

Failure to Rescue and the Weekend Effect: A Study of a Statewide Trauma System

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Introduction: Differential patient outcomes based on weekday or weekend patient presentation (i.e. the “weekend effect”) have been reported for several disease states. Failure to rescue (FTR, the probability of death after a complication) has been used to evaluate trauma care. We sought to determine whether the weekend effect impacts FTR across a mature statewide trauma system.

Methods: We examined all 30 Level I and II trauma centers using the Pennsylvania Trauma Outcomes Study (PTOS) from 2007-2015. Patients age >16y with a minimum Abbreviated Injury Score 2 were included; burn patients and transfers were excluded. Our primary exposure was first major complication timing (weekday vs weekend), FTR was the primary outcome. We used multivariable logistic regression to examine the association between weekend complication occurrence and mortality.

Results: Of 178,602 patients, 15,304 had a major complication [median age 58 (IQR 37-77) years, 68% male, 89% blunt injury mechanism, median injury severity score (ISS) 19 (IQR 10-29)]. Patient characteristics by complication timing were clinically similar (Table). Major complications were more likely on weekdays than weekends (9.3% vs 7.1%, $p<0.001$). Pulmonary and cardiac complications were most common in both groups (Table). Death occurred in 2,495 of 15,304 patients with complications, for an overall FTR rate of 16.3%. Weekday vs weekend FTR was similar (16.1% vs 16.8%; $p=0.33$). After controlling for patient age, ISS, complication type, and revised trauma score (RTS), there was no association between weekend complication occurrence and mortality (adjusted OR 1.03, 95% CI 0.92-1.16).

Table. Patient Characteristics by Weekday vs Weekend Timing of Major Complication

| Variable | Weekday N=11,251 | Weekend N=4,053 | P-Value* |
|---|---------------------|--------------------|-------------|
| Age, y, median (IQR) | 58 (37-77) | 57 (36-77) | 0.11 |
| Sex, male, No. (%) | 7,658 (68.1) | 2,787 (68.8) | 0.42 |
| Race, white, No. (%) | 8,787 (78.1) | 3,116 (76.9) | 0.01 |
| Blunt Injury Mechanism, No. (%) | 10,038 (89.2) | 3,571 (88.1) | 0.06 |
| Injury Severity Score, median (IQR) | 19 (10-29) | 19 (10-29) | 0.55 |
| Revised Trauma Score, median (IQR) | 7.8 (6.9-7.8) | 7.8 (6.9-7.8) | 0.62 |
| Complication Day Post-Admission, median (IQR) | 3 (1-6) | 3 (1-5) | <0.01 |
| Complication Type, No. (%) | | | |
| Pulmonary | 4,606 (40.9) | 1,627 (40.1) | 0.38 |
| Cardiac | 2,397 (21.3) | 919 (22.7) | 0.07 |
| Bleeding or Clotting | 363 (3.2) | 139 (3.4) | 0.54 |
| Infectious | 648 (5.8) | 259 (6.4) | 0.15 |
| Iatrogenic | 1,527 (13.6) | 490 (12.1) | 0.02 |
| Other | 1,710 (15.2) | 619 (15.3) | 0.91 |
| Failure to Rescue (FTR), No. (%) | 1,814 (16.1) | 681 (16.8) | 0.33 |

*Mann-Whitney U test for continuous variables, Chi-squared test for categorical variables

Conclusions: The ability for trauma centers to rescue patients from death after a complication is not impacted by weekday or weekend complication timing. Requirements for trauma centers to be operational with full staffing at all times likely counteracts the weekend effect phenomenon seen in other time-sensitive conditions. Restructuring staffing for management of other conditions to mimic the 24/7 trauma care model may improve outcomes.

EVALUATION OF HELICOPTOR TRANSPORT OF TRUAMA PATIENTS IN A RURAL STATE: HAVE WE GONE TOO FAR?

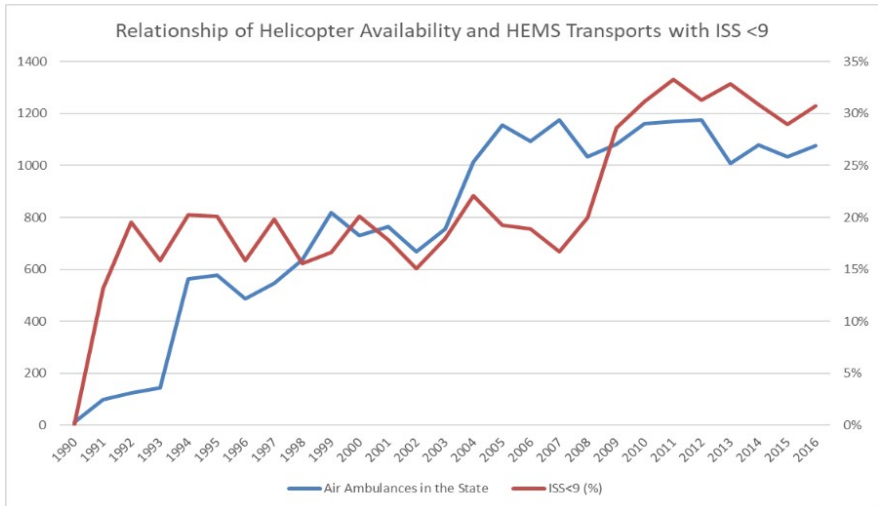
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Introduction: Helicopter emergency medical services (HEMS) overtriage increases the cost of trauma care. Private HEMS expansion could increase overtriage. We sought to determine whether increased utilization of HEMS in our rural state is associated with overtriage.

Methods: A retrospective analysis of all trauma patients transported to an ACS verified Level I trauma center via helicopter over a 26 year period (1990-2016) was performed using data from the trauma registry. HEMS overtriage was defined as one or more of the following: LOS <2 days, disposition from the ED other than ICU or OR, ISS <9.

Results: 21,177 HEMS patients were transported to our center. Annual helicopter transports increased dramatically from 1990 (11) to 2016 (1076). Overall overtriage rate was 57.3%. Overtriage doubled from 2007 to 2009, which corresponds to an increase in air ambulances in the state within the same time period from 8 to 23. The counties with the highest percent of patients transported who met overtriage criteria had the furthest distance to the trauma center. Scene HEMS transports had greater overtriage rates than interfacility transfers. Patients with LEG AIS scores <2 were more likely to be transferred from the scene, 18.8% versus 11.9% (p<0.001) compared to interfacility transfers which had higher rate of facial AIS scores <2, 6.9% versus 4.4% from scene (p <0.001).

Conclusion: There was a near doubling of overtriaged HEMS patients in our rural state from 2007-2009, at which time there was also a tripling of air ambulances. This suggests an increase in HEMS is likely secondary to an increased number of available helicopters and not an increase in injury severity. Our data also demonstrate that a higher percentage of patients who met overtriage criteria were transferred from the scene. However, patterns of injury were different when comparing scene versus interfacility transports.



DOES THE TIME OF THE DAY OF SURGERY INFLUENCE PERIOPERATIVE COMPLICATIONS – A NATIONWIDE DATABASE ANALYSIS IN 31'692 PATIENTS

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Introduction: Emergency and surgery for acute injuries is often required to avoid excessive bleeding and prevent from infections in open fractures. However, it has previously been discussed, that surgeon related factors (e.g. experience of the surgeon, teaching vs. non-teaching hospital) might play a role in adverse outcomes for these surgeries. The purpose of this study was to evaluate whether the time of day for emergent surgery is associated with complications.

Methods: A prospective database (AQC, nationwide Swiss quality assurance project) was used to evaluate all trauma surgeries within 11 years in more than 70 Swiss surgical units. Inclusion criteria: All trauma coded diagnosis that were surgically treated in Swiss hospitals. Exclusion criteria: missing data for time of surgery. The daytime of surgery was stratified into morning (7AM - noon), afternoon (1PM – 6PM), evening (7PM – 11PM) and night (Midnight – 6AM). The primary outcomes were intraoperative (e.g., nerve, tendon, or vascular damage, iatrogenic fractures), postoperative (e.g., bleeding, infection, impaired wound healing, incorrect axial, rotational or length reduction) and general complications (pulmonary, cardiovascular, gastrointestinal, renal, or neurological) and mortality. Co-factors included age, gender, ASA classification, type of surgery, experience of the surgeon, length of surgery and length of stay). Variables were sought in bivariable and multivariate analysis.

Results: Of 31'692 patients, 44% were operated in the morning, 40% in the afternoon, 14% in the evening and 1.7% at night. The in-hospital mortality rate was significantly higher after nightly (2.4%) as well as afternoon surgery (1.7%). The time of surgery had no significant influence on intra- (0.5%) or postoperative complication rates (3.4%) in multivariable analysis, but a significant influence on general complications (7.9%). Afternoon- and night-surgery were significant predictors for general complications. Age, gender, higher ASA classification, and emergency procedures were typical risk factors for mortality and complications in this cohort.

Conclusion: Emergency procedures performed at night and in the afternoon appears to be associated with an increased incidence of adverse outcomes. Further studies should evaluate whether this is relevant for certain diagnoses and/or procedures.

THE PROGNOSTIC VALUE OF NATIONAL FIELD TRAUMA TRIAGE GUIDELINES IN INJURED OLDER ADULTS AND DEVELOPMENT OF THE GERIATRIC FIELD TRAUMA TRIAGE (GFTT) SCORE

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Introduction: The Field Triage Decision Scheme developed by the American College of Surgeons Committee on Trauma (ASCOT) with periodic revision forms the basis of field triage guidelines for injured adult patients in many regions including Oklahoma. The decision scheme has been shown to have low sensitivity for seriously injured *older* patients. Proposed alternative criteria for injured older adults has been shown to improve sensitivity at the expense of specificity (over-triage). We sought to develop two prognostic tools with improved sensitivity and specificity to identify seriously injured older adults including those at a high risk of in-hospital mortality in the prehospital or in a resource-limited setting based on, current national field triage guidelines, previously proposed alternative criteria, and other potential risk factors such as pre-existing comorbidity.

Methods: This was a retrospective cohort study of injured adults ≥ 55 years transported directly from the scene of injury by EMS to a trauma facility for definitive care and reported to the Oklahoma State Trauma Registry between 2005 and 2014. Patient demographics, pre-existing comorbidity, variables used to define the current national field trauma triage guidelines as well as variables proposed by other investigators for alternative triage criteria were considered. The primary outcome of interest was serious injury, defined as an Injury Severity Score (ISS) ≥ 16 . In-hospital mortality was considered as a secondary outcome. Based on the two prognostic models, we developed the Geriatric Field Trauma Triage (GFTT) score to summarize identified significant risk markers/factors for the outcomes of interest. Logistic regression was used for multivariable modeling, and bootstrapping with resampling was used to adjust the prognostic models for overfitting and regression-to-the-mean bias.

Results: A total of 13275 patients met study eligibility. Of these, 28.5% (3782) had an ISS ≥ 16 (serious injury) and 9.8% (1300) died. The final models for predicting both serious injury and in-hospital mortality included the following variables: demographic, mechanism of injury, modified physiologic criteria, anatomic injury criteria and specific comorbid conditions (cardiac disease and coagulopathy). At the optimal GFTT scores where sensitivity and specificity are maximized, the prognostic model for serious injury (AUC, 0.86; 95%CI 0.86-0.87) outperforms current triage guidelines, sensitivity (87.4% vs 76%) with minimal loss in specificity (74% vs 78%); and the model for in-hospital mortality (AUC, 0.82; 95%CI 0.80-0.83) shows reasonable accuracy (73.4% sensitivity and 74% specificity). When stratified into low, moderate and high risk groups using recursive partitioning analysis, patients in the highest risk category had 83% and 42% predicted probability of serious injury and in-hospital mortality respectively.

Conclusion: Identification of high-risk injured older adults in the prehospital or resource-limited setting could be improved by considering other variables such as age group, pre-existing comorbidity, and modified physiologic criteria without loss in specificity. Use of risk scores may be used to simplify the prehospital triage process, enhance compliance with the triage guidelines, and reduce under-triage in the injured older adult.

Leaving the frail behind: the role of frailty in trauma triage of the elderly

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Introduction: Older adults with severe injuries are less likely to be triaged from the scene of injury to trauma center care. Secondary triage at non-trauma centers allows those older adults to be transferred to a trauma center for definitive care. Although physiologic and anatomic criteria have traditionally been used to guide secondary triage, these factors may not identify older adults at highest risk for adverse outcomes. Frailty is a geriatric syndrome that represents a loss of physiologic reserve and is associated with increased mortality and morbidity in trauma patients. In this study, we evaluated the impact of frailty on transfer to trauma center care among older adults.

Methods: We performed a population-based, retrospective cohort study that evaluated triage patterns for older adults in a large regional trauma system over 2006-2016. All patients aged ≥ 65 with severe injury (ISS > 15 or death within 48 hours of injury) were included. For patients initially triaged from the field to a non-trauma center, we evaluated the relationship between frailty and subsequent transfer to a trauma center. Generalized estimating equations were used to adjust for patient and injury factors associated with transfer.

Results: We identified 21,499 patients aged ≥ 65 with severe injuries. One quarter of patients were frail. 77% of patients were triaged from the field to a non-trauma center. Of these patients, only 23% were transferred to a trauma center. Among those transferred, 18% were frail, compared to 30% who remained at a non-trauma center (Table 1). Adjusting for patient and injury variables, frailty was independently associated with decreased probability of transfer (OR 0.87, 95% CI 0.76-0.99) and with death (OR 1.32, 95% CI 1.21-1.44).

Conclusion: Despite being a strong predictor of adverse outcomes among older adults with severe injuries, frailty was associated with a lower rate of transfer to trauma center care. These data suggest that variables pertinent to the outcomes of older adults should be incorporated into transfer guidelines.

Table 1: Characteristics of patients triaged to a non-trauma center

| | Admitted to NTC | Transferred to TC | SD |
|-------------------------|-----------------|-------------------|------|
| | N=12,628 | N=3,872 | |
| Mean age | 81.6 \pm 8.2 | 77.7 \pm 7.8 | 0.48 |
| Female (%) | 7,006 (55.5%) | 1,621 (41.9%) | 0.27 |
| History of CHF (%) | 678 (5.4%) | 125 (3.2%) | 0.11 |
| History of AMI (%) | 279 (2.2%) | 75 (1.9%) | 0.02 |
| History of stroke (%) | 415 (3.3%) | 92 (2.4%) | 0.05 |
| History of diabetes (%) | 4,157 (32.9%) | 1,240 (32.0%) | 0.02 |
| History of dementia (%) | 3,124 (24.7%) | 586 (15.1%) | 0.24 |
| Frailty (%) | 3,837 (30.4%) | 715 (18.5%) | 0.28 |
| Admitted from LTC (%) | 937 (7.4%) | 109 (2.8%) | 0.21 |

Abbreviations: NTC: non-trauma center; TC: trauma center; SD: standardized difference; CHF: congestive heart failure; AMI: acute myocardial infarction; LTC: long-term care

IMPLEMENTATION OF A TRAUMA RE-ORGANIZATION INITIATIVE TO IMPROVE TRAUMA CARE AND TEAM DYNAMICS IN A LEVEL I TRAUMA CENTER

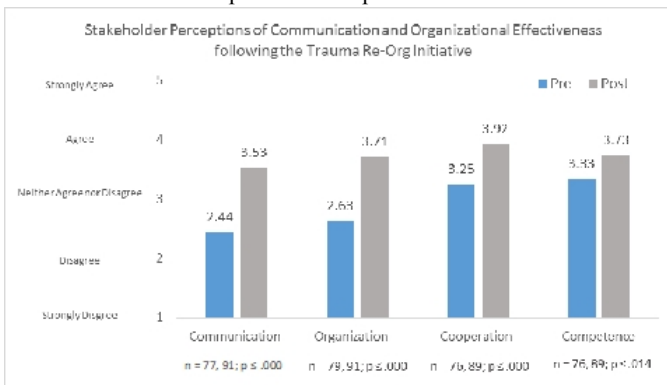
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Introduction: Good teamwork and collaboration among multi-disciplinary and multi-professional trauma team members has been known to improve timeliness of patient disposition and management. While few would disagree that these qualities are important, achieving and maintaining functional trauma response teams requires work. The Trauma Re-Organization Initiative (Trauma Re-Org) was collaboratively developed between the Departments of Emergency Medicine (EM) and Trauma Surgery at a Level 1 Trauma Center to improve communication, teamwork, and the management of trauma patients in the emergency department (ED).

Methods: Trauma Re-Org was launched in January 2017 after a 9 month planning process. The planning team was comprised of faculty and residents from both departments and ED nursing. The group reviewed and modified a protocol that designated the roles and responsibilities for all personnel and designed the initiative didactic and simulation training activities. Prior to the launch, planners also conducted a series of “listening tours” with key stakeholder groups which included faculty, residents, and nursing leadership. The initiative was supported by a formative process evaluation that included observation of planning and training events, a survey of trauma response stakeholders, and post-implementation observations of trauma response in the ED.

