLUME – ARE ALL MASSIVE TRANSFUSIONS CREATED EQUAL?

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Background: Among patients subjected to massive transfusion (MT), it is expected that some will require considerably more blood than others, depending on the rate and quantity of hemorrhage, which would obviously impact mortality. In analyses concerning plasma:RBC ratios, this has not been studied. We evaluated the effect of the *number* of RBC units transfused on plasma:RBC ratios and mortality in massively transfused patients.

Methods: Prospective data was collected on trauma patients taken directly to surgery from the resuscitation room. Only those receiving ≥ 10 RBC units by completion of operation were included. MT protocol was in place for all patients. To account for survival bias, intra-operative deaths were excluded. Patients were stratified by plasma:RBC ratios (HIGH >0.5 , MID 0.33-0.5, LOW <0.33). Crude and adjusted risk ratios (RRs) for hospital mortality were determined, using the HIGH ratio as the reference group.

Results: 135 patients met inclusion criteria. Overall mortality was 38%. There were no significant differences with respect to patient age, gender, injury mechanism, ISS, initial base deficit, or initial blood pressure. However, the mean number of intra-operative RBC units transfused was significantly different between groups (LOW: 25.1, MID: 19.7, HIGH: 16.2; $p < 0.001$). The crude risk for mortality was significantly higher for the LOW group relative to the HIGH group. However, after adjustment for number of RBCs transfused, the risk was not significantly different (Table).

Mortality risk by FFP:RBC ratio group (LOW and MID compared to HIGH)				
	Crude RR	95% CI	Adjusted RR	95% CI
LOW	1.99*	1.02-3.89	1.54	0.75-3.15
MID	1.38	0.72-2.66	1.22	0.62-2.39

* $p < 0.05$

Conclusions: Among patients subjected to MT, those that receive relatively higher quantities of RBCs are both more likely to receive a lower plasma:RBC ratio and are more likely to die. Any analysis concerning plasma:RBC ratios should take the potential confounding of this heterogeneity among MT patients into account.

DAMAGE CONTROL RESUSCITATION STRATEGY INCREASED UNEXPECTED SURVIVORSHIP IN CASES WITH A PROBABILITY SURVIVAL RATE LESS THAN 50%.

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Introduction: Damage control resuscitation (DCR) improves mortality among trauma patients with hemorrhagic shock (HS) in battlefield hospitals. However, there are a few data available for civilian trauma centers. We implemented a DCR strategy from September 2008 and this retrospective study examined the effectiveness of the strategy compared with historical controls. **Methods:** Of 1859 trauma patients admitted to a Japanese civilian trauma center between July 2007 and September 2010, 116 developed HS and served as subjects in this study. We divided the 116 patients into two groups: the DCR strategy group (S: September 2008 to September 2010) and the control group (C: July 2007 to August 2008). The DCR strategy introduced at our center includes a massive transfusion (MT) protocol, permissive hypotension, body temperature maintenance, restricting use of crystalloids. **Results:** Seventy-two patients were assigned to the S group and 44 to the C group. Victims of blunt trauma accounted for 89.1% and emergency surgery was performed in 81.9% of the patients. Median age of the patients was 50 [37–67] years, median injury severity score (ISS) was 30 [22–41], and hospital mortality (HM) rate was 9.5%. Age (S: 50, C: 49.5 years), ISS (S: 31, C: 29), and HM rate (S: 8.3%, C: 11.3%) were similar between the two groups. Body temperature on ICU admission was higher in the S group than in the C group ($P=0.04$). Use of crystalloids for resuscitation and PRBC/FFP ratio within 24 hours after admission was lower in the S group than in the C group ($P=0.04$, $P<0.01$, respectively). The rate of unexpected survivorship (US: defined as a survivor with a probability survival rate $<50\%$) was significantly higher in the S group than in the C group (S: 18/22 [81.8%], C: 3/10 [30.0%], $P=0.01$). Multivariate regression analysis revealed the independent factors for US were ISS (OR 0.88 [$P<0.01$; 95%CI: 0.8–0.9]) and implementation of the DCR strategy (OR 8.87 [$P=0.01$; 95%CI: 1.5–50.8]). **Conclusion:** The implementation of a DCR strategy in a civilian trauma center significantly increased US for trauma patients with HS.

CENTRAL HYPOVOLEMIA INDUCED BY LOWER BODY NEGATIVE PRESSURE ACTIVATES COAGULATION FACTORS, PLATELETS AND FIBRINOLYSIS

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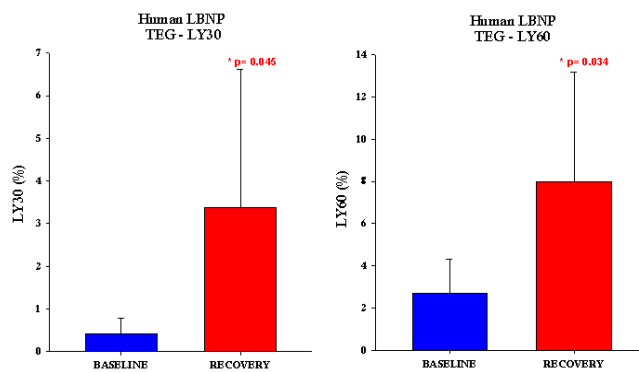
Introduction: Lower body negative pressure (LBNP) causes central hypovolemia and has been used to model early physiologic changes in hemorrhagic shock. We measured coagulation system function in 8 healthy volunteers undergoing LBNP until pre-syncope to assess the utility of this model in studying acute coagulopathy in hemorrhage.

Methods: Volunteers underwent LBNP as described, under an IRB-approved protocol. Blood was sampled at baseline and recovery. Measured coagulation parameters included: PT, PTT, factor activity (FVIII, vWF, Protein C), D-Dimer, thromboelastography (TEG), platelet count and activation (PAC-1 antibody binding activated GPIIb/IIIa).

Results: LBNP caused activation of the coagulation system as shown by a 14% reduction in TEG R-time ($p < 0.001$), platelet activation manifested as a 20% increase in PAC-1 mean fluorescence intensity, and a 2.6-fold increase in percentage of PAC-1 positive platelets ($p < 0.05$ for both). Platelet count increased by 13% ($p = 0.006$). Factor activities increased: FVIII 18%; vWF 12%; Protein C 7% ($p < 0.05$ for all). Fibrinolysis was also activated (see figure) as shown by an 8-fold increase in TEG LY30, a 3-fold increase in LY60 (50% of subjects showing = 10% lysis at 60 minutes), and a 12% increase in D-dimer. There were no changes in PT, PTT, or in TEG K, angle, or MA.

Conclusions: LBNP-induced central hypovolemia causes coagulation system and platelet activation as well as fibrinolysis in the absence of tissue damage.

LBNP may provide a useful human model for isolating the effects of hemodynamics on coagulation function independent of tissue damage.



GROUP VIB PHOSPHOLIPASEA2 IS ASSOCIATED WITH ACUTE LUNG INJURY FOLLOWING TRAUMA AND HEMORRHAGIC SHOCK.

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Introduction: Mesenteric lymph (ML) is the mechanistic link between splanchnic hypoperfusion and acute lung injury (ALI), but the culprit mediators remain elusive. Our studies have already demonstrated that the post hemorrhagic shock mesenteric lymph (PHSML) contains biologically active lipids, such as lyso-phosphatidylcholine (LPC) and lyso-phosphatidylethanolamine with polyunsaturated fatty acid (PUFA). We hypothesize that Group VIB phospholipase_{A2} (iPLA₂ γ) may be the enzyme involved in the production of these lipids. The purpose of our study was to determine the role of iPLA₂ γ in ALI following trauma /hemorrhagic shock (T/HS) using (*E*)-6-(*bromomethylene*)-3-(1-naphthalenyl)-2*H*-tetrahydropyran-2-one (R-BEL), an iPLA₂ γ specific inhibitor.

Methods: Male SD rats were anesthetized and cannulated ML duct, femoral artery and jugular vein. In T/HS group rats underwent a laparotomy (trauma), 30min of shock (MAP 40 mmHg) and resuscitation (shed blood+ normal saline) over 2 hours. ML was collected hourly up to 2 hours after shock. Lungs were harvested after shock. In trauma/sham shock (T/SS) group rats underwent the identical procedures without shock and resuscitation. ML were extracted by Bligh-Dyer method and measured with LC/MS/MS. Furthermore lung injury was assessed by lung permeability (Evans blue dye method) and lung histology.

Results: LC/MS/MS analysis revealed that R-BEL attenuated LPC with PUFA in PHSML compared with DMSO ($p < 0.05$).

Lung permeability of R-BEL+T/HS (0.024 \pm 0.004 μ g/g of tissue wt) was significantly decreased in comparison to that of DMSO+T/HS (0.044 \pm 0.014; $p < 0.01$). The histological appearance of the lungs of R-BEL+T/HS showed no evidence of inflammatory changes.

Conclusions: Administration of R-BEL decreased LPC with PUFA in PHSML and attenuated ALI following T/HS. iPLA₂ γ is possibly involved in the pathogenesis of ALI.

THE IMPACT OF ADMISSION HYPERFIBRINOLYSIS ON MORTALITY IN TRAUMA PATIENTS

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Background: Thromboelastography (TEG) is a point of care test that assesses coagulation in real time. The role of TEG in evaluating the acute coagulopathy of trauma is not well understood. The purpose of this study was to determine the utility of TEG in the assessment of acute traumatic coagulopathy.

Methods: After IRB approval, injured patients meeting our institution's trauma team activation criteria had a TEG performed at admission, 1 hour, 2 hours, and 6 hours using citrated blood. Acute traumatic coagulopathy (ATC) was defined as any TEG parameter in the hypocoagulable range. Patients were followed throughout their hospital course to collect data on their injury demographics and outcomes.

Results: The study population (n=86) was 77.9% male, mean age 35.9 years (range 11-91), Mean ISS 13.43 ± 11.13 , 53.5% penetrating, 9.4% SBP < 90 on admission. 46.5% required blood products in the first 24 hours, 16.3% (n=14) were massively transfused (>10 u pRBCs in 24 hours). Mean amount of pRBCs transfused was 5.4 ± 14.9 units, range (0,127); FFP 3.7 ± 13.1 units (0,113); apheresis platelets 0.6 ± 2.1 units (0,17). 18.6% (n=16) had ATC on admission, and 34.9% (n=30) went on to develop ATC. When the components of ATC were evaluated separately, only hyperfibrinolysis (estimated percent lysis (EPL) >15) was associated with mortality. Patients with hyperfibrinolysis on admission (n=5) had increased in-hospital mortality ($p=0.028$, adjusted OR 15.2, 95%CI(1.4,166.7)). Of the 12 patients (15.6%) dying in the first week of admission, 75% (n=9) demonstrated hyperfibrinolysis. Only one patient with hyperfibrinolysis on admission survived past 7 days, and this patient was treated with tranexamic acid on hospital day 1. The greatest admission EPL value in a surviving patient was 3.6.

Conclusion: In this study, trauma patients with hyperfibrinolysis on admission had significantly greater in-hospital mortality. Early administration of targeted therapies may be warranted.

**THE EPIDEMIOLOGY OF NON-COMPRESSIBLE TORSO HEMORRHAGE
IN THE WARS IN IRAQ AND AFGHANISTAN (2002-2010)**

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Background: Although non-compressible torso hemorrhage is the leading cause of potentially survivable trauma on the battlefield, the definition and epidemiology of this injury pattern has not been reported. The objective of this study is to define relevant and specific injury patterns which constitute non-compressible torso hemorrhage and to characterize their frequency and mortality in combat.

Methods: Four categories of torso injury, each based on vascular disruption, were identified in US military casualties from the Joint Theater Trauma Registry (2002-2010): 1. thoracic, including lung 2. solid organ (high grade spleen, liver and kidney), 3. named axial vessel 4. pelvic fracture with ring disruption. Injuries were evaluated in the context of procedural and physiologic identifiers documenting hemorrhage and shock.

Results: Of 15,209 battle injuries, 17.7% (n=2,695) of patients were identified with one or more categories of torso injury; 12.8% (n=346) of whom had concomitant shock or the need for immediate intervention. The average ISS and mortality were 27.7 (SD12.6) and 19.4% respectively with injuries to the thorax/lung (59.2%) and axial vessels (57.8%) being the most common and the most lethal (ISS-adjusted odds ratios associated with mortality of: 4.7: 95% CI [2.3-9.8] and 2.0: 95% CI [1.1-3.7] respectively). Pelvic fracture (32.4%) and solid organ injury (spleen: 22.2%, kidney: 14.7% and liver 13.9%) were less common and not associated with mortality (p=NS). The average ISS of the 67 deaths was 33.7 (SD 16.0), although 37% (n=25) had ISS <25 and 25% (n=17) had ISS<20 suggesting potentially survivable injury.

Conclusions: This study characterizes a definition for and incidence of non-compressible torso hemorrhage on the modern battlefield. Within this category, injuries to the thorax and axial vessels are the most common and lethal. A subset of patients with this injury pattern had potentially survivable injury which highlights the need for novel strategies to expedite resuscitative intervention.

IMPACT OF PRE-HOSPITAL HYPOTHERMIA ON TRANSFUSION REQUIREMENTS AND OUTCOMES

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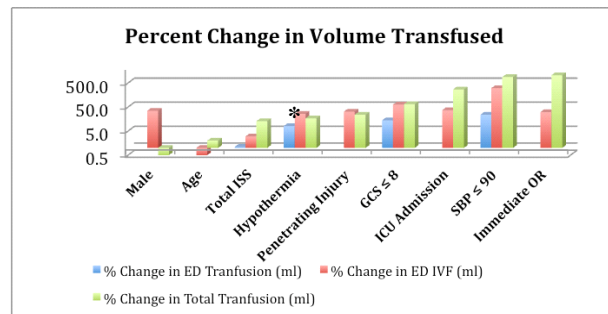
Introduction: Pre-hospital hypothermia (PH) is known to increase mortality following traumatic injury. PH relationship with transfusion requirements has not been documented. The purpose of this investigation was to analyze the impact of PH on blood product requirements and subsequent outcomes.

Methods: The Los Angeles County Trauma System Database was queried for all patients admitted between 2005 and 2009. Demographics, physiologic parameters, and transfusion requirements were obtained and dichotomized by admission temperatures with a core temperature of $< 36.5^{\circ}$ considered hypothermic. Multivariate analysis was performed to determine factors contributing to transfusion requirements and to derive adjusted odds ratios (AOR) for mortality and rates of Acute Respiratory Distress Syndrome (ARDS) and pneumonia.

Results: 21,023 patients were analyzed in our study with 44.6% presenting with PH. Hypothermic patients required 26% more fluid resuscitation in the

emergency department (ED) and 17% more total blood products than those who were admitted with a normal temperature ($p < 0.05$, figure). There was a trend towards an increase in ED transfusion (8%, $p=0.06$). PH was independently associated with the need for a transfusion (AOR 1.1, $p=0.047$), increased mortality (AOR 2.0, $p<0.01$), as well as incidence of ARDS (AOR 1.8, $p<0.05$) and pneumonia (AOR 2.6, $p<0.01$).

Conclusions: PH is associated with increased transfusion and fluid requirements and subsequently worse outcomes. Interventions that correct hypothermia may decrease transfusion requirements and improve outcomes. Prospective studies investigating correction of hypothermia in trauma patients are warranted.



MACROPHAGE INFLAMMATORY PROTEIN 1 ALPHA INCREASES ADHESION MOLECULE EXPRESSION ON ENDOTHELIAL CELLS IN-VITRO.

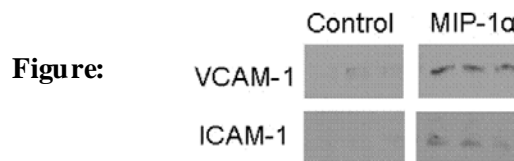
Dennis I Sonnier MD, Stephanie R Bailey BS, Ritha M Belizaire MD, Jay A Johannigman* MD, Alex B Lentsch PhD, Timothy A Pritts MD, PhD. Department of Surgery, University of Cincinnati College of Medicine.

Introduction: The vascular endothelium acts as a gatekeeper between circulating inflammatory mediators and end-organs on which these mediators act. During acute inflammatory states, the endothelium may respond by up-regulating intercellular adhesion molecule 1 (ICAM-1) and vascular cell adhesion molecule 1 (VCAM-1), proteins responsible for leukocyte adhesion and invasion into tissues. Macrophage inflammatory protein 1 alpha (MIP-1 α /CCL3) is a proinflammatory chemokine involved in tissue leukocyte recruitment, but its role in the response to traumatic injury is poorly understood. Serum MIP-1 α is increased after hemorrhagic shock and can be decreased using protective resuscitation strategies. The effect of MIP-1 α on the production of leukocyte adhesion molecules is not known. We hypothesized that MIP-1 α will increase VCAM-1 and ICAM-1 production by the vascular endothelium.

Methods: bEnd.3 cells, a murine endothelial cell line, were grown in culture for 7 days then treated with serum free media or MIP-1 α (5ng/ml) for 24 hours. Cells were scraped from the culture dish, cytoplasmic extracts were prepared, and Western blot analysis was performed using specific antibodies.

Results: There is a baseline level of VCAM-1, as evidenced by faint bands in the control treatment. MIP-1 α treatment resulted in robust increase in VCAM-1 expression (Figure). After MIP-1 α treatment, ICAM-1 expression was also increased (Figure).

Conclusion: MIP-1 α treatment of bEnd.3 endothelial cells significantly increased VCAM-1 and ICAM-1 production, resulting in a proinflammatory endothelial cell phenotype. These findings are important because they suggest that MIP-1 α release during hemorrhage and resuscitation may, at least in part, mediate leukocyte infiltration into tissues of the injured patient.



EFFECT OF ESTROGEN CONCENTRATION ON INTESTINAL MUCUS PRODUCTION AND BARRIER FUNCTION IN AN IN VITRO MODEL

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Introduction: Clinical and experimental studies demonstrate gender dimorphism following trauma/hemorrhagic shock (T/HS). Specific to this study, gut injury and gut induced lung injury are significantly decreased in estrus or proestrus rats vs. diestrus rats and male rats. Intestinal mucus, an important component of the intestinal barrier has also been found to be sensitive to sex hormones. We hypothesized that intestinal mucus production may vary with estradiol (E) concentrations noted during the menstrual cycle. The effect of E dose on mucus content and subsequent barrier function was examined in an intestinal epithelial cell model *in vitro*.

Methods: HT-29 MTX (mucus producing clone) intestinal epithelial cells (IEC) were exposed to variable E concentrations in tissue culture flasks for 3 days and then grown to confluence on transwell plates for an additional 5 days. Nonadherent and adherent mucus content was indexed by analysis of mucin using an ELISA. In other experiments, HT-29 MTX cells from the different treatment groups were cocultured with *E. coli* (10^4 CFU/ml) and bacterial passage across IEC monolayers determined. Monolayer integrity was indexed by TEER.

Results: Mean \pm S.D. (N = 4 for all groups)

	Mucus content		Barrier function	
	Non-adherent (ng/ml)	Adherent (ng/ml)	Bacterial passage (\log_{10} CFU/ml)	TEER ($\text{ohm}\cdot\text{cm}^2$)
HT-29 control	0	0	1.47 \pm 0.02	299 \pm 8
HT-29MTX	4.9 \pm 0.2	6.4 \pm 0.3	0.84 \pm 0.03#	294 \pm 11
HT-29MTX+30pg/ml E	6.0 \pm 0.4*	6.8 \pm 0.4	0.68 \pm 0.04*#	295 \pm 10
HT-29MTX+60pg/ml E	7.1 \pm 0.3*	7.2 \pm 0.3*	0.59 \pm 0.03*#	297 \pm 10
HT-29MTX+90pg/ml E	8.9 \pm 0.6*	10.1 \pm 0.6*	0.43 \pm 0.02*#	304 \pm 12

*p<0.001 vs. HT-29 MTX, #p<0.001 vs. HT-29 control

Conclusions: Mucus production in HT-29 MTX cells varied directly with clinically relevant E concentrations. Bacterial passage across HT-29 MTX monolayer's varied inversely with mucus content. Gender differences in gut barrier function following T/HS may in part be related to intestinal mucus content as noted in this study.

ACUTE TRAUMATIC COAGULOPATHY: CHARACTERIZATION OF INITIAL AND LONGITUDINAL COAGULATION FACTOR ABNORMALITIES AND THEIR RESPONSE TO RESUSCITATION

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Background: A subset of critically injured patients in hemorrhagic shock present with coagulopathy, portending markedly worse outcomes. However, the specific coagulation factor abnormalities underlying acute traumatic coagulopathy (ATC), their longitudinal temporal change, and their correction in response to resuscitation remain unexplored.

Methods: From 2/2005 – 1/2010, plasma factor levels were prospectively assayed from 175 highest-level trauma activation patients at 0, 6, 12, 24, 48, and 72h after admission to an urban level I trauma ICU. Resuscitation and outcomes data were extracted.

Results: Of 175 patients, 23 (13.3%) had INR =1.3 on admission. Those with ATC were younger (32.7 ± 18.0 vs. 42.8 ± 18.6 y), with higher ISS (32.9 ± 13.4 vs. 23.7 ± 13.0) and mortality (47.8 vs. 19.3%; all $p < 0.05$); prehospital crystalloid was similar (246 ± 337 mL, $p = 0.92$). Coagulopathic patients had lower admission prothrombin (53.9 ± 19.8 vs. $82.2 \pm 17.9\%$, $p < 0.001$), factors V (35.3 ± 17.6 vs. $67.8 \pm 23.4\%$, $p < 0.001$), VII (52.4 ± 13.9 vs. $67.8 \pm 23.4\%$, $p < 0.001$), IX (71.2 ± 31.6 vs. $108.1 \pm 27.8\%$, $p < 0.001$), and X (51.2 ± 21.5 vs. $86.8 \pm 20.3\%$, $p < 0.001$), and protein C (68.2 ± 18.2 vs. $87.9 \pm 27.7\%$, $p = 0.002$); tPA (35.7 ± 12.9 vs. 21.4 ± 18.6 ng/mL, $p = 0.002$) and D-dimer (23.2 ± 24.1 vs. 7.6 ± 12.2 mcg/L, $p = 0.02$) levels were elevated. Those transfused with RBC:FFP ratio =1:1 at 6h had higher levels of factors V (55.9 ± 23.2 vs. $38.5 \pm 18.9\%$, $p = 0.047$), VII (98.0 ± 12.0 vs. $87.5 \pm 46.8\%$, $p = 0.025$), and X (72.1 ± 12.1 vs. $55.5 \pm 18.4\%$, $p = 0.01$) compared to ratios >1:1. At 24h, =1:1 ratio patients had higher prothrombin (73.8 ± 9.7 vs. $66.3 \pm 14.1\%$, $p = 0.025$), factor X (70.2 ± 15.2 vs. $59.5 \pm 12.1\%$, $p = 0.003$), and protein C (78.6 ± 20.4 vs. $65.9 \pm 19.0\%$, $p = 0.029$).

Conclusions: ATC is associated with depletion of thrombin, factors V, VII, IX, and X, and protein C, and elevated tPA and D-dimer; this reflects a factor-depleted, hyperfibrinolytic phenotype. Hemostatic resuscitation (RBC:FFP ratios =1:1) repletes these deficient coagulation factors over time, providing evidence that a plasma-based resuscitation strategy corrects specific coagulogenic defects and restores functional coagulation.

PLASMA TRANSFUSION IMPROVES SURVIVAL INDEPENDENT OF PRBC TRANSFUSION AND PLASMA:PRBC RATIO

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Introduction Red cell transfusion independently increases morbidity and mortality in trauma patients. The risks of plasma (FFP) transfusion have not been evaluated in trauma patients. Current practice is to transfuse FFP and PRBC in a 1:1 ratio. The purpose of this study was to simultaneously determine the independent risk of FFP and PRBC transfusion and the effect of the FFP:PRBC ratio in one cohort of trauma patients.