Results: The Stakeholder survey included responses from EM physicians, trauma surgeons, and ED nurses (Pre N = 79; Post N = 91). Mann-Whitney U tests showed positive and significant change in the post period for overall communication, organization, and cooperation between personnel during trauma response, and improved perceptions of the clinical skill competence of other responders. The analysis also showed specific improvements for communication between EM attending physicians and nurses with trauma surgery residents. In addition, trauma surgeons reported improved communication with ED staff. Open-ended questions identified both achievements and areas for continuing improvement, including: improved but imperfect communication, further need for role clarification, and support for the designation of an identifiable trauma team leader.

Conclusions: A multi-faceted trauma improvement program that includes a number of interventions, including organizing roles, organizing responsibilities within team framework, in situ simulations, team building exercises, and the inclusion of stakeholder perspectives can re-build a culture of cooperation, collaboration, and an overall increase in the belief that one’s contribution is valued. The initiative is easily adaptable to other trauma centers that have practitioners from various disciplines who want to optimize teamwork and collaboration to improve trauma patient care.



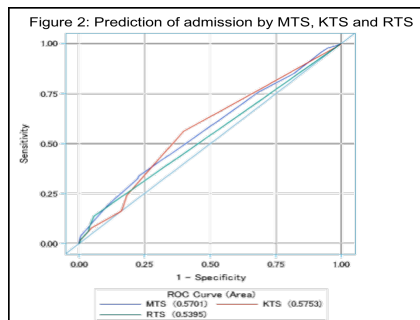
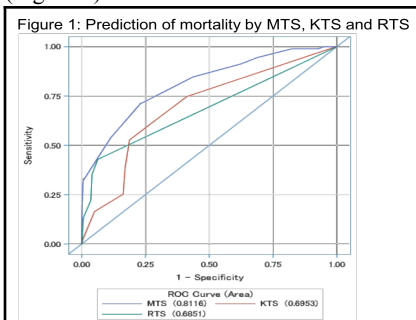
COMPARISON OF SIMPLIFIED TRAUMA SCORES TO PREDICT MORTALITY AT A SUB-SAHARAN TERTIARY REFERRAL CENTER

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Introduction: Injury severity scoring systems are often utilized to predict injury outcomes but usually require diagnostic adjuncts and imaging that are often unavailable in resource-limited settings. Several simplified scores have been developed for trauma prediction, including the Malawi Trauma Score (MTS), which includes age, sex, AVPU neurologic status (A-Alert, V-Voice, P-Pain and U-Unresponsive), presence of a palpable radial pulse and body area injured; the Kampala Trauma Score (KTS), which uses APVU, age, respiratory rate (RR), systolic blood pressure (SBP) and number of serious injuries; and the Revised Trauma Score (RTS), which uses Glasgow Coma Scale (GCS), SBP and RR. While these scores have each shown predictive power in different low-resource settings, their performance has not been compared in the same population.

Methods: A trauma surveillance registry from a tertiary referral hospital in sub-Saharan Africa was analyzed using patients seen between 2010 through 2014. We used logistic regression and generated ROC curves, using each of the three scoring systems for patients. We then compared the performance of each score in predicting mortality. Secondary analysis evaluated each scoring system's ability to predict hospital admission.

Results: A total of 62,425 patients were included in the trauma registry during that time; 1,120 (1.8%) died while in the ED or hospital, and 10,954 (17.6%) were admitted to the hospital. Sufficient information was available to calculate the MTS for 26,829 patients, the KTS for 22,127, and the RTS for 21,831. The MTS predicted mortality (ROC AUC= 0.813) better than KTS and RTS (ROC AUC = 0.711 and 0.683 respectively) (Figure 1). The KTS and RTS curves did not differ statistically ($p= 0.75$), however, the MTS curve, discriminated better than either KTS or RTS ($p < 0.001$, both). For admissions, KTS performed best, but prediction was low overall (AUC= 0.575) (Figure 2).



Conclusion: Simplified scoring systems are needed for limited-resource settings to triage patients appropriately and to allocate scarce resources. The MTS predicted mortality better than KTS or RTS. The MTS also requires no equipment, not even a sphygmomanometer, nor does it rely on subjective assessment of injury severity, as the KTS does. Future work to compare these scores in varied populations, and in prehospital triage, is imperative.

OUTCOMES WITH ADVANCED VERSUS BASIC LIFE SUPPORT IN BLUNT TRAUMA

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Introduction: The role of advanced life support (ALS) versus basic life support (BLS) in blunt trauma is controversial. Previous studies have shown no mortality benefit for penetrating trauma, particularly in urban environments, with ALS over BLS. The distinction for blunt trauma in an urban/suburban environment has mostly remained unaddressed.

Methods: A retrospective cohort study was conducted in patients transported to a Level 1 trauma center in an urban/suburban environment. Adult blunt trauma patients transported by ALS and BLS from July 1, 2014 to December 31, 2014, were identified. Institutional trauma records were used to assess Injury Severity Score (ISS) and select Abbreviated Injury Score (AIS). Logistic regression was used to determine differences in mortality, length of stay (LOS) and in-hospital complications based on mode of transportation, time of transport, and number of interventions performed pre-hospital.

Results: 698 total patients were identified, 67.8% were transported by ALS. ALS patients grossly had higher rates of mortality ($p=0.01$) and complications ($p=0.009$). However, ALS patients did have a higher ISS ($p < 0.001$) and when adjusted for ISS and AIS, there was no difference between patients transported by ALS and BLS with respect to mortality (ISS: $p = 0.47$, AIS: head, thorax, abdomen $p=0.6-0.8$). There was no difference between ALS and BLS for time of transport ($p=0.61$) or LOS ($p=1.35$). After adjusting for ISS, the number of interventions performed in the field did not increase transport time ($p=0.46$) but did correlate with increased mortality ($p<0.001$).

Conclusion: When accounting for injury severity, there is no mortality advantage for patients being transported by ALS versus BLS transport. The number of interventions performed did not alter transport time, but did influence mortality. This suggests that ALS transport may not be necessary in blunt traumas and increased interventions may be detrimental to patient outcomes.

BACK TO THE FUTURE: IMPACT OF A PAPER-BASED ADMISSION H&P ON CLINICAL DOCUMENTATION IMPROVEMENT AT A LEVEL 1 TRAUMA CENTER

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Introduction: Case Mix Index (CMI), calculated from patient MS-DRG-weights determined from clinical documentation (CD), is a standard indicator of patient complexity and determines reimbursement for inpatient care. CD language, however, is not aligned with physician language, resulting in potential for CMI under-representative of true patient complexity and severity of illness. We postulated that returning to a paper-based admission form (H&P) that included a “picklist” of standard admission diagnoses in CD language would improve CD at our trauma center. The purpose of this study was to determine the impact of this practice change with regards to the change in CMI.

Methods: Consecutive inpatient discharges from our trauma service from October-December 2016 were deemed EHR cohort and May-November 2017 PAPER cohort. Excluded cases included discharge dates during the period of transition to paper-based charting between January and April 2017. Cases with DRG-weights greater than 10, relatively unaffected by documentation, were excluded given their propensity to skew CMI. MS-DRG weight, length of stay (LOS), Injury Severity Score (ISS), and expected reimbursement were recorded for each patient. CMI calculated as the average of MS-DRG-weights was determined for each cohort.

Results: Our cohort consisted of 218 (29%) EHR and 535 (71%) PAPER records coded using MS-DRG version 34. There were not significant differences between groups in hospital length of stay (LOS; $P = 0.966$) or Injury Severity Score (ISS; $P = 0.350$). CMI and expected payment were significantly higher in the PAPER cohort (CMI: 2.3 ± 1.7 vs. 2.6 ± 1.9 , $P = 0.001$; expected payment $\$24,599 \pm 29,593$ vs. $\$18,520 \pm 19,553$, $P < 0.001$). Regression modeling determined PAPER cohort was associated with average increase in CMI of 0.30 (adjusted for ISS and LOS), resulting in an average increase of 11.1% in expected reimbursement per patient.

Conclusion: A paper-based H&P form at a level-1 trauma center was associated with an increase in CMI and expected reimbursement. This simple approach provided physicians with the ability to choose diagnoses that align with CD language, resulting in CD improvement. H&P forms with “picklist” diagnoses should be considered by trauma centers to more accurately document the relative complexity of their inpatient populations.

WOULD PRE-HOSPITAL WHOLE BLOOD TRANSFUSION IMPROVE MORTALITY IN SEVERELY INJURED PATIENTS?

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Introduction: Hemorrhage is the most common cause of preventable death in trauma patients, with approximately 40% of trauma deaths attributed to uncontrolled blood loss, and up to half of these deaths taking place before the patient arrives at the hospital. These mortalities might be prevented with pre-hospital transfusion. The goal of this analysis was to characterize injured patients requiring massive transfusion to determine the potential impact of a pre-hospital whole blood transfusion

Methods: Using our level I trauma center's registry, we retrospectively identified all adult trauma patients from January 2015 to August 2017 requiring activation of the massive transfusion protocol (MTP). Patient demographics, Emergency Medical Services (EMS) times, vital signs [systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), shock index [HR/SBP (SI)], pulse pressure divided by heart rate (PP/HR), mean arterial pressure (MAP), and PP] and injury severity scores (ISS) were evaluated by the independent samples t-test and chi-square test to assess for differences between survivors and non-survivors.

Results: Our study population of 124 MTP patients had the characteristics shown in Tables 1 and 2. The all-cause mortality was 73% (90/124) with 84% (76/90) of deaths due to bleeding. Of the hemorrhage-related deaths, 57% (43/76) spent less than or equal to 30 minutes in the pre-hospital setting. The odds of death were higher for both elderly patients (age ≥55 years) and for blunt trauma compared to penetrating, [1.22 (95% CI, 0.99 – 1.50 and 0.94 – 1.58 respectively)]. Positive predictive value (PPV) of death for patients with PP<45 and SI>1 was 0.79 for all patients, but was 0.81 and 0.92 for blunt injury and elderly patients, respectively.

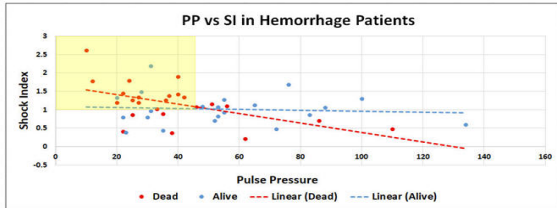
Conclusion: Our data demonstrate a high mortality rate in trauma patients who require MTP, with a mortality trend in older patients and patients with blunt trauma. We recommend using EMS pulse pressure in combination with either shock index or systolic blood pressure to serve as a trigger for initiation of pre-hospital whole blood transfusion. This study supports the development and implementation of a pre-hospital whole blood transfusion program. Realizing that most hemorrhage-related deaths had less than a 30-minute pre-hospital time, transfusion initiated by EMS may decrease mortality in the MTP patient.

| | Total | Dead | Alive | p-value |
|-------------------------------|------------|------------|------------|---------|
| # of Patients | 124 | 90 (73%) | 34 (27%) | |
| # of Blunt Injury (67%) | 83 (71%) | 64 (56%) | 19 (44%) | 0.108 |
| # of Penetrating Injury (33%) | 41 (29%) | 26 (44%) | 15 (37%) | 0.115 |
| Age (18-87) | 42 (18-87) | 43 (18-87) | 37 (19-83) | 0.115 |
| ISS | 30 | 34 | 20 | <0.001 |
| EMS SBP | 78 | 74 | 88 | 0.222 |
| EMS DBP | 45 | 45 | 45 | 0.984 |
| EMS HR | 97.1 | 93.4 | 106.1 | 0.112 |
| EMS SI | 1.15 | 1.18 | 1.11 | 0.514 |
| EMS PP | 33.0 | 29.1 | 43.0 | 0.022 |
| EMS MAP | 56.1 | 54.8 | 59.3 | 0.587 |
| EMS PP/HR | 0.37 | 0.34 | 0.44 | 0.166 |
| EMS Time (in minutes) | 40.1 | 42.2 | 34.7 | 0.605 |

Table 1. Characteristics of MTP patients (reported as means unless otherwise noted). ISS is significantly higher and PP is significantly lower in the group that died.

| Positive Predictive Value of Death | | | | | |
|------------------------------------|------|----------|-------------------|----------------|--------------------|
| PP<45 | SI>1 | SBP ≤110 | SBP ≤110 and SI>1 | PP<45 and SI>1 | SBP ≤110 and PP<45 |
| 0.78 | 0.71 | 0.73 | 0.73 | 0.79 | 0.79 |

Table 2. PPVs of death in MTP patients. "PP<45 and SI>1" and "SBP≤110 and PP<45" are highly predictive of death.



Graph 1. Plot of pulse pressure against shock index in MTP patients suffering primarily from hemorrhage. PP<45 appears to be correlated with death.

HEAD INJURY ALERT: A NEW LEVEL OF TRAUMA ACTIVATION AT COMMUNITY HOSPITALS?

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Introduction: Trauma activation at a hospital requires mobilization of significant resources and personnel. The trauma team, operating room, CT scan and X-ray technologists all have to be available to assist at short notice. While Level 1 trauma centers are better equipped to designate personnel and resources to trauma activations, community hospitals tend to be more limited in their capacity to allocate resources to the trauma patient. In 2014, the Committee on Trauma of the American College of Surgery issued the updated Orange Book with its latest recommendations for optimal care of the injured patient. Amongst trauma activation criteria was included elderly patients that sustain falls from any height on anticoagulation. Based on our experience with this specific trauma population, we hypothesized that a new tier of trauma activation composed of a limited trauma team could preserve patient safety while reducing time and cost.

Methods: A "Head Injury Alert" was created to denote patients with a GCS > 14 who had fallen from a height of <20 feet while on anticoagulation. The team, composed of an ED attending, a surgical resident and one nurse, triage and evaluate the patient with the goal of obtaining a CT scan of the head within 30minutes of presentation. At any time, the Head Injury team could raise the level of trauma activation if deemed necessary. Data was prospectively acquired utilizing the Electronic Medical Record at our institution for all head trauma activations from its inception in June 2017 to January 2018. Data collected included patient age, type of anticoagulation, Injury Severity Score (ISS), time from arrival to CT scan, outcomes, missed injuries, disposition (admission vs discharge) and number of activations requiring escalation of care.

Results: From June 1st 2017 to January 31st 2018, 150 head injury activations occurred. 52% of patients were female while 48% were male. The median age was 77 years old. The most common anticoagulant observed was Coumadin, corresponding to 28% of all patients. 46% of patients were discharged to home from the emergency room, while 43% were admitted and 7% required admission to the intensive care unit. The median time-to-CT was 26 minutes, with 45 out of 152 CT scans delayed more than 30minutes. The ISS ranged from 0 to 25, with the worst ISS seen in patients taking ticagrelor. Eleven patients (7.3%) presented with positive head CT, but only one underwent neurosurgical intervention. Of the 5 deaths, three patients (2%) succumbed to intracranial hemorrhage, one to pneumonia present on admission and one to cardiac arrest which led to his fall.

| | Patients | Patient Percentage | Median Age | Head CT Time | Length of stay (days) | Admission to ICU (%) | Admit to Medicine (%) | Admit to Surgery (%) | Discharges (%) | Death (%) | ISS |
|------------------|----------|--------------------|------------|--------------|-----------------------|----------------------|-----------------------|----------------------|----------------|-----------|------|
| Brillinta | 1 | 0.67 | 56 | 24 | 1 | 100 | 0 | 0 | 0 | 0 | 5 |
| Coumadin | 43 | 28.67 | 82 | 27.4 | 2.45 | 4.65 | 37.2 | 11.63 | 46.51 | 2.33 | 1.76 |
| Eliquis | 32 | 21.33 | 77.5 | 26.7 | 1.88 | 6.25 | 43.75 | 3.13 | 46.88 | 0 | 0.9 |
| Heparin SQ | 1 | 0.67 | 91 | 21 | 2 | 0 | 0 | 0 | 100 | 0 | 0 |
| Lovenox | 3 | 2 | 60 | 21.3 | 1.83 | 0 | 66.7 | 0 | 33.3 | 0 | 2 |
| Plavix | 40 | 26.66 | 79 | 27.5 | 1.76 | 12.5 | 30 | 5 | 50 | 7.5 | 2.6 |
| Pradaxa | 6 | 4 | 79.5 | 26.2 | 0.92 | 0 | 16.67 | 0 | 83.33 | 0 | 0 |
| Xarelto | 18 | 12 | 72 | 31.8 | 1.72 | 5.56 | 55.56 | 5.56 | 33.33 | 5.56 | 1.83 |
| Coumadin/Lovenox | 2 | 1.33 | 72.5 | 39.5 | 4.25 | 0 | 50 | 0 | 50 | 0 | 0 |
| Coumadin/Plavix | 2 | 1.33 | 66 | 35 | 3.25 | 0 | 50 | 0 | 50 | 0 | 0 |
| Plavix/Eliquis | 1 | 0.67 | 73 | 14 | 0.5 | 0 | 0 | 0 | 100 | 0 | 0 |
| Plavix/Xarelto | 1 | 0.67 | 87 | 27 | 3 | 0 | 100 | 0 | 0 | 0 | 4 |
| Total | 150 | 100 | | | | | | | | | |

Conclusion: Head Injury Alert can be safely applied as a new level of trauma activation for patients that fall from <20 feet while on anticoagulation. This new level of activation helps identify a specific patient population and injury mechanism that can be safely triaged by a limited trauma team. With this, community hospitals can maximize their resources and minimize cost, while maintaining patient safety.

FALL DOWNS SHOULD NOT FALL OUT -- BLUNT CEREBROVASCULAR INJURY AND ITS SEQUELAE ARE COMMON IN GERIATRIC PATIENTS FOLLOWING LOW ENERGY BLUNT TRAUMA

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Introduction: Blunt cerebrovascular injuries (BCVI) are associated with specific injuries to the face, skull base and cervical spine. There are limited studies examining the impact of screening protocols for BCVI in geriatric patients after low energy falls. We hypothesized that BCVI screening in this cohort would rarely identify injuries and would infrequently result in a change in management.

Methods: A retrospective study was conducted over a 36-month period (2014-2016) of patients ≥ 18 years with Abbreviated Injury Scores for the head, neck or face region of ≥ 2 . Patients were defined as meeting criteria for BCVI screening if any of these anatomic criteria were present: diffuse axonal injury, C1-3 fracture, any cervical subluxation or fractures involving foramina transversaria, Leforte 2 or 3, petrous temporal bone or bilateral mandibular fractures. Outcomes were in-hospital mortality and stroke in the 30-day period following presentation. Univariate analysis was used where appropriate with a p value of 0.05 indicating statistical significance.

Results: 303 patients met criteria for BCVI screening with 141 (47%) being ≥ 65 years. Patients were screened with computed tomographic angiography (94%) and magnetic resonance angiography (6%). 120 (85%) sustained falls, of which 58 (48%) underwent screening. Screened patients were younger (mean age 78 vs 82, $p=0.02$), less likely to have serum creatinine of > 1.5 mg/dl (14% vs 29%, $p=0.04$) but had similar AIS- head and neck scores (median, 3 vs 3, $p=0.8$). Mortality was similar for those with and without screening (7% vs 16%, $p=0.2$). Of the 62 patients not screened, 38 (61%) were already on antithrombotic agents and another 12 (20%) died from severe traumatic brain injuries or had cardiac arrest shortly after arrival. Of the 58 screened patients, 17 (29%) had BCVI. Four (24%) of the 17 BCVI patients had strokes compared with one (2%) of 41 without BCVI ($p=0.01$). Seven of the 17 (41%) BCVI patients had antithrombotic agents started. Mortality rates were similar for patients with and without BCVI (12% vs 5%, $p=0.3$).

Conclusion: In geriatric patients with falls who had screening for BCVI, the yield was high and management changes common. BCVI was associated with stroke. Screening seems warranted in this cohort when prognosis after trauma is not bleak.

INFUSED CEREBRAL NOREPINEPHRINE EXACERBATES NEUROLOGIC DEFICITS FOLLOWING REPEAT TRAUMATIC BRAIN INJURY

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Introduction: Catecholamine levels surge immediately after acute traumatic brain injury (TBI), often to levels reflecting the severity of injury, causing inflammation and apoptosis. The degree of catecholamine surge following mild repetitive TBI (rTBI) and its relationship to the injury sequela is unknown. We hypothesized that mild repetitive TBI (rTBI), causes increased basal norepinephrine (NE) levels over time and artificially elevated NE is associated with further functional impairments in a rat rTBI model.

Methods: Fifty-six wild type rats were administered sham, or rTBI once per week for 5 weeks. NE levels were measured on the day prior to injury 1, 2 and 3. One week following the last injury, animals received ventricular infusion of vehicle or NE (0.4 µg/hour) for 6 weeks. Rats were tested on the rotarod, the open field, Barnes Maze, and Basso, Beattie, and Bresnahan (BBB) analysis to determine changes in neurologic function.

Results: rTBI led to increased basal NE levels over the time course of injury, relative to sham. No rotarod or open field differences were observed in TBI rats administered NE compared to vehicle. However, after rTBI NE administration resulted in impairments in short-term working memory. Cerebral NE infusion after rTBI led to lower BBB scores, indicating mild paralysis and impaired locomotion (Figure 1). The infusion of NE to sham rats did not alter BBB scores.

Conclusion: After mild recurrent TBI, elevated NE may lead to secondary brain injury and additional functional deficits. Mitigation of an excess catecholamine response, possibly with beta blockers, might therefore be essential for ameliorating the long-term morbidity associated with rTBI.

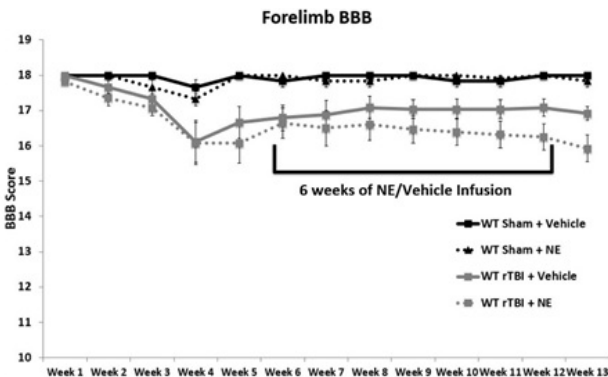


Figure 1. rTBI rats administered intracerebroventricular (ICV) infusion of norepinephrine (NE) developed worse paralysis and impaired locomotion.

ASSOCIATION OF EARLY MORTALITY AND ELEVATED SHOCK INDEX AT ADMISSION IN PATIENTS WITH TBI AND CONCOMITANT HEMORRHAGIC SHOCK: A POST-HOC ANALYSIS OF THE PROHS STUDY

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Introduction: Rapid and effective treatment of hemorrhagic shock (HS) is important for critically injured patients with traumatic brain injury (TBI) in order to reduce secondary brain injury. The shock index (SI) rapidly assesses hypovolemic shock severity which can complicate TBI. The Prehospital Resuscitation on Helicopter Study (PROHS) assessed the impact of blood product resuscitation during prehospital air transport for severely injured patients. Utilizing the PROHS database, we evaluated whether elevated SI at admission impacted mortality in TBI-HS and TBI+HS patients. We hypothesized that a normal SI on admission was associated with improved patient mortality.

Methods: A post-hoc analysis of the multi-center PROHS study was performed. PROHS inclusion criteria were: heart rate > 120 bpm, systolic blood pressure <90 mmHg, penetrating truncal injury, tourniquet/pelvic binder application, intubation or receipt of blood product during air prehospital transport. Patients with TBI (head abbreviated injury scale ≥ 3), prehospital HS (base excess ≤ -6 or a pulse pressure <45 mmHg) and/or receiving a massive transfusion (critical administration threshold; CAT: at least three units of RBCs given in any one-hour interval during first 24 hours after ED admission) were identified. SI was calculated for prehospital and admission time points with SI normalization defined as a prehospital SI value >0.9 improving to 0.4-0.89 at admission. Comparison of patient mortality (3, 24 hours and 30 days) between TBI-HS and TBI+HS groups was performed. Logistic regression was used to evaluate prehospital factors associated with 24 hour mortality using odds ratios (OR) with 95% confidence intervals (95% CI).

Results: A total of 396 patients were analyzed; 192 TBI+HS (48%) and 204 TBI-HS (52%). **Table** demonstrates injury severity, fluid resuscitation, and coagulation parameters for each group. Notably at admission, TBI+HS patients had a higher ISS, likelihood of receiving blood products, and coagulopathy than patients with TBI-HS. CAT rates were dissimilar in TBI+HS and TBI-HS groups (43% vs 30% respectively, $p=.03$). The proportion of uncorrected SI (≥ 0.9) at admission was higher in TBI + HS (60%) compared to TBI-HS (29%). Within the TBI-HS group, patients with admission SI <0.9 demonstrated lower mortality compared to those with a SI ≥ 0.9 at three (0% vs 8.3%, $p=.002$) and 24 hours (6.7% vs 16%, $p=.03$). In the TBI+HS group, patients with admission SI <0.9 demonstrated lower mortality compared to those with a SI ≥ 0.9 at three (5.6% vs 23.1%, $p=.002$) and at 24 hours (14.1% vs 36.4%, $p=.001$). On regression, factors independently associated with 24 hour mortality in both groups included penetrating injury (OR 6.7 95% 2.6-11.5), increasing age (OR 1.03 95% CI 1.01-1.05 per year), ISS (1.04 95% CI 1.01-1.1 per ISS unit), a lack of normalized admission SI (OR 2.4 95% CI 1.1-5.6) and the presence of coagulopathy at admission (OR 4 95% CI 2-8.5).

Conclusions: Patients with TBI+HS demonstrated increased mortality compared to TBI-HS at 3 and 24 hours but not at 30 days. TBI+HS patients also demonstrated concomitant coagulopathy by INR but not on thromboelastography compared to TBI-HS. At admission, SI that improved with treatment was associated with a reduction in mortality despite age, injury mechanism, or injury severity for both groups. Further analysis evaluating SI to improve prehospital resuscitation in patients with TBI+HS is warranted.

| | TBI | TBI + HS | |
|------------------------------------|----------------|------------------|----------------|
| | N=204 | N=192 | P value |
| Age in years | 35 [24-57] | 41 [26-57] | .77 |
| ISS | 26 [19-33] | 28 [22-36] | .007 |
| Prehospital SI > 0.9 (%) | 20 | 54 | 0.001 |
| Admission SI > 0.9 (%) | 29 | 60 | 0.001 |
| Crystalloid (cc) | 300 [0-750] | 375[0-1000] | .85 |
| Blood utilized (%) | 6.9 | 17.2 | .001 |
| R time | 1.3 [0.7-3] | 0.9 [0.7-4] | 0.54 |
| MA | 61 [55-67] | 63 [53-68] | 0.32 |
| Coagulopathy (%) | 39.1 | 55.1 | .001 |
| INR | 1.1 [1.1-1.2] | 1.3 [1.1-1.5] | .026 |
| Lactate | 2.5 [1.6-3.6] | 3.3 [2.4-6.1] | .0001 |
| Hemoglobin | 13.4 [12-14.6] | 12.6 [10.8-13.8] | .0001 |
| Mortality (%) | | | |
| 3 hour | 3.9 | 16.7 | .0001 |
| 24 hour | 13.2 | 28.1 | .0003 |
| 30 day | 29.4 | 37.5 | .09 |

A NOVEL LABORATORY RAT MODEL OF FOCUSED BLAST WAVE-INDUCED MILD TRAUMATIC BRAIN INJURY

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Introduction: Mild blast-induced TBI (mbTBI) is a quite common combat injury, and the number of victims with mbTBI is increasing worldwide due to terrorism. Thus, the mechanism of and treatment for blast injury must be understood. This study aimed to establish a rat model of mbTBI to assess chronic disability including immunohistological changes in the brain and discover clues for intervention.

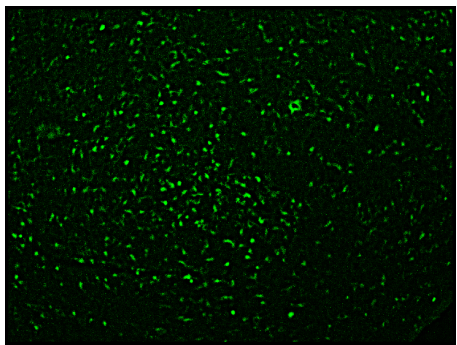
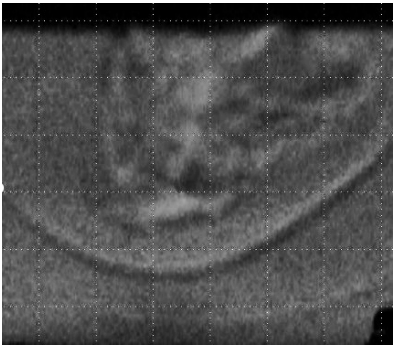
Methods: We built and used a blast wave generator described by Jaffin et al. (1987). The blast wave exited through a 20-mm I.D. nozzle aimed at the target. Rat brains showed no detectable injury at a nozzle-to-brain distance determined by preliminary testing (n=5). Peak shock wave pressure measured (93.7 ± 10.2 psi) at 2.5 cm under the nozzle. The blast wave was directed at the head of male SLC:Wistar rats weighing 247 ± 3.9 g under general anesthesia positioned prone 2.5 cm below the nozzle. Blast wave-induced brain injury was evaluated by Iba1 immunoreactivity at 3 days and 1, 2, and 6 weeks after injury. A forced swim test was performed 2 and 6 weeks after injury to assess depressive-like behavior.

Results: The mbTBI rat model showed no macroscopic findings of brain hemorrhage or contusion after blast injury, and behavioral changes appeared unchanged from the control group. However, early post-injury food intake decreased significantly in the blast group rats (day 1: 4.7 vs. 16.7 g/day; day 2: 11.3 vs. 18.7 g/day, n=3) and they lost weight compared to control (-18 vs. +10 g on day 3; $P=0.001$, n=11 vs. 3). The blast group showed increased immobility time in the forced swim test at 2 weeks (165 s vs. 125 s; n=6) and at 6 weeks (199 s vs. 162 s; n=6). Iba1 immunostaining show microglial accumulation in the hypothalamus at 2 weeks after injury and also in the thalamus and brain stem at 6 weeks.

Conclusions: This novel mbTBI rat model showed chronic-phase immunohistological abnormality and depressive-like behavior indicating that chronic traumatic encephalopathy by mbTBI may cause mental state change. This model will allow more precise identification of the mechanism of and best treatment method for mbTBI.

(Left) Shock wave from the generator.

(Right) Microglial accumulation in hypothalamus at 6 weeks.



MANAGING CRANIOMAXILLOFACIAL INJURY WITHOUT ROUTINE INPATIENT CONSULTATION: OUTCOME REVIEW AND REDUCTION IN PATIENT CHARGES

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Introduction: Traumatic craniomaxillofacial (CMF) injuries are commonly assessed by the trauma team and refer consultation to otolaryngologist or oral maxillofacial specialist. We hypothesized that trauma surgeons can safely selectively manage CMF injuries identified on computed tomographic (CT) scans without specialized surgical services, thereby decreasing the overall cost burden to patients.

Methods: We performed a retrospective analysis of all traumatic CMF fractures diagnosed on facial CT scan at a Level 1 trauma center during a 3-year period (January 2013 to December 2015). Those requiring CMF consultation were determined by the following injuries: lower midface, upper midface, and the craniobasal-facial unit. Patient population then categorized to those with CMF consultation versus no-CMF consultation. Patient age, sex, Glasgow Coma Scale (GCS) score, and Injury Severity Score (ISS) recorded. Specialty consultation charges were also calculated for review. All penetrating injuries, skull fractures or any patient completing inpatient craniofacial surgery were excluded from the analysis.

Results: 303 patients with CMF fractures on CT met inclusion criteria (124 [41%] CMF consultation versus 179 [59%] no-CMF consultation). Mean age was 47.8 ± 19.7 years (range, 5 to 94 years), and 70% males. Mean GCS and ISS was 13 ± 3.4 (3-15) and 10 ± 9 (1-66) respectively. Patients with CMF consults were more likely to have higher ISS ($p < 0.001$) and need surgery on admission ($p < 0.001$), while those with no-CMF consult had shorter LOS ($p < 0.002$). No in-hospital mortality or 30-day readmission rates were related to no-CMF consult. Those with CMF consultation, only 18.5% had inpatient consult follow up and 31 (22 patients [17.7%]) inpatient surgical procedures (18% ENT vs 52% OMFS) by surgical specialist. Of the accepted transfers (7 of 11) for isolated CMF injuries, a mean of 1.5 days length of stay was observed and no required surgical interventions recorded. Total patient charges saved with no-CMF consultation was \$26,539.96 during this review.