Methods After obtaining IRB approval, the trauma registry at an urban Level I trauma center was searched from 7/05 to 12/08 for all patients with age = 18 and ISS > 15. Patients with pre-existing coagulopathy, burns or death within 30 minutes of admission were excluded. Demographic, physiologic and laboratory data and the number and type of blood products transfused in the first 48 hours were collected. Propensity scoring was used to adjust for the non-random use of transfusion. Logistic regression was used to determine the independent mortality risk of red cell and plasma transfusion.

Results Four hundred thirty-three patients met inclusion and exclusion criteria. The median age was 43 (IQR 29-54), the median ISS was 22 (IQR 17-29) and 10% had penetrating injuries. Overall mortality was 12.7%. One hundred six patients (24.5%) received a median of 4 (IQR 2-6) units of FFP and 140 (32.3%) received a median of 4 (IQR 2-9.5) units of PRBC. The risk-adjusted odds ratio for mortality for each PRBC unit was 1.26 (95% CI 1.13-1.41, $p < 0.001$); for each FFP unit was 0.748 (95% CI 0.595-0.940, $p = 0.013$). The FFP:PRBC ratio was significantly higher among survivors 3:4 versus non-survivors 1:2 ($p = 0.002$)

Conclusion These results confirm previous findings that red cell transfusion is associated with increased mortality and that a higher FFP:PRBC ratio is associated with improved survival. We have also shown that plasma transfusion is associated with improved survival independent of PRBC transfusion and the FFP:PRBC ratio. These results should be used to inform transfusion practices in trauma.

ANEMIA AND TRANSFUSIONS ON TRAUMATIC BRAIN INJURY

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Introduction: The impact of anemia and restrictive transfusion strategies in traumatic brain injury (TBI) is unclear. The purpose of this study was to examine the safety of varying degrees of anemia in patients who have sustained a TBI.

Methods: We performed a retrospective study of all adult patients with blunt TBI admitted between January 2003 and June 2010. Anemia was defined as a Hb = 8g/dl, Hb = 9g/dl or Hb = 10g/dl measured for three consecutive draws within the first 7 days. The impact of increasing severity of anemia and transfusions on complications, length of stay and mortality using logistic regression was examined.

Results: Of the 48,589 patients admitted to the trauma service during the study period, 880 had a blunt TBI. 225 of these met the criteria for anemia within the first 7 days. Our study population was 77.6% male with a mean age of 47.2 ± 22.5 yrs, mean ISS = 17.4 ± 10.0 and median head AIS = 3. Anemia, at all 3 threshold levels was not associated with an increase in mortality or complications (AOR = 0.34 [0.05, 2.22] p = 0.26, AOR = 1.56 [0.38, 6.26] p = 0.53, AOR = 0.38 [0.10, 1.47] p = 0.16). However, for all anemic patients, the transfusion of packed red blood cells was associated with an increase in mortality (AOR=3.20, p = 0.047) and septic complications (AOR = 6.64, p = 0.02).

Conclusion: The presence of anemia in patients with traumatic brain injury as low as 8g/dl was not associated with increased mortality or complications. The use of transfusions was associated with both an increase in mortality and septic complications. Prospective evaluation of an optimal transfusion trigger is warranted.

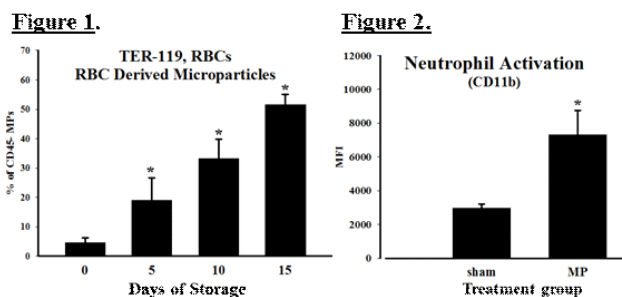
RED BLOOD CELL STORAGE RESULTS IN INCREASED MICROPARTICLE FORMATION

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Introduction: Recent studies suggest that transfusion with aged blood products, as compared to fresh blood products, worsens clinical outcomes, but the mechanisms behind these findings are unknown. Microparticles (MPs) are small vesicles released from cells that may play a role in cellular dysfunction, but the presence and role of microparticles in red blood cell storage is unknown. We utilized a murine model of blood banking to determine if pRBC storage results in increased MP formation as well as the potential effect of these MPs on pRBC recipients.

Methods: Murine blood was harvested, separated into plasma and pRBCs and stored in AS-3. Centrifugation was used to fractionate pRBC units into cells, MPs, and supernatant. Flow cytometry was used to determine the presence of MPs. In additional experiments, mice were treated with stored blood derived MPs.

Results: Stored pRBC unit analysis indicated that there was a time dependent increase in RBC derived MPs in stored units (Fig 1; * $p < 0.05$ vs. other groups). Treatment of mice with stored blood derived MPs resulted in increased recipient neutrophil activation (Fig 2; * $p < 0.05$ vs. sham).



Conclusion: Increased MP formation was seen in stored pRBCs. These MPs appeared to be RBC derived. Treatment of mice with MPs resulted in increased recipient neutrophil activation. The pro-inflammatory nature of old blood may be due, in part, to the presence of RBC derived microparticles in aged blood.

ASSOCIATION OF GCSF WITH ANEMIA AND INFECTION IN PATIENTS FOLLOWING SEVERE TRAUMA

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Introduction: Plasma Granulocyte Colony Stimulating Factor (GCSF) is increased after trauma/hemorrhagic shock in rats. This results in an egress of bone marrow (BM) cells to the periphery which is associated with persistent anemia and increased incidence of infection. We hypothesize that following trauma in humans, GCSF is elevated and correlates with shock, anemia and infection. **Methods:** Blood from 50 severely injured patients (TP) was collected within 24 hours of admission and compared to 16 healthy volunteers (V). Plasma was analyzed for GCSF by ELISA and categorized by Injury Severity Score (ISS), age, base deficit (BD), lactate, hemoglobin (Hgb), pneumonia (PNA) and mortality. Data expressed as mean GCSF±SD in pg/mL *p<0.01 by Mann-Whitney test. **Results:** Plasma GCSF is increased in TP vs. V (1634±2435* vs. 32±30). GCSF elevation is more profound in TP with shock vs. no shock (2886±3023* vs. 651±1172). TP with higher initial GCSF (>500 pg/mL) had similar ISS but significantly higher BD and lactate. Higher GCSF was also associated with a lower Hgb on day 7 and higher rate of pneumonia.

	N	Age	ISS	BD	Lactate	Hgb D0	Hgb D7	PNA	Mortality
GCSF ≤ 500 pg/mL	28	41±22	21±2	-3.1±0.7	2.8±0.3	12.4±0.4	10.1±0.4	18%	11%
GCSF >500 pg/mL	22	34±13	25±3	* -8.2±1	* 5.8±.8	11.9±0.5	* 8.7±0.3	*59%	9%

Conclusion: After trauma, there is a significant increase in plasma GCSF which is more profound in patients who present in shock. Elevation of GCSF in humans following severe trauma may play a significant role in the development of post traumatic anemia and infection. Modulation of the BM response to GCSF post injury may have a salutatory role.

IMPACT OF LOW FIBRINOGEN LEVELS IN THE PUZZLE OF TRAUMA INDUCED COAGULOPATHY: IS THIS THE MISSING LINK?

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Introduction: Patients with severe tissue injury and tissue hypoperfusion can present with low fibrinogen levels and signs of hyperfibrinolysis. The role of Damage Control Resuscitation (DCR) in addressing the hyperfibrinolytic aspect of Trauma Induced Coagulopathy (TIC) is unknown. We hypothesize a survival advantage when DCR is used in TIC patients with severe tissue injury and low fibrinogen levels.

Methods: This is a 2 year prospective observational study of TIC patients who received DCR. TIC was defined as initial base deficit ≥ -6 in combination with ISS ≥ 12 . Low fibrinogen was considered when serum level < 200 mg/dL. Patients were stratified into those with an Injury Severity Score (ISS) < 20 , and those with an ISS ≥ 20 . Variables analyzed between groups included: initial serum fibrinogen, INR, base deficit, intra-operative FFP: PRBC ratio and mortality.

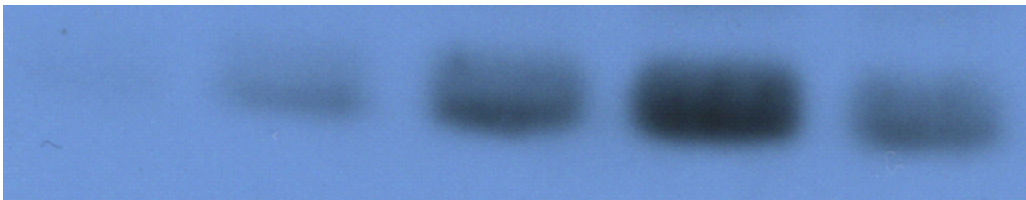
Results: Of 67 patients with TIC, 29 (43.2%) had ISS < 20 group, and 38 (56.7%) an ISS ≥ 20 . Mean ISS was 13.9 vs. 32.8 ($p < 0.0001$) for the ISS < 20 group vs. the ISS ≥ 20 group respectively. Mean initial fibrinogen levels for the ISS < 20 group vs. the ISS ≥ 20 group was 357.4 mg/dL vs. 148.5 mg/dL ($p = 0.0007$). Intra-operative DCR with FFP: PRBC for the ISS < 20 group vs. the ISS ≥ 20 group showed no statistical difference: 1 to 1.12 vs. 1 to 1.3 ($p = 0.12$). Overall mortality after controlling for DCR in the ISS < 20 group was 29% and 73% in the ISS ≥ 20 group ($p = 0.0007$). In a stepwise logistic regression, low fibrinogen levels was associated with mortality, $p = 0.01$; OR 1.01 (1.23-11.55) with area under the receiver operating characteristic curve of 0.701. The correlation coefficient for ISS vs. initial fibrinogen level was -0.5635 ($p = 0.0001$).

Conclusion: Overall mortality was significantly increased in patients who had an ISS ≥ 20 with low fibrinogen level despite effective DCR. Given the correlated decrease in fibrinogen levels in patients with severe tissue injury, further investigation regarding potential benefits of antifibrinolytic agents in DCR is warranted.

LTB₄ ACTIVATES THE NEUTROPHIL P38 MAPK

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Background: p38 mitogen-activated protein kinase (MAPK) is an enzyme present in neutrophils (PMNs) that is activated in response pro-inflammatory mediators, e.g. platelet-activating factor (PAF) following its release in trauma/hemorrhagic shock (T/HS). PMNs primed by PAF cause p38 MAPK activation. Leukotriene B₄ (LTB₄), another PMN priming agent, is also released after T/HS. We therefore hypothesize that LTB₄ stimulation of PMNs cause p38 MAPK activation. **Methods:** After PMNs were isolated from whole blood obtained from healthy donors, incubation was done in either isotonic buffer or LTB₄ (1 μM) for 3 minutes. Reactions were stopped with the addition of ice-cold buffer and immediately sonicated (2 X 30s). Lysates were cleared and used for Western blot analysis. Proteins were separated by SDS-PAGE (10%) acrylamide gel with SDS electrophoresis, transferred to a nitrocellulose membrane, and were cross-linked and probed with p38 MAPK antibodies. **Results:** Following addition of LTB₄, p38 MAPK activation was increasingly observed where it was maximal at 1 minute. Pretreatment of PMNs with SB203580 (p38 MAPK inhibitor) inhibited priming by 84±10%. **Conclusion:** LTB₄-stimulated neutrophils involved the activation of the p38 MAPK and its inhibition may likely abrogate priming and decrease the PMN-mediated cytotoxicity postinjury.



Control | 15 seconds | 30 seconds | 1 minute | 3 minutes

Fig.1: PMN p38 MAPK Activation after addition of LTB₄. p38 MAPK activation was maximal at 1 minute.

HEPARIN-MEDIATED PLATELET AGGREGATION EXACERBATES ACUTE LUNG INJURY IN TRAUMA HEMORRHAGIC SHOCK MODELS

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Introduction: Heparin is utilized in T/HS models to anticoagulate shed blood, but the return of heparinized shed blood remains controversial due to potential anti-inflammatory properties. However, the effectiveness of heparin as an anticoagulant continues to be overlooked, especially with regard to platelets. Therefore, we hypothesized that returning heparinized shed blood would paradoxically enhance ALI following T/HS due to the infusion of platelet aggregates.

Methods: Sprague-Dawley rats underwent laparotomy and hemorrhage induced to maintain a MAP of 30 mmHg for 45 min. Animals were resuscitated by twice their shed blood volume (SBV) with NS over 30 min, half their SBV with whole blood over 30 min, and twice their SBV with NS over 1 hr. Shed blood was collected in 80U/kg of heparin, 800U/kg of heparin, citrate, or diluted 1:6 with NS with NS. BALs, blood smears, and lung MPO assays were completed. Statistical analysis was performed by ANOVA.

Results: Peripheral blood smears revealed large platelet aggregates, and BAL protein increased in animals with blood collected in heparin ($p < 0.05$). Sham animals that received heparin IV and no shed blood did not develop ALI. The lung MPO assay showed PMN sequestration in all animal subjected to T/HS ($p < 0.05$).

Conclusion: T/HS is sufficient to sequester and prime pulmonary PMNs, and transfusion of heparinized shed blood functions as a “second-hit” to produce ALI. Since heparin alone does not produce ALI, and PMN accumulation is unchanged in the presence of increased lung leak, a component of heparinized shed blood is suspected, such as activated platelets propagating microthrombi or platelet mediated release of pro-inflammatory cytokines.

	BAL Protein (mg/ml)	MPO (units/mg)
Sham (n=5)	0.52 (± 0.15)	3.58 (± 1.07)
Heparin Sham (n=3)	0.56 (± 0.15)	3.76 (± 0.66)
Heparin 80U/kg (n=5)	1.64 (± 0.28)*	5.92 (± 0.93)*
Heparin 800U/kg (n=3)	1.33 (± 0.17)*	5.89 (± 0.78)*
Citrate (n=5)	0.65 (± 0.13)	5.93 (± 1.15)*
Blood Dilution (n=4)	0.66 ($+ 0.18$)	6.68 ($+ 0.53$)*

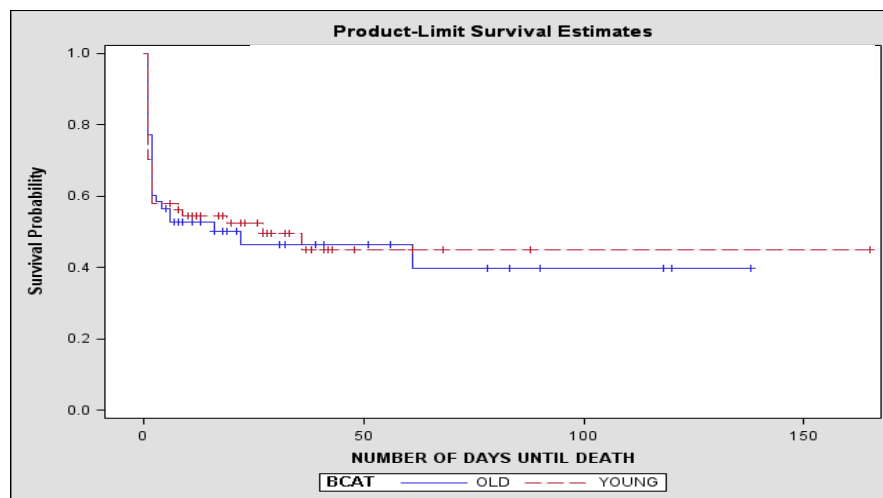
TRAUMA PATIENTS RESUSCITATED WITH HEMOSTATIC CLOSE RATIO RESUSCITATION- IMPACT OF YOUNG VS. OLD BLOOD

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Objective: Hemostatic Close Ratio Resuscitation (HCRR) conveys a survival advantage in patients with severe intra-operative hemorrhage (IOH). Impact of blood age during HCRR has not been analyzed. We hypothesized that old blood when use during HCRR has a detrimental impact on survival in patients with IOH.

Methods: All HCRR requiring =10 units of packed red blood cells (PRBC) were retrospectively analyzed. Fresh blood was defined as mean age =14 days. Mortality was compared between patients resuscitated with fresh blood versus old blood.

Results: During a 3 year period 180 patients received HCRR. 118 (66%) received =10 units of PRBC. Overall mortality was 50.8%. There was no statistically difference in mortality between fresh blood group vs. old blood group, whether fresh was defined as =14 days ($\chi^2 = 3.12$, $p = 0.126$) or as =21 days ($\chi^2 = 0.04$, $p = 0.84$). Kaplan-Meyer survival curve showed no difference in survival probability between groups (logrank p-value = 0.89):



Conclusions: There was no survival advantage associated with providing fresh PRBC during HCRR. Caution is warranted prior to diverting fresh blood to patients with IOH.

**THROMBELASTOGRAPHY IDENTIFIES DIFFERENCES IN COAGULATION
IN BRAIN INJURED PATIENTS WITH AND WITHOUT PROGRESSION OF
INTRACRANIAL HEMORRHAGE**

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Background: Traumatic brain injury is the leading cause of morbidity and mortality after injury. Increases in the size of intracranial hemorrhage (ICH) have been associated with coagulopathy. Identification of clinically significant coagulopathy may be missed or delayed by routine assays. In patients that demonstrate progression of ICH, as many as half will have normal routine coagulation assays. Thrombelastography (TEG) has been shown to provide an earlier and more complete characterization of coagulopathy than routine assays. Our objective was to determine whether values obtained from TEG early after injury are associated with progression of ICH.

Methods: This is a prospective observational study of adult trauma patients with ICH who had a computed tomographic (CT) scan of the brain and a repeat brain CT within 24 hours of injury. TEG was performed as soon as possible after admission and at the time of repeat brain CT. Hemorrhage volumes were quantified using the previously validated ABC/2 technique. ICH progression was prospectively defined as an increase in hemorrhage volume of at least 33% or the appearance of a new lesion on repeat CT. The relationship between TEG values and ICH progression was examined.

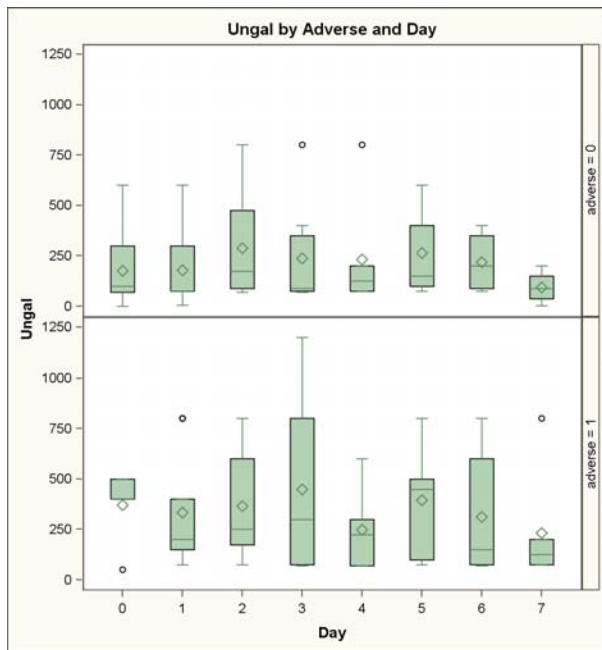
Results: Sixty-three patients met entry criteria, of which 47% (n=30) demonstrated ICH progression. Initial TEG was performed at a median time of 112 minutes (IQR 69-189 min) and initial brain CT scan was obtained 42 minutes (IQR 35-60 min) after arrival. Patients with ICH progression had lower maximum amplitude (MA) values on the initial TEG (60.7, IQR 52.9-67.0 vs. 67.2, IQR 61.0-69.7; $p = 0.042$) than patients without ICH progression. There were no differences in admission international normalized ratio (INR), activated partial thromboplastin time (aPTT), fibrinogen levels, platelet counts, D-dimer, and other TEG values between patients with and without ICH progression.

Conclusion: In patients with brain injury, TEG may be more sensitive than routine coagulation assays for identification of patients at risk for progression of ICH.

UNGAL, A NOVEL BIOMARKER FOR ACUTE KIDNEY INJURY, PREDICTS ORGAN DYSFUNCTION IN TRAUMA AND BURN PATIENTS

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Urinary Neutrophil Gelatinase Associated Lipocalin (uNGAL), a recently discovered protein, is expressed by renal tubular cells as a result of kidney injury (AKI). In children undergoing cardiac surgery, uNGAL was 100% sensitive and 98% specific for the development of AKI. Also, the rise of uNGAL is proportional to the extent of the insult. In contrast to serum creatinine, uNGAL is not elevated in volume depletion. **Methods:** We prospectively collected daily urine samples for uNGAL (>100ng/ml is abnormal) for 7 days. Investigators blinded to uNGAL values adjudicated the diagnosis of MODS (Marshall Score>5). **Results:** 43 patients had complete data and 9 developed MODS. Patients injured: (%trauma=82, %burn=22), male (MODS=88%, no MODS=67%) with a



mean age (MODS =45±9.5, no MODS =54±20.1), mean APACHE II (MODS=8±5.1, no MODS =12.6±5.8). A repeated measures linear model analysis of uNGAL found a significant adverse effect (p=0.006), with the mean uNGAL difference MODS=1 minus no MODS=0) equal to 146, with 95% confidence interval 44.5 to 247.

Conclusions: uNGAL may represent an important new biomarker for the development of

organ dysfunction. Further investigation is warranted.

PROSPECTIVE EVALUATION OF TEMPORAL CHANGES IN COAGULATION AND INFLAMMATION IN TRAUMA PATIENTS WITH HEMORRHAGIC SHOCK

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Background: Temporal changes of coagulation parameters during and after hemorrhagic shock and massive blood transfusion (MBT) are poorly understood.

Methods: Prospective evaluation of 33 patients arriving in the emergency department (ED) in hemorrhagic shock to determine factors associated with massive blood transfusions (MBT), ≥ 10 units of red blood cells in the first 6 hours, and mortality.

Results: Mean injury severity score was 30 ± 10 , Glasgow Coma Scale score (GCS) was 12 ± 4 , and ED systolic blood pressure was 73 ± 21 mmHg. MBT was used in 21 patients (64%), and 10 patients died (30%). Thrombin and PAI-1 (western blot) and other variables at initial presentation, end of operation (EndOp) and POD5 are shown in the table.

Variable	Initial	EndOp	POD5
Thrombin	4,712 \pm 2958	22,350 \pm 15,294*	4,136 \pm 2,477*
PAI-1	26,395 \pm 16280	35,584 \pm 13,385*	34,918 \pm 11,000
Fibrinogen	115 \pm 49	221 \pm 58*	NA
INR	1.6 \pm 0.6	1.5 \pm 1.7	1.0 \pm 0.1*
IL-6	112 \pm 108	248 \pm 43*	221 \pm 71*
pH	7.2 \pm 0.1	7.4 \pm 0.1*	7.4 \pm 0.05*
Base Deficit (BD)	-11 \pm 6	-4 \pm 5*	-1.3 \pm 2.8*

*=p<.05 from Initial

Thrombin and PAI-1 increased markedly at EndOP but did not correlate with MBT or mortality. The only factor that was significantly different in MBT than no MBT was BD (-14 \pm 6 vs -8 \pm 4; P=.04). Significant univariate factors for nonsurvivors and survivors were GCS (9 \pm 6 vs. 13 \pm 3; P=.01), initial fibrinogen (71 \pm 42 vs. 133 \pm 41; P=.001), and initial INR (2 \pm .08 vs. 1.4 \pm .2; P=.01). None of these factors were independent predictors of mortality in a multivariate analysis.