Conclusion: Trauma surgeons can selectively manage acute CMF injuries without inpatient specialist consultation. Additional guidelines can be established to avoid tertiary transfers to tertiary center for specialty consultation and decrease patient charges.

| Patient Demographics | Total (n=303) | Consult (n=124) | No Consult (n=179) | P-value |
|---------------------------|------------------------|-------------------------|------------------------|---------|
| Age, mean \pm SD | 47.8 \pm 19.7 (5-94) | 50.6 \pm 20.1 (17-94) | 45.9 \pm 19.3 (5-89) | 0.039 |
| Male, n (%) | 209 (69.0) | 82 (66.1) | 127 (70.9) | 0.372 |
| Transfer in, n (%) | 11 (3.6) | 4 (3.2) | 7 (3.9) | 0.570 |
| ISS, mean \pm SD | 10.0 \pm 9.0 (1-66) | 12.8 \pm 9.5 (1-66) | 8.0 \pm 8.1 (1-45) | < 0.001 |
| GCS, mean | 13.5 \pm 3.4 (3-15) | 13.1 \pm 3.9 (3-15) | 13.7 \pm 3.1 (3-15) | 0.160 |
| LOC, n (%) | 176 (58.1) | 75 (60.5) | 101 (56.4) | 0.481 |
| Inpatient surgery, n (%) | 24 (7.9) | 24 (19.4) | 0 (0.0) | < 0.001 |
| Outpatient surgery, n (%) | 3 (1.0) | 3 (2.4) | 0 (0.0) | 0.068 |
| LOS, mean \pm SD | 6.6 \pm 9.6 (0-52) | 8.7 \pm 11.4 (0-52) | 4.7 \pm 7.2 (0-46) | 0.002 |
| ICU Admit, n (%) | 87 (28.7) | 48 (38.7) | 39 (21.8) | 0.001 |
| ICU LOS, mean \pm SD | 7.9 \pm 8.0 (1-42) | 9.4 \pm 8.2 (1-42) | 6.1 \pm 7.5 (1-37) | 0.057 |
| Died, n (%) | 13 (4.3) | 4 (3.2) | 9 (5.0) | 0.570 |

PREDICTORS OF CONCURRENT CERVICAL SPINE FRACTURES IN PATIENTS WITH DIAGNOSED INTRACRANIAL HEMORRHAGE

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Introduction: Cervical spine fractures (CSF) have long been assumed present in high proportions of patients with a primary diagnosis of intracranial hemorrhage (ICH) due to the magnitude of injury required to cause ICH. However, the risk due to mechanism of injury (MOI) is unclear to suggest if additional computed tomography (CT) imaging is required. We hypothesize that the incidence of concurrent CSF injury with ICH is low based on MOI, and over utilization of CT scans has increased radiation burden and hospital cost.

Methods: A 2-year retrospective review was conducted for all patients admitted at a Level 1 trauma center sustaining blunt injury. Demographic data, radiographic imaging, GCS, ISS, length of stay (LOS), and ethanol levels were analyzed. To evaluate blunt impact trauma, patients were categorized as low or high impact mechanisms, by either fall (low) or motor vehicle collision (MVC - high); our facilities two most commonly treated MOI. Patients were further reviewed for isolated or combined ICH/CSF injury. The diagnostic yield of CT scans for clinically significant injury was then calculated.

Results: 3,222 patients were reviewed, and 861 identified with ICH or CSF. Patients were divided into three injury groups: CSF only, ICH only, or combination injury (CI). MOI was evaluated within injury groups and compared. Median age was 55 ± 23 years (range, 20-103) and 65% male. Incidence of CI was 3.0% (26 of 861) in the fall and MVC study groups. Mean GCS and ISS was 15 (3-15) and 5 (1-50), respectively. Fall patients with ICH were less likely to have CSF compared to fall patients with a negative head CT ($p > 0.001$). Increased age, higher ethanol concentration ($p = 0.030$), higher ISS, and lower GCS were positive predictive factors in CI fall patients ($p < 0.001$). These factors were also similar for CI MVC group (ethanol $p = 0.035$; ISS, GCS $p < 0.001$). MVC patients were 5.9 times more likely to have CI ($p < 0.001$). Patients with an isolated CSF due to fall were 2.0 times more likely to have a C2 vertebra injury compared to patients with an isolated CSF due to MVC ($p = 0.049$). Patients who sustained an isolated CSF due to MVC were 4.0 times more likely to have a C7 vertebra injury compared to patients with CSF due to fall ($p < 0.001$). There were no significant differences in location of cervical spine fracture between CI groups.

Conclusion: Fall patients with ICH have low incidence of concomitant CSF, and fall as an MOI does not have a significant positive predictive value for cervical spine injury. Existing guidelines for cervical spine clearance should be followed to limit unnecessary additional radiographic imaging thereby decreasing the radiation exposure and cost burden to the patient.

Table 1: Patient Demographic Comparison for the Identification of Predictors

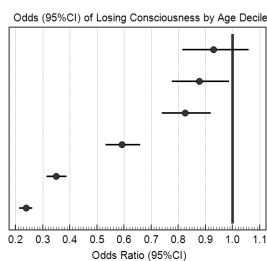
| | Fall Combined injury (n = 7) | Fall ICH (n = 340) | Fall CSF (n = 101) | p-value | MVC Combined injury (n = 19) | MVC ICH (n = 90) | MVC CSF (n = 53) | p-value |
|------------------------------------|------------------------------|----------------------------|--------------------------|---------|------------------------------|---------------------------|-------------------------|---------|
| Age, mean \pm SD (range) | 75.4 \pm 12.9 (56 – 86) | 70.2 \pm 17.2 (0.3 - 94) | 67.5 \pm 18.3 (20-103) | < 0.001 | 45.8 \pm 23.1 (18-91) | 45.5 \pm 23.7 (0.1 -86) | 51.7 \pm 20.4 (15-90) | 0.003 |
| Male, n (%) | 4 (57.1) | 184 (54.1) | 57 (56.4) | 0.911 | 11 (57.9) | 53 (58.9) | 30 (56.6) | 0.965 |
| ETOH \geq 0.08, n (%) | 3 (42.9) | 40 (11.8) | 17 (16.8) | 0.030 | 8 (42.1) | 15 (16.7) | 15 (28.3) | 0.035 |
| ISS, mean \pm SD (range) | 12.9 \pm 6.7 (5-21) | 14.8 \pm 7.5 (1-41) | 9.7 \pm 4.9 (4-25) | < 0.001 | 19.4 \pm 9.2 (5-45) | 21.2 \pm 11.5 (4-66) | 13.0 \pm 7.2 (4-29) | < 0.001 |
| Arrival GCS, mean \pm SD (range) | 11.5 \pm 5.7 (3-15) | 13.4 \pm 3.3 (3-15) | 14.1 \pm 2.8 (3-15) | < 0.001 | 10.1 \pm 5.7 (3-15) | 10.7 \pm 5.3 (3-15) | 14.6 \pm 1.4 (6-15) | < 0.001 |
| LOS, mean \pm SD (range) | 12.4 \pm 7.3 (2-23) | 8.1 \pm 9.1 (1-79) | 7.4 \pm 7.3 (1-41) | < 0.001 | 21.4 \pm 18.6 (2-80) | 16.5 \pm 23.3 (1-142) | 10.5 \pm 11.8 (1-60) | < 0.001 |
| ICU admission, n (%) | 6 (85.7) | 265 (77.9) | 39 (38.6) | < 0.001 | 17 (89.5) | 79 (87.8) | 28 (52.8) | < 0.001 |
| ICU LOS, mean \pm SD (range) | 8.5 \pm 4.6 (2-14) | 5.0 \pm 5.9 (1-40) | 5.3 \pm 5.8 (1-24) | < 0.001 | 12.1 \pm 9.2 (1-30) | 9.2 \pm 10.9 (1-49) | 11.1 \pm 10.9 (1-42) | 0.522 |
| Ventilator required, n (%) | 3 (42.9) | 70 (20.6) | 14 (13.9) | 0.093 | 8 (42.1) | 39 (43.3) | 9 (17.0) | 0.005 |
| Vent days, mean \pm SD (range) | 6.0 \pm 3.6 (2-9) | 7.8 \pm 7.4 (1-35) | 8.2 \pm 6.8 (1-21) | 0.891 | 15.8 \pm 7.1 (7-27) | 13.6 \pm 14.8 (1-74) | 18.4 \pm 9.9 (6-36) | 0.177 |
| Survived, n (%) | 6 (85.7) | 311 (91.5) | 96 (95.0) | 0.407 | 17 (89.5) | 81 (90.0) | 51 (96.2) | 0.380 |

IS AGE PROTECTIVE OF LOSING CONSCIOUSNESS AFTER CONCUSSION: WHAT CAN 35,000 MILD TRAUMATIC BRAIN INJURIES TELL US?

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Introduction: Aging is significantly associated with decreasing volume of brain parenchyma and increasing volume of cerebrospinal fluid (CSF). One role of CSF is to protect the brain from forces caused by head trauma. Moreover, the mechanism by which loss of consciousness (LOC) occurs after a head injury is not well defined but must somehow be attributable to the forces experienced by the brain. Thus, it is possible that age-related increases in CSF volume will protect against losing consciousness after a TBI. The primary objective of this study was to examine to what extent age is associated with a change in the risk of LOC after sustaining a concussion in the setting of mild TBI (mTBI, Glasgow coma scale [GCS] 13-15). Our secondary objective was to generate hypotheses to help direct future research on this topic.

Methods: This was a retrospective observational study utilizing six years of National Trauma Data Bank data. We included patients with 1) diagnosis of concussion; 2) positive or negative affirmation of post-injury LOC; 3) age ≥ 18 years; 4) had a "fall" mechanism of injury; and 5) with an initial Glasgow coma scale 13-15. We excluded patients with skull fractures or diagnoses of intracranial hemorrhage. Age groups were analyzed continuously, and categorically by decade (starting at 18-29 and ending at ≥ 80). The primary outcome was a reported LOC vs. a reported lack of LOC (ICD-9 850.1-850.5 vs. 850.0). Chi-square tests were used to assess differences in proportions between outcome groups, and multivariable logistic regression examined independent predictors of LOC. All statistical tests were two-tailed with an alpha of 0.05.



Results: There were 35,577 patients included in our study. The overall rate of LOC was 78.7% (n=27,990). The median (IQR) age in patients with a LOC was 55 yrs (40-70), and in those without LOC was 69 (52-81). There was a significant decrease in the odds of LOC with increasing age decade (Figure 1). The most pronounced decrease in odds of LOC started after age 50-59 yrs. (Figure 1). There was no significant difference in the odds of LOC between patients

aged 18-29 vs. 30-39 yrs. Patients aged ≥ 80 yrs. had a 76% decrease in the odds of having a LOC, compared to patients aged 18-29 (OR=0.24, 95%CI [0.21-0.26]). When age was analyzed as a continuous predictor, each 10-year increase in age was associated with a 23% reduction in the odds of suffering a LOC (OR=0.77, 95%CI [0.76-0.78]).

Conclusion: These nationwide data suggest a strong inverse association between age and odds of LOC, in a select population with concussion and mTBI. Furthermore, our data are in agreement with multiple quantitative CT studies suggesting that age-related cerebral atrophy begins to accelerate at age 50-55. It is possible that increased CSF volume mitigates sheer-related diffuse axonal injury and the likelihood of LOC. It is also possible that increased CSF volume helps to dissipate rotational and acceleration forces on the brainstem, reducing their effects on the reticular activating system and thus reducing the likelihood of LOC. These notable results offer a opportunity to generate important hypotheses to examine in smaller clinical studies.

AN ANALYSIS OF OUTCOMES AFTER ADMINISTRATION OF KCENTRA FOR URGENT REVERSAL OF ANTICOAGULATION IN PATIENTS WITH INTRACRANIAL HEMORRHAGE

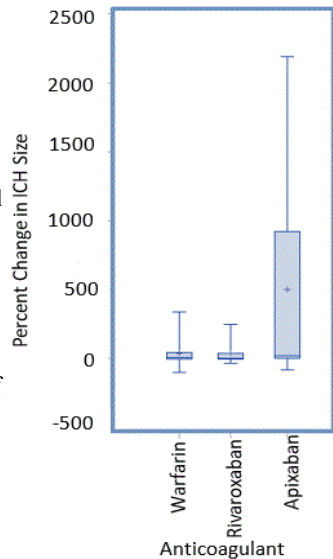
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Introduction: Intracranial hemorrhage (ICH) is presenting with increasing incidence in anticoagulated patients. Kcentra is currently recommended for urgent reversal of vitamin K antagonist (VKA) anticoagulation. While Kcentra is being used for urgent reversal of Xa inhibitor (XaI) mediated anticoagulation, the data to support this is limited and focused on relatively healthy patients with small ICHs. These studies do recognize an accepted 30 day mortality risk of approximately 6% and an associated thromboembolic event rate of approximately 4%. We evaluated the effectiveness and outcomes of utilizing Kcentra to urgently reverse anticoagulation in patients with ICH.

Methods: A retrospective observation study of anticoagulated patients at a single institution who received Kcentra between September 2013 and December 2016 for ICH was completed. The primary endpoint was change in ICH size between initial and repeat head CT in patients who did not have an intervening cranial procedure. Secondary endpoints included: mortality, discharge disposition, and thromboembolism development.

Results: 110 ICH patients received Kcentra (31.8% traumatic). Three anticoagulation groups were analyzed: warfarin (n=75), rivaroxaban (n=21), and apixaban (n=14). No significant differences were noted with respect to median ICH size at initial (p=0.88) or repeat (p=0.48) head CT or in median percent change (p=0.71) (Figure 1). There was no difference among groups in the number of patients in which ICH volume either increased or decreased by 20% (p=0.75). Approximately half of all patients died during their hospital course with a median life expectancy of 3 days. Of those who survived there was no difference in discharge disposition between groups with 60-80% of those who survived requiring further nursing care (p=0.99). Overall, requiring a drainage procedure was not associated with increased mortality (p=0.55). Rates of thromboembolic complications, resulting in 2 deaths, were noted in 13.3% of VKA patients, but 0% of XaI patients.

Conclusion: In patients given Kcentra for warfarin and rivaroxaban, ICH size does not change significantly. The median ICH size increased in apixaban but this was not significantly different due to wide variability and limited sample size. Mortality rates were higher in all groups than previously reported though not higher for any specific anticoagulant or in patients requiring a drainage procedure. Thromboembolic complications were seen in the warfarin group and were directly related to Kcentra administration.



ANTIBIOTICS FOR DRAINS AFTER TRAUMATIC SPINE INSTRUMENTATION ARE NOT PROPHYLACTIC OR THERAPEUTIC

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Introduction: Antibiotics after spine instrumentation are often extended while the surgical drain is in place without strong evidence. Patients with traumatic spine injuries are considered a higher risk population. The recommendations to continue antibiotics after instrumentation in this group of patients is undefined. Judicious use of antibiotics is important for a myriad of reasons and is under investigation. Some current studies in elective spine surgery patients have shown no benefit to continuing antibiotics beyond 24 hours even if a surgical drain is in place. We sought to study if continuing antibiotics past 24 hours after traumatic spine instrumentation when a surgical drain is placed in a county safety net hospital impacted outcomes.

Methods: We performed a retrospective observational study of all patients who underwent spine fixation with hardware and surgical drains for traumatic injury at our Level I Trauma Center between 1/1/14 and 12/31/17. Routine demographic and injury variables were obtained to determine the effect of perioperative (≤ 24 hours of antibiotics) versus prolonged (>24 hours) antibiotics on surgical site infections (SSI), mortality, hospital length of stay (HLOS), and intensive care unit length of stay (ICU LOS). Bivariate and multivariable logistic and linear regression statistics were performed.

Results: Three hundred forty-six patients were included in the analysis. On multivariate analysis, antibiotic duration longer than 24 hours did NOT predict surgical site infection (SSI) (OR 2.68, 95% CI 0.88-8.10, $p=0.08$), death (OR 0.59, 95% CI 0.10-3.44, $p=0.56$), HLOS ($p=0.13$), or ICU LOS ($p=0.37$), when controlling for age, gender, mechanism of injury, spinal cord injury, and insurance status.

Conclusion: Continuing antibiotics past 24 hours, even if a surgical drain is left in place, after traumatic spine instrumentation is not necessary. Prolonged antibiotics are not inferior to standard perioperative antibiotics. A prospective study that could control for potential confounders such as race and comorbidities may be warranted.

Table 1. Bivariate Statistics

| | Perioperative Antibiotics (≤ 24 hours) (n=194) | Prolonged Antibiotics (>24 hours) (n=152) | p-value |
|-----------------------|--|--|---------|
| Age | 45.6 \pm 17.3 | 49.5 \pm 16.4 | 0.98 |
| Sex | | | |
| Male | 151 | 109 | 0.15 |
| Female | 43 | 43 | |
| Insurance | | | |
| Commercial & Medicare | 148 | 122 | 0.42 |
| Medicaid & self-pay | 45 | 30 | |
| ISS | 20.5 \pm 15.3 | 22.5 \pm 15.5 | 0.88 |
| Shock Index | 1.5 \pm 0.5 | 1.5 \pm 0.5 | 0.5 |
| GCS | 13.8 \pm 3 | 14 \pm 2.6 | 0.74 |
| Mechanism | | | |
| Blunt | 192 | 150 | 0.81 |
| Penetrating | 2 | 2 | |
| Spinal cord injury | | | |
| Yes | 124 | 93 | 0.66 |
| No | 70 | 58 | |
| SSI | | | |
| No | 186 | 141 | 0.07 |
| Yes | 5 | 10 | |
| Hospital LOS | 16.1 \pm 15.9 | 19.4 \pm 16.9 | 0.9 |
| ICU LOS | 11.8 \pm 12 | 13.7 \pm 14.4 | 0.9 |
| Death | | | |
| Lived | 189 | 150 | 0.59 |
| Died | 4 | 2 | |

PROLONGED PARTIAL RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA (pREBOA) IS SAFE IN A SEVERE HEMORRHAGIC SHOCK MODEL, IN THE ABSENCE OF TRAUMATIC BRAIN INJURY

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Introduction: The use of partial REBOA (pREBOA) in combined hemorrhagic shock (HS) and traumatic brain injury (TBI) has not been well studied. We hypothesized that prolonged pREBOA deployment in the setting of concurrent TBI + HS would worsen the clinical outcomes.

Methods: Fifteen female Yorkshire swine were subjected to a combination of 40% total blood volume hemorrhage, computer-controlled cortical TBI, and pREBOA treatment (1 hr). Three groups were studied: HS + TBI (Group 1), HS + TBI + pREBOA (Group 2), and HS + pREBOA (Group 3) (n=5/cohort). After 60 minutes of shock with a mean arterial pressure (MAP) of 30-35 mmHg, Group 1 was left in shock for an additional 60 minutes, whereas Groups 2 and 3 were treated with Zone 1 pREBOA inflation (60 minutes). All animals were then resuscitated with normal saline (NS; 3 x volume of shed blood). Physiologic parameters were monitored for six hours, during which further resuscitation (CVP goal of 6) and vasopressor therapy (MAP goal of 55-60 mmHg) were administered as needed. Brain edema (% increase compared to the uninjured side) and lesion size (mm³) were quantified at the end of the observation period.

Results: pREBOA deployment resulted in a higher maximal proximal MAP (Group 2, 64.4 ± 11.1 mmHg; Group 3, 66.6 ± 14.7 mmHg; Group 1, 33.4 ± 2.7 mmHg; p < 0.05), while maintaining a distal MAP goal of 20-25 mmHg. Mortality was highest in Group 2 (40% vs 0% in the other groups, p = 0.1), but no significant differences were noted in the brain edema and lesion size (Group 2, 32.5 ± 6.6%, 3084 ± 619 mm³; Group 1, 26.5 ± 8.6%, 3107 ± 999 mm³; p > 0.05). Severity of shock was greatest in Group 2 (**Figure 1**). Lactate level at the end of experiment was significantly higher in Group 2 (Group 2, 15 ± 2 mmol/L; Group 3, 2 ± 1 mmol/L; Group 1, 3 ± 2 mmol/L; p < 0.01), while pH nadir was significantly lower for Group 2 (Group 2, 7.16 ± 0.04; Group 1, 7.26 ± 0.04; Group 3, 7.31 ± 0.03; p < 0.01). In addition, fluid and norepinephrine requirements were significantly higher in Group 2 (Group 2, 3360 ± 706 mL, 0.14 ± 0.02 µg/kg/hr; Group 3, 660 ± 371 mL, 0.014 ± 0.001 µg/kg/hr; Group 1, 300 ± 0 mL, 0 ± 0 µg/kg/hr; p < 0.01).

Conclusion: Prolonged application of pREBOA for up to an hour is safe in severe HS and does not worsen the extent of TBI. However, the addition of TBI to HS significantly exacerbates the degree of circulatory shock when pREBOA is deployed. Aortic occlusion should be undertaken with extreme caution in the setting of TBI.

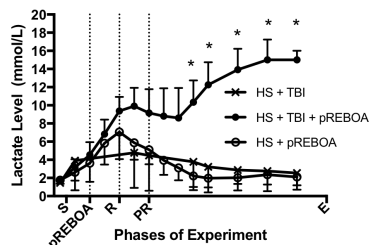


Fig 1. Lactate level over phases of experiment. Data presented as mean ± standard deviation. * designates p < 0.05.

IS INTRA-OPERATIVE REBOA DELAYED REBOA? AN ANALYSIS OF THE AMERICAN ASSOCIATION FOR THE SURGERY OF TRAUMA AORTA REGISTRY

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Introduction: Resuscitative endovascular balloon occlusion of the aorta (REBOA) has emerged as a less invasive alternative to open aortic occlusion (AO) in trauma. REBOA is commonly performed in the emergency department (ED), while the role of intra-operative REBOA is less well defined. We hypothesized that delayed insertion until arrival in the operating room (OR) is associated with increased mortality.

Methods: The American Association for the Surgery of Trauma (AAST) AORTA registry prospectively enrolls trauma patients undergoing open and endovascular AO from 29 centers. Patient demographics, admission physiologic variables, and outcome data from this registry were compared between OR and ED REBOA placement. Mann-Whitney U and chi-square analyses were performed where appropriate. Multivariable logistic regression was performed on the outcome of mortality.

Results: Of 321 patients who underwent REBOA, location and timing of insertion were available for 305 (95%). 58 patients underwent OR REBOA (19%) vs. 247 in the ED (81%). There were no differences between populations with respect to sex, lactate, and injury severity score (ISS). Patients who underwent OR REBOA were younger (33 years vs 41 years, $p=0.01$) and more likely to have a penetrating mechanism (36% vs 15%, $p<0.001$). There were significant differences with respect to admission physiology (**Table 1**). Unadjusted mortality was lower in the OR group (36.2% vs 68.8%, $p<0.001$), but there were no differences in transfusion requirements or acute kidney injury. Time from admission to AO was longer in the OR group (75 minutes vs 23 minutes, $p<0.001$). After controlling for age, admission CPR, systolic blood pressure, heart rate, lactate, ISS, and GCS, there was no association between REBOA insertion location or time to successful AO and mortality.

Conclusions: Nearly one in five REBOAs is placed in the OR, generally in patients who present with more stable initial physiology. In our analysis, delaying REBOA insertion in the appropriate patient until OR arrival was not associated with adverse outcomes.

| TABLE 1 | Operating Room | Emergency | p-value |
|---------------------------------|-----------------------|-------------------------------------|------------------|
| | (OR) REBOA (n= 58) | Department (ED) REBOA (n=247) | |
| Age | 32.5[22-51] | 40.5[27-58] | 0.01 |
| Sex | | | 0.92 |
| M | 44 (75.8%) | 189 (76.5%) | |
| F | 14 (24.2%) | 58 (23.5%) | |
| Mechanism | | | <0.001 |
| Penetrating | 21 (36.3%) | 38 (15.4%) | |
| Blunt | 37 (63.7%) | 206 (83.4%) | |
| ISS | 34[25-42] | 34[25-45] | 0.38 |
| SBP | 110[80-130] | 80[0-111] | <0.001 |
| HR | 114[92-132] | 101[52-129] | 0.04 |
| GCS | 7[3-15] | 3[3-9] | <0.001 |
| Lactate | 6.45[3.9-10.8] | 8.2[5.2-12.1] | 0.05 |
| Prehospital CPR | 2 (3.4%) | 87 (35.2%) | <0.001 |
| Time of occlusion (min) | 33[11-67] | 30[15-63] | 0.61 |
| Time from Admission to AO (min) | 75[36-110] | 23[14-27] | <0.001 |
| pRBC (# units) | 16[8-28] | 12[5-22] | 0.06 |
| Acute Kidney Injury | 10(21%) | 47(19%) | 0.75 |
| Mortality | 21 (36.2%) | 170 (68.8%) | <0.001 |

Resuscitative endovascular balloon occlusion of the aorta (REBOA) for severe torso trauma in Japan: A descriptive study

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Introduction: Resuscitative endovascular balloon occlusion of the aorta (REBOA) spread early in clinical settings in Japan. REBOA has the potential to be applied as an alternative to the aortic cross-clamp procedure (ACC). The practical indication, usage conditions, and efficacy remain unknown, however. We examined the usage trend of procedures related to aortic occlusion for resuscitation (REBOA and ACC) in Japan for severe torso trauma, and investigated if these procedures were associated with time of death distribution based on a large database from the Japan Trauma Data Bank (JTDB).

Method: The JTDB for 2004 to 2014 was reviewed. Eligible patients were restricted to those with severe torso trauma, which was defined as an Abbreviated Injury Scale (AIS) score of 4 or more for chest, abdomen, or pelvic fracture. Patients were classified into groups according to aortic occlusion procedure: non-procedures, REBOA, and ACC. We classified the clinical situation according to patient blood pressure and primary source of hemorrhage (Figure 1). The primary outcomes were the rates of REBOA and ACC used according to the clinical situation. We also evaluated whether the time of death distributions for the first 8 h differed on the basis of aortic occlusion procedure.

Results: During the study period, a total of 21,533 patients met all of our inclusion criteria. Of those, 611 patients (2.8%) underwent REBOA, and 322 patients (1.5%) underwent ACC. ACC was more frequently used in cases of thoracic injury. Patients with severe hypotension (1-59 mmHg) were more likely to receive REBOA. In contrast, patients with cardiac arrest were more likely to receive ACC (Figure 1). Multiple regression analysis revealed that REBOA (odds ratio [OR]: 5.07, 95% confidence interval [CI]: 4.04-6.36) and ACC (OR: 21.4, 95%CI: 12.8-35.8) were greatly associated with worse outcomes. With respect to the time of death distribution in the first 8 h, the cumulative curve for death in REBOA cases was much more slowly elevated and overtook those of non-aortic procedures around 4 h. It is of note that the cumulative curve for death in REBOA cases was mostly flat for the first 100 min (Figure 2).

Conclusion: The intended purpose of REBOA in Japan is very similar to the current proposed strategy. In addition, it appears that REBOA influences the time of death distribution in the hyper-acute phase, and allows rapid death to be avoided for the first 100 min. Future research on REBOA is needed to investigate its indications and proper use.

Fig. 1 The usage rate of REBOA and ACC

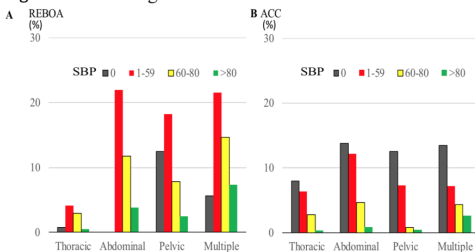
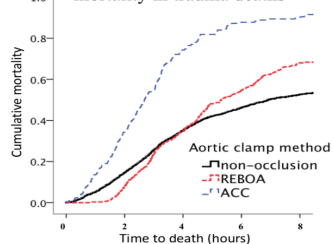


Fig. 2 Time distribution of cumulative mortality in trauma deaths



AORTIC ZONE 1 REBOA APPLICATION AS AN ADJUNCT TO STANDARD HEMOSTATIC TREATMENT OF LIVER INJURY/HEMORRHAGE IN SWINE

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Introduction: REBOA is recognized as adjunctive therapy for the temporary control of bleeding from non-compressible torso wounds. For the military it has sparked interest in endovascular approaches to hemorrhage control. The present study evaluated whether REBOA placement in aortic zone I improves standard treatment (packing) of liver hemorrhage in a swine model.

Methods: Anesthetized female swine (50.5 kg) were subjected to a controlled hemorrhage (20 ml/kg), a femur fracture and then to a grade IV/V liver laceration injury (uncontrolled hemorrhage). After a total of 40% blood loss, bleeding was controlled by standard gauze packing of the liver alone (P) or by packing but after placing REBOA in aortic zone I (P+R), n=10/gp. Aortic flow was occluded for 60 min. Five min before release of the balloon, animals in both groups were resuscitated with autologous blood (WB) at 15 ml/kg. A femur fracture only group (n=5) was included as a control. All animals were monitored for 6 hr after liver injury or until death.

Results: Hemorrhage and liver injury reduced MAP ~ 38% in both groups. As expected, REBOA placement raised MAP above baselines, while MAP continued to fall slowly in the P group. Limited resuscitation with WB raised MAP transiently, but it continued to fall toward post-hemorrhage levels during the remainder of the experiment in both groups. Heart rate rose nearly 2-fold in both groups after hemorrhage and remained elevated throughout the experiment. Cardiac output fell about 50% after hemorrhage and tended to be higher in P than P+R after WB resuscitation. Lactate concentration rose nearly 6-fold after hemorrhage and continued to rise in P+R where by the end of the experiment it was over 2-fold higher than in the P group. A similar response was observed for base deficit. Post-treatment blood loss was not different between the two groups. Overall survival was 7/10 in P and 4/10 in P+R with all deaths in P+R occurring after balloon deflation, whereas deaths in the P group occurred within the first hr after injury due to exsanguination. As a result, survival times did not differ significantly between groups. None of these variables changes over time and there were no deaths in the femur fracture only group.

Conclusion: These results suggest that in this model of predominately venous bleeding, full occlusion of the aorta in zone I for 60 min did not improve standard hemostatic treatment of liver injury. Although REBOA appears to delay death due to exsanguination, the ischemia reperfusion injuries associated with its release caused significant hemodynamic and metabolic derangement that were not reversed with limited WB resuscitation in this model. Taken together these data suggest that additional research to modulate the physiologic derangements observed after balloon deflation is warranted as efforts continue to improve the safety of REBOA application, particularly in prolonged care situations.

AORTIC OCCULSION TIME IS NOT ASSOCIATED WITH INCREASED MORBIDITY OR MORTALITY IN REBOA OR RESUSCITATIVE THORACOTOMY: AN ANALYSIS OF THE AAST AORTA MULTICENTER PROSPECTIVE REGISTRY

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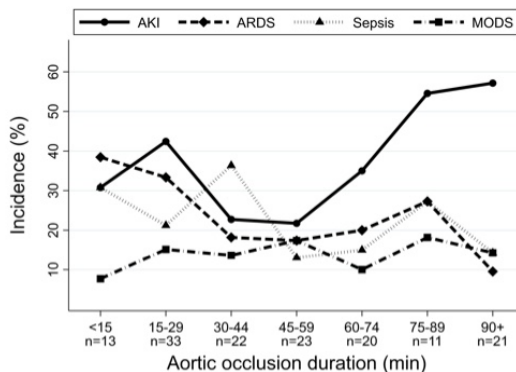
Introduction: Non-compressible torso hemorrhage is the most common cause of potentially preventable death in trauma patients. Resuscitative thoracotomy (RT) has been employed for the past half century as a method to obtain aortic occlusion (AO) in trauma patients and Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) use has become an increasing common method of AO. We hypothesized that increasing AO time (by any method) would be associated with increased ischemia reperfusion related complications and death.

Methods: The prospective multicenter AAST AORTA registry was utilized to identify patients undergoing AO from Nov 2013 until Feb 2018. To evaluate late complications of AO, patients receiving CPR during aortic occlusion or those who exsanguinated prior to 6 hours were excluded from analysis. Chi-squared test was performed to compare incidence of inflammatory complications in patients receiving RT or REBOA in Zone 1 (above celiac axis) or Zone 3 (below renal arteries). To examine time-associated morbidity, incidence of complications and mortality were analyzed by 15-minute intervals of AO (0 to >90 min) using Chi-squared test and multivariable Poisson regression.

Results: 992 patients from 18 AORTA centers were reviewed. 807 patients were excluded because they received CPR during AO (621) or exsanguinated within 6 hours of admission (186). The remaining 185 patients lived long enough to potentially develop ischemia reperfusion related complications. Univariate analysis demonstrated there were no significant differences in the rates of complications, (Table). 143 patients (77%) had duration of AO data available for analysis (0 to >90 minutes). When inflammatory complications were examined based on duration of AO, no association was observed based on univariate or multivariable analyses (FIGURE).

Conclusion: RT and REBOA are techniques to rapidly obtain temporary hemorrhage control for massive bleeding. After eliminating patients who received CPR or who died rapidly from exsanguination, there were no differences in mortality or complications based on technique, location, or duration of AO, suggesting that the initial physiological insult, and not duration of AO, is the predominate cause of inflammatory mediated morbidity and mortality.

| No CPR or exsanguination | RT | Zone 1 | Zone 3 | N=185 | p-value |
|--------------------------|-----|--------|--------|-------|---------|
| AKI | 33% | 35% | 33% | 0.963 | |
| ALI/ARDS | 22% | 16% | 21% | 0.611 | |
| Sepsis | 25% | 24% | 10% | 0.068 | |
| MODS | 14% | 12% | 12% | 0.921 | |
| Mortality | 33% | 38% | 22% | 0.154 | |



EFFECTS OF DIASTOLIC BLOOD PRESSURE ON MORBIDITY AND MORTALITY IN BLUNT TRAUMA PATIENTS

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Introduction: Trauma resuscitation protocols focus on maintaining systolic blood pressure (SBP) to promote end-organ perfusion. However, whether a low diastolic blood pressure (DBP) affects outcome or simply reflects progression of physiologic changes from injury remains unclear. We hypothesize that diastolic blood pressure affects morbidity and mortality in blunt trauma patients irrespective of systolic blood pressure.

Methods: We reviewed the trauma registry at our Level 1 trauma center for all adult blunt trauma admissions to surgical critical care units between August 2015 to August 2016. Those with previously documented vascular disease and those who died within 24 hours were excluded from our sample. Hourly vital signs and lab values were extracted for seven days after presentation. The primary outcome was mortality, and secondary outcomes included rates of non-ST elevation myocardial infarction (NSTEMI) and acute kidney injury (AKI). We used the collected data points to construct a model describing the relationship among SBP, DBP, and outcomes based on Cox proportional hazard regression with time varying covariates.