Conclusions: Coagulation parameters including thrombin and PAI-1 are markedly altered in hemorrhagic shock and follow different time courses during resuscitation, operation and recovery. Only initial BD was associated with MBT while initial fibrinogen, INR and GCS were significantly associated with mortality.

RACIAL DISCREPANCIES IN LEUKOCYTE RESPONSE TO TRAUMA

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Background: Race has been associated with variations in outcomes following trauma. The inflammatory response significantly affects a patient's reaction to, and survival from traumatic injuries. Genetic differences between races in host immune and inflammatory cells and their responses to infections have been demonstrated. We postulate that racial differences exist in inflammatory leukocyte and neutrophil responses to traumatic injury.

Methods: All trauma patients admitted to the trauma service at a Level 1 trauma center over 5 years were included. Data included age, gender, race, ISS, mortality, initial white cell count (WCC) and neutrophil count following presentation, as well as the highest white cell count and highest neutrophil count over the first 4 days following injury. Multiple regression analysis was done to predict first and highest WCC and neutrophil as a function of age, gender, ISS and race. A similar analysis was done to predict mortality.

Results: 7,741 patients, of whom 583 were black, were included in the dataset. Black patients had a lower median initial WCC (8.9 versus 10.4 $\times 10^9/L$, $p < 0.001$) and lower initial median neutrophil count (5.6 versus 7.3 $\times 10^9/L$, $p < 0.001$). Adjusting for age, gender, and ISS, being black remained significantly associated with a 2.8 $\times 10^9/L$ lower initial WCC ($p < 0.001$) and 1.1 $\times 10^9/L$ lower peak WCC ($p = 0.02$) than other races. Further, using similar analysis, black patients had a 2.1 $\times 10^9/L$ lower initial neutrophil count ($p < 0.001$) and 1.1 $\times 10^9/L$ lower peak neutrophil count ($p < 0.001$) compared with other races. There was no association between race and overall mortality, and no association between leukocyte response in varying races and mortality.

Conclusions: Racial disparities exist in the inflammatory response to trauma with black patients displaying a relatively hypo-responsive initial and highest WCC and neutrophil count. These differences may underlie an inability to tolerate the inflammatory burden of traumatic injuries. Understanding different inflammatory responses to traumatic injury between races is critical to addressing outcome disparities following trauma.

USE OF GEOCODING AND US CENSUS DATA TO ASSESS OUTCOMES IN TRAUMA PATIENTS

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Introduction: Numerous studies have demonstrated a correlation between disparities in clinical outcomes and factors such as race, ethnicity, socioeconomic status (SES) and insurance status. We hypothesized that these were surrogates for other risk factors that might independently contribute to outcome.

Methods: We conducted a retrospective review of our single-institution trauma registry. Data were geocoded and spatially merged with ecological census data using ArcGIS 10.0. Risk of in hospital mortality related to type of insurance (private, Medicare, Medicaid and self-pay) was examined in a logistic regression model in pts with an ISS > 16 adjusting for age, ISS, GCS, medical comorbidities, alcohol and drug abuse, and geographic prevalence of poverty.

Results: Logistic Regression Model Adjusting for ISS, Age, Geographic Poverty Level

Mortality	p value	Adjusted OR	95% Confidence Interval for Adjusted OR	
ISS	<.001	1.114	1.094	1.135
Age (yr)	.131	1.007	.995	1.019
Percent Poverty (Block Group)	.023	1.016	1.002	1.030
Self Pay:Medicaid	<.001	4.500	2.994	6.764
Self Pay:Private Insurance	<.001	5.109	3.930	6.642
Medicaid:Private Insurance	.232	1.245	.870	1.781

Conclusion: Our data demonstrated an increased risk of death associated with increased ISS and with residing in a poor neighborhood. These factors are dwarfed by the impact of insurance status on mortality. Our data demonstrate a striking increase in risk of death for uninsured patients following traumatic injury, even accounting for factors such as pre-existing comorbidities, alcohol, and illicit drug use. We attempted to control for SES by comparing patients with Medicaid to self-pay patients in those patients residing in block groups with high levels of poverty. Even controlling for geographic poverty level, as well as age and ISS, insurance status stands out as the single most influential factor associated with risk of death in patients following traumatic injury.

VARIABILITY IN END-OF-LIFE CARE: IMPACT ON MORTALITY AS A QUALITY MEASURE

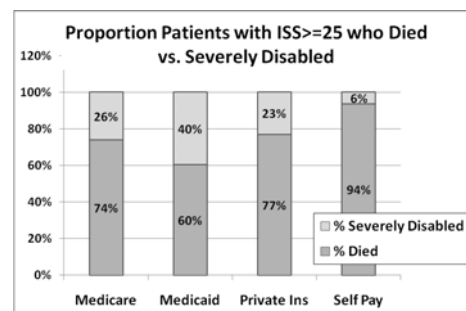
Kristan Staudenmayer, MD, Ewen Wang, MD, Elizabeth Pirrotta, MD, Kit Delgado, MD, Rachael Callcut, MD, MSPH, Matt Mell, MD, David Spain*, MD. Stanford University.

Introduction: Hospital quality rankings are based on the assumption that patient factors and quality of care are the sole determinants of mortality. However, mortality may also reflect a *decision* to not pursue aggressive care. This could be reflected in a trade-off between those who died vs. those who were discharged severely disabled. We hypothesized that there is variability in the proportion of severely injured patients who died vs. severely disabled at discharge by demographics and state.

Methods: We evaluated head-injured patients using the Nationwide Inpatient Sample from 2008. To risk stratify for injury severity and hospital variability, we analyzed only patients who had an ISS \geq 25 treated at academic hospitals. Outcome measures were death and “severe disability,” defined as patients who were discharged to long-term nursing or hospital care after tracheostomy and/or gastrostomy.

Results: A total of 96,045 patients with head injuries from 33 states were identified. Of these, 19,154 (20%) had an ISS \geq 25 with a mortality rate of 20% and severe disability rate of 7%. There was significant variability in the proportion of patients who died vs. experienced any poor outcome (died + severely disabled) by demographics and state. For states, this proportion ranged from 2% to 75%. The proportion who were discharged severely disabled based on payer status ranged from 6% for self-pay to 40% for Medicaid patients (see Figure, $p=0.0003$), and for ethnicity ranged from 13% for Hispanic to 37% for Black ($p=0.029$).

Conclusion: Significant variability exists in the proportion of head-injured patients who died vs. discharged with severe disability. This raises a red flag that differences in end-of-life decision-making may impact outcomes and quality rankings based on mortality data.



DO RACIAL DISPARITIES IN COMPLICATIONS AFTER TRAUMA VARY BY SITE OF CARE?

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 Johns Hopkins School of Medicine- Center for Surgery Trials and Outcomes Research.

Background: Differences in hospital complications have been recognized as a significant contributor to racial disparities. It is unknown if this also true for trauma patients and whether site of care impacts this. We compared odds of in-hospital complications between black and white patients at Level 1 Trauma Centers (TC) and at non-TC (NTC) hospitals.

Methods: Cohort study using National Study of Costs and Outcomes of Trauma data including patients with ISS ≥ 9 , race classified as white or black and ≥ 3 day hospital stay. White and black patients were compared within TCs and NTCs for demographic background and injury type and severity. Complications were compared across races separately within TCs and NTCs. Chi Square tests compared dichotomous variables and student t-tests compared continuous variables. Logistic regression models controlled for age, gender, injury severity, insurance status, and blunt vs. penetrating trauma. Potential interactions between race and TC status were also modeled and analyzed.

Results: The odds of major complication did not differ by race at TCs. However at NTCs, Black patients had increased odds of Cardiac Arrest, Myocardial Infarction, Deep Vein Thrombosis, Renal Failure and Surgical Site Infection. Interaction analysis corroborated the differential effects

Adjusted odds of Complications in Black versus White Patients	Trauma Center Black v. White (n=7,729) O.R. (95% CI)	Non-TC Black v. White (n=2,329) O.R. (95% CI)
Cardiac Arrest	0.88 (0.46 – 1.70)	3.32 (1.27 – 8.64)
Myocard Inf.	0.60 (0.16 – 2.24)	10.51 (2.20 – 50.1)
DVT	0.69 (0.23 – 2.09)	4.45 (1.07 – 18.55)
Renal Failure	1.54 (0.86 – 2.76)	3.01 (1.18 – 7.70)
Surg. Site Inf.	0.87 (0.50 – 1.54)	3.55 (1.41 – 8.95)
Hosp Mortality	1.36 (0.89 – 2.09)	1.30 (0.59– 2.85)

of race across centers with the exception of Renal Failure (p =0.219).

Conclusion: Black trauma patients treated at NTCs have greater odds of developing life threatening complications. This disparity is absent in TCs. These data provide a target group for potential interventions aimed at reducing inequities in trauma care and outcomes.

IMPROVING ORGAN DONATION RATES BY MODIFYING THE FAMILY APPROACH PROCESS

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Introduction: A critical shortage of organs available for transplantation continues in this country. The purpose of this study was to identify steps during family approach for organ donation that may be modified to improve consent rates of potential organ donors.

Methods: Six year (2005 – 2010) retrospective study of our local OPO database of potential organ donors. Modifiable variables involved in the family approach of potential organ donors were collected and included race and gender of OPO representative, individual initiating approach discussion with family (RN or MD vs. OPO), length of donation discussion, use of a translator, number of family members (≥ 3 vs. < 3) in the room during approach, and time of day of approach. **Results:** Of 1,137 potential organ donors 661 (58%) consented while 476 (42%) declined organ donation. Consent rates were higher with matched race of donor and OPO representative (66% vs. 52%, $p < 0.001$), family approach by female OPO representative (67% vs. 56%, $p = 0.002$), if approach was initiated by OPO representative (69% vs. 49%, $p < 0.001$), and consent rate was dependent on time of day the approach occurred: 6 AM – noon (56%), noon – 6 PM (67%), 6 PM – midnight (67%), and midnight – 6 AM (44%), $p = 0.04$. Family approach that led to consent lasted longer than those declining (67 minutes vs. 43 minutes, $p < 0.001$). After stepwise logistic regression, independent predictors of consent to donation included female OPO representative [OR 1.7 (1.2,2.4), $p = 0.006$], approach discussion initiated by OPO representative [OR 1.9 (1.3,2.7), $p = 0.001$], and longer approach discussions [OR 1.02 (1.01 – 1.03), $p < 0.001$]. Independent predictor of declined donation was the use of a translator [OR 0.39 (0.19,0.81), $p = 0.01$]. **Conclusions:** Variables such as race and gender of OPO representative and time of day should be considered prior to approaching a family for organ donation. Avoiding translators during the approach process may improve donation rates. Education for healthcare providers should reinforce the importance of allowing OPO representatives to initiate the family approach for organ donation.

THE MORTALITY RISK AFTER MOTOR VEHICLE COLLISION HAS INCREASED OVER THE LAST DECADE IN CALIFORNIA

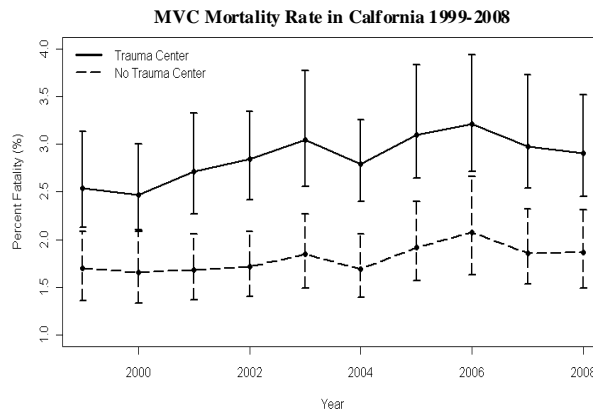
Seema Izfar, MD, Kenneth Waxman*, MD, Jonathan Grotts, MA. Santa Barbara Cottage Hospital.

Objective: To compare outcomes of California counties with and without trauma centers by looking at overall MVC mortality rates and to determine whether mortality rates have improved in California over the last decade.

Methods: The California Highway Patrol provided data from all motor vehicle crashes over the years 1999-2008 for the 58 counties in California. Percent fatality was calculated as the number of motor vehicle fatalities divided by the number of injuries. Data were analyzed to compare outcomes in those counties with and without trauma centers, and compare trends in both groups over the past decade. Further, demographic data were studied to determine the relationship of population and hospital density upon outcome.

Results: Mortality following motor vehicle collision has trended upwards in both counties with and without trauma centers. Mortality was significantly lower in counties with trauma center access ($p=0.006$). Low population density and hospital density also correlate with increased risk of mortality (OR= 0.999, 0.985).

Conclusion: Overall, the presence of a trauma center improved the chances of survival following a motor vehicle crash in California per county. However, mortality rates increased over the past decade in both counties with and without trauma centers. Future efforts to improve outcomes for injured patients should be directed towards access to trauma centers and quality review of care provided at both trauma and non-trauma center hospitals.



**SIMPLIFIED, EVIDENCE-BASED TRAUMA TEAM ACTIVATION CRITERIA
AT A LEVEL II TRAUMA CENTER**

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PURPOSE: Care of trauma patients is very resource intensive. Determining quickly those patients that require surgical intervention is paramount, but at that same time, over use of the trauma team can overwhelm local hospital resources.

METHODS: Based on a prior study examining our hospital's trauma team activation criteria, we changed our activation criteria from a complex 3-step system to a more integrated and user friendly criteria beginning in April of 2010.

RESULTS: Trauma admissions and activations were reviewed from January 2001 to January 2011. During that time, 4714 patients were treated through the trauma system with 6.9% requiring direct transfer to the operating room, with no difference in the monthly rate after the change (2.8 vs. 1.9, $p=0.2$). Before the transition to the new activation criteria, there averaged 11.7 full trauma activations (Step 1 and 2) per month compared to 3.4 afterwards (Level 1). Additionally, modified activation occurred on average 4.1 times per month (Step 3) prior to the change and 5.1 times after the change (Level 2 and Trauma Consultation). After the transition, 80% of patients were appropriately triaged compared to 60% ($p=0.015$) with no under triage of patients using the new criteria. There was also an overall decrease in the number of trauma activations discharged directly from the emergency room (6 vs. 4.4, $p=0.045$) and in the overall admissions to the surgical services.

CONCLUSION: This study underlines the ability for individual hospitals to improve the efficiency of their activation criteria, thereby minimizing resources—particularly surgical manpower--without compromising patient care.

**APPLICATION OF EMERGENCY TELEMEDICAL DIRECTION TO
IMPROVE COMBAT CASUALTY CARE AT A PRE-HOSPITAL TREATMENT
FACILITY**

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Objectives: Determine whether emergency telemedical direction improves success rate for critical actions by primary care providers during simulated combat trauma resuscitation.

Background: Recent data imply improved casualty survival with skilled triage and treatment in the pre-hospital phase. The demand for military trauma surgeons and emergency physicians exceeds supply, and is unlikely to improve in the near term.

Methods: A prospective, simulator-based trial of telemedical intervention during a simulated ATLS casualty resuscitation encounter. Subjects were randomized to experimental or control teams. Experimental team leaders were equipped with a telemedical interface, and telementored by a combat-experienced emergency physician or trauma surgeon. A standardized scripted clinical scenario and high-fidelity patient simulator were employed, with 14 critical actions and 8 life saving interventions. At completion, subjects were surveyed. Standard contingency table analysis and two-tailed T-test was used for statistical analysis. This study was reviewed and approved by our IRB.

Results: 18 experimental teams and 16 controls were studied. By ITT analysis, 89% of experimental teams vs. 50% of controls completed all LSI's ($P < .03$). 98% of experimental teams vs. 71% of controls completed all critical actions ($P < .01$). 89% of experimental teams vs. 56% of controls established advanced airways within 8 minutes ($P < 0.06$). Average time to completion was 12 minutes for experimental teams and 18 minutes for controls ($p < 0.01$). Surveys revealed no reports of distraction or encumbrance, high scores for utility and satisfaction.

Conclusion: Real-time telementoring of trauma resuscitations is both feasible and effective in improving the rate and speed of completion of critical actions and LSI's for non-emergency trained resuscitators. Prospective validation of these findings, as well as assessment of utility for directing forward providers and medics conducting remote damage control resuscitation with blood product administration, is warranted.

**ADVANCED AGE AS CRITERION FOR ACTIVATION AND ADMISSION:
HOW FAR CAN TRAUMA RESOURCES FALL?**

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Intro: Age ≥ 65 is associated with a 2-3 times increased risk of mortality from injury, leading to proposals for age inclusion into trauma activation criteria. However in these studies, ground-level falls (GLF) were excluded. At our level I trauma center, GLF patients undergo initial trauma evaluation and are admitted to the Trauma service (TR) for injuries requiring, or potentially requiring, surgical intervention, *or* to the Medicine service (MED).

Purpose: To compare patients age ≥ 65 sustaining GLF admitted to TR and MED services for severity of injury, resource utilization and outcomes.

Methods: Patients ≥ 65 years of age admitted after GLF, from 1/2006 to 6/2010, were retrospectively reviewed. Data included age, ISS, Ps, initial GCS, AIS, ICU admission (ICU), need for ventilator support (VENT), length of stay (LOS), and outcomes. Statistical analysis was performed with Fisher's exact test and paired t-test, with significance attributed to $p < 0.05$.

Results: 1,237 patients were admitted after GLF. 606 patients were > 65 years. Of these, 167 were admitted to TR, and 396 to MED (43 with minimal injuries, admitted to other services, were excluded). Groups did not differ by age, LOS or outcome. Chest AIS was higher in TR ($p < 0.01$), while extremity AIS was higher in MED ($p < 0.01$). ISS, ICU admission, and VENT were greater in TR, with lower Ps and initial GCS, although outcomes did not differ between the groups.

	ISS	Ps	GCS	%ICU	%VENT	Home/Rehab%	ECF/Death%
TR	14	0.86	13	25	24	59	41
MED	9	0.94	14	8	5	55	45
p value	<0.0001	<0.0001	<0.01	<0.0001	<0.0001	0.35	0.40

Conclusions: Triage of elderly GLF patients to MED admission after trauma service evaluation allows better use of limited TR resources, does not increase LOS, VENT or ICU use, and does not impact outcomes. Age should not be a criterion for trauma activation.

DEFINING THE TARGETS FOR QUALITY IMPROVEMENT: TOP TEN COMPLICATIONS INCURRED BY TRAUMA PATIENTS AT A LEVEL I TRAUMA CENTER

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Introduction: Trauma quality improvement programs have demonstrated contributions through decreases in morbidity, mortality, and costs of care. While these programs often target the correction of specific problems, the penultimate goal promotes the continued evolution of systematic improvements. We undertook this study to define the most commonly encountered complications in trauma patients.

Methods: All complications incurred by trauma patients at a Level I trauma center from 2005-2009 were identified through a quality improvement database. A retrospective chart review was then conducted for each of these events.

Results: The ten most predominant complications during the 5-year study period are outlined in the following table:

	2005	2006	2007	2008	2009	Total	Percent
Admissions	2204	2211	2382	2796	2644	12237	
Death	197	254	274	245	206	1176	9.6%
Readmission	52	54	54	60	75	295	2.4%
Return to ICU	27	37	51	50	44	209	1.7%
Delayed diagnosis	23	24	49	29	28	153	1.3%
System Issues	42	28	21	24	21	136	1.1%
Respiratory Failure	23	26	15	6	57	127	1.0%
Return to OR	14	18	18	18	16	84	0.7%
PE	15	9	20	15	12	71	0.6%
Cardiac Arrest	2	7	16	15	22	62	0.5%
DVT	17	16	9	9	11	62	0.5%

Wound infections/abscesses (19%) and recurrent hemothoraces/pleural effusions (11%) accounted for 30% of all readmissions. Respiratory failure represented the most common reason for return to the ICU. Of interest, 45% of patients who experienced unexpected respiratory failure had also incurred traumatic brain injuries.

Conclusions: This study identifies the ten most common complications encountered at a Level I trauma center, many of which represent potentially preventable occurrences. Quality improvement programs must continue to evaluate local shortcomings in efforts to promote systematic improvements.

DELAYED TRAUMA TEAM ACTIVATION: PATIENT CHARACTERISTICS AND OUTCOMES

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Objective: to characterize factors linked to trauma team activation delay (ACTDEL) at a level II trauma center and to establish whether these delays are linked to worse outcomes.

Methods: Trauma registry data was analyzed in regard to ACTDEL for years 2008-2010. ACTDEL was defined as cases when a trauma consult was called more than 30 minutes after ED arrival in the presence of triaging criteria or clinical evidence of traumatic injury. Demographics, injury characteristics (mechanism, intent, body region and severity), and outcomes [disposition, mortality and length of stay(LOS)] were studied in relation to ACTDEL using contingency tables (Chi square-test) and multiple linear and logistic regressions. P value of 0.05 was used for all statistics.

Results: ACTDEL occurred in 1.5% of the 9,525 cases seen by the trauma service. ACTDEL was significantly linked to age >55 (37% vs. 18%), non-White ethnicity, intentional injury (47% vs. 25%), blunt assault (26% vs. 10%), ISS >16 (25% vs. 14%), GCS=15 (74% vs. 57%) and head injury with maximum abbreviated injury severity >3 (MAIS3+) (24% vs. 9%). Firearm and vehicular injuries were significantly less common among those with ACTDEL (3% vs. 9% and 36% vs. 42%, respectively). No link was found for gender, falls, stabbings or ETOH >80. While mortality and LOS did not differ, discharge to rehab was more common among those with ACTDEL. Multivariate models for the prediction of ACTDEL revealed significant associations with Age >55 [OR 3.63 (2.35-5.55)], non-White ethnicity [OR 2.28 (1.26-4.48)], intentional injury [2.40 (1.56-3.68)], and GCS=15 [OR 2.50 (1.63-3.97)]. Multivariate analyses did not reveal any association of ACTDEL with LOS and mortality.

Conclusion: Delays in trauma team activation occur infrequently. They are linked to older age, non-White ethnicity, intentional injuries and normal GCS. While their outcome is not affected by the delay, the presence of more MAIS3+ head injuries among those with ACTDEL should encourage earlier recognition and prompt activation of the trauma team.

TROPONIN ELEVATION IN THE TRAUMA PATIENT: AN INDEPENDENT RISK FACTOR FOR MORTALITY

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Stamford Hospital.

Introduction: Elevation in troponin (T) levels is typically associated with a myocardial infarction (MI). However, an emerging body of literature has described the clinical significance of troponin elevation in conditions other than MI.

Hypothesis: Troponin elevation in trauma patients admitted to a surgical ICU is an indicator of severe illness and a possible marker for increased morbidity and mortality.

Methods: This is a retrospective analysis of prospectively collected data from the SICU's database. Between 10/01/05 and 12/31/10 546 trauma patients were admitted to the SICU; 172 (31.5%) had at least one T obtained. Patient data were stratified by peak T (ng/dL): Tnone: no T obtained; T1: 0.01-0.09; T2: 0.10-0.75; T3: >0.75. APACHE IV predicted MORT (APIV PM) and observed:expected mortality ratios were calculated.