Results: Our sample population consisted of 458 patients with 52802 data points. The median age was 63, 60% were male, and median ISS score was 14. Seven-day mortality was 21 (4.6%). Rates of AKI and NSTEMI were 13.8% and 4.6%, respectively. We identified no significant relationship between DBP and mortality. At 48 hours after presentation, among those with a systolic pressure 80 mmHg the hazard ratios for AKI and NSTEMI were 0.748 (95% CI: 0.661-0.846) and 0.888 (95% CI: 0.761-1.037), reflecting the decreasing risk of these two events per every mmHg increase of diastolic pressure. Among those with a systolic pressure of 100 mmHg, the hazard ratios for AKI and NSTEMI were 0.879 (95% CI: 0.805-0.959) and 0.908 (95% CI: 0.833-0.989) for those with higher compared to lower diastolic blood pressures. From 72 to 168 hours after admission we observed significant associations between DBP and both AKI and NSTEMI regardless of SBP.

Conclusion: Higher DBP, even within normal SBP ranges, confers a decreased risk of AKI & NSTEMI in blunt trauma patients. Diastolic hypotension may play a larger role in the pathophysiology of end-organ injury than previously described. Treatment algorithms that target patients with low DBP may decrease complications in blunt trauma patients.

HYBRID TRIAGE: PREDICTORS OF NEED FOR SIMULTANEOUS OPERATIVE AND ANGIOGRAPHIC INTERVENTION

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Introduction: A subset of trauma patients requires both operative and angiographic intervention for hemorrhage control. Conventionally, the surgeon must prioritize between these treatments, but use of the hybrid operative suite – with both catheter-based and open surgical capacities – can attenuate workflow logistics. However, most trauma patients do not need angiography, and inappropriate patient selection may increase resource strain or exclude appropriate patients from care. We hypothesize that there is a subset of trauma patients whose initial presentations are predictive of need for both operative and angiographic hemorrhage control, and that identifying these factors can inform the decision to use the hybrid OR.

Methods: All trauma patients from 2013-2016 in the Trauma Quality Improvement Program (TQIP) database who underwent operation for hemorrhage control with or without angiography were evaluated. Injury patterns and presentations were compared between those who underwent operative intervention alone, and those also requiring angiography.

Results: Of the 28,908 patients who underwent hemorrhage control surgery, 4,277 (14.7%) also required angiography. While these cohorts presented with varying degrees of hemorrhagic shock, vital signs were not predictive. Mechanisms associated with need for angiography included blunt injury (OR 1.32), especially involving motor vehicles (OR 1.63); injury patterns included pelvic injuries (OR 2.24), especially unstable pelvic ring fractures (OR 4.00) or those with concomitant external genitourinary or perineal injuries (OR 2.48), extremity vascular injuries (OR 2.62) and injuries in multiple compartments (OR 3.24). Negative predictors include gunshot wounds (OR 0.63), and isolated injuries to the thorax (OR = 0.41) Interventions were implemented in a mean of 1.89 hours for the operative group, but 5.65 hours in the angiography group, and need for angiography was associated with transfusion of 1.5 to 2 times more blood products in 24 hours. (All p-values significant to $p < 0.0001$).

Conclusion: Injury patterns can be identified in the trauma bay that correlate with a heightened need for angiography in addition to operative control of hemorrhage. This will allow the trauma surgeon to more accurately select patients who might benefit from hybrid room use, potentially decreasing time to hemostasis. This information will allow for optimal triage of the hybrid OR suite support while not overburdening a shared, multidisciplinary resource.

CLINICAL IMPACT AND RESOURCE UTILIZATION OF A HYBRID OPERATING ENVIRONMENT AMONG SEVERELY INJURED PATIENTS: OVERSTATED OR UNDERUTILIZED?

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Introduction: The potential utility and clinical benefit of hybrid operating theaters are increasingly postulated. Unfortunately, the economic cost and real-world efficiencies of these environments remain unclear. The primary aim of this study was to evaluate the utility, clinical impact and work flow of a new trauma hybrid operating theater.

Methods: All severely injured patients who were transferred to the hybrid suite for emergent care between April 4, 2013 and April 4, 2017 were compared to matched pre-hybrid patients from the 4 preceding years. Standard statistical methodology was employed ($p < 0.05$ = significant).

Results: 170 patients with severe injuries (mean ISS=23; hemodynamic instability=69%; hospital/ICU stay=21/10 days; mortality=14%) were transferred urgently (0-2hrs) to the hybrid suite. Most were young (38 years) males (84%) with blunt injuries (51%). Combined/hybrid trauma procedures occurred in 18% of cases (surgery (82%) and angiography (7%) alone). Procedures within the hybrid suite included: laparotomy (57%), thoracotomy/sternotomy (12%), extremity (14%), angioembolization of the spleen/pelvis/liver/other (9%), neck (9%), craniotomy (4%) and aortic endostenting (6%). The mean theater and procedure times were 178 and 124 minutes respectively. Compared to historical matched controls, the hybrid suite resulted in shorter door to intervention and total procedure times, and faster hemorrhage control in select patients ($p < 0.05$). A clear benefit for survival was evident in specific cohorts.

Conclusion: Availability of a hybrid environment for severely injured patients reduces time to intervention, total procedural duration and salvages a select subset of patients who would not otherwise survive. The cost associated with a hybrid suite remains prohibitive for many centers.

ANALYSIS OF OUTCOMES POST OPERATIVE MANAGEMENT OF TRUNCAL GSW AT LEVEL I VERSUS LEVEL II TRAUMA CENTERS

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Introduction: While both Level I and II trauma centers have the resources necessary to manage gunshot wounds (GSW), limited research exists comparing outcomes for this injury mechanism between designations. We hypothesized that there would be no differences in mortality or complications following surgical intervention for truncal GSW victims between Level I vs. II center types.

Methods: All adult (aged >18) firearm-related admissions to the Pennsylvania Trauma Outcome Study database from 2003-2015 were queried. Dead on arrival, transfer, and cases with a head Abbreviated Injury Scale (AIS) score ≥ 3 were excluded. The specific population of interest included all patients with truncal injuries (thorax AIS and/or abdomen AIS ≥ 3). Multilevel mixed-effects logistic regression models assessed the adjusted impact of trauma center level (Level I) on overall mortality and complications.

Results: Of the 385,689 adult patients presenting to Pennsylvania Level I-II trauma centers from 2003-2015, 17,465 GSWs were identified, of which 4,761 met inclusion criteria (Level I: 3,949; Level II: 812). Overall unadjusted mortality rate (Level I: 16.8%; Level II: 14.2%; $p=0.063$) was not different between center types. Unadjusted complication rate was significantly higher at Level I centers (Level I: 35.6%; Level II: 29.4%; $p=0.001$). Adjusted analysis did not reveal any significant differences between center types in mortality (AOR 0.978, $p=0.918$) and complication (AOR 1.305, $p=0.112$) rates post-surgical intervention (Table 1). Within each institution, there was a difference in incidence of complications if surgical intervention was mandated, with Level I centers associated with a 2.9 increased odds of complications compared to 4.1 increased odds of complication at Level II centers.

Conclusion: Despite higher unadjusted complications at Level I centers, firearm-injured patients may experience better outcomes when managed at Level I rather than Level II trauma centers. Within center type, Level II institutions are associated with higher odds of complications in the event of operative management for truncal GSW, which may be attributed to low volume experience in treatment of these injuries.

Table 1. Adjusted odds ratios (AOR) for GSW outcomes post-operative management.

| Variable | Mortality | | Complications | |
|---------------------|---------------------|--------|---------------------|--------|
| | AOR (95% CI) | p | AOR (95% CI) | p |
| Level I | 0.978 [0.635-1.504] | 0.918 | 1.305 [0.940-1.814] | 0.112 |
| Age | 1.025 [1.016-1.034] | <0.001 | 1.019 [1.012-1.026] | <0.001 |
| ISS | 1.058 [1.049-1.067] | <0.001 | 1.021 [1.014-1.028] | <0.001 |
| AUROC: 0.778 | | | AUROC: 0.633 | |

*Adjusted for male sex, shock index and injury year

DO HOSPITAL CHARACTERISTICS INFLUENCE COMPLIANCE WITH 1:1:1 MASSIVE TRANSFUSION PROTOCOL?

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Introduction: Studies suggest that the ratio of red blood cells to plasma to platelets during massive transfusion impacts outcomes in trauma patients, though debate remains which ratio is superior (6:6:1 or 6:3:1). It is unknown if current national practice reflects these recommended standards. This study assesses overall compliance and the hospital characteristics associated with nonadherence to the recommended massive transfusion ratios.

Methods: The Trauma Quality Improvement Program database from 2013-2016 was queried for patients undergoing massive transfusion (defined as 50% of blood volume transfused within 4 hours of arrival or greater than 10 total units transfused within 24 hours of admission). Compliance was defined by transfusion ratios: 5.5-6.5:5.5-6.5:0.5-1.5 (blood:plasma:platelet packs) for 6:6:1 and 5.5-6.5:2.5-3.5:0.5-1.5 for 6:3:1. Univariate analysis was performed on patient and hospital characteristics and multivariable logistic regression was performed to identify characteristics associated with noncompliance in the use of the massive transfusion protocol (MTP). The role of thromboelastography in resuscitation could not be assessed as these data are not captured.

Results: There were 29,323 patients who underwent a massive transfusion protocol. Overall, 1,205 (4.1%) patients received the recommended transfusion ratio and 28,118 patients (95.9%) did not in the 6:6:1 group compared to 1098 (3.7%) receiving the recommended ratio and 28,225 (96.3%) receiving the non-recommended ratio in the 6:3:1 group. In the 6:6:1 group, transfusion volume >10 units (AOR 2.77, $p < 0.001$), hospital transfer (AOR 1.25, $p = 0.018$), ED disposition to the ICU (AOR 1.18, $p = 0.044$), West region (AOR 1.30, $p = 0.04$), and hospitals with >15 ICU beds (16-25 beds AOR 1.41, $p = 0.004$, 26-35 beds AOR 1.44, $p = 0.004$, >35 beds AOR 1.19, $p = 0.13$) were associated with increased odds of adhering to the recommended MTP ratio. Interventions other than laparotomy (reference group, AOR 1.00), university teaching status (OR 0.76, $p = 0.003$), and hospital bedsize >200 (201-400 bed OR 0.50, $p < 0.001$, 401-600 beds OR 0.79, $p = 0.39$, >600 beds OR 0.67, $p = 0.18$) were associated with decreased odds of standard 6:6:1 MTP administration. In the 6:3:1 group, increasing transfusion volume >10 units (AOR 3.40, $p < 0.001$), West region (AOR 1.30, $p = 0.03$), and increasing time in the ED (40-100 minutes AOR 1.24, $p = 0.007$, >100 minutes AOR 1.26, $p = 0.008$) were associated with increased odds of standard MTP. Interventions other than laparotomy (reference group, OR 1.00), length of stay >24 hours (AOR 0.52, $p < 0.001$), South region (AOR 0.69, $p < 0.001$), and >6 trauma surgeons at treatment hospital (AOR 0.84, $p = 0.02$) were significantly associated with decreased odds of standard MTP.

Conclusions: Few massively hemorrhaging trauma patients receive recommended ratios of transfusion products suggesting poor overall compliance. Notably, university teaching status and smaller numbers of ICU beds (markers of hospital resources) are associated with noncompliance with recommended transfusion ratios, although it is possible that thromboelastography may have been used and resulted in lower ratios but equivalent outcomes. Further studies are needed to improve compliance and evaluate mortality of those receiving compliant versus noncompliant transfusion protocols.

ASSOCIATION BETWEEN CONTRAST EXTRAVASATION ON CT SCAN AND PSEUDOANEURYSM IN PEDIATRIC BLUNT SPLENIC AND HEPATIC INJURY: A MULTI-INSTITUTIONAL OBSERVATIONAL STUDY

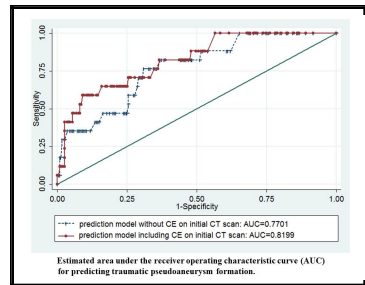
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Introduction: Considerable practice variation remains in the management of pediatric patients with solid organ injury, and only limited data regarding traumatic pseudoaneurysm formation exist. The purpose of this study was to describe natural history and practice pattern for blunt splenic or/and hepatic injury in pediatric patients and to examine the association between an active contrast extravasation (CE) on initial computed tomography (CT) scan and the incidence of pseudoaneurysm.

Methods: We conducted a multi-institutional observational study using retrospectively enrolled children aged 16 years and under with blunt splenic or/and hepatic injury. Patients who showed CE on initial CT scan were compared with those that did not. A multivariate analysis using a logistic regression model was performed to determine the association between CE on initial CT scan and subsequent pseudoaneurysm formation. We generated the area under the receiver operating characteristic curve (AUC) to assess predictive performance of CE for pseudoaneurysm formation.

Results: A total of 236 patients (150 liver injury and 90 spleen injury) were enrolled from 10 institutions. Follow up CT scan were performed in 188 patients (80%). Pseudoaneurysm formations were observed in 17 patients (7.2%), and 4 patients (2%) were diagnosis by the delayed rupture of pseudoaneurysm. Abdominal angiography with/without embolization was performed in 33 patients (14%). The incidence of pseudoaneurysm was 29% in patients with CE and 5% in those without CE. A multivariate analysis showed that CE on initial CT was significantly associated with the higher incidence of traumatic pseudoaneurysm formation (Odds Ratio, 5.55; 95% Confidence Interval (CI), 1.54-20.1) after adjusting for AAST grade of injury, ISS and hemoperitoneum volume. AUC of the model including CE was 0.82 (95% CI, 0.72-0.92) and AUC of the model without CE was 0.77 (95% CI, 0.66-0.88).

Conclusion: In this study, follow up CT scans were frequently performed and angiographic intervention was considered the treatment modality of choice in a high proportion of cases in Japan. These findings suggested that the aggressive screening and treatment for pseudoaneurysm was carried out. Our results revealed that the sign of an active CE on initial CT scan was an independent predictor for traumatic pseudoaneurysm formation.



THE ASSOCIATION OF SIMULATION-BASED TRAINING FOR PEDIATRIC TRAUMA RESUSCITATION AND RISK-ADJUSTED MORTALITY AMONG ACS TQIP PEDIATRIC CENTERS

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Introduction: The use of simulation-based team training for pediatric trauma resuscitation has recently increased, but an impact on patient outcomes has not been demonstrated. The purpose of this study was to determine the association between simulation use and patient outcomes.

Methods: ACS TQIP-Pediatric centers were surveyed to determine frequency of simulation use in 2014-15. Center-specific clinical data for 2016-17 were abstracted from the ACS TQIP registry (N=57,916 patients) and linked to survey responses. Comparisons were made across levels of simulation use: no simulation, low-volume simulation, high-volume simulation, and survey non-responders. Multivariable hierarchical logistic regression was used to evaluate the association of simulation use with mortality.

Results: Survey response rate was 75% (94/125 centers) with 78% of the responding centers (73/94) reporting simulation use. Risk-adjusted mortality was higher in centers not using simulation compared to centers using high-volume simulation (OR 1.73, 95% CI 1.09-2.73, p=0.02). Resuscitation process times (endotracheal intubation, head CT, craniotomy, and surgery for hemorrhage control) were not different between centers of differing levels of simulation use.

Conclusion: Risk-adjusted mortality is lower in TQIP-Pediatric centers using simulation-based training, but this decreased mortality may not be mediated by a reduction in time to critical procedures. Alternative mechanisms might relate to improved communication and teamwork, which together may improve resuscitation quality or decrease errors and lower the risk of adverse outcomes.

ADULT TRAUMA CENTERS CARE FOR MORE PEDIATRIC PATIENTS THAN PEDIATRIC TRAUMA CENTERS: IS THERE A DIFFERENCE IN OUTCOMES?

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Introduction: Trauma-centers (TC) designation requires substantial financial and human resources. The aim of our study was to analyze the association of TC designation and mortality in pediatric patients.

Methods: We performed 6-years (2005-2012) analysis of all pediatric (age1-16) trauma patients in the NTDB. All severely injured (ISS>15) trauma patients were included. TC designation [Adult (A): A-I, A-II, A-III, A-IV & pediatric (P): P-I, P-II] was recorded. Our Outcome measure was mortality. We performed regression analysis to control for demographics, injury and vital parameters, and operative intervention.

Results: We included 47,279 patients from 400 trauma centers. Mean age was 9±5y. Median ISS was 17 [16-25]. Overall 45% were managed at pediatric-TC, with a mortality rate of 5.6%. There was no difference in mortality between adult and pediatric-TC. On regression analysis, the adjusted mortality was similar in patients managed at either center (OR: 1.01 [0.93-1.12]). On Sub-analysis, patients managed at P-II were more likely to die compared to P-I (OR:1.62[1.59-1.66]). Patients managed at P-II or A-II/III/IV centers were independently associated with a higher mortality compared to P-I, while there was no difference for A-I (**Figure 1**)

Conclusion: Severely injured pediatric trauma patients managed at the ACS-Level-I pediatric center have improved survival compared to those managed at level-II pediatric, and level-II, III or IV adult centers. Appropriate triage to either pediatric level I or adult level I trauma centers can improve survival in severely injured pediatric patients.

Figure 1:

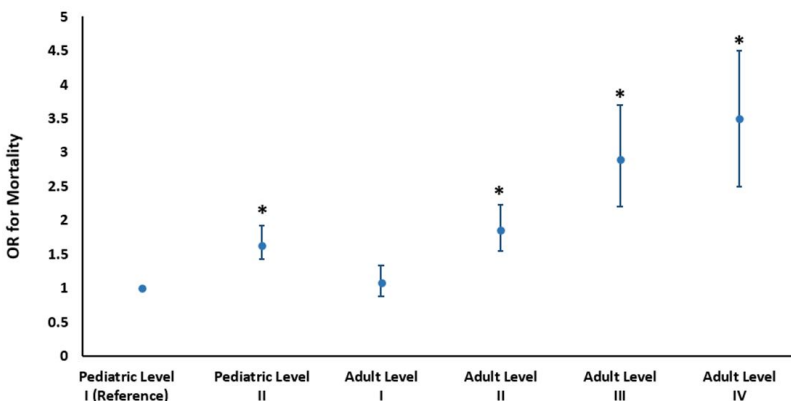


Fig. 1: All Trauma Centers

NATIONAL TRENDS OF THORACIC ENDOVASCULAR AORTIC REPAIR (TEVAR) VERSUS OPEN REPAIR IN PEDIATRIC BLUNT THORACIC AORTIC INJURY

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Introduction: Blunt thoracic aortic injury (BTAI) occurs in <1% of all trauma admissions. Thoracic endovascular repair (TEVAR) has become the preferred treatment modality in most adult patients with BTAI but its use in pediatrics is not currently supported by device manufacturers. Little is known TEVAR application in pediatric patients. Considering the increased trend of using TEVAR in adult trauma patients, we hypothesized that this also extends to pediatric patients and confers a lower risk of mortality compared to open repair.

Methods: The National Trauma Data Bank (2007-2015) was queried for patients age ≤ 16 with BTAI. The primary end-points of interest included the incidence of TEVAR and open repair, as well as mortality in pediatric patients with BTAI undergoing intervention. Covariates (injury severity score ≥ 25 and hypotension on admission) were included in a multivariable analysis to determine risk for mortality in pediatric patients with BTAI undergoing open repair versus TEVAR.

Results: We identified 428 pediatric BTAI patients with 88 (20.6%) undergoing intervention. Of these, 65 underwent TEVAR (15.2%) and 23 (5.4%) underwent open repair. The rate of TEVAR increased from 2007 to 2015 (10.9% vs. 24.1%, $p < 0.001$). Compared to open repair, TEVAR had a shorter mean length of stay (LOS) (16.2 vs. 24.0 days, $p < 0.05$) and similar rate of mortality (3.5% vs. 2.3%, $p = 0.49$). TEVAR was not associated with a lower risk for mortality compared to open repair ($p = 0.61$). This remained true in a subset analysis of patients with Glasgow Coma Scale ≥ 8 ($p = 0.96$).

Conclusion: The rate of TEVAR in pediatric BTAI more than doubled from 10.9% in 2007 to 24.1% in 2015. Compared to open repair, TEVAR was associated with a shorter mean LOS but was not associated with a lower risk for mortality. This remained true in patients without severe brain injury. Longitudinal studies to determine the long-term efficacy and complication rates, including re-intervention, development of endoleak, and/or need for further operations is needed as this technology is being rapidly adopted for pediatric trauma patients.

COMPARISON OF GROUND LEVEL AND HIGHER LEVEL FALLS ON SUBSEQUENT MIDLINE SHIFT IN PEDIATRIC TRAUMATIC BRAIN INJURY

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Introduction: The mechanism of injury in trauma triage criteria is associated with pediatric traumatic brain injury (TBI). Up to 44% of cases occur after falls, with more activations occurring after falls from an elevated height compared to ground level (62.2% vs. 37.8%). We hypothesized that a fall from height is associated with higher risk for subsequent midline shift in pediatric TBI, compared to a fall from ground level.

Methods: The pediatric Trauma Quality Improvement Program (2016) was queried for patients age ≤ 16 with TBI. Patients with known midline shift (> 5 mm) within 24 hours after time of injury were identified, as were patients that underwent imaging with no midline shift. The mechanism was identified by ICD-10 event codes. A logistic regression model was used for analysis.

Results: From 191 pediatric TBI patients with midline shift secondary to a fall, 44 (23.0%) were from ground level and 147 (77.0%) were from an elevated height. The most common mechanism in those with a fall from height was a fall from bed (24.5%). Compared to a ground level fall, patients with falls from height were younger (mean age, 3.3 vs. 5.5 years, $p < 0.05$) with no difference in the highest Glasgow Coma Score within 24 hours ($p = 0.56$). The risk of a midline shift was lower in those with a fall from a height (OR 0.64, CI 0.46-0.91, $p = 0.01$), compared to ground level. In a subgroup analysis of patients age > 4 years, there was no association between the level height of the fall and subsequent midline shift ($p = 0.62$). However, the risk for midline shift in patients age < 4 years after a fall from height was even lower (OR 0.40, CI 0.24-0.67, $p = 0.001$).

Conclusion: In infants and toddlers with TBI, trauma activations due to falls from ground level (compared to from a height) are associated with nearly a three-fold higher risk of subsequent midline shift. In children four years and older that arrive as a trauma activation, there is no association between the level height of the fall and midline shift. Between birth and four years, children undergo significant cranial changes, rapid increase in brain size and suture ossification, possibly influencing their vulnerability to injuries after a fall. Trauma activations due to a minor mechanism of injury should not be discounted in predicting the severity of injuries, particularly in infants and toddlers with TBI.

Pelvic angiography is effective for pediatric pelvic fracture; A Nation-wide propensity score matching cohort study in Japan

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Background: The guidelines of Eastern Association for the Surgery for Trauma recommended that patients of pelvic fractures with hemodynamic instability and/or evidence of arterial intravenous contrast extravasation by CT should be considered for pelvic angiography. However, there was little evidence for children with pelvic fracture. We assessed the relationship between pelvic angiography for children with pelvic fracture and the prognosis using nation-wide hospital-based trauma registry in Japan.

Methods: Using Japanese Trauma Data Bank, we included pelvic fracture patients who were under 19 years old and registered from 2004 to 2015 in this study. Multivariable logistic regression analysis and conditional logistic regression analysis were used to assess the association between pelvic angiography and the prognosis of pediatric pelvic fracture patients after one-to-one propensity score matching for pelvic angiography versus non-pelvic angiography. The primary outcome was dead at hospital discharge.

Results: Among 1351 eligible patients with pelvic fractures, 221 patients (16.4%) received pelvic angiography and 1130 patients (83.6%) did not receive pelvic angiography. In the univariate analysis, the proportion of dead at discharge was higher in the pelvic angiography group than the non-pelvic angiography group (13.6% [30/221] vs. 7.1% [80/1130]). However, in the multivariate analysis, the pelvic angiography group showed a more favorable survival outcome than the non-pelvic angiography group (adjusted OR 0.458, 95% CI: 0.251-0.836). In the propensity-matched cohort, the pelvic angiography group also showed a more favorable survival outcome than the non-pelvic angiography group (12.5% [27/216] vs. 19.9% [43/216], adjusted OR 0.469, 95% CI: 0.248-0.889, confidential OR 0.500, 95% CI: 0.274-0.911).

Conclusion: Pelvic angiography is also effective among children with pelvic fractures.

| | All patients | | | Propensity-score matched patients | | |
|------------------------------------|-----------------------------------|------------------------------------|------------------------|-----------------------------------|-----------------------------------|--------------------------|
| | Pelvic angiography (+) (N=221) | Pelvic angiography (-) (N=1130) | SMD | Pelvic angiography (+) (N=216) | Pelvic angiography (-) (N=216) | SMD |
| Time of day, n (%) | | | | | | |
| Daytime (9:00 am - 5:59 pm) | 71(32.1) | 458(40.5) | 0.180 | 82(38.0) | 71(32.9) | 0.110 |
| Nighttime (6:00pm - 8:59am) | 134(60.6) | 614(54.3) | 0.130 | 125(57.9) | 134(62.0) | 0.090 |
| Unknown | 11(5.0) | 58(5.1) | 0.010 | 9(4.2) | 11(5.1) | 0.040 |
| Weekend, n (%) | 48(21.7) | 334(29.6) | 0.180 | 48(22.2) | 48(22.2) | 0.000 |
| Age, median (IQR) | 17(15-19) | 16(13-18) | 0.300 | 17(15-18) | 17(15-18) | 0.050 |
| Male, n (%) | 124(56.1) | 684(60.5) | 0.090 | 122(56.5) | 124(57.4) | 0.040 |
| Shock on hospital arrival, n (%) | 40(18.1) | 74(6.5) | 0.360 | 41(19.0) | 40(18.5) | 0.010 |
| ISS, median (IQR) | 30(21-41) | 18(10-29) | 0.800 | 29(21-41) | 29(18-43) | 0.040 |
| | Total | Pelvic angiography (+) | Pelvic angiography (-) | Crude OR (95% CI) | Adjusted OR (95% CI) | Confidential OR (95% CI) |
| All patients* | (N=1351) | (N=221) | (N=1130) | | | |
| Dead at hospital discharge | 110 (8.1%) | 30 (13.6%) | 80 (7.1%) | 2.061 (0.876-2.141) | 0.458 (0.251-0.836) | |
| Propensity score-matched patients* | (N=432) | (N=216) | (N=216) | | | |
| Dead at hospital discharge | 70 (16.2%) | 27 (12.5%) | 43 (19.9%) | 0.574 (0.466-1.327) | 0.469 (0.248-0.889) | 0.500 (0.274-0.911) |

THE TRAUMA “PIT STOP”: A MORE EFFICIENT MEANS OF EVALUATING THE LESS SEVERELY INJURED PATIENT

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Introduction: Avoidance of undertriage remains a primary goal of trauma systems and centers. To manage the resultant overtriage, innovative programs to effectively use hospital resources are essential. In our previously published study, we added Trauma Resource (TR) category to our tiered Trauma Activation (TA) algorithm, which allowed for prompt evaluation by the Emergency Department (ED) physician without activating the trauma surgeon (TS) and team. The TR protocol was subsequently modified by adding a Pit Stop (PS), wherein the patient would stop in the trauma resuscitation bay rather than go to an ED bed. We hypothesized that we could further improve efficiency without compromising patient care.

Methods: Patients in a level II trauma center not meeting criteria for TA but injured enough to be brought to a trauma center were assigned as TR for expedited ED evaluation. A PS was created in the ED resuscitation bay where TR patients were immediately assessed by a trauma nurse and/or an ED nurse, and board-certified ED physician. Diagnostic studies were ordered, and the TS consulted as needed. Demographic and outcome data were analyzed over a period of nine months and compared to the same data from pre-PS period. Comparisons were made using 95% confidence interval for variance and standard deviation calculations and unpaired t tests for two-tailed P values, with statistical difference, $p < 0.05$.

Results: In the first 9 months after implementation, we treated 994 TAs and 474 TRs. The mean door to doc time were similar in the PS and pre PS periods (6.6 vs 7.1 min, $p = 0.535$). Mean door to CT time were better in the PS than the pre PS period (39 vs 61.1 min, $p < 0.0001$). Of the TR patients 346 (73%) were discharged from ED; 2 (0.4%) were upgraded to TA, and 126 (27%) were admitted. The admitted patients were similar to admitted TA patients (N=684) with regard to gender, mean Injury Severity Score, mean LOS and in-hospital mortality, but were older (61.4 vs 47.2 years, $p < 0.0001$) and more often involved in a fall from same level injury (59.5% vs 20.1%, $p < 0.0001$). TR patients had increased door to doc evaluation times (8.5 vs 0.4 minutes, $p < 0.0001$) and increased door to CT times (34.5 vs 25.4 minutes, $p < 0.0001$) as compared to admitted TA patients.

Conclusion: Instituting a PS resulted in a faster door to CT time and the same door to doc time. This approach has been safe and efficient. Although there is technically a 9.2% undertriage rate, the time to TS evaluation is minimized by the timeliness of CT scanning. This approach could be readily generalized and could save many resources on a large scale.

VALUE OF DIAGNOSTIC IMAGING VARIES BY PATIENT AGE AND GENDER AND AFFECTS NEGATIVE APPENDECTOMY RATES

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Introduction: Improved imaging modalities increase the accuracy of diagnosis for appendicitis. However, negative appendectomies (NA) still exist and are associated with unnecessary cost and morbidity. Past studies cite age and gender as predictors of NA, but the value of advanced imaging modalities remains unclear. We sought to analyze the effect of imaging on NA based on age and gender using a large national database.

Methods: The 2015 National Surgical Quality Improvement Project (ACS-NSQIP) database was queried for all patients who underwent appendectomy for suspected appendicitis. Data on patient demographics, imaging modality, imaging results, and pathology results were obtained. NA were defined as patients with no evidence of appendicitis on pathology. Patients were categorized by age and gender, with ≤ 45 defined as “younger” and >45 as “older”. Rates of NA (NAR) for each imaging combination were calculated and compared with the Pearson’s chi-squared test.

Results: Of the 11,841 patients in the study, 5.4% proceeded to surgery without imaging, while the rest had CT (78.7%), US (7.2%), MRI (0.3%), US+CT (7.5%), US+MRI (0.5%), CT+MRI (0.4%), or all three (0.1%). Of all age/gender groups, younger males were most likely to have no imaging (6.8%), while younger females were most likely to have an US (13.0%), US+MRI (1.5%), or US+CT (12.9%), $p < .001$. Overall NAR was 4.5%. CT’s had the lowest overall NAR compared to US, MRI, or no imaging (2.5% vs 9.6% vs 11.1% vs 21.0%, $p < .001$). Younger males with no imaging had the lowest NAR (14.9%) compared to older males, younger females, and older females (18.4%, 26.7%, and 31.2%, $p < .001$). CT alone and US alone had similar NAR in older females (2.7% vs 2.5%, $p = 1$), younger males (2.1% vs 2.0%, $p = .95$), and older males (2.2% vs 2.9%, $p = .54$). For younger females, CT alone had the lowest NAR (3.3%) compared to US only (15.4%), MRI only (11.5%), US+CT (9.8%), and US+MRI (9.4%), $p < .001$.

Conclusion: Imaging is frequently used in the diagnosis of appendicitis, and is associated with lower NAR. While patients of all age and gender groups benefit from imaging studies, CT alone and US alone are equivalent in older females, younger males and older males. In contrast, younger females have the lowest NAR with CT alone. Of patients who underwent surgery without imaging, younger males had the lowest NAR. These variations in NAR should be considered when obtaining imaging for appendicitis.

EARLY VASOPRESSOR ADMINISTRATION IN PEDIATRIC BLUNT LIVER AND SPLEEN INJURY

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Introduction: Traditionally, use of vasopressors for children with blunt liver and spleen injuries (BLSI) has been avoided. In a large multicenter prospective study of pediatric BLSI, some centers reported use of vasopressors in patients with BLSI. No prior studies have examined the outcomes associated with early vasopressor use in pediatric populations with BLSI. In this research, we compared outcomes for pediatric BLSI patients with and without vasopressor use in the first 48 hours of injury.

Methods: We completed a planned secondary analysis of vasopressor use from a multicenter, prospective study of 1006 children with confirmed BLSI. We matched vasopressor use within 48 hours to a propensity-scored control group of BLSI patients who were not given vasopressors within 48 hours of injury. Propensity scores were estimated from pre-treatment factors (demographics, hemodynamic instability upon admission, injury type, GCS, injury severity). Logistic regression was utilized to assess the risk of vasopressor use with mortality. Secondary outcomes were failure of BLSI non-operative management (NOM) due to bleeding, delayed bleeding, and PICU readmission. Fisher's exact tests were used to assess subgroup differences.

Results: 69 patients received vasopressors within the first 48 hours of injury, 62% had TBI and 54% were male. Median [interquartile range] age = 8.8 [3.9, 14.3] years; GCS = 5 [3, 15]; injury grade for spleen: 1 [0, 3]; and liver: 2 [1, 4]. The mortality rate for those who received vasopressors was 33% versus 11% for those who did not (AOR=4.1; $p<.05$). Failure of NOM for the patients who received vasopressors was 32% versus 7% (AOR=4.8; $p<.05$). For the subgroup of patients with TBI who received vasopressors, the mortality was 44% versus 20% [$p=.09$] for those who did not; and the failure of BLSI NOM was 28% versus 0% [$p<0.05$] for those who did not. For the non-TBI subgroup, the difference in mortality between the vasopressor group and the matched control did not reach statistical significance (15% vs 0.0%; $p=.20$), nor did the NOM failure (39% vs 17%; $p=.12$).

Conclusion: Vasopressor use in pediatric patients with BLSI is uncommon. Compared to a propensity matched control group, vasopressor use in pediatric BLSI is associated with a 4.1 increased risk of mortality and a 4.8 increased risk of NOM failure.