Results: ICU LOS, % of patients requiring ventilation, and severity of illness scores (ISS, APACHE II, AP IV PM) increased with increasing T. Multivariate logistic regression analysis, with AP IV PM in the model, demonstrated that T2 and T3 were independently associated with increased risk of mortality. Odds Ratio (95% CI) for mortality:

Troponin 0.10-0.75 4.42 (1.61-12.16) p = 0.0040

Troponin > 0.75 6.99 (2.05-23.85) p = 0.0019

	Tnone	T1	T2	T3
Number of patients	374	111	38	23
Age	44 (27-67)	65 (50-83)	75 (40-84)	57 (30-83)
ISS	N/A	16.3	17.2	24.7
Mech vent (%)	24.6	30.6	39.5	65.2
ICU LOS	1.2 (0.7-2.2)	1.8 (0.9-3.7)	2.6 (1.0-5.5)	4.4 (1.5-17.1)
APACHE II score	9.2 (6.1)	12.7 (6.4)	16.9 (9.3)	19.0 (23.5)
AP IV PM (%)	6.9 (11.3)	12.1 (17.2)	19.0 (23.5)	34.4 (32.1)
Mortality (%)	3.2	9.0	26.3	52.2
O :E mort ratio	0.46	0.74	1.38	1.52

Conclusion: Even modest elevation in Troponin occurring in trauma patients admitted to the SICU is associated with increased risk of mortality.

CREW RESOURCE MANAGEMENT IMPROVES TRAUMA TEAM LEADERSHIP AND PATIENT SAFETY IN TRAUMA RESUSCITATION

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Introduction Crew Resource Management (CRM) has successfully improved safety in the operating room. We developed a CRM program tailored toward trauma resuscitation as a means to improve team function, communication, and patient safety during trauma resuscitations.

Methods A pre-implementation survey of personnel (n=160) responding to trauma activations identified perceptions on communication, team leadership, and willingness to voice concerns about patient safety issues. A CRM program tailored to trauma resuscitations was developed to target roadblocks to communication and teamwork identified in the survey. Trauma team staff (n=324) were trained in a 3-hour course. Staff were re-surveyed 3-months after implementation of CRM (n=118), to determine improvements in team leadership, communication, and willingness to voice concerns about patient safety issues.

Results

Survey Question	Pre-CRM Agreement	Post-CRM Agreement	P-Value
Team Leader (TL) identifies self to team members	28.9%	80.0%	<0.001
TL assigns roles for team members	37.4%	74.5%	<0.001
Accurate information is obtained from EMS during team transfer	88.9%	100%	<0.003
TL communicates plan before patient arrives	27.0%	74.0%	<0.001
Pre-arrival briefing is important	91.7%	98.0%	<0.04
Staff will speak up if they see something that may negatively effect patient care	63.7%	83.5%	<0.001

Conclusions CRM techniques can be successfully implemented in the trauma resuscitation setting as a patient safety program tailored to this unique venue. After a brief period of implementation, improvements were noted in team leadership, communication, and willingness to speak up when patient safety issues arise, and employee satisfaction.

ADVANCED PRACTICE NURSES REDUCE LOS WHEN DEPLOYED TO AUGMENT WEEKEND COVERAGE FOR LEVEL ONE TRAUMA SERVICE

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Introduction: Health-care providers include nurse practitioners (NPs) and physician assistants (PAs). We hypothesize that the outcomes of NPs participation, specifically weekend work hours, on a busy trauma surgery service will reduce length of stay (LOS).

Method: Retrospective trauma registry review from our urban Level 1, ACS verified trauma center. Nurse practitioners began weekend coverage in September of 2010. Trauma service data from September-January for two consecutive years was compared (2009 and 2010). Data abstracted included demographics, mechanism of injury (MOI), injury severity score (ISS), and LOS. Univariate analysis using t-test and multivariate analysis using linear regression was performed. p value <0.05 statistical significance.

Results: Total 1445 patients studied. Group A (No NPs weekends), n= 614 patients and group B (NPs weekend rounding), n= 831 patients were admitted to the trauma service in consecutive years and comprised comparator groups. Age and gender were similar in both groups with mean age of 39.5 ± 22.4 vs 40.6 ± 21.7 . Gender distribution was ~70% male patients in both groups. ISS avg <15 both groups: Group A, 10.5 ± 8.9 vs Group B, 8.0 ± 7.9 . The average LOS was 5.2 days and 3.6 days respectively (p<0.001).

Conclusions: Nurse practitioners are effective at reducing LOS on a busy trauma service. Despite increased trauma admissions over a one-year period, the length of stay decreased on the trauma service as NPs were added to weekend coverage.

DETERMINANTS OF PHYSICIAN TRIAGE DECISIONS

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Context: Despite an unprecedented effort by federal, state, and professional organizations to encourage the transfer of severely injured patients to trauma centers, non-compliance with clinical practice guidelines (CPGs) in trauma persists.

Objective: To use signal detection theory, a well-established behavioral science methodology, to examine physician cognitive processes in trauma triage, and to identify potential sources of continued non-compliance.

Design and setting: A web-based survey with thirty clinical vignettes. Physicians were asked to describe how they would manage the patients, including disposition decisions.

Participants: A national convenience sample of 280 emergency medicine physicians.

Main Outcome Measures: Under-triage and over-triage rate. Signal detection theory quantifies two aspects of decisions: decisional threshold (preference for erring on the side of keeping patients with moderate-severe injuries at a non-trauma center or transferring patients with minor injuries), and physician perceptual sensitivity (ability to discriminate among patients who did and did not meet CPGs for transfer).

Main results: Of 280 physicians, 210 logged in to the website (response rate 74%) and 168 eligible physicians completed the survey (cooperation rate 83%). The under-triage rate was 68%; the over-triage rate was 32%. Few physicians (12%) had a decision making profile consistent with the ACS-COT benchmarks for trauma triage. The majority of physicians preferred to avoid transferring patients with minor injuries (mean decisional threshold score 2.5, range -3.5 to 6.8), and had moderate ability to discriminate among patients (mean perceptual sensitivity score 3.1, range -1.4 to 8.2).

Conclusions: Most physicians do not follow clinical practice guidelines in trauma triage either because of their decisional threshold or perceptual sensitivity. Interventions that target either the physician's decisional threshold or perceptual sensitivity have different implications for the trauma system.

THE FALSE COMFORT OF RESOURCES: A POPULATION-BASED ANALYSIS OF TRAUMA TRANSFER PRACTICES IN A REGIONAL TRAUMA SYSTEM

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Background Previous work has shown that even across similarly resourced centers, outcomes at trauma centers (TC) are better than those at non-trauma centers (NTC). Furthermore, a significant proportion of patients initially triaged to NTCs are never transferred. We postulated that the lack of transfer to TCs is in part due to the perception among providers at NTCs that high quality care is ONLY associated with human and physical resources. To test this hypothesis, we performed a population-based analysis evaluating the relationship between center resources and probability of transfer to TC care.

Methods We identified all severely injured adult patients who received initial care in NTCs (2002-2010). NTCs were characterized based on the availability of general and orthopedic surgery, a CT-scanner, an ICU and type of ED staffing. NTCs that had all of the resources were characterized as *resource-rich* while those with none were characterized as *resource-limited*. We evaluated 30-day mortality among those who were never transferred, as well as the relationship between center resources and likelihood of transfer.

Results We identified 15,906 patients across 163 NTCs; 22% of NTCs were resource-limited, 57% resource-intermediate and 21% of centers were resource-rich. Resource-rich centers provided care for 40% of patients. Only 32% (n=5154) of patients were transferred to TC. Among those who were never transferred, mortality was similar whether cared for in a resource-rich or resource-limited center (OR for death resource rich-center 0.91, 0.61-1.35). Patients who received care at resource-rich centers were less likely to be transferred to a TC compared to resource-limited centers (27% vs. 50%, $p < 0.01$). This effect persisted after adjustment for patient and injury characteristics (OR for transfer 0.66, 0.47-0.91).

Conclusions: The 30-day mortality of those who stayed at NTCs was independent of resources; however, resource-rich centers were less likely to transfer patients to TCs. The merits of TC care are either unknown to providers at these centers or other factors (e.g. financial incentives) might be at play and together significantly limit access to TC care.

PROTECTING TRAUMA PATIENTS FROM REPEAT CT SCANS: THE RELEVANCE OF A VERTICALLY INTEGRATED CARE SYSTEM

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Introduction: Duplication of Computed Tomography (CT) scanning in trauma patients is a source of inefficiency and potential patient harm but occurs commonly. CT utilization has been described in trauma systems with university-based trauma centers (UH) as the tertiary referral center but has not been described in a vertically integrated healthcare system (VS). The goal of this study was to compare CT utilization and reasons for repeat CT scans at two regional Level 1 Trauma Centers, one UH and the other VS.

Methods: Patients transferred to two regional ACS-verified Level I trauma centers for a higher level of care were identified at the time of transfer. These centers constitute the only two adult Level 1 trauma centers for a 4-state region. The reason for CT scanning at the Level I center was captured by real-time reporting in the trauma bay and recorded as one of four possible categories. IRB approval was obtained.

Results: 348 adult trauma patients with 1566 body region CT scans were included, 141 at UH and 207 at VS. 197 patients (56.6%) had CT scans obtained at both the referring and receiving facilities. The rate of repeat scanning at UH was 47.8% (99/207) and at VS was 20.6% (29/141) ($p<0.01$). The rate of additional imaging at UH was 61.3% (127/207) and 49.6% (70/141) at VS ($p=0.02$). Incomplete imaging was the most common reason for repeat or additional imaging at UH (26.3%) and VS (31%). 38.6% (71/207) of UH patients and 50.4% (71/141) of VS patients received CT scans only at the referring facility ($p=0.02$)

Conclusions: The rate of repeat CT scanning is significantly lower for trauma patients transferred within a vertically integrated care system but occurs most commonly because of incomplete imaging obtained at the referring center. Given the extra cost, inefficiency and harm to patients from additional CT scans, trauma system development could benefit from an examination of the processes followed in such a vertically integrated system.

THE IMPACT OF NERVE BLOCKS ON OPIOID USE AND HOSPITAL LENGTH OF STAY IN PATIENTS WITH TRAUMATIC LOWER-EXTREMITY INJURY

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Objectives: To determine whether having a nerve block predicted total dose of postoperative opioid analgesic medication and length of hospital stay (LOS) in patients with traumatic lower-extremity injury (TLEI).

Methods: 120 patients admitted for surgery after TLEIs were prospectively enrolled. Surgery was performed for acute trauma (53%), reconstruction (31%), and infection (16%) from a prior TLEI. Patient demographics were collected using an interview format. Postoperative analgesics administered until discharge, LOS, and injury characteristics were abstracted from medical records. All opioid analgesics were converted to oral morphine equivalents (OME). Treatment satisfaction (6-point likert scale) and pain intensity (Brief Pain Inventory) were measured at discharge. Chi-square, ANOVA, and t-tests assessed differences in patient variables by nerve block. Association between nerve block and OME and LOS were analyzed using multivariable linear regression.

Results: 61 (51%) patients received blocks. Total OME ranged from 0 to 5,355 mg, mean 809 mg (SD: 1025 mg). Mean LOS was 3.8 days (SD: 3.0). Patients receiving a block were more likely to have insurance vs. none (56% vs. 29%, $p = .02$) and surgery for reconstruction (73%) vs. trauma (44%) or infection (32%) ($p = .003$). No significant differences were noted for total OME (688 mg vs. 934 mg), pain intensity (4.9 vs. 5.3), or satisfaction with pain treatment (4.9 vs. 4.8) in patients with block vs no block, respectively. However, a shorter LOS (3.0 days) was found for patients receiving a nerve block vs none (4.6 days) ($p = .002$). Nerve block remained a significant predictor of LOS, after controlling for age, injury severity, insurance status, surgery type, and comorbidities.

Conclusions: Nerve blocks appear to reduce LOS in patients with TLEI. Additional prospective research is needed to examine outcomes across types of nerve block (single injection vs. continuous) and to assess their impact following upper-extremity traumatic injury.

EARLY HOSPITAL READMISSION IN THE TRAUMA POPULATION: ARE THE RISK FACTORS DIFFERENT?

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Introduction: Hospital readmission rates will soon impact Medicare reimbursements and identifying risk factors for readmission may improve pay-for-performance rates. While risk factors for readmission have been described for medical and elective surgical patients, our aim was to evaluate their predictive value in trauma patients.

Methods: We retrospectively identified all admissions after trauma resuscitation to our urban level I trauma center from 1/1/2004 to 8/31/2010. All patients discharged alive were included. Data collected included demographics, Injury Severity Score (ISS), and length of stay (LOS). We analyzed these index admissions for the development of complications which have previously been shown to be associated with readmission.

Readmissions that occurred within 30 days of index admission were identified. Univariate and multivariate analyses were performed. P<0.05 was considered significant.

Results: We identified 10,306 index admissions, with 447 (4.3%) readmissions. On multivariate analysis, pre-existing chronic obstructive pulmonary disease (COPD) and

	Patients Not Readmitted (N=9859)	Patients Readmitted (N=447)	OR (95% C.I.)	P
Mean ISS (STD)	10.9 (10.3)	15.1 (12.6)	NA	<0.001
Median LOS, days (25-75% IQR)	4 (2-7)	8 (4-17)	1.02 (1.01-1.02)	<0.001
Comorbidities, N (%)				
COPD	650 (6.6)	43 (9.6)	1.47 (1.1-2.1)	0.023
DM	881 (8.9)	68 (15.2)	1.7 (1.3-2.2)	<0.001
Admission factors, N (%)				
SCI	242 (2.5)	29 (6.5)	1.54 (1.0-2.4)	0.045
ICU Adm.	2472 (25.1)	213 (47.7)	2.23 (1.8-2.7)	<0.001
Complications, N (%)				
SSI	123 (1.2)	18 (4)	1.95 (1.1-3.3)	0.014

diabetes mellitus (DM) predicted readmission. Spinal cord injury (SCI), ICU admission, and increased LOS also predicted readmission. Only surgical site infection during the index admission increased risk for readmission. The indications for readmission varied, with no clear association with the risk factors analyzed.

Conclusions: Trauma patients have a low overall risk of readmission and unlike many elective surgical patients, complications other than SSI during initial hospitalization do not increase the risk of readmission.

IMPROVING TRAUMA TRIAGE WITH AUTOMATIC CRASH NOTIFICATION

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Background: New automotive technology allows the estimation of injury risk from onboard sensors. Triage decisions can now be augmented by this crash information in real-time. A CDC Expert Panel recommended that triage to a trauma center should be required if the risk of ISS 15 or higher injury exceeds 20%. The Urgency algorithm predicts risk based on crash factors including impact direction, crash deltaV, number of impacts, use of safety belts and the occurrence of rollover. The objective of this study is to determine the effect on over and under triage of applying URGENCY risk thresholds lower than 20%.

Methods: A variety of logistic regression models were compared to predict the risk of ISS >15 injury and MAIS3+ injuries. Multinomial methods were introduced to further enhance the predictive value of the models compared. The regression models were trained using 11,194 cases from NASS CDS data (crash years 1999-2008). Included within the training population are front seat occupants whose crashes exceed the threshold for activation of the Automatic Crash Notification (ACN) system. This training dataset consists of 3,642 cases.

Results: The rate of overtriage is low (3%) when an ISS >15, 20% risk criteria is used yet a small percentage of the seriously injured population is correctly identified (less than 38%). Conversely, an MAIS3+, 10% risk criteria greatly improves the sensitivity of the model to detect the seriously injured (68%), yet this approach increases the rate of overtriage (15%). The overtriage rate for a 10% risk exceeds the acceptable level for a Trauma Center but not for most EMS systems.

Conclusions: The ultimate goal of the use of the enhanced ACN system is to improve trauma triage decisions by EMS. The limited nature of the vehicle sensor data may preclude trauma triage decisions based on sensor information alone, but can be relied upon to rapidly inform rescue of a potentially serious event. On-scene evaluations can then establish the need for trauma center transport. A lower injury risk threshold is more appropriate for rescue decisions than triage decisions.

BENCHMARKING THE INCIDENCE OF ORGAN FAILURE AFTER INJURY AT TRAUMA AND NON-TRAUMA CENTERS IN THE U.S.

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Background: Organ failure after injury is a significant cause of morbidity and mortality. We sought to benchmark the incidence of organ failure following injury at trauma centers and non-trauma centers using a nationally representative sample of hospital discharges.

Methods: We used the 2006 Nationwide Inpatient Sample (NIS) to identify injured adults (age = 15) with organ dysfunction using specific ICD-9 codes by system. A multivariate logistic regression model was created to compare rates of organ dysfunction between trauma centers (TC) and non-trauma centers (NTC). The model was also adjusted for bed size of hospital, geographic region, co-morbidities, injury severity score (ISS), age, and sex.

Results: We identified 422,355 injured patients, representing the patient care experience of a total of 2,068,349 patients. Among these patients, 6.64% had concurrent organ failure. Patients receiving their care at trauma centers had a higher incidence of respiratory and cardiac failure compared to non-trauma centers. All patients had an increased incidence of organ failure with increasing ISS. Injured patients who had acute organ failure were more likely to die than injured patients without organ failure (15.0% vs. 1.7%, $p < 0.001$).

	Renal	Renal (dialysis)	Respiratory	Hepatic	Cardiac
Rate (TC)	3.14%	0.09%	4.71%	0.15%	0.56%
Rate (NTC)	4.61%	0.07%	1.68%	0.15%	0.42%
Adjusted OR	1.02	1.21	1.98	1.01	1.41
95% CI	0.95-1.10	0.89-1.64	1.69-2.33	0.83-1.24	1.20-1.66
Mortality	9.3%	33.7%	24.9%	22.8%	41.8%

Conclusions: We offer the first national benchmark of rates of acute organ failure among injured patients. Post-injury organ failure is uncommon, but incidence increases with injury severity and correlates with mortality. Patients at trauma centers had higher rates of respiratory and cardiac failure, possibly representing differences in referral patterns or resuscitation strategies.

ABBREVIATED INJURY SCALE REVISIONS: IMPACT AND IMPLICATIONS

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Objective: To identify the impact of the Abbreviated Injury Scale (AIS) changes from AIS98 to AIS08 on Injury Severity Score (ISS) and attendant implications for programs.

Methods: Injuries for patients within our institution’s trauma registry from July 2008 through July 2010 were coded using both AIS98 and AIS08 scales. Impact of AIS code revisions and severity variations on ISS were determined. Statistical analysis included *t* test, McNemar’s test, chi-square. A *P*<0.05 was considered significant.

Results: 1446 patients were analyzed. Code revisions and severity changes between AIS98 and AIS08 occurred in 361 (25%) and 292 (20%) patients, respectively. Overall, ISS decreased in 19.8% of patients, with code severity changes accounting for greater than two thirds of this decrease.

	AIS98	AIS08	<i>P</i> value
ISS, mean	10.2	9.2	0.001
ISS >15, n (%)	326 (22.5)	248 (17.2)	0.001
AIS =3, n (%)			
Head/Neck	323 (22.3)	256 (17.7)	0.001
Chest	260 (18)	226 (15.6)	0.001
Face	5 (0.3)	2 (0.1)	0.083
Abdomen	75 (5.2)	63 (4.4)	0.001
Extremities	247 (17.1)	250 (17.3)	0.180
External	3 (0.2)	6 (0.4)	0.083

Conclusions: Revisions from AIS98 to AIS08 resulted in a decrease in overall ISS as well as patients classified as “major trauma” (ISS>15). The decrease in ISS was primarily driven by changes in code severity in three anatomic regions: head/neck, chest and abdomen. The revisions have significant implications for ACS verification criteria and dataset comparisons between AIS version.

PRE-HOSPITAL TRIAGE: IN-DEPTH REVIEW OF UNDER TRIAGED AND MISTRIGED PATIENTS IN A MATURE TRAUMA SYSTEM

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Objective: To determine characteristics of patients not meeting trauma team activation (TTA) criteria in a mature Trauma System (established over 25 years ago).

Methods: All trauma patients evaluated at one Level II Trauma Center from 2007-2010 were reviewed. Patients were divided into those that had TTA (Grp A) and those that were non-TTA. All non-TTA patients were classified as mistriage (Grp B = meeting TTA criteria) and under triage (Grp C = not meeting TTA criteria). Demographics, mechanism, presence of head injury, ISS, LOS, and outcome were analyzed.

Results: There were 5054 TTA cases (Grp A) and 659 non-TTA cases with 241 non-TTA mistriage (Grp B) and 418 non-TTA under triage (Grp C) cases.

	A (TTA)	B (Mistriage)	C (Under triage)	p value (A v B)	p value (A v C)	p value (B v C)
N (5713)	5054 (88.5%)	241 (4.5%)	418 (8.3%)			
Males	3574 (70.7%)	150 (62.2%)	227 (54.3%)	<0.0060	<0.0001	<0.0501
Ave Age (s.d.)	42.7 (22.03)	51.2 (23.64)	61.7 (24.40)	<0.0001	<0.0001	<0.0001
Age > 75yrs	647 (12.8%)	56 (23.2%)	180 (43.1%)	<0.0001	<0.0001	<0.0001
Falls	1587 (31.4%)	111 (46.1%)	288 (68.9%)	<0.0001	<0.0001	<0.0001
MVC	1869 (37.0%)	78 (32.4%)	57 (13.6%)	0.1516	<0.0001	<0.0001
ISS (s.d.)	11.5 (9.90)	12.0 (7.15)	11.9 (6.62)	0.4387	0.4173	0.8652
LOS (s.d.)	5.5days (11.8)	5.6days (7.33)	5.3 days (6.07)	0.8971	0.7337	0.5719
Expired	185 (3.7%)	10 (4.1%)	7 (1.7%)	0.6023	0.0365	0.0724

Of the non-TTA patients ≥ 75 yrs old, 84% of Grp B and 70% of Grp C had head injuries.

Conclusions: Even in a mature trauma system, patients meeting TTA criteria but are not designated as a TTA persist. Ongoing education of prehospital staff is essential to decrease the mistriage rate. The under triaged patients were older with 43% ≥ 75 yrs of age commonly with head injury. Falls were the most common mechanism with similar ISS and LOS when compared to those with TTA. Further investigation is needed to identify the older under triaged patient that would benefit from TTA and not overburden the trauma system.

**UPDATE AND REANALYSIS OF THE SAFETY AND EFFECTIVENESS OF
PREHOSPITAL RAPID SEQUENCE INTUBATION**

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Introduction: Airway establishment remains the priority in the care and resuscitation of trauma patients. Prehospital rapid sequence intubation (RSI) by emergency medical service providers (EMS), while controversial, has become common practice for many regional trauma systems. We undertook this study to evaluate the performance of field RSI on trauma patients performed by regional EMS versus the aeromedical transport team at a Level I trauma center.

Methods: We conducted a retrospective review of prospectively collected regional data on all trauma patients who underwent prehospital field RSI from 2006 through 2008. Data included number of attempts, complications, airway salvage maneuvers, and mortality.

Results: Field RSI was performed on 216 patients by local EMS with an average of 1.64+/-1.23 attempts. First time success was achieved in only 143 patients (66.2%); 19 patients required 4 or more intubation attempts (8.8%). Forty-six patients (21.3%) required intervention by a third party for a success rate of 78.7%. The number of attempts and the need for third party reintubation had no effect on mortality ($p>0.05$). Rescue airway devices included LMA (n=6), Combitube (n=2), and surgical airway (n=1). Nine attempts (4.2% of all attempts) resulted in undetected esophageal intubations with 2 subsequent deaths. In comparison to our previous data, the aeromedical transport team successfully intubated 96.2% (329/342) of patients who underwent RSI ($p<0.001$).

Conclusion: Prehospital RSI success by regional EMS is dismal and is significantly lower than that our aeromedical transport team. Inquiries should be raised regarding the appropriate training and recertification of EMS on the technique of RSI.

**LIMITED TRANSTHORACIC ECHOCARDIOGRAM: SO EASY ANY
TRAUMA ATTENDING CAN DO IT**

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Therèse M Duane*, MD, Julie Mayglothling, MD, Ajai K Malhotra*, MD, Rao R Ivatury*, MD.
Virginia Commonwealth University.

Background: Limited transthoracic echocardiogram (LTTE) represents an attractive alternative to formal cardiology performed transthoracic echocardiogram (TTE), since it can be completed at any time and with a simplified ultrasound machine. Our hypothesis is that trauma attendings can learn LTTE effectively with minimal training.

Methods: Seven attendings at a level I trauma center received didactic and hands-on training in LTTE and performed this test on hypotensive patients to evaluate for contractility, fluid status and pericardial effusion. Therapy to improve perfusion (administration of fluids, inotropes or vasopressors) was guided by these findings. Perfusion status was determined by serum lactate level before and 6 hours after LTTE. Findings were compared with cardiology performed TTE.

Results: 7 trauma attendings had some previous training in ultrasound but none in LTTE. Range of post-residency training was 1–29 years. LTTE training was 70 min of didactics and 25 min of hands-on. 52 LTTEs were performed. 2 patients were excluded due to blunt trauma arrest. Two LTTEs were done in the trauma bay and the rest in the ICU. Age ranged from 22 to 89 years with an average of 55. Admission diagnosis was blunt trauma in 34 patients, 2 patients had gun shot wounds, one patient had a stab wound, and 13 patients had intra abdominal sepsis. Parasternal, subxiphoid views, and IVC assessment (diameter and collapsibility) were obtained in all studies. Apical views were obtained in only 43. Average time for LTTE was 4 minutes 38 seconds. Cardiology performed TTE was obtained in all patients, and correlation for contractility with LTTE was 100%. 37 hypotensive patients received intravenous fluid, 9 received vasopressors and 4 received inotropes as guided by LTTE findings; with lactate reduction in all patients ($P < 0.00001$). The attendings scored a mean of 88% in a written test one month after the training.

Conclusions: Trauma attendings can successfully learn LTTE with minimal training and use it effectively as a resuscitation tool in the hypotensive patient.

TIME TO TRANSFER TO DEFINITIVE CARE: AN EVALUATION OF THE RURAL TRAUMA TEAM DEVELOPMENT COURSE

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Objective: To evaluate the effectiveness of the Rural Trauma Team Development Course (RTTDC) on the time to transfer to definitive care.

Methods: Our Level I trauma center provided two RTTDC to a rural referring hospital (RRF) in January and March of 2010. Approximately 90% of the RRF Emergency Department's nursing staff attended the educational offering along with 2 unit secretaries, 2 ED techs and 5 Paramedics from the local EMS agency. To evaluate the effectiveness of the educational intervention, our trauma registry was queried to identify patients transferred from RRF during three 2-month periods in 2009 and 2010. A retrospective analysis of transfer times was performed pre- and post-RTTDC training including a one-way analysis of variance to test for significant main effect for transfer time and a Levene's test of homogeneity of variance to meet statistical assumption ANOVA. Descriptive statistics on demographic variables and covariants specifically consult, modified or full alert, and air or ground transport were performed.

Results: A total of 38 trauma patients were transferred during the 3 time periods examined (n=38). For the 2 months (Nov/Dec. '09) prior to the first course 6 patients were transferred (n=6). The mean time from entry to the referring hospital to arrival at the Level I trauma center was 262.5 minutes. For the two month (Apr/May '10) period following the educational intervention 13 patients (n=13) were transferred with a mean transfer time of 195.54 minutes revealing a decrease in time to definitive care of 66.96 minutes. The final time period evaluated was 7 months post intervention (Nov/Dec '10) and a total of 19 patients (n=19) were transferred with a mean transfer time of 198.74 minutes.

Conclusion: The RTTDC is effective in decreasing time to transfer to definitive care and the results of the course may be sustained. Due to the small sample size the results of this study are not statistically significant. However, the results support the potential promise of the RTTDC in decreasing time to definitive care and sustaining the results.

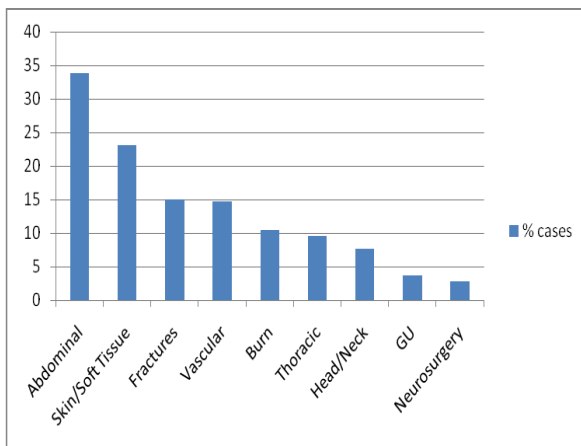
COMBAT READINESS FOR THE MODERN MILITARY SURGEON: DATA FROM A DECADE OF COMBAT OPERATIONS

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Objective: Hundreds of general surgeons from the Army, Navy and Air Force have been deployed over the past 10 years to support combat forces, but little data exists on their preparedness to handle the challenging injuries that they are currently encountering. Our objective was to assess operative and operational experience in theater with the goal of improving combat readiness for surgeons.

Methods: A detailed survey was sent to 244 active duty surgeons from the Army, Navy and Air Force who had been deployed at least once in the past 10 years, requesting information on cases performed, perceptions of efficacy of pre-deployment training, knowledge deficits, and post-deployment emotional challenges. Survey data was kept confidential and analyzed using standard statistical methods.

Results: 137 individuals responded (56%). 68% had been deployed 2 or more times. Over 18,500 operative procedures were reported with abdominal and soft tissue cases predominating (Figure 1). Many surgeons identified knowledge/practice gaps in pre-deployment vascular (46%), neurosurgical (29.9%) and orthopedic (28.5%) training. The personal burden of deployment manifested itself with both family (nearly 10% deployment-related divorce rate) and personal (37 surgeons with 2 or more symptoms of PTSD) stressors.



Conclusions: Military surgeons continue to serve with distinction in the care of combat wounded, but these data suggest a need for modifications of combat surgical training curriculum as well as an emphasis on social and emotional well-being.

MORE CONFIDENT TRAUMA RESUSCITATION TEAM LEADERS: A NOVEL SIMULATION-BASED TRAINING CURRICULUM UTILIZING VIDEO FEEDBACK

John L Falcone, MD, Paul E Phrampus, MD, Andrew B Peitzman,* MD, Louis H Alarcon,* MD, Raquel M Forsythe,* MD. University of Pittsburgh Medical Center.

Introduction: There are deficiencies in trauma resuscitation leader performance regarding Advanced Trauma Life Support adherence and other leadership behaviors. Simulation training and video-based feedback can lead to durable changes in leadership behavior. We hypothesize that trauma resuscitation leaders will have improved attitudes about trauma resuscitation leadership following a curriculum based on human patient simulation.

Methods: In this randomized prospective trial, trauma resuscitation leaders were randomized 1:2 between a dedicated trauma resuscitation team leader training curriculum and the standard practice of team leader training over six months. The curriculum consisted of a one-on-one didactic session with a trauma surgeon. This was followed by a series of eight simulated trauma scenarios with a mix of acuities and a mix of blunt and penetrating injury using programmed SimMan patient simulators. Other members of the trauma team included a trauma surgeon, an anesthesiologist, a chief resident, a trauma nurse, a medical student, and a presenting emergency medicine technician. Each scenario was followed by video-based feedback with the surgeon. Attitudes regarding simulation and trauma resuscitation were evaluated before and after the intervention with a Likert-based survey. One-tailed non-parametric statistics were performed using an alpha = 0.05.

Results: Seven of 20 residents were randomized to the intervention arm, with a median age of 29. On a seven-point Likert scale, the median curriculum rating, the video discussion quality, the feedback rating, the plan to apply leadership skills, and the recommendation for using the curriculum to train all trauma residents was 7/7. A sign test showed improved confidence for leading Level 1 trauma resuscitations and that residents felt that the curriculum adequately trained them to be trauma resuscitation leaders ($p = 0.02$). There was a trend towards reduced nervousness of being the team leader ($p = 0.12$).

Conclusion: Residents found this curriculum valuable regarding their duties as a trauma resuscitation leader. We will consider using this curriculum to train all trauma residents.

**ANTIBIOTIC RESISTANCE AND THE DIFFICULTY OF EMPIRIC
COVERAGE FOR LATE PNEUMONIA IN THE SURGICAL INTENSIVE CARE
UNIT: A PLEA FOR ANTIBIOTIC STEWARDSHIP**

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Background: Adequate empiric antibiotic therapy for pneumonia saves lives. Multidrug resistant (MDR) organisms, promoted by injudicious antibiotic use, make adequate coverage more difficult. MDR pathogens are a growing problem worldwide, and are associated with poorer outcomes. We sought to determine the effect of MDR organisms on our ability to provide adequate empiric coverage for both early and late pneumonia in the surgical intensive care unit (SICU).

Methods: Retrospective analysis of SICU pneumonia patients admitted over a 1.5 year period. Microbiology and sensitivity profiles were analyzed. Risk factors for MDR pathogens were based on American Thoracic Society (ATS) guidelines.

Results: 64 first pneumonias were caused by 90 pathogens; 28% of pathogens were early (<5 days), 72% were late (≥5 days). 24 of 25 (96%) early occurred in patients with MDR risk factors; 10 (40%) were true MDR organisms. In this early high-risk cohort, ATS-recommended broad-spectrum regimens provided excellent empiric coverage of 92% (ciprofloxacin/vancomycin), 99% (cefepime/vancomycin), and 96% (piperacillin-tazobactam/vancomycin). Examining late pneumonia, 35 of 65 (54%) pathogens were MDR. Guideline-recommended broad-spectrum regimens provided much worse coverage of 71% (ciprofloxacin/vancomycin), 74% cefepime/vancomycin) and 71% (piperacillin-tazobactam/vancomycin). Addition of carbapenems, aminoglycosides, or alternative cephalosporins failed to improve coverage above 78%.

Conclusions: Late pneumonia in our SICU is significantly more difficult to cover than early high-risk pneumonia. This is driven by late MDR pathogens, and is extremely concerning, as a vast majority of SICU pneumonias are late. As the problem of MDR pathogens continues to worsen, antibiotic stewardship to prevent further deterioration of susceptibility becomes more vital than ever.

BLADDER PRESSURE MEASUREMENTS AND RISK OF UTI: DOES TECHNIQUE MATTER?

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Introduction: To decrease UTI in our ICU we evaluated the role of bladder pressure measurements (BPM) as a possible risk factor. The purpose of this study was to compare an open to a closed BPM technique to determine if the approach was associated with UTI.

Methods: Data was collected prospectively from 1/03 -12/10 by a dedicated epidemiology nurse and combined with trauma registry data at our Level 1 trauma center. STICU patients with and without UTI's were compared. CDC definitions were used to diagnose UTI. BPM were performed when there was a concern for intra abdominal hypertension. Subset analysis of patients with BPM was performed comparing those who had an open technique (1/03-12/05) to those with a closed (1/06-12/10). An open technique required puncture of the catheter (UDC) and disruption of the system whereas with a closed technique the integrity of the system was maintained using one-way valve side ports for measurements.

Results: 3172 patients were included with the UTI group being more injured (Table 1, $p < 0.0001$). 484 patients never had a catheter. 2564 patients had a UDC, no BPM and 85 had a UTI (3.32%) while 124 patients had a UDC, BPM and 18 had a UTI (14.52%) (p

Table 1	No UTI	UTI
ISS	18.9 ± 11.8	27.1 ± 11.1
Vent LOS(days)	1.7 ± 4.5	7.7 ± 10.3
ICU LOS (days)	5.8 ± 8.4	30.2 ± 25.1
Hosp LOS (days)	11.7 ± 13.0	42.7 ± 35.4
UDC days	4.5 ± 7.0	23.8 ± 16.5

< 0.0001). Subset analysis found that patients who underwent an open technique had more UTI's than those who had a closed (4.92% (50/967) vs. 2.51% (54/2101), $p < 0.001$) although the rates/1000 UDC days were not significant (12.94 open vs. 5.75 closed, $p = 0.1$). Regression noted UDC days (1.097-1.134, OR 1.116, $p < 0.0001$) and not technique to be a predictor of UTI.

Conclusion: Patients who undergo BPM are more likely to have a UTI but it is prolonged UDC use that increases UTI risk regardless of type of technique used. Hence patients should have discontinuation of the UDC whenever possible.

SURGICAL SEPSIS: CARS NOT SIRS IS THE PROBLEM!

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Introduction: Sepsis screening and early interventions aimed at limiting the systemic inflammatory response syndrome (SIRS) to prevent progression to septic shock has been shown to decrease mortality in surgical sepsis. SIRS was believed to have a causal link to the compensatory anti-inflammatory response syndrome (CARS) that causes late MOF. However, recent basic research indicates that SIRS and CARS occur simultaneously, and recent translational studies suggest that their early balance determines 1 of 3 clinical trajectories: 1) excessive SIRS - early MOF / fulminant death; 2) balanced SIRS / CARS - preconditioned state with rapid / uncomplicated recovery; and 3) excessive CARS - immune paralysis / secondary infection / late MOF/ indolent death. Incidence of these trajectories and sepsis severity are compared in a cohort of surgical sepsis patients.

Methods: A prospective database of 309 surgical sepsis patients over 3 years ending Dec 2010 was queried to categorize trajectories of: Excessive SIRS (early MOF or death within 5 days); Preconditioned state (discharge to home within 10 days); and Excessive CARS (late MOF or death after 5 days or discharge to long term healthcare). Sepsis severity was defined using standard definitions at initial presentation. (X^2 tests; $p < 0.05$)

Results: Excessive SIRS occurred in half of septic shock patients, but was uncommon in sepsis and severe sepsis patients. Of note, half of these patient developed Excessive CARS.

^{1,2} rows; ^{a,b,c} columns: $p < 0.05$	sepsis	severe sepsis	septic shock	total
Excessive SIRS	^{1,a} 2 (4%)	^{1,a} 22 (13%)	^{2,a} 45 (54%)	69 (22%)
Preconditioned	^b 22 (42%)	^b 69 (40%)	^b 26 (31%)	117 (38%)
Excessive CARS	^{1,b} 28 (54%)	^{1,b} 82 (47%)	^{2,c} 13 (16%)	123 (39%)
total	52 (17%)	173 (56%)	84 (27%)	309

Conclusion: Excessive CARS is the predominant problematic clinical trajectory among surgical sepsis patients with incidence inversely related to sepsis severity. Novel diagnostic methods and interventions are needed to predict, diagnose and treat sepsis induced CARS.

IMMUNE REGULATION OF NEUTROPHILS ON T LYMPHOCYTES

Bruce Chung, MD, Mita De, MA, Asit De, PhD, Paul E Bankey, MD, PhD. University of Rochester.

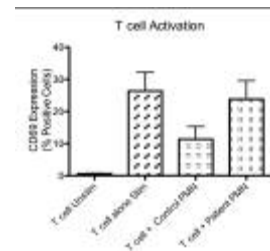
Introduction: Recent evidence suggests an expanded role of neutrophils (PMNs) in host defense and T cell responses. Following injury, PMNs show delayed apoptosis and increased expression of T cell co-signaling molecules and cytokines that may play a role in T cell regulation and adaptive immune responses. We hypothesize that post-injury PMNs regulate T cell activation. To test this, we examined the effect of co-cultured PMNs on T cell activation.

Methods: A prospective study was conducted with patients of major injury (ISS > 20) compared to age and gender matched healthy controls (n=4). PMNs were isolated by Ficoll-Hypaque density centrifugation and dextran sedimentation, while T cells were isolated by rosetting with sheep red blood cells. PMNs were cultured with allogeneic T cells, and stimulated with aCD3/aCD28 for 16 hours. T cell activation was then assessed by detection of CD69 and CD25 using flow cytometry.

Results: PMNs from healthy subjects significantly decreased T cell activation, measured by CD69 expression, 11.36%±3.9 vs. 26.3%±5.8 in T cells alone, p-value 0.04. In contrast, PMNs from trauma patients showed minimal decrease in T cell activation (23.8%±5.7, p-value 0.79). Expression of CD25

demonstrated similar patterns with control T cells demonstrating a CD25+ of 21.1%±6.8, while T cells cultured with control PMNs expressed 6.6%± 3.5 (p-value 0.03), and T cells with trauma PMNs expressed 20.5%± 3.9 (p-value 0.93).

Conclusion: These results demonstrate that PMNs alter T cell activation *in vitro*. Further, they demonstrate that PMNs that are *in vivo* stimulated during trauma alter T cell activation compared to the inhibitory effect of PMNs from healthy subjects. Together, these results suggest a novel interaction of innate and adaptive immunity between PMNs and T cells and a less immune inhibitory phenotype of PMNs following injury.



PEPTIC ULCER PROPHYLAXIS IN TRAUMA PATIENTS

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Objective: The practice of providing prophylaxis for peptic ulcers in patients admitted to the hospital following trauma is poorly supported by the literature. Medications given for ulcer prophylaxis that neutralize the stomach's pH, especially histamine-receptor antagonists (HRA) and proton-pump inhibitors (PPI), are associated with increased risk of pneumonia and Clostridium difficile colitis in medical patients.

Methods: We examined the peptic ulcer prophylaxis practices at our institution, an academic tertiary care medical center with level-I trauma designation. Prospectively-collected data from our trauma database and electronic hospital data warehouse were reviewed on all trauma patients admitted once to our institution for >48 hours between 10/1/2001 and 11/11/2009, including 4527 patients.

Results: 3495 patients (77%) received medication for peptic ulcer prophylaxis. HRA were given to 3178 (70%). PPI were given to 705 (15.5%). Other agents (sucralfate or antacids) were given to 609 (13.4%). Combinations of these medications were given to 853 (18.8%) patients including 344 (7.6%) who received HRA and PPI. 38 (0.8%) patients were diagnosed with peptic ulcer during admission. Pneumonia was diagnosed in 129 (2.8%) patients 54 (41.9%, OR 0.54, p=0.0057) of whom had been given HRA, 35 (27%, OR 2.62, p=0.0001) of whom had been given HRA and PPI, and 5 were given no peptic ulcer prophylaxis (3.9%, OR 0.116, p<0.001). Clostridium difficile colitis was diagnosed in 24 (0.5%) patients, 7 of whom received HRA and PPI (29%, OR 6.16, p=0.0001), and 4 of whom received HRA and antacids (16%, OR 3.52, p=0.02).

Conclusion: These data suggest medications given to prevent peptic ulceration, a rare event, have potential for harmful side effects.

**TRAUMA PATIENT GASTRIC VOLUME IDENTIFIES AT RISK
POPULATION FOR DEVELOPING PNEUMONIA**

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Introduction: Trauma patients may have full stomachs and/or impaired airway reflexes placing them at risk for aspiration and pneumonia. Our hypothesis was that trauma patients with a larger gastric volume as measured by admission abdominal CT have a higher rate of pneumonia and poorer outcomes.

Methods: Medical records of all trauma patients treated at our university-based urban trauma center from 2003-2010 were reviewed. An initial cohort of 76 trauma patients with an admission CT of the abdomen and a diagnosis of pneumonia were matched with a control group of 76 trauma patients who did not develop pneumonia. Patient demographics and outcomes were examined. A receiver-operating-characteristic (ROC) curve analysis determined a threshold value for gastric volume that was predictive of pneumonia. Variables were compared using Chi square and unpaired t-tests.

Results: Patients with pneumonia had larger gastric volumes on admission CT compared to patients without pneumonia (911 cm^3 versus 587 cm^3 , $p=0.0002$). The area under the curve (AUC) calculation from the ROC curve was 0.7. Selecting for both optimal sensitivity and specificity gave a threshold value of 600 cm^3 as a determinant of large gastric volume. Patients with a gastric volume $\geq 600\text{ cm}^3$ were found to have higher ISS (23 vs 18, $p=0.02$) and lower P_s (81% vs 88%, $p<0.05$). Patients with a gastric volume $\geq 600\text{ cm}^3$ had a higher percentage of pneumonia (63% versus 37%, $p=0.001$), increased LOS (23 vs 15 days, $p=0.03$) and trends towards increased mortality (8% vs 3%, $p=0.1$) and ICU LOS (22 vs 17 days, $p=0.2$).

Conclusions: Estimating gastric volume on admission abdominal CT may predict those trauma patients at risk for developing pneumonia and worse outcomes. ROC curve analysis showed a decent clinical discriminating ability. Clinicians should be especially vigilant in taking precautions against pneumonia and have a lower threshold for suspecting pneumonia in patients with gastric volumes $\geq 600\text{ cm}^3$.

SMALL-BORE FEEDING TUBE PLACEMENT: A TEAM APPROACH WITH AN ELECTROMAGNETIC PLACEMENT DEVICE VS. TRADITIONAL OR MODIFIED BLIND PLACEMENT

Kevin McCutcheon, ASN, RN, Victoria Klink BSN, RN, PCCN, Phillip Efron, MD, Darwin Ang, MD, Lawrence Lottenberg*, MD. University of Florida College of Medicine.

Introduction The purpose of this study was to compare the outcomes of small-bore feeding tube (SBFT) placements using a team of nurses and an electromagnetic placement device (EPD) to the traditional blind placement method in adult ICU and medical-surgical units. Specific aims were to contrast outcomes for complications (lung placement or pneumothorax), efficiency of placement (time) and resource utilization (staff involvement, number of radiographs, amount of equipment used and number of attempts to achieve placement). Mishaps with SBFT placements represent a significant patient safety hazard.

Methods This was a prospective, descriptive, non-interventional study comparing SBFT placements using a team approach with an EPD vs. the modified blind placement method. Study data included patient demographics, diagnoses, co-morbidities, treatments, all radiology information and related EPD information.

Results 101 patients were included in the study, 54 EPD and 47 blind. Six adult ICUs and 6 Medical Surgical Units were used. More x-rays were obtained on patients who had SBFT placed using the modified blind method ($m=3.45$) than the EPD ($m=1.02$) where m =mean number of x-rays ($p<0.0001$). The length of time from initial order until clearance for use was significantly longer with the modified blind placement method (24.14 hours) compared to the EPD placement group (6.72 hours). Finally, more SBFTs were used during a single placement event with the modified blind placement method (1.8) compared to the EPD method (1.04).

Conclusions Based on the analysis of 101 patients, an evolving trend with statistically significant differences between the electromagnetic placement device and the modified placement method of small bore feeding tubes. SBFTs placed using the modified blind placement method took an average of 17 hours longer to achieve desired placement. Patients who received SBFT using the modified blind placement method also had significantly more x-ray exposures and a greater share of hospital resources were used.

MODIFIABLE FACTORS ASSOCIATED WITH QUALITY OF LIFE AFTER PROLONGED POST-INJURY ICU STAY.

Karen J Brasel, MD, MPH*, Terri deRoon-Cassini, PhD, Abbey Valvano, MS, Ed de StAubin, PhD. Medical College of Wisconsin.

Objective: To determine the long-term quality of life (QoL) of trauma survivors after a prolonged ICU stay, and the factors that are related to QoL after severe traumatic injury.

Method: Injured patients 6 months-10 years after traumatic injury completed standardized measures of anxiety, depression, PTSD, hardiness, religiousness, personal and social well-being, and QoL (SF-36). Pearson correlations were used to assess the relationship between mental (MCS) and physical (PCS) QoL and the study variables of interest.

Results: Sixty-three participants completed the interview protocol. Average time since injury was 1,897 days. Average ICU stay was 20.3 days. Twenty-three percent had some recall of their ICU stay. Average length of post-traumatic amnesia was 38.75 days. Twenty percent met criteria for PTSD, 10% for depression, and 15% for anxiety. Overall quality of life was poor, with mean PCS = 27 and mean MCS = 16. MCS was correlated with most variables assessed, while PCS was not correlated with any measured variables.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.PTSD										
2.Anxiety	.87*									
3.Depression	.66*	.69*								
4.Religion	.07	.09	.21							
5.Personal WB	-.54*	-.53*	-.71*	.01						
6.Social WB	-.31*	-.39*	-.61*	.01	.70*					
7.Hardiness	-.50*	-.51*	-.63*	-.05	.76*	.69*				
8.PCS	-.16	-.04	-.17	-.09	.13	.12	.03			
9.MCS	-.67*	-.74*	-.70*	-.10	.61*	.46*	.59*	-.33*		
10.% ICU	-.08	-.17	-.20	.23	-.04	.01	.11	-.30*	.33*	
11.PTA	-.09	-.04	.13	-.06	-.06	-.08	.02	.12	-.04	-.23

% ICU = % recall of ICU stay; PTA = posttraumatic amnesia *p<0.05

Conclusions: Quality of life in many long-term trauma survivors who have a prolonged ICU stay is poor. Mental QoL has modifiable correlates, while psychological well-being, level of resilience, and psychopathology are not related to physical QoL. Although longitudinal studies need to substantiate these findings, patients with extended ICU stays could benefit from targeted psychological intervention to improve long-term QoL.

VENOUS LACTATE IS A BETTER PREDICTOR OF MORTALITY THAN TRADITIONAL VITAL SIGNS IN THE GERIATRIC TRAUMA POPULATION

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Introduction: Traditional vital signs (including blood pressure and pulse) and their composite, the shock index, may be poor prognostic indicators in elderly trauma patients. Recent studies indicate that lactate, on the other hand, is a strong predictor of hypoperfusion and shock. The purpose of this study is to determine whether lactate better predicts mortality than traditional vital signs (TVS), including the shock index (SI).

Methods: We studied trauma patients age \geq 65 admitted to a level 1 trauma center from 1/1/2009 – 9/30/2010. Abnormal TVS were defined as the presence of hypotension (ED SBP = 90 mm Hg) and/or tachycardia (ED pulse = 120 beats/min), while SI was defined as pulse divided by SBP. An elevated lactate was defined as ED venous lactate \geq 2.5 mMol/L. The predictive capability of these variables for in-hospital mortality was compared using Chi-square tests, receiver operator characteristic curves and logistic regression.

Results: There were 1,053 geriatric trauma patients, with an overall mortality of 3.3%. Undertriage occurred in 17.4% of patients, and was associated with increasing lactate ($p = 0.04$). Mortality was not significantly different in patients with abnormal TVS vs. normal TVS (2.50% vs. 3.30%, $p = 1.00$). However, mortality was significantly greater in patients with an elevated lactate vs. a normal lactate (10.76% vs. 2.34%, $p < 0.001$). The area under the curve (AUC) was significantly better for lactate (AUC: 0.70) compared to SBP (AUC: 0.53, $p = 0.03$), pulse (AUC: 0.52, $p = 0.02$), and shock index (AUC: 0.52, $p = 0.02$). After adjustment, lactate significantly predicted mortality (OR: 2.71, $p = 0.04$), whereas abnormal TVS (OR: 0.32, $p = 0.30$) and shock index = 1 (OR: 1.33, $p = 0.74$) did not.

Conclusions: While abnormal TVS and SI are predictive of mortality in the general trauma population, their predictive value was negligible in geriatric trauma patients. An elevated lactate was associated with nearly three-fold increased odds of mortality in elderly patients. Geriatric resuscitation guidelines should incorporate an admission lactate to ensure adequate triage and monitor resuscitation.

SEVERITY OF ILLNESS FOR ELECTIVE AND NON-EMERGENT PROCEDURES BETWEEN TRAUMA AND NON-TRAUMA CENTERS

Darwin Ang, MD PhD MPH, Lawrence Lottenberg*, MD, Makesha Miggins, MD, Timothy Flynn, MD, Huazhi Liu, MS, Philip Efron, MD. University of Florida.

Purpose: Patients in trauma centers have a higher severity of illness (SOI) due to an acute injury or need for emergent surgery. However, little is known about the SOI for the other case-mix of patients in trauma centers. The purpose of this study is to examine whether or not the difference in SOI still exists among patients who undergo elective and non-emergent surgeries.

Methods: Over 170 hospitals were divided into trauma centers and non trauma centers using the University HealthConsortium database. Patients with ICD-9 codes that were associated with trauma as defined by the American College of Surgeons were excluded. Fourteen high volume, elective, and non-emergent procedures were examined between trauma and non-trauma centers. SOI was assigned to each patient using 3M Health Information Systems designation. Poisson Regression was used to calculate the relative risks.

Results: The SOI was consistently lower in 11 out of 14 elective procedures in non-trauma centers. Moderate and major SOI were particularly higher for laparoscopic cholecystectomies among trauma centers; RR 1.09 95% CI (1.03, 1.15) and RR 1.33 95% CI (1.18, 1.5) respectively. Major and extreme SOI were also higher for obesity related procedures among trauma centers; RR 1.16 95% CI (1.04, 1.29) and RR 1.31 95% CI (1.00, 1.71) respectively.

Conclusions: Even among elective non-emergent cases, trauma centers continue to operate on patients with higher SOI compared to non trauma centers. This suggests that for the same procedures, the case-mix of patients is different. This has implications concerning differences in patient selection and practice patterns.

DO NOT RESUSCITATE (DNR) STATUS, BUT NOT AGE AFFECTS OUTCOMES IN 15,227 TRAUMA PATIENTS

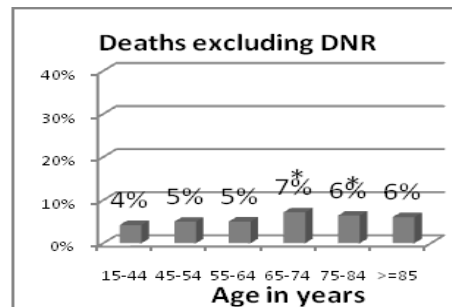
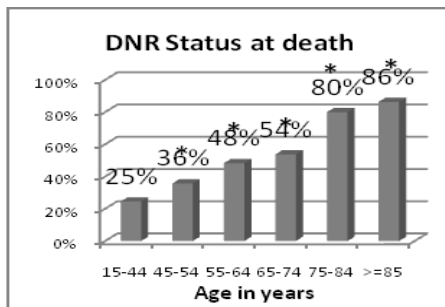
Sasha D Adams, MD, Bryan A Cotton*, MD, Charles E Wade, PhD, Rosemary A Kozar*, MD, Edmundo Dipasupil, CSTR, Jeanette M Podbielski, RN, Brijesh S Gill, MD, James R Duke, MD, Phillip R Adams, MD, John B Holcomb*, MD. UT Health, Houston.

Introduction: Despite a well described association of age and injury with mortality and decreased functional status, inpatient mortality studies have traditionally not considered DNR status. We hypothesized that the increased likelihood of DNR status in older patients alters age-adjusted mortality rates in trauma.

Methods: The trauma registry was queried for adult patients admitted to our Level I trauma center (01/2005-12/2008) and divided into 8 age groups by decade, collapsing ages 14-44. We compared age, mortality, DNR and disposition by univariate analysis and trends by Chi-square ($p < 0.05$).

Results: 15,227 adult patients were admitted, 13% were elderly (≥ 65), and 7% died. Mortality and rehabilitation/nursing facility placements increased with age, while discharges to home decreased. DNR status was known in 775 deaths, 42% were DNR and DNR likelihood increased with age ($p < 0.05$). With DNRs excluded, mortality variability across all ages was markedly diminished (4%-7%).

Conclusions: DNR status among trauma patients varies significantly, with successive ages more likely DNR at time of death. When DNR patients were excluded, age was not associated with an increased risk of death. Inclusion of DNR patients within mortality studies likely skews analyses, falsely indicating failed resuscitative efforts rather than humane decisions to limit care after injury.



**CLINICAL FACTORS ASSOCIATED WITH NEED FOR TRACHEOSTOMY
AND PROLONGED MECHANICAL VENTILATION AFTER CERVICAL
FRACTURE WITHOUT HEAD OR SPINAL CORD INJURY**

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Introduction: Patients with cervical spine fracture and spinal cord (SCI) or head injury (HI) have high risk of tracheostomy for prolonged mechanical ventilation (>96h) (TPMV), which is associated with a 44% one-year mortality and high rates of functional dependency. We sought to identify factors associated with TPMV in patients with cervical spine fracture without HI or SCI to inform prognosis and improve the allocation of supportive resources for patients and families.

Methods: We used the trauma registry at our level one trauma center to identify all patients with cervical spine fracture without HI or SCI from 2007- 2009. Demographics, injury characteristics, and hospital complications associated with need for tracheostomy were abstracted. We used t-test, chi-square, and Fisher's exact test for comparisons between groups as appropriate. Alpha= $p < 0.05$

Results: There were 186 patients in our cohort. Their mean age was 65 (SD \pm 22) years, 72 (39%) patients were admitted to the ICU, and 33 (18%) required mechanical ventilation. Of the 186, 13 (7%) had TPMV. Patients with TPMV had lower mean GCS in the emergency department (14.2 (SD \pm 2.6) vs. 10.2 (SD \pm 5.9), $p=0.0001$), and higher rates of pneumonia (5 (3%) vs. 4 (31%), $p=0.002$) and diagnosis with dysphagia (7.6% vs. 46.2%, $p < 0.0001$) than patients without TPMV. In the TPMV group, the mean hospital stay (24.0 days (SD \pm 8.8) vs. 6.3 days (SD \pm 7.3), $p < 0.0001$) and ICU length of stay (17.2 days (SD \pm 9.7) vs. 1.7 days (SD \pm 5.4), $p < 0.001$) were considerably longer; two (15%) died and none were discharged home (0% vs. 41.0%, $p=0.006$). There was no difference in age, ISS, facial or thoracic trauma, or delirium between groups.

Conclusion: Even in the absence of HI and SCI, patients with cervical spine fractures are at significant risk for TPMV which is associated with high mortality and functional dependence. Admission GCS, dysphagia, and pneumonia are most closely associated with TPMV suggesting that aspiration is an important factor and potential target for prevention.

FAILURE TO RESCUE: THE RISK OF MORTALITY FOLLOWING COMPLICATIONS AT A LEVEL I TRAUMA CENTER

Patrick K Kim*, MD, Patrick M Reilly*, MD, C William Schwab*, MD. University of Pennsylvania.

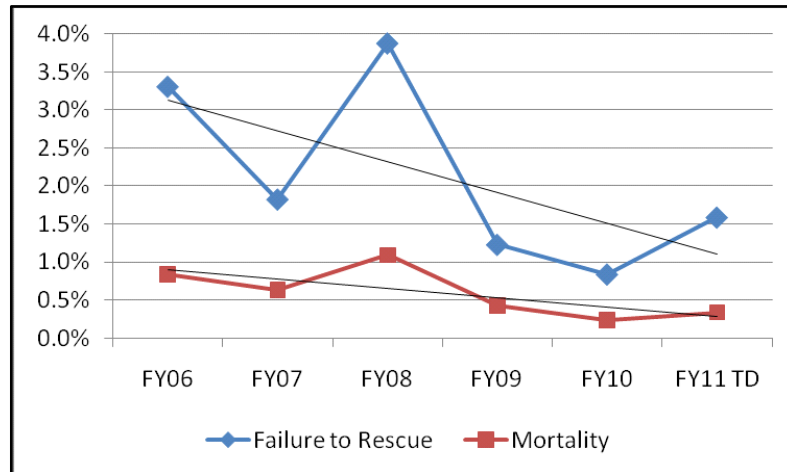
Background: Inpatient “rescue” (survival after occurrence of a complication) may indicate effective processes of care. Conversely, failure to rescue (FTR) is defined as mortality given the presence of a complication: $FTR = (\text{deaths after complication}) / (\text{all patients with complication})$. We hypothesized that FTR is a useful metric to evaluate inpatient care.

Methods: The study center is a level I trauma center whose registry captures 46 complications defined

by the Pennsylvania Trauma Outcomes Study (PTOS). We reviewed complication rates and mortality of PTOS patients admitted 7/2005—12/2010 with LOS >2 days and determined FTR.

Results: 6636 patients met criteria. Age, ISS, LOS and complication rates were stable over time (Table). Mortality and FTR decreased over

	FY06	FY07	FY08	FY09	FY10	FY11TD
Patients	1201	1269	1101	1180	1290	595
Age, mean	42.9	43.6	43.0	44.6	45.2	43.1
ISS, mean	14.6	14.5	14.5	15.0	14.0	14.4
LOS, mean	8.3	8.8	9.8	8.7	8.3	8.6
Any PTOS complication	20.1%	21.6%	23.4%	20.7%	18.4%	21.2%



time (Figure). Pearson’s $r = -0.63$ and -0.71 for FTR and mortality, respectively.

Conclusions: Failure to rescue decreased over time, suggesting improved care of patients who sustained complications. By focusing only on patients with complications, FTR may add insight into mortality trends and may help identify effective processes of trauma care.

VENOUS THROMBOEMBOLISM IN THE ELDERLY: THE RESULT OF COMORBID CONDITIONS OR A CONSEQUENCE OF INJURY?

Leslie Kobayashi, MD, Dennis Y Kim, MD, Galinos Barmparas, MD, Dale Fortlage, BA, Terry Curry, RN, Raul Coimbra*, MD, PhD. University of California San Diego.

Background: Trauma is significantly associated with venous thromboembolism (VTE). Increased age is also a risk factor for VTE. The purpose of the current study was to determine the incidence and outcomes of VTE in geriatric trauma patients as well as to identify risk factors for VTE in this population.

Methods: A 10 year retrospective review of all trauma patients \geq 65 years of age discharged with a diagnosis of VTE. Demographic data, injuries, mechanism, Injury Severity Scores (ISS), Abbreviated Injury Scores (AIS), Glasgow Coma Scale (GCS), length of stay (LOS), and mortality were collected. VTE were identified by screening ultrasound or CT pulmonary angiography upon clinical suspicion.

Results: During the study 2521 trauma patients aged \geq 65 were admitted, of these, 82 (3.2%) were diagnosed with VTE. DVT was diagnosed in 74 (90.2%) and pulmonary embolism (PE) was found in 8 (9.76%), 2 patients had both DVT and PE. On multivariate regression analysis, independent predictors of VTE included: TBI (adjusted OR [AOR] 2.34 95% CI 1.3-4.2, $p < 0.05$); chest AIS \geq 3 (AOR 3.02 95% CI 1.61-5.68, $p < 0.001$); mechanical ventilation (AOR 3.65 95% CI 1.93-6.90, $p < 0.001$); major operation (AOR 2.67 95% CI 1.47-4.88, $p < 0.001$); and history of VTE (AOR 4.76 95% CI 1-22.72, $p = 0.05$). Other comorbid conditions were not significantly associated with VTE. Pre-injury anticoagulation was not significant but had a trend toward a protective effect. LOS was significantly longer in patients with VTE (mean difference 19 d, $p < 0.001$; adjusted mean difference 14.7 d, $p < 0.001$). Mortality for patients with VTE was 8.5% and 7.0% in those without VTE ($p = 0.59$).

Conclusion: VTE in the elderly trauma population is associated with TBI, severe chest injury, and a history of thromboembolic complications. Comorbid conditions exert less influence on VTE than injury pattern and severity. VTE results in increased length of stay but does not impact mortality.

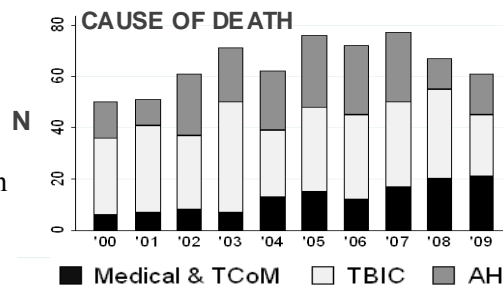
THE CHANGING NATURE OF DEATH ON THE TRAUMA SERVICE: THE IMPACT OF AN AGING POPULATION AND IMPROVEMENTS IN THE CARE OF THE INJURED

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

Introduction: The trimodal distribution of trauma deaths describes a late third peak due to sepsis, multiorgan failure (MOF), and other complications. We hypothesized that an aging trauma patient population and improvements in trauma care have altered this pattern.

Methods: We reviewed the cause and timing of in-hospital trauma deaths from 2000 through 2009 at our Level I center. Demographic data, ISS, comorbidities, and withdrawal of care (WOC) were noted. Lung protective ventilation (LPV), aggressive management of venous thromboembolic risk (AMVTE), and damage control resuscitation (DCR) with male donor fresh frozen plasma (MFFP) were introduced during the study interval.

Results: We identified 699 deaths. Yearly mortality varied from 2.5% to 3.8% (p = NS). Median age at death increased (43 to 60 years) (trend p=0.02) and median ISS decreased (28 to 26) (trend p=0.02). Deaths were due to traumatic brain injury or cervical spine injury (TBIC) - 46%, acute hemorrhage (AH) - 29%, and trauma and associated comorbidities (TCoM) - 8.2%. TCoM increased from 2% to 20% (p=0.002). Purely medical deaths (PM) increased from 6.7% to 12.5% (trend p=0.012). Deaths from MOF, sepsis, or ARDS decreased linearly over time from 5% to 0% (p=0.004). Transfusion related lung injury occurred in 1 patient (0.1%) at year 2 prior to MFFP. Fatal pulmonary embolism occurred in 2 patients (0.3%) at year 3 before AMVTE. WOC occurred in 93% dying > 24 hours and in 89% dying > 1 week. Cause of death in WOC was TBIC in 63% and TCOM or PM in 28%.



Conclusion: Trauma deaths result from severity of injury and TCoM and are rarely due to complications. They frequently involve WOC and age at death is rising. These findings suggest that improving outcomes requires attention to injury prevention, resuscitation strategies, managing comorbidities, response to injury in the elderly, and end of life care.

LIFE AFTER NEAR-DEATH: LONG-TERM FUNCTIONAL OUTCOMES IN SURVIVORS OF EMERGENCY DEPARTMENT THORACOTOMY

Deborah Keller MD, Niteesh Bharara MD, Gilbert Siu MD, Heather Kulp MPH, Abhijit S Pathak* MD, Thomas A Santora* MD, Ernesto Cruz MD, Amy J Goldberg* MD, Mark J Seamon* MD. Temple University School of Medicine.

Introduction: Predictors of hospital survival after emergency department thoracotomy (EDT) are well established, but little is known of long-term outcomes after hospital survival. Our primary study objective was to analyze the long-term social, cognitive, functional, and psychological outcomes in EDT survivors.

Methods: A review of our level I trauma center registry (2000-2010) revealed 37 of 448 patients survived hospitalization after EDT. Demographics and clinical characteristics were analyzed. After attempts to contact survivors, 21 patients or caretakers were invited to an outpatient study evaluation and 16 were unreachable (none of whom were present in the Social Security Death Index). The study evaluation included demographic and social data, and an outpatient multidisciplinary assessment with validated scoring instruments (Mini-Mental Status Exam [MMSE], Glasgow Outcome Scores [GOS], Timed Get-Up and Go Test [TGUG], FIM Score, SF-36 Health Survey, and the civilian PTSD checklist).

Results: After extended hospitalization (43±41 days), disposition varied (home 62%, rehab 32%, SNF 6%) but readmission was common (33%) in the 37 EDT hospital survivors. Of 21 contacted, 16 completed the study evaluation (time to follow-up, 5±3 yrs), 2 had died, 1 remained in a comatose state, and 2 were available by phone only. Unemployment (75%), daily alcohol (50%) and drug use (38%) were common. MMSE and GOS determined that 48% had impaired cognition and limited capacity to return to normal activities. 24% required assistance with ADLs and 13% were wheelchair dependent (TGUG, FIM Score). The SF-36 and civilian PTSD checklist found that 69% of long-term survivors scored >1 standard deviation below national SF-36 means and 25% met PTSD criteria. In all, 74% had long-term social, cognitive, functional, or psychological impairment after EDT.

Conclusions: Most patients that survive EDT have lasting, detrimental effects. Our results suggest that better follow-up and longstanding multidisciplinary cognitive, physical, and psychological therapy is required to optimize long-term outcomes in EDT survivors.

TEMPORAL CHANGES IN TRAUMA MORTALITY IN JAPAN AFTER INTRODUCING JAPAN ADVANCED TRAUMA EVALUATION AND CARE PROTOCOL

Kenichi Hondo, MD, Atsushi Shiraishi, MD, Mitsuaki Kojima, MD, Fujie Satoshi, Yasuhiro Otomo*, MD. Tokyo Medical and Dental University.

Objective: A standardized trauma care guideline named Japan Advanced Trauma Evaluation and Care (JATEC) has introduced in 2002 in Japan. Our study purpose is to assess temporal change in trauma mortality in Japan after introducing JATEC.

Methods: Our data source was Japan Trauma Databank (JTDB), which is a nationwide, multi-center and prospectively recruited trauma registry in Japan. We selected the record of JTDB which fulfilled complete data sets to estimate Trauma Injury Severity Score (TRISS) and a clear outcome. Logistic regression analysis after adjustment for TRISS estimated the temporal change in risk of in-hospital mortality. We also performed the sub-analysis stratified by TRISS probability of death (PD).

Results: Of a total of 42336 records registered in JTDB, 23895 patients matched the selection criteria. Overall trauma mortality (and PD) in the year of 2003-2005 (5269 cases), 2006-2007 (7907 cases) and 2008-2009 (10719 cases) were 21.0% (20.6%), 14.8% (16.0%) and 13.2% (14.9%), respectively, and those odds ratios (95% confident interval [95%CI] and P-value) for in-hospital death after adjustment for trauma severity were 1.00 (reference), 0.72 (95%CI: 0.62-0.84, P<.001) and 0.67 (95%CI: 0.58-0.77, P<.001), respectively. In dichotomizing the subjects at PD of 0.5, patients with higher predicted survival (PD<.5) showed statistically significant improvements which are 1.00 (reference), 0.67 (95%CI: 0.56-0.80, P<.001) and 0.66 (95%CI: 0.56-0.78, P<.001), respectively, and those with lower predicted survival (PD>.5) however showed relatively smaller changes in mortality, similarly, those odds ratios for in-hospital death were 1.00 (reference), 0.87 (95%CI: 0.66-1.16, NS) and 0.69 (95%CI: 0.53-0.89, P<.01).

Conclusion: Trauma mortality in Japan was rapidly improving after the year of 2006 especially in trauma patients with mild severity. We speculated that our standardized trauma care guideline (JATEC) might contribute to rescue more trauma patients from the preventable trauma death.

REGIONAL DIFFERENCES IN ACCESS TO CARE AND SELF REPORTED OUTCOMES IN ADOLESCENT BRAIN INJURY: RESULTS OF THE 2007 NATIONAL SURVEY OF CHILDREN'S HEALTH

Jeff Seroogy, BS, Melissa McPheeters, PhD, MPH, Enoch Sizto, BS, Shanthi Krishnaswami, MD, MPH, Oscar D Guillamondegui*, MD, MPH. Vanderbilt University Medical Center.

Introduction: Brain injury (BI) is the leading cause of death in adolescents and may lead to long-term debilitation. Improved outcomes are associated with cognitive therapy. Barriers to care in trauma populations are well described and, in pediatric oncology patients, regional differences in access to care have been identified in treatment seekers. Our objective is to identify patterns of prevalence of brain injury in adolescents, and describe reported difficulties in accessing specialty care.

Methods: We conducted a cross sectional analysis of data from the 2007 National Survey of Children's Health (NSCH), conducted by the CDC, to be representative at the state and national levels, comparing adolescents with reported BI to those without. Covariates examined as potential confounders were selected on the basis of clinical and statistical significance. Multivariate logistic regression was conducted to examine the association between report of having a BI and report of difficulty accessing specialist care.

Results: Of 20,761,908 (weighted) respondents, 691,908 parents (3.3%) reported an adolescent with a history of BI and 7% having problems accessing specialist care. Parents of adolescents with a history of BI reported 3.1 times the odds of difficulty accessing specialist care compared to those without a history of BI (95%CI: 1.85-5.20). Regional differences were identified. BI adolescents in the western region had almost 5 times the odds of difficulty accessing specialist care (OR: 4.7, 95%CI: 1.97-11.06) whereas in northeast, there was no significant associations (OR:1.8, 95%CI: 0.73-4.55). Poor general health of the child and lack of a medical home were the only confounders significantly associated with the outcome in the adjusted models both regionally & nationally.

Conclusions: The 2007 NSCH identified approximately 3.3% of adolescents having ongoing issues with brain injury. There appears to be difficulty accessing specialty care with obvious regional differences identified, most notably the Western region. Poor general health and lack of a medical home were associated with this disparity.

**RISK OF VENOUS THROMBOEMBOLISM AFTER SPINAL CORD INJURY:
NOT ALL LEVELS ARE THE SAME**

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Yale School of Medicine.

Background: Venous thromboembolism (VTE), a diagnosis that includes both DVT and PE, is a well recognized complication following injury. Previous studies have identified multiple risk factors including spinal cord injury (SCI). We hypothesized that the level of SCI also influences the likelihood of VTE.

Methods: The National Trauma Data Bank® was queried to identify all patients with SCI admitted in 2007 and 2008. Rates of VTE, demographics, admitting comorbidities, in-hospital complications, level of SCI (divided by NTDB® into 5 groups), associated injuries, and outcome variables were abstracted. Multivariable logistic regression was used to identify independent risk factors for VTE.

Results: During the two year period, 18302 patients were admitted with SCI. The overall rate of VTE was 4.3% but varied significantly depending on the level of SCI injury (χ^2 44.8, $p < 0.05$). Patients with high cervical spine (C1-4) injury had a rate of VTE of 3.4% while patients with high thoracic spine (T1-6) injury had the highest rate of VTE at 6.3%. The lowest rate of VTE was in patients with lumbar injury (3.2%). There were no significant differences in pre-existing comorbidities or in hospital complications among the five SCI groups with the exception of pneumonia. In a multivariable logistic regression model, the level of SCI was an independent risk factor for VTE as was increasing age, increasing ISS, male gender, traumatic brain injury and chest trauma.

Conclusions: The rates of VTE are different at various SCI injury levels. Patients with high thoracic (T1-6) injury appear to be at the highest risk and patients with high cervical (C1-4) injury at one of the lowest. A higher index of suspicion for VTE should therefore be maintained in patients with a high thoracic SCI. Further studies are required to elucidate the underlying mechanisms.

**WHEN IS IT SAFE TO ADMINISTER LOVENOX FOR DVT PROPHYLAXIS
IN HEAD TRAUMA?**

Aileen Murphy, DO , Deborah Jair, PA-C, Cody Cox, BS, William Meyer, MD, Ray Chung,
MD, Victor Sorensen*, MD. Kern Medical Center.

Introduction Head injured patients are at a significantly higher risk for deep vein thrombosis (DVT) and pulmonary embolism (PE) than the general hospital population. Recent studies have reported that the initiation of Lovenox within less than 72 hours of admission does not increase the risk of bleeding complications in traumatic head injured patients. Since the risk of DVT and PE can be fatal, administration of Lovenox should be initiated as early as possible. Our hypothesis is that the administration of Lovenox to traumatic head injury patients within 24-48 hours is safe compared to administration after 48 hours.

Method We retrospectively evaluated the use of Lovenox prophylaxis in traumatic head injury patients from October 1, 2005 to June 30, 2009. Two hundred forty-three (243) patients were identified from our trauma registry. Computed tomography scan results, Glasgow Coma Scale (GCS), Injury Severity Score (ISS), length of stay (LOS) and hospital day Lovenox administration was initiated (DLA) were analyzed. Patients were either started on Lovenox within 48 hours of admission (early group), or after 48 hours of admission (late group).

Results Out of 243 patients, 60 were in the early group, while 183 were in the late group. Out of 60 patients in the early Lovenox group, one patient had bleeding complications or worsening of their initial head injuries (1.6%), while no patients in the late Lovenox group had bleeding complications or worsening of the injuries (0%). Fisher's Exact Test used for statistical analysis, two-tailed probability was found to be $p=0.25$. There was no significant difference in complication rate between the early and late groups.

Conclusion Administration of Lovenox in traumatic head injury patients within 24-48 hours of hospital admission is safe and should be utilized in these patients.

THE RELIABILITY OF NONRECONSTRUCTED COMPUTERIZED TOMOGRAPHIC SCANS OF THE TORSO IN DETECTING BLUNT THORACOLUMBAR SPINE INJURIES

Tammy R Kopelman, MD*, Nicole E Berardoni, MD, Patrick J O'Neill, PhD, MD, Poya Hedayati, MD, Bradley Bowles, BS, Paola G Pieri, MD, Sydney J Vail, MD, Iman Feiz-erfan, MD, Melissa A Pressman, PhD. Maricopa Medical Center.

Introduction: The EAST guideline for thoracolumbar spine (TLsp) clearance recommends radiographic evaluation based on high-energy mechanism of injury. Our purpose was to test the reliability of standard torso (chest/abdomen/pelvis) computed tomographic (T-CT) images without TLsp reconstruction (recon) in evaluating the blunt trauma patient.

Methods: A retrospective evaluation was performed at a Level I trauma center of all blunt trauma patients having undergone T-CT with recon images of the TLsp over a 3-year period. With recon images used as the gold standard, sensitivity (sens), specificity (spec) and accuracy (acc) were calculated to assess the reliability of non-recon T-CT images in detecting TLsp fractures (fx).

Results: 2637 patients met inclusion criteria. 422 patients (16%) were diagnosed with TLsp fx on recon images. Standard T-CT identified all fx noted on recon images in 327 patients (sens 78%; spec 100%; acc 96%) and correctly screened for the presence of any recon-identified fx in 385 patients (sens 91%; spec 100%, acc 99%). Standard T-CT failed to identify any TLsp fx in 37 of the 422 patients with recon-identified fx. While surgery was not required for any patient in this subgroup, 7 patients required bracing secondary to vertebral body fx. In the 1109 asymptomatic, evaluable patients (age >15 years, GCS >14), standard T-CT appropriately diagnosed the presence of a TLsp fx in 89 of 95 patients (sens 94%; spec 100%; acc 99.5%). All missed injuries in this subgroup were transverse process fx that did not require treatment. Of note, the Medicaid allowance in our state for recon imaging and interpretation of the TLsp is approximately \$6100 per patient.

Conclusion: Standard T-CT alone is not as reliable as recon imaging of the TLsp but may be considered as a screening tool in the asymptomatic, evaluable trauma patient who requires TLsp evaluation. Use of this algorithm may have produced a \$6,000,000 cost saving to the healthcare system over the 3-year study period.

THE STEADILY INCREASING INCIDENCE AND LETHALITY OF PENETRATING BRAIN INJURY: A SINGLE TRAUMA BAY GCS POINT DROP INCREASES MORTALITY

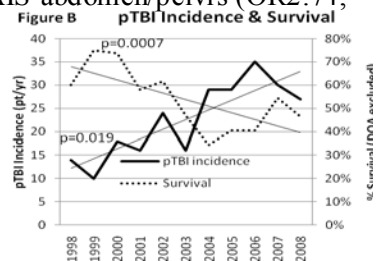
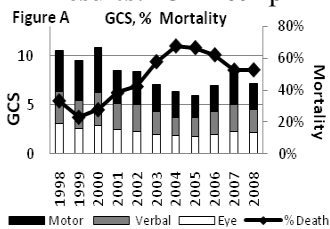
Jose L Pascual MD, PhD, Penny Fang, Babak Sarani*, MD, Carrie Sims*, MD, C William Schwab*, MD. University of Pennsylvania School of Medicine.

Traumatic brain injury (TBI) accounts for half of trauma deaths and 35% are caused by a penetrating mechanism (pTBI). Despite dropping trends in national fatality rates from all gunshot wounds (GSWs), pTBI rates and mortality remain unclear. We hypothesized that pTBI in our level 1 urban trauma center had worsened in the last decade.

Methods: After IRB approval, pTBI trauma registry patients were identified from 1998-2008 with abstraction of their age, ISS, non-head GSWs, AIS, mortality and surgeries. Logistic/linear regression were used to identify mortality predictors and trends over time.

Results: Of 269 pTBI patients, 93% suffered GSWs, 6% were stabbed. Mean AIS head/neck was 5, 9% underwent neurosurgical intervention, 26% other surgical procedures. Over time, neurosurgery service patient admission decreased (20 to 10%, $p=0.01$), remaining stable to the trauma service, while those never undergoing admission, increased (0 to 30%, $p=0.005$). Trauma bay GCS correlated directly with mortality ($p<0.001$) with each point drop increasing mortality by 11.8% ($p<0.001$) (FigA). pTBI incidence ($p=0.02$), mortality ($p<0.01$) (FigB), number dead on arrival (DOA) ($p<0.01$), AIS head/neck ($p=0.06$), and non-head GSWs ($p=0.01$) increased over time. AIS head/neck (OR56.6, $p<0.01$), AIS chest (OR2.33, $p<0.01$), AIS abdomen/pelvis (OR2.74, $p<0.01$), and GSW mechanism (OR 5.56, $p=0.04$) predicted higher mortality. Surgical intervention (OR 0.203, $p<0.001$) predicted lower mortality. 11 patients underwent ED thoracotomy of whom none survived.

Conclusion: The incidence, mortality, and severity of penetrating head injuries have steadily increased in the last decade. Higher head/neck, chest, and abdomen AIS are predictors of increased mortality. Trauma Bay GCS is directly proportional to pTBI patient mortality. ED thoracotomy may be futile in pTBI patients.



**HIGH DENSITY SPOT(S) ON MDCT ANGIOGRAPHY PREDICTS
NEUROLOGICAL DETERIORATION IN PATIENTS WITH MILD TO
MODERATE TRAUMATIC BRAIN INJURY**

Jiro Iba, Osamu Tasaki, Kazuhisa Yoshiya, Tadahiko Shiozaki, Hiroshi Ogura*, Yasuyuki Kuwagata, Hajime Nakamura, Toshiyuki Fujinaka, Takeshi Shimazu*. Department of Traumatology and Acute Critical Medicine, Osaka University Graduate School of Medicine.

Background: Although expansion of traumatic intracranial hemorrhage (EH) is one of the most important causes of neurological deterioration in patients with mild to moderate traumatic brain injury, there is no reliable indicator for EH on admission. High density spot(s) (HDS) in hematoma(s) on multi-detector row computed tomography (MDCT) angiography is considered to be an extravasation of contrast medium suggesting persistent bleeding. The purpose of this study was to examine the predictive value of HDS as an indicator of EH on admission.

Method: MDCT Angiography was prospectively performed on admission in patients with intracranial hemorrhage due to high energy blunt trauma accompanied by fracture in skull, face or neck. Excluded were those patients who were transported after more than two hours from injury, or GCS score was < 8. Thus, 53 patients were included in this study. HDS was defined as an irregular high density area on MDCT angiography which was distinctly different from vascular enhancement. EH was defined as neurological deterioration due to hematoma growth which required surgical evacuation.

Results: EH occurred in 16 of 53 patients (30.2%). HDS was observed in 16 of 53 patients. HDS was observed in 13 of 16 patients with EH. Out of the other 37 patients without EH, HDS was observed in only 3 patients (Sensitivity: 81.3%, Specificity: 91.9%, positive predictive value: 81.3%, negative predictive value: 91.9%). There was no difference between the patients with and without EH in age, sex, GCS score on admission, or history of antiplatelets or anticoagulants administration.

Conclusions: HDS on MDCT angiography is one of the most important predictive indicators of EH on admission in patients with mild to moderate traumatic brain injury. HDS would be predictive of neurological deterioration and early treatment should be started as such.

**EARLY PROGNOSTIC FACTORS IN SEVERE TRAUMATIC BRAIN INJURY
TREATED WITH MILD HYPOTHERMIA FOR REFRACTORY
INTRACRANIAL HYPERTENSION**

Koichi Hayakawa, MD, Osamu Tasaki, MD, PhD, Tomoyoshi Mohri, MD, PhD, Tadahiko Shiozaki, MD, PhD, Jiro Iba, MD, Hiroshi Ogura*, MD, PhD, Yasuyuki Kuwagata, MD, PhD, Takeshi Shimazu*, MD, PhD, Toshimitsu Hamasaki, PhD, Yasushi Nakamori, MD, PhD, Satoshi Fujimi, MD, PhD. Department of Traumatology and Critical Medicine, Osaka University Graduate School of Medicine.

Backgrounds We previously reported that mild hypothermia (HT) had some beneficial effects in patients with intracranial hypertension (ICH) (J Neurosurg, 1993), but no effects on those with low intracranial pressure (J Neurosurg, 2001). Therefore, we have introduced HT for the treatment of refractory ICH following traumatic brain injury for more than ten years. The purpose of this study is to clarify early prognostic factors for good indications of HT in patients with traumatic brain injury.

Methods Consecutive 140 patients treated with HT for ICH in two trauma centers were included in this study. Intracranial pressure (ICP) monitor was inserted in each patient, and target ICP was less than 25 mmHg. HT was introduced when combination of sedation, ventricular drainage, and barbiturate coma was ineffective. Decompressive Craniectomy (DC) was also considered for ICH refractory to HT. HT was continued until ICH was resolved. Outcome was assessed at 6 months according to Glasgow outcome scale (F: GR+MD; P: SD+VS+D). The CT features were identified on scans obtained within 24 hours of injury, and the most serious findings were recorded. After 11 candidate prognostic variables were selected from 21 with univariate analysis, stepwise multivariate logistic regression was performed to find prognostic factors.

Results Out of 140 patients, F was observed in 17 patients (12.1%). Three prognostic factors were detected; age (F: 23±16 vs P: 50±22, $p<0.01$), presence of light reflex on admission (F: 88.2% vs P: 49.6%, $p<0.01$), and presence of extensive subarachnoid hemorrhage (SAH) on CT (F: 35.3% vs P: 87.8%, $p<0.01$). Out of 17 patients with F, 7 patients were treated with HT alone and DC was combined with HT in the others.

Conclusion HT was useful as one of treatment measure for refractory ICH and should be considered for patients with younger age, presence of light reflex, or absence of extensive SAH.

**DOES DEDICATED SURGEON LED TRAUMA CARE IN A STANDALONE
TRAUMA CENTER IMPROVE OUTCOMES IN TRAUMATIC BRAIN
INJURY? THE ANSWER IS YES!**

Jeanne Lee, MD, Vishal Bansal, MD, Jay Doucet*, MD, Leslie Kobayashi, MD, Dale Fortlage,
MS, Raul Coimbra*, MD. UCSD.

Introduction: Recent work has highlighted the role of Emergency Medicine in the initial assessment of the trauma patient with trauma teams on standby. We have a freestanding trauma center where major trauma victims are transported directly to a trauma resuscitation room in an area physically distinct from the emergency department. Care is provided by a dedicated trauma team led by a trauma surgeon with 100% response that is mobilized prior to the patient's arrival. We postulated that patients with mild to moderate brain injury (AIS=3) without obvious exterior signs of trauma would benefit from initial evaluation by a dedicated trauma team and have improved outcomes.

Methods: Data was collected from the trauma registry of our level 1 trauma center. All patients diagnosed with *isolated* blunt head injury from 2000-2009 were included. We compared patients who received their initial workup in the trauma resuscitation room (RR) to those seen in the emergency department (ED). Results were analyzed using Student's *t*-test and chi-square test with $p < .05$ significance.

Results: 4933 patients were treated for isolated blunt head trauma with an overall mortality of 2.68% ($n=132$). 462 patients were assessed in the ED and 4471 in the RR. Patients with mild to moderate brain injury initially evaluated in the RR had significantly lower mortality than patients seen in the ED (0.16% vs. 1%, $p=0.017$). The time to initial CT head imaging was significantly shorter in the RR (45 vs. 124 min, $p < 0.0001$) as was time to the surgical intensive care unit (119 vs. 420 min, $p < 0.0001$).

Conclusion: In standalone trauma centers, direct access to experienced trauma teams allow for expedited workup and decreased time to definitive care. Focused driven care by trauma surgeons and immediate availability of resources improve outcomes in minor to moderate traumatic brain injured patients.

Poster # 124

This poster has been withdrawn

ASPIRIN USE INCREASES THE INCIDENCE OF INTRACRANIAL HEMORRHAGE WITH HEAD TRAUMA IN THE ELDERLY

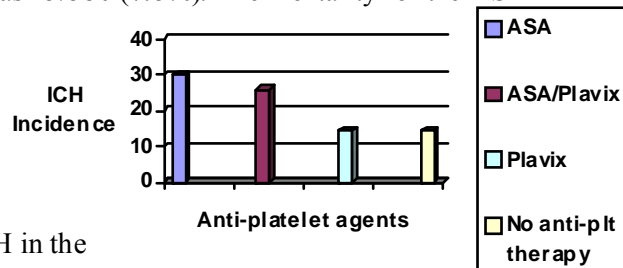
Leah W Bassin, MD, Paul N Chugay, MD, Carla P Rennie, RN, Lloyd Miller, RN, Jeremy Aiss, Timothy Hall, MD, Kevin Dwyer*, MD. Stamford Hospital.

Introduction: Antiplatelet therapy is associated with increased mortality in patients with intracranial hemorrhage (ICH) secondary to head trauma, but the incidence is unclear. Our objective was to look at the incidence of ICH in elderly patients on antiplatelet therapy.

Methods: This is a retrospective analysis of data obtained from our ACS verified Level II trauma center's trauma registry from 12/1/05 to 7/30/10. All patients with head trauma over the age of 65 with a head CT were identified. Demographics, head CT results, anti-platelet and anticoagulation medication use, and the use blood products were obtained.

Results: 714 patients were identified, average age of 82.3, ISS 7.98 and 67% were falls < 3ft. 186 patients took antiplatelet medication, 133 aspirin only (ASA), 42 clopidogrel only (CLO) and 11 both. 394 took no anti-platelet or anticoagulation medication (non-med). Overall mortality for these patients was 45/580 (7.8%). The mortality for the ASA

group was 9% and 8.4% for the non-med group. There were no deaths in the CLO, or CLO/ASA group. The rate of ICH in the overall population was 18.3% (106/580). The rate of ICH in the



ASA group was 30.1% (40/133) compared to 14.5% (57/394) of the non-med group which was significant $p < 0.001$). The rate of ICH for anti-platelet therapy was 26.7%, but the small group of patients on clopidogrel alone had no increased incidence 14.3%. Of note the ASA group had an increase incidence of ICH compared to the warfarin group, 13.1%.

Conclusion: There is an increased incidence of ICH after minor head trauma in elderly patients on aspirin. As with patients on warfarin, even minor head trauma in the elderly population on antiplatelet therapy warrants trauma team activation. Protocols need to be designed to offer consistent treatment for these patients.

**VAGAL NERVE STIMULATION PREVENTS BLOOD BRAIN BARRIER
DYSFUNCTION FOLLOWING TRAUMATIC BRAIN INJURY**

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INTRODUCTION: It is well established that traumatic brain injury (TBI) increases sympathetic tone causing autonomic abnormalities and organ dysfunction. Vagal nerve stimulation (VNS) has been shown to decrease inflammation and distant organ injury following TBI. It is unknown whether VNS may reduce TBI induced neuronal damage and brain edema. We hypothesize that VNS prevents blood brain barrier (BBB) breakdown and subsequent edema following TBI.

METHODS: A weight drop model was used to create severe TBI in Balb/c mice. Animals were divided into 3 groups. Group TBI: TBI only; Group TBI/VNS: animals were treated with 10 minutes of VNS immediately prior to TBI; Group Sham: opening of the skull but no TBI, nor VNS treatment. Brain vascular permeability to injected (70kDa) FITC-Dextran was measured by radiated fluorescence 6 hours following injury. Injured tissue sections were stained for peri-vascular Aquaporin-4 (AQP-4), an important protein causing BBB mediated brain edema. Fluorescence was quantified under laser scanning by confocal microscopy.

RESULTS: Six hours following TBI, cerebral vascular permeability was increased four-fold compared to sham ($6.6^{E+08} \pm 5.5^{E+07}$ vs. $1.5^{E+08} \pm 2.9^{E+07}$ arbitrary fluorescence units (afu); $p < 0.001$). VNS prevented the increase in permeability when compared to TBI alone ($3.5^{E+08} \pm 8.3^{E+07}$ vs. $6.6^{E+08} \pm 5.5^{E+07}$ afu; $p < 0.05$). Perivascular expression of AQP-4 was increased two-fold in TBI animals compared to sham (0.96 ± 0.12 vs. 1.79 ± 0.37 afu; $p < 0.05$). Similarly, VNS decreased post-TBI expression of AQP4 to levels similar to sham (1.15 ± 0.12 afu; $p < 0.05$).

CONCLUSIONS: VNS prevents cerebral vascular permeability and decreases the up-regulation of AQP4 following TBI. The mechanism is most likely mediated through an intact BBB. Future studies are needed to assess whether preventing BBB breakdown by VNS will improve outcomes following TBI.

**SERUM FROM PATIENTS WITH TRAUMATIC BRAIN INJURY INCREASES
PROLIFERATION AND SUPPORTS EXPRESSION OF OSTEOBLAST
MARKERS IN HUMAN PRIMARY SKELETAL MUSCLE CELLS**

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

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

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

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

**OSTEOBLASTIC RESPONSE DUE TO ELEVATED LEVELS OF
PARATHYROID HORMONE**

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Introduction: This study aimed to investigate the hypothesis that a spike in parathyroid hormone (PTH) may be capable of setting off an osteoblastic response or differentiation *in vitro*. Transiently elevated serum concentrations of PTH in patients with a severe traumatic brain injury (TBI) could play a role in the enhanced osteogenesis demonstrated in those patients.

Methods: The *in vitro* osteoinductive potential of PTH was determined by measurements of the proliferation rate of the human fetal osteoblastic cell line 1.19 (hFOB). Cells were incubated with 2.5, 25, and 250 nM PTH(1-84) for 4, 8, and 24 hours. Additionally, serum samples were collected from patients with a closed long-bone fracture and a severe TBI (n=17), patients with an isolated severe TBI (n=21), and patients with an isolated long-bone fracture (n=24) at 6, 24, 72, and 168 hours after the injury. The osteoinductive potential was determined by incubating the hFOB cells with the collected samples. The levels of PTH were measured.

Results: PTH(1-84) enhanced the proliferation of hFOB 1.19 cells in a dose dependent manner with the highest proliferation effect after 4 hours incubation. The sera from patients with a TBI and a long-bone fracture induced higher proliferation rates of hFOB cells compared to the other study groups ($p < 0.05$). Patients with a TBI and a long-bone fracture had considerably higher mean serum levels of PTH than patients with an isolated TBI or an isolated long-bone fracture ($p < 0.05$).

Conclusions: These results suggest that transiently elevated concentrations of PTH are able to stimulate osteoblastic proliferation *in vitro*. This may play a role in the enhanced osteogenesis demonstrated in TBI patients.

**IMPACT OF ANTIPLATELETS AGENTS ON BRAIN INJURY AND
OUTCOME FOLLOWING FALL FROM STANDING POSITION**

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Objective: The purpose of this study was to see the impact of pre injury antiplatelets agents on brain injury in patients who fall from a standing position.

Methods: Data of all patients who were on Aspirin, plavix or in combination prior to fall from a standing position (FFS) were analyzed. Patients who were on coumadin were excluded from the study. Patient's demography, clinical information and outcomes were measured and compared with the group who were not on any blood thinner. Data were summarized as means, standard deviation, or percentage. Student t-test, Chi-square test or Fisher exact test was used to compare the groups. **Results:** From January 2001 through December 2008, forty seven out of 169 patients were on Aspirin, Plavix or in combination prior to FFS position. When this group was compared with the control group (not taking any anticoagulation or antiplatelets agents), there were no significant difference between the group in regards to sex (female $P=0.23$), initial systolic blood pressure ($P=0.4$), initial heart rate (83 ± 16.4 vs. 87 ± 18.9), Revised trauma score ($P=0.33$) and Glasgow Coma Scale ($P=0.26$). Patients who were in the antiplatelet group had significantly higher mean age ($P=0.0002$), injury severity score ($P=0.019$), International normalization score ($P=0.04$) and initial serum creatinin level ($P=0.04$). There was no significant difference between the groups in term of initial CT scan for intracranial bleed (60% vs. 50%, $P=0.14$), or progression of the bleed (11% vs. 7%). There was no significant difference in terms of mortality (15.2% vs. 7.3%, $P=0.11$) and hospital length of stay (8.0 ± 9.1 vs. 6.0 ± 8.5 , $P=0.06$). **Conclusion:** Use of pre injury antiplatelets agents in patients who FFS position showed increased intracranial bleed, progression of the bleed, mortality and hospital length stay, however, it did not reach the statistical significance.

THE EFFECT OF INCREASING COMPUTED TOMOGRAPHY RESOLUTION ON APPARENT HEAD INJURY DIAGNOSES AMONG BLUNT TRAUMA PATIENTS

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Introduction: Computed tomography (CT) is increasingly the principal means of diagnosing blunt head trauma. However, as CT resolution improves, the apparent incidence of head injuries may artifactually change, falsely influencing both the management of specific patients as well as large-scale healthcare policy.

Methods: A retrospective review of all blunt trauma patients between 7/2005 – 7/2008 at our Level I urban trauma center was conducted. 7/2005 – 10/2006 a single-slice scanner was used; 11/2006 – 7/2008 a 16-slice scanner; and 10/2008 – 6/2009 a 64-slice scanner (8 – 9/2008 was excluded since both 16- and 64-slice scanners were used during this period). The radiologist’s final report of the initial head CT was reviewed.

Results: 7560 patients were identified. Rates of head CT among blunt trauma patients did not change appreciably during the period. Head and Neck Abbreviated Injury Scores overall (HNAIS) decreased significantly (1.17 for single versus 0.98 for 64, $p < 0.001$). However, among the 1955 patients with a HNAIS > 0, AIS was significantly higher in the 64-slice group than the single (2.95 vs 2.51, $p < 0.001$). Table I shows the incidence of specific diagnoses.

	Single-slice	16-slice	64-slice	p-value
Intracranial Hemorrhage	26.2%	36.7%	48.1%	<0.001
Midline Shift	7.4%	9.7%	12.8%	<0.001
Pneumocephalus	5.9%	6.3%	13.1%	<0.001
Calvarial Fracture	13.9%	20.7%	26.9%	<0.001

Conclusions: Increasing resolution of head CT scans is associated with fewer diagnoses overall, but these diagnoses are of greater severity. Critical diagnoses such as intracranial hemorrhage are almost twice as common following 64-slice scans relative to single-slice. Both individual patient care and interpretation of epidemiologic research should reflect this evolution.

DELIRIUM IN THE TRAUMA INTENSIVE CARE UNIT: TIME COURSE, RISK FACTORS, AND OUTCOMES

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Background: Intensive care unit (ICU) delirium has been linked to adverse outcomes including prolonged ICU and hospital length of stay (HLOS) as well as increased mortality. ICU delirium has not been thoroughly explored in trauma patients. The purpose of our study was to describe the course of and identify risk factors for delirium in the trauma ICU population.

Methods: We performed a retrospective evaluation of patients admitted to the trauma ICU at a Level I trauma center from May to July 2010. Evidence of delirium was assessed using a validated protocol described by Inouye et al. A regression analysis was used to determine factors associated with duration of delirium while adjusting for ICU LOS.

Results: 80 patients met inclusion criteria. 51.3% of patients had evidence of delirium during their ICU stay. Mean time to onset of delirium after ICU admission was 2.4 ± 1.7 days, and delirium lasted a mean of 2.9 ± 4.7

days. 8% of delirious patients had more than one episode of delirium. Admission blood alcohol >10 mg/dL was the only significant factor on multivariate regression analysis; it was predictive of increased delirium incidence and duration (OR 1.21, C.I. 1.02-1.42; $p < 0.05$). After adjusting for severity of illness, delirium was independently predictive of longer ICU LOS ($p = 0.001$).

	Delirium		p-value
	Yes	No	
Age (yrs)	50	39	.176
ISS	20	16	.105
Admission B.D.	-5.8	-5.4	.736
ICU LOS (days)	9.44	3.85	.000
HLOS (days)	23	17	.137
Death	9.8%	2.6%	.36

Conclusions: ICU delirium is common in trauma patients and is associated with increased ICU LOS. Elevated admission blood alcohol level is an important predictor. Knowledge of the typical course of development and resolution of delirium in trauma patients may lead to heightened awareness of the incidence of delirium. Recognition of delirium is the first step in developing effective interventions for this significant contributor to morbidity and mortality in ICU patients.

**PROSPECTIVE EVALUATION OF POST TRAUMATIC VASOSPASM:
DETERMINING ITS CLINICAL SIGNIFICANCE AFTER TBI**

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Introduction: The etiology and outcome of cerebral aneurysm related vasospasm is well documented. Posttraumatic cerebral vasospasm (PTV) has been described, however, its significance following trauma remains unclear. The objective of this study was to evaluate the clinical significance of cerebral vasospasm in patients with moderate to severe traumatic brain injury (TBI).

Methods: A prospective observational study was conducted in moderate to severe blunt TBI patients (GCS = 12) with hemorrhage found on a non-contrast head CT scan, admitted to the surgical/neurosurgical ICU at a Level I trauma center, between February 2010 and February 2011. Transcranial Doppler (TCD) ultrasound was conducted daily on all patients to detect PTV. Diffusion weighted MRI or non-contrast head CT scan was used to confirm the presence of infarction. Patient demographics and outcomes were compared between patients with and without PTV.

Results: Twenty-nine patients met our inclusion criteria. Most patients were men (82.8%) with a mean GCS of 6.6 +/- 3.1. 55% underwent a craniotomy/craniectomy after admission. Overall mortality was 31%. PTV was detected in 14 (48%) and occurred 3.9 days +/- 2.9 days post injury. Only one PTV patient was treated with blood pressure augmentation. Cerebral infarcts were detected in 4 PTV patients (29%), whereas 3 non-PTV patients (20%) developed infarcts (p=0.68). There was no significant difference in patient outcomes (mortality, ICP levels and management, ICU length of stay (LOS), or hospital LOS) between TBI patients with and without PTV.

Conclusions: PTV occurs commonly following TBI. Its clinical significance remains unclear. Further studies are warranted to determine if aggressive management of PTV has a role after TBI.

ASSESSMENT OF AN INTERVENTION BUNDLE FOR TRAUMATIC BRAIN INJURY: WHEN ARE INTRACRANIAL PRESSURE MONITORS NECESSARY?

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Objective: Brain Trauma Foundation (BTF) guidelines recommend intracranial pressure (ICP) monitoring for traumatic brain injury (TBI) patients with GCS 8 or less, with an abnormal head CT. The benefits of these guidelines on outcome remain unproven. The purpose of this study was to examine if adherence to these guidelines can affect outcome.

Methods: All patients sustaining TBI with GCS =8 and an abnormal head CT admitted to a Level I trauma center were retrospectively identified. Adherence to the individual components of our institutional TBI Bundle (ICP Monitoring, SpO₂>95%, PaCO₂ 30-39, SBP>90, CPP>60, ICP <25, Temp 36-37°C) was assessed, and comparisons in mortality and discharge functional status made between the different bundle elements.

Results: We identified 1,918 TBI patients, 163 of whom met BTF criteria for ICP monitoring. After excluding those with non-survivable injuries, 77 patients were available for analysis (39 received an ICP monitor and 38 did not). There were no significance differences in demographics, mean admission GCS (median 3), or ISS (29.5±12.4 vs. 25.4±10.5, $p=0.125$). As assessed by the neurosurgeon, median initial GCS for the cohort without an ICP monitor was 5 (IQR 3-10) as compared to 7 (IQR 3-11) in those with ICP monitoring ($p<0.022$). Survival was higher in patients without an ICP monitor (97.4% vs. 69.2, $p<0.001$). Non-monitored patients were discharged with higher levels of function per discharge location ($p<0.001$). No other components of the bundle were statistically different between groups, but overall compliance was poor - median 3 (IQR 2-4). There was no significant difference between the hospital length of stay, ICU or ventilator days.

Conclusion: Our data suggest that there is a subset of patients meeting BTF criteria for ICP monitoring that do well without pressure monitor insertion. These patients tend to have higher GCS scores than their monitored counterparts. This finding should provoke reconsideration of ICP monitoring for all patients with GCS 8 or less, and suggests that a randomized controlled trial of ICP monitoring in brain injured patients is overdue.

SCIWORA - MUCH MORE COMMON IN ADULTS THAN CHILDREN!

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Objective: Spinal cord injury without radiographic abnormality (SCIWORA) has long been thought of as a disease of the pediatric population. However, we have noted this entity commonly in adults. The purpose of this study is to describe characteristics of patients with SCIWORA admitted to our center.

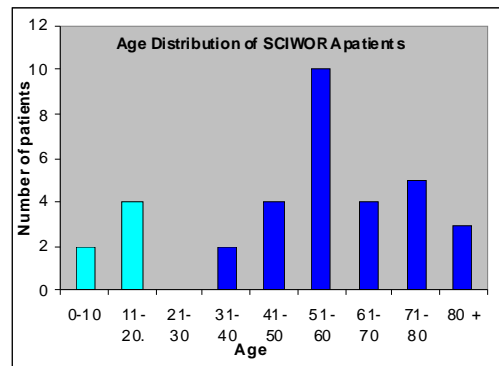
Methods: A retrospective review of all patients admitted to an ACS-verified adult and pediatric trauma center from 1/2005-12/2009 with spinal cord injury ICD-9 codes was performed. All patients with injury identified on CT cervical spine were excluded. Data gathered on the remaining patients included demographics, injury mechanism, ISS score, level and severity of spinal cord injury, MRI results, and long-term functional outcome.

Results: Over the 5-year period of this study, 11,644 adult and 1,442 pediatric trauma patients were admitted. Of these, 313 patients were identified as having spinal cord injury and 277 (88.5%) were excluded due to injury noted on CT cervical spine. The remaining 36 patients (11.5%) were described as having SCIWORA. Eighty-two percent were male. The patient ages ranged from 10-91 with a mean and median of 53. Mean ISS was 22.1. Sixty-five percent had a mechanism of fall.

Degenerative joint disease on CT cervical spine was found in 62%. Only 6 patients (17%) were less than 21 years of age. Of this young patient population, one had a positive MRI with neurological symptoms lasting over 48 hours.

The others were thought to have conversion disorder as they had negative MRI and full recovery within 48 hours.

Conclusion: SCIWORA is mainly a disease of adults, not of children. The characteristics of this patient population are important as SCIWORA is the concern when clearing the cervical spines of trauma patients with a CT cervical spine negative for injury.



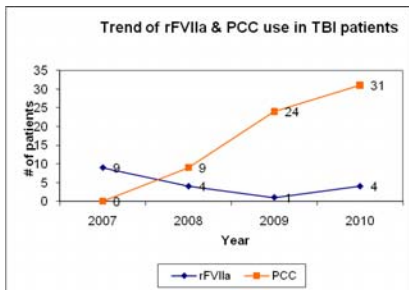
PROTHROMBIN COMPLEX CONCENTRATE: AN EFFECTIVE THERAPY IN REVERSING THE COAGULOPATHY OF TRAUMATIC BRAIN INJURY.

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Introduction: Studies have demonstrated the effectiveness of Factor VIIa (rFVIIa) in the reversal of coagulopathy in traumatic brain injured (TBI) patients. The effectiveness of Prothrombin Complex Concentrate (PCC) in the same patient population has yet to be determined. The purpose of this study was to document any changing trends in the use of rFVIIa and PCC in TBI patients and explore for differences in outcome.

Methods: All patients with a TBI receiving rFVIIa or PCC at our Level I trauma center over a 4-year period (2007-2010) were reviewed. We examined the yearly changes in the use of rFVIIa and PCC in TBI patients and compared the two groups with respect to baseline demographics and outcomes using ANOVA analysis.

Results: Our study population included 82 TBI patients of which 17 received rFVIIa and



65 patients received PCC. PCC group was significantly older (59.5 ± 23.7 ; $p < 0.01$), however there was no difference in the admission GCS (8.8 ± 5.3 vs 8.0 ± 5.3 ; $p = 0.53$), and Head AIS (4.0 ± 1.2 vs 4.4 ± 0.7 ; $p = 0.13$) in comparison to the rFVIIa group. PCC group were more likely to be on warfarin (44% vs 17%;

$p=0.033$). Overall mortality for TBI remained constant over the study period.

Conclusions: PCC is safe and effective for treating coagulopathy in TBI patients, while reducing costs and resource utilization. PCC should be considered as an effective therapy to treat both acquired and induced coagulopathy in traumatic brain injury.

Outcome	Factor VII	PCC	p-value
INR			
Before therapy	2.6 ± 2.1	2.2 ± 0.6	0.46
After therapy	1.58 ± 1.9	1.4 ± 0.3	0.77
Change in INR	0.39 ± 2.4	0.7 ± 0.7	0.58
Cost of therapy	5757.2 ± 3865.5	1007.63 ± 348.3	< 0.01
Hospital Cost	62491.9 ± 39512.7	31694.6 ± 32664.2	< 0.01
Hospital Charges	197928.1 ± 134532.0	120594.2 ± 122575.4	0.02
Complications	0% (0/17)	0% (0/65)	1
ICU LOS	6.4 ± 6.7	6.0 ± 6.0	0.81
Hospital LOS	9.6 ± 11.7	8.3 ± 8.3	0.65
Mortality	65% (11/17)	47.8% (31/65)	0.18

ROUTINE REPEAT HEAD CT IS UNNECESSARY IN PATIENTS PRESENTING WITH GOOD GCS SCORES

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Introduction: Scheduled repeat head CT after mild traumatic brain injury (TBI) has been shown to have limited utility for predicting need for an intervention. We hypothesized that selective repeat CT of mild TBI would not impact discharge Glasgow Coma Score (GCS).

Methods: This prospective cohort study followed all patients presenting to our urban, Level I trauma center with intracranial hemorrhage and a GCS of 13-15 from 2/2010 to 12/2010. Patients were divided into two groups: those whose repeat CT scans were performed routinely (ROUT) and those in whom they were performed selectively (SELECT) based on clinical exam. Group allocations were made at the discretion of the neurosurgical service attending, and patients transferred with a known CT were excluded.

Results: One hundred five patients met inclusion criteria (ROUT n=76, SELECT n=29).

Group demographics, including age, sex, ISS, and presenting GCS were not significantly different. Of SELECT pts, 4/29

(14%) required a repeat CT head for a neurologic change, with 1/4 (25%) having a radiographic progression of hemorrhage and none requiring medical or surgical intervention.

ROUT patients had radiographic progression in 24/76 (31%), with none requiring medical or surgical intervention. Discharge GCS was similar for both groups while ROUT patients required significantly more CT scans (p=.001). NPV of a no-change in clinical exam was 100% for both groups.

Conclusion: A practice of selective repetition of head CT in TBI patients admitted with GCS of 13-15 can decrease scan utilization without impacting discharge GCS. Having shown safety, further work will investigate if wider incorporation of this practice will decrease hospital and ICU length of stays (LOS).

	SELECT	ROUT
ICU LOS (days)	1.5±1.4	2.5±2.0
Hosp LOS (days)	4.0±4.7	6.1±4.9
Total CT scans	1.17±0.5*	2.8±0.9
Hrs to 2 nd scan	32±19 (n=4)	11.6±6.0
D/C GCS	14.9±0.2	14.9±0.2

PROCESS IMPROVEMENT AS A RESEARCH TOOL: IN-DEPTH ANALYSIS OF MORTALITY AT A LEVEL 1 TRAUMA CENTER

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Background: We hypothesized that the addition of a second, fellowship-trained trauma surgeon would enhance performance at our level 1 trauma center. However, routine benchmarking conducted 24 months after second surgeon arrived revealed a decline in performance, prompting a major process improvement (PI) investigation.

Methods: Internal benchmarking (IB) included W-scores and unadjusted mortality from June 2007 to May 2008. External benchmarking (EB) utilized University HealthSystem Consortium (UHC), Survival Measuring and Reporting Trial for Trauma (SMARTT), and Trauma Quality Improvement Project (TQIP) data from 2007 through 2009. To find assignable variance, we analyzed 10 years of data and compared mean differences in mortality between 2 time periods: June 1999 to May 2007 (prior to the arrival of the second surgeon) was designated as time period 1 (TP1), and June 2007 to May 2009 was designated as time period 2 (TP2). Statistics included means \pm SD, and P-values were calculated using independent samples *t*-tests.

Results: W-scores remained stable from May 2007 to May 2008. EB demonstrated increased observed-to-expected mortality ratios from 2007 to 2008. Mortality in patients with AIS-Head=4 increased from TP1 to TP2 (21.6% \pm 3.9% to 29.2% \pm 0.4%, $p=0.029$). Mortality due to withdrawal of care increased overall (23.6% \pm 14.1% to 82.1% \pm 25.4%, $p=0.002$), in patients with AIS-Head=4 (10.9% \pm 6.9% to 37.6% \pm 1.8%, $p<0.001$), and in patients with ISS=25 (10.4% \pm 8.1% to 31.9% \pm 6.4%, $p=0.008$). There were no other differences between the two time periods in either patient or injury-related factors.

Conclusions: Our research demonstrates the importance of a robust PI program. With the use of a comprehensive trauma registry and internal and external benchmarking, we were able to determine that assignable variance was attributable to complex issues of end-of-life decision-making. This allowed for accuracy in determining the root-causes of increased mortality and prevented counter-productive measures and policy changes.

CHANGES IN CULTURES OR CHANGE IN CULTURE?

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Introduction: Delivering care utilizing evidence based checklists and Crew Resource Management (CRM) techniques have been applied to medical care. These interventions improve care by reducing variability, avoiding abrogating key steps, and ensuring strict adherence to technical skills. CRM involves allowing all stakeholders to observe and intervene to assure protocol compliance. We hypothesized that the implementation of one such protocol would have lasting effects on other “protocols” to improve ICU outcomes, similar to the Michigan NSQIP collaborative reported recently.

Materials: During January of 2011, a multidisciplinary, evidence based checklist was introduced for central line placement at a Level 1 trauma center. The charge nurse of the Trauma ICU was assigned a recording role and could halt the procedure if there was a violation. The expectations for Central Line Associated Blood Stream Infections (CLABSI) were set at zero. Prior to the protocol, teams of residents and nurses underwent simulation of both the protocol and CRM. CLASBI data was recorded for the next two months. In addition, other ICU infections – Catheter Associated Urinary Tract Infections (CAUTI) and Ventilator Associated Pneumonias (VAP) were tracked, neither of which had new protocols or crew resource methodology.

Results: CLABSI rates were 10/1000 line days before the intervention and 3/1000 line days after, a statistically significant decrease (Chi Square analysis, $p = 0.05$). Both CAUTI and VAP rates were also reduced. (15/1000 catheter days to 5/1000 catheter days [$p=0.02$] and 19/1000 ventilator days to 0/1000 ventilator days [$p < 0.01$], respectively)

Conclusions: The introduction of crew resource training in ICU central line insertion spilled over into other processes of critical care, resulting in an overall improvement in outcomes. Changes in culture and resetting expectations involving all stakeholders participating in ICU care rather than a specific protocol improves the delivery and quality of care. This study validates the NSQIP data in a Trauma ICU setting.

DEATH AFTER LIFE: AN ANALYSIS OF LATE DEATHS IN SURVIVORS OF SEVERE TRAUMA

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Introduction: Patients surviving to discharge (DC) after severe traumatic injury have been shown to have an increased death rate compared to uninjured age-matched individuals.

Objective: To characterize the cause of death (COD) in severely injured patients who survive to DC and to identify the etiology of late deaths after trauma.

Methods: Registry data from 4 trauma centers identified adult trauma patients admitted to the ICU = 4 days and survived to DC between 1991 and 2005. Social security databases were used to identify patients who died post DC. Deceased patients were then queried in the National Death Index for COD listed on death certificates. Review of the data by two physicians was used to categorize the COD as well as assign whether the cause was attributable to the trauma (ATT).

Results: 567 patients were identified as having died post DC reflecting a 15% mortality with follow up times of 3 to 18 years. 19% of deaths were ATT, with 82% ATT rate in deaths = 90 days post DC compared to 4% ATT rate in deaths > 3 years post DC. 11% of the deaths occurred = 90 days post DC; which were significantly older, 74 vs. 61, than the remaining cohort ($p < 0.01$). COD analysis revealed that the 16% of patients died secondary to infectious causes, which is increased in the population at all time points from discharge. Patients who died of suicide or poisoning/overdose were significantly younger, mean ages of 47 and 46 respectively, compared to the overall mean age of 67 ($p < 0.01$).

Conclusion: Severe trauma results in a marked increased mortality even in individuals who survive to DC. A modest number of deaths are directly ATT, however in patients who survive > 3 years, ATT rate is negligible. 1 in 9 severely injured patients dies within 90 days of DC representing a need for improved end of life planning prior to DC. Severe trauma is associated with an increased risk of death from infectious causes. Further study is needed to determine the cause of early suicides and poisoning/overdose and determine if psychological or social interventions could alter these early deaths.

INFLUENCE OF THE NATIONAL TRAUMA DATA BANK (NTDB) ON THE STUDY OF TRAUMA OUTCOMES: A CALL FOR RESEARCH BEST PRACTICES STANDARDS

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Background: Risk adjusted analyses are a critical tool in evaluating trauma outcomes. The NTDB is a robust registry that allows such, but standardization of analytical techniques are nonexistent. Our objective is to examine research arising from the NTDB, with particular attention to characteristics known to have a strong association with trauma outcomes.

Methods: A database of all NTDB studies published by October 2010 was created by searching Pubmed and Embase. Those with multivariate risk adjusted analyses were assessed for their central question, main outcome measures, handling of missing data, analytical techniques and covariates used while performing an adjusted analyses.

Results: Of 278 peer reviewed publications, 116 performed an adjusted analysis. Studies focused on Clinical Outcomes (49), Public Health Policy or Prevention (28), Quality (14), Disparities (14), Trauma Center Designation (6) or Scoring Systems (4). Multivariate regression analyses was used in 88 papers to model for mortality as an outcome, however there were considerable differences in covariates used for case adjustment between studies:

% NTDB Studies using covariates below to risk adjust for mortality	%
Age	94.6
Any Measure of Anatomic Injury Severity (eg, ISS, AIS, APS or NISS)	91.3
Gender	77.2
Any Measure of Physiological Injury (e.g. RTS, SBP, HR, BD)	68.5
Any Measure of Head Injury (e.g. GCS, GCS components, Head AIS)	63.0%
Type of Injury (Penetrating or Blunt)	57.6%
Race/ Ethnicity	33.7%
Insurance Status	21.7%

Less than 5% papers used clustering for facility effects or imputation for missing data.

Conclusion: The NTDB is a powerful tool used by hundreds of researchers to study trauma outcomes, but there is an alarming variability in how risk adjusted analyses are performed. Many do not control for important confounders. Best practices for data analysis are vital in order to ensure the quality of research from the NTDB and enhance its impact.