POSTER 40 WITHDRAWN

DOWN AND OUT: A MULTICENTER ASSESSMENT OF ROUTINE SYNCOPE WORKUP AFTER TRAUMATIC FALL

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Introduction: As the population of the United States ages, the incidence of traumatic falls is increasing. Falls are classified either as mechanical or as secondary to syncope. Controversy exists as to the utility of a syncope workup in patients who suffer a traumatic fall. Recent, single-institution studies suggest that routine syncope workup after a traumatic fall may not be necessary. An ECG, an echocardiogram (echo), and an evaluation of the carotid arteries by either ultrasound (US) or CT angiogram (CTA) are frequently reported to be the components of a complete “trauma syncope workup”. The purpose of this project is to provide a multicenter assessment of the utility of a routine syncope workup after traumatic fall and of which factors may predict syncope as a cause of fall.

Methods: A multi-institutional, retrospective review of all patients presenting with a ground-level fall over a one year period was conducted at 2 ACS-verified centers. Patients were classified as having syncope leading to a fall or a mechanical fall based on review of the electronic medical record. Data collected included demographics, ISS, length of stay (LOS), and information relating to syncope workup testing.

Results: A total of 545 patients met the inclusion criteria. 189 patients had syncope or near syncope as a cause for fall and 356 sustained mechanical falls. Syncope positive patients were more likely to have an ECG (75.6% vs. 52.0%, $p<0.001$), an echo (54.0 % vs 20.2%, $p<0.001$), a CTA of the neck (15.9% vs 9.0, $p=0.016$), a carotid US (18.5% vs 2.5%, $p<0.001$), and to have received all 3 components of the complete trauma syncope workup (26.5% vs 5.9%, $p<0.001$). Syncope positive patients were more likely to have an arrhythmia on ECG (20.1% vs 11.0%, $p=0.004$), an ejection fraction (EF) $<50\%$ on echo (7.9% vs 2.3%, $p=0.002$), and carotid stenosis (5.8% vs 1.7%, $p=0.008$). On multivariable analysis, patients were more likely to be syncope positive if they had an EF $<50\%$ on echo (OR-3.363, CI-(1.322-8.555), $p=0.011$) or a previous history of syncope (OR-13.994, CI-(5.197-37.684), $p<0.001$), whereas patients were less likely to be syncope positive with increasing age (OR-0.985, CI-(0.975-0.996), $p=0.006$).

Conclusion: Due to the high incidence of arrhythmia, an ECG should be part of the routine workup of patients experiencing a fall after syncope. Echocardiogram has less utility in the standard assessment of these patients, however it should be considered on an individual basis. Carotid US or CTA is unnecessary in the routine workup of syncope and should be employed only if additional indications exist. Patients who have syncope as a cause for fall are more likely to have a low EF or a previous history of syncope than patients experiencing a mechanical fall. Compliance was poor in this multi-institutional review, as only a quarter of patients reporting syncope received a complete trauma syncope workup.

WHOLE BODY COMPUTED TOMOGRAPHY VERSUS SELECTIVE IMAGING FOR BLUNT TRAUMA IN AN ACADEMIC TRAUMA CENTER

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Introduction: Whole body computed tomography is frequently employed in trauma centers to diagnose injury after blunt trauma. Recently, studies have suggested that trauma surgeons and emergency medicine physicians can safely pursue selective imaging based on clinical judgment and physical exam findings. Many level I trauma centers in the United States are academic centers and resident physicians are an important part of the trauma team. The objective of this study was to determine if chief residents are able to accurately determine which computed tomography (CT) scans to obtain based on clinical judgment and physical exam.

Methods: This was a prospective IRB approved study undertaken at an academic Level I trauma center between. All patients between ages of 18-89 who were evaluated in the emergency department as lower level alerts with blunt trauma and evaluated by the trauma chief resident on arrival were included in the study. Patients who had already undergone imaging at a referring hospital were excluded. After performing a FAST exam and physical exam, the chief resident completed a questionnaire indicating whether they thought the patient would have a thoracic, abdominal or pelvic injury that would necessitate CT imaging. All patients received CT imaging of their head, cervical spine, chest, abdomen and pelvis after initial evaluation in the trauma bay. Imaging results were then compared to the questionnaires to determine resident accuracy in selective imaging for blunt trauma. Additional data regarding incidental findings, blood alcohol level, time of day, body mass index, Glasgow coma scale and presence of head or cervical injury was also obtained.

Results: We studied 232 patients, of whom 59.5% were male with an average age of 43.5 +/- 18.5 years. The total number of clinically significant thoracic, abdominal and pelvic injuries was 41, 17 and 10, respectively. If chief residents had proceeded with selective imaging and not obtained a CT scan, 58.5% of chest injuries, 88.2% of abdominal injuries and 80% of pelvic injuries would have been missed. Overall sensitivity and specificity was 30.9% and 94.9%, respectively. Injuries most often missed in the chest were rib, clavicle and scapula fractures. Lumbar fractures and pelvic fractures were the most commonly missed in the abdomen and pelvis. With selective scanning, 78 incidental findings (mostly pulmonary and adrenal nodules) would have been missed.

Conclusion: Our data suggests that, at our level I trauma center, the practice of selective scanning would have missed 69.1% of injuries. These injuries ranged in severity from simple rib fractures to splenic lacerations and vertebral fractures. While chief residents had excellent specificity, sensitivity was 30.9%. The poor ability to selectively image may be in part due to a false sense of security, as the resident knew that the patient would have a total body CT regardless of their predictions. There are frequently times when the chief resident is not able to be present for the initial evaluation of lower level alerts if they are involved in other patient care or are in the operating room. This further supports the use of whole body CT scans. While some studies have shown that attending emergency medicine and trauma surgeons can safely selectively scan blunt trauma patients, selective scanning in an academic institution with residents may result in a significant number of missed injuries and is not recommended at this time.

RUN DON'T WALK: IMPLEMENTATION OF A STAT INTERVENTIONAL RADIOLOGY RESPONSE TO BLEEDING PATIENTS

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Background: The American College of Surgeons Committee on Trauma (ACS-COT) now requires an experienced radiologist to be available within 30 minutes to perform interventional procedures for level 1 and 2 trauma centers. To address this, we created a new interventional radiology (IR) STAT trauma activation pathway and prospectively followed the impact on early blood product utilization and mortality.

Methods: Development and implementation of an IR STAT trauma activation pathway was performed after identifying three activation criteria through retrospective review of our trauma registry: intravenous (IV) contrast extravasation with transfusion requirement, zone 3 resuscitative endovascular balloon occlusion of the aorta (REBOA) placement, and need for IR recognized in the operating room (OR). All activations from March 2017 through January 2018 were prospectively identified and maintained in a database. Outcomes were compared to a matched historical control group one year prior to IR STAT trauma with same three clinical indications. Mann-Whitney U-test and chi-square analyses were performed ($p < 0.05$).

Results: Of the 5,715 adult trauma patients, 1,329 were level 1 trauma activations, and 30 IR STAT trauma activations occurred. Reasons for IR STAT included IV extravasation with transfusion requirement [$n=17$, 57%], trauma attending discretion [$n=6$, 20%], zone 3 REBOA placement [$n=4$, 13%], and need for IR from OR [$n=3$, 10%]. Our survival rate was 86% despite a median ISS of 36 and 50% predicted survival based on median trauma injury severity score (TRISS). No deaths were secondary to hemorrhage and 68% of survivors were discharged home. Compared to the historical control group, the IR STAT group had a significantly shorter time to start of IR procedure (75 min vs 196 min, $p < 0.001$). Although the IR STAT group had a statistically lower predicted survival by TRISS, there was no difference in actual survival rate (Table). While the overall compliance with IR response time of 30 minutes was 53%, compliance improved over time after PI opportunities were identified and the pathway adjusted. Patients that did not meet the 30 minute IR response time had a median response time of 60 minutes.

| | IR STAT (n=30) | Control (n=23) | p-value |
|--|-------------------|-------------------|---------|
| Median age, years (IQR) | 39 (27, 65) | 44 (28, 55) | 0.801 |
| Median Injury Severity Score (IQR) | 36 (29, 42) | 38 (30, 43) | 0.653 |
| Median time to IR procedure start, min (IQR) | 75 (62, 92) | 196 (147, 210) | <0.001 |
| Therapeutic embolization rate, % | 73% | 67% | 0.635 |
| Median RBC+FFP transfusion, 0-4 hr (IQR) | 8 (4, 11) | 10 (4, 18) | 0.574 |
| Median RBC+FFP transfusion, 0-24 hr (IQR) | 8 (6, 13) | 12 (4, 26) | 0.280 |
| Predicted survival rate by TRISS, % | 50% | 81% | 0.020 |
| Actual survival rate, % | 86% | 78% | 0.447 |
| Discharge home, % | 68% | 39% | 0.035 |

Conclusion: Implementation of an IR STAT trauma pathway to treat critically injured, bleeding patients at a high-volume level 1 trauma hospital is feasible and results in excellent outcomes. This protocol was associated with a dramatic reduction in time to IR intervention, and did so with a high therapeutic embolization rate (limited over-triage) and zero bleeding-related deaths. Early IR remains an important adjunct to hemorrhage control in the trauma patient.

Single Pass Whole-Body versus Organ-Selective Computed Tomography for Trauma: Is it a matter of time to diagnosis versus radiation exposure?

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Introduction: Single Pass Whole-body computed tomography (WBCT) has been used as a high yield diagnostic tool in trauma. However, increased exposure to radiation and delay in treatment, have been cited as challenges to its widespread use. We hypothesized that WBCT has at least the same radiation exposure compared to organ-selective CT scan (OSCT) and it does not necessarily inflict further delays in treatment.

Methods: We performed a retrospective review of all trauma patients in whom CT-scans were performed on arrival at a Level I Trauma Center from January, 2016 to December, 2017. Patients were divided into two groups: patients with OSCT and patients in whom WBCT's were performed. Patient demographics, clinical, imaging (CT-scan), and injury-related characteristics were compared between the two groups.

Results: A total of 123 patients were included: 53 in the OSCT group and 70 in the WBCT group. In the OSCT group the median age was 28 (IQR 22-39), ISS 10 (IQR 9-17), RTS 7.9 (IQR 5.9-7.8), 64.1% of the patients had penetrating trauma and chest injuries were the most common injured body cavity (79.3%). In the WBCT group the median age was 29 (IQR 23-50), ISS 16 (IQR 11-25), RTS 6,9 (IQR 5.9-7.8), the most common trauma mechanism was blunt (65.7%) and head injuries were the most common (71.9%) injured organ. The OSCT group had longer ER-to-CT scan time than the WBCT group (41 vs 28 minutes, $p=0.01$) (Table 1). The OSCT group required subsequent trips to the scanner suite for follow-up studies to rule out other potential injuries which in turn did not occur in the WBCT group (47.2% vs 0%, $p < 0.001$). CT Brain was the most frequent follow-up study required in the OSCT group. The total radiation exposure dose was higher in the OSCT group compared to the WBCT group [22 mSv (IQR 6-31) vs 15.1 mSv (IQR 9.9-24.8) $p < 0.001$].

Table 1.

| | WBCT N=70 n (%) | OSCT N=53 n (%) | P value |
|--------------------------------------|--------------------|--------------------|-------------|
| ISS* | 16 (11 – 25) | 10 (9-17) | $p < 0.001$ |
| RTS* | 6.9 (5.9-7.8) | 7.9 (5.9-7.8) | 0.01 |
| Trauma Mechanism | | | |
| Penetrating | 10 (14.3%) | 34 (64.1%) | $p < 0.001$ |
| Blunt | 60 (85.7%) | 19 (35.9%) | |
| Multiple Trauma | 57 (81.4%) | 31 (58.5) | $p < 0.001$ |
| ER-to-CT Scan time (minutes)* | 28 (13-50) | 41 (21-60) | 0.01 |
| Extra CT-Scan | 0 (0) | 25 (47.2%) | $p < 0.001$ |
| Total radiation (mGy)* | 1004 (658-1652) | 2040 (1475-3098) | $p < 0.001$ |
| Total radiation (mSv)* | 15.1 (9.9-24.8) | 22 (6-31) | $p < 0.001$ |

WBCT: Whole Body CT scan, ISS: Injury severity score, RTS: Revised Trauma Score, *Median (Interquartile range)

Conclusion: Trauma patients undergoing WBCT's had lower total radiation exposure with no delay in treatment secondary to the information obtained from their initial scan. OSCT has the potential of missing potentially life threatening injuries that require subsequent follow-up scans, which in turn increases the patients overall radiation exposure and potentially delaying definitive surgical treatment.

A NOVEL QUANTITATIVE METHOD TO PREDICT THE LIKELIHOOD OF HOLLOW VISCUS INJURY IN ABDOMINAL TRAUMA WITH FREE FLUID ON COMPUTED TOMOGRAPHY

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Introduction: The presence of free fluid on Computed Tomography (CT) in a stable patient with abdominal trauma presents a diagnostic and therapeutic challenge. A surgeon must balance the likelihood of non-therapeutic laparotomy with the morbidity of delayed diagnosis and treatment of a hollow viscus injury (HVI). Hounsfield units (HUs) in conjunction with other CT features suggestive of HVI (bowel wall thickening, mesenteric vascular edema, fat stranding, free air, beading, extraluminal contrast extravasation) may provide additional diagnostic and therapeutic value and lead to more rapid diagnosis and treatment. We sought to validate the utility of HU of intraabdominal fluid at predicting HVI, and to create a model integrating HUs to predict the presence of HVI in stable patients with abdominal trauma.

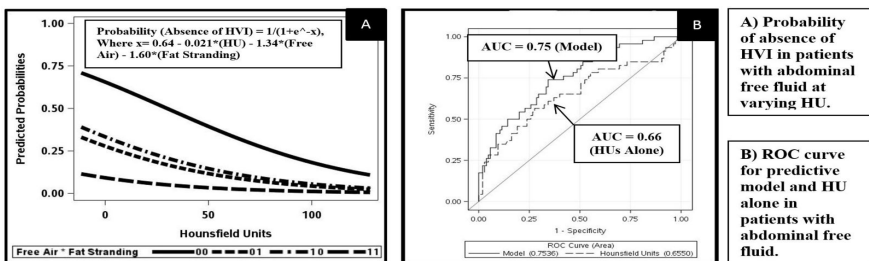
Methods: We retrospectively reviewed the abdomino-pelvic CTs of 297 consecutive patients (2011-2015) with free fluid findings (n = 152) that underwent exploratory laparotomy for suspected HVI. Patients with concomitant solid organ injury and abdominal vascular injury on CT were excluded from analysis. Variables abstracted from the registry included patient demographics, presenting vitals, and findings suggestive of HVI on CT (Hounsfield Units, bowel wall thickening, free air, fat stranding, mesenteric vascular edema, contrast extravasation). Stepwise logistic regression analysis was used to identify statistically significant predictors on CT scan for HVI.

Results: Of 152 patients (mean age \pm SD = 33 \pm 15 years, mean ISS \pm SD = 12 \pm 9, 55% blunt injury) with intraabdominal fluid on CT, 106 (70%) had HVI. Vitals were normal on presentation (HR \pm SD = 93 \pm 20, BP \pm SD = 127 \pm 22/82 \pm 18). A novel predictive index (**Figure A**) was developed to rule out HVI in patients with intraabdominal free fluid on CT, defined by the equation:

PROBABILITY(ABSENCE of HVI) = $1/(1+e^{-x})$,

where $x = 0.64 - 0.021*(HU) - 1.34*(FREE AIR) - 1.60*(FAT STRANDING)$.

A receiver operating curve (ROC) analysis of the model achieved an AUC of 0.75 (CI 0.67-0.84, $p < 0.01$), with 0.66 (CI 0.55-0.75, $p < 0.01$) attributable to HU (**Figure B**). A HU of 30 was identified as the optimal threshold to maximize both sensitivity and specificity of the model (Youden's J index). Patients with HU < 30 were substantially and significantly less likely to have HVI than their HU > 30 counterparts (OR 2.9, CI 1.4-5.9, $p < 0.01$).



Conclusion: In trauma patients with intraabdominal free fluid on CT, a novel predictive index may limit the number of unnecessary operations in patients with CT evidence of free fluid and miss fewer HVIs.

DOES FAST EXAM DECREASE NON-THERAPEUTIC LAPAROTOMIES IN ABDOMINAL GUNSHOT WOUNDS?

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Introduction: Most abdominal gunshot wounds (GSW) that violate the peritoneal cavity will cause injuries requiring therapeutic laparotomy. However, some abdominal, flank, chest and back GSW do not violate the peritoneal cavity and will not require laparotomy. Non-therapeutic laparotomy carries increased length of stay and many associated morbidities. We hypothesized in hemodynamically normal patients with torso GSW, FAST exam would be beneficial in minimizing non-therapeutic laparotomy rates.

Methods: Over the time period January 1, 2016 to Feb 28, 2018, a retrospective review was conducted of patients with torso GSW and systolic blood pressure (SBP) greater than 90 mmHg. Demographics such as age, gender, initial systolic blood pressure, base deficit and FAST results were identified. FAST results were correlated with computed tomography (CT) or operative findings. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of FAST in abdominal GSW were determined.

Results: Over 26 months we evaluated 683 patients at our level 1 Trauma Center with GSWs. Torso GSW with SBP greater than 90 mmHg was seen in 231 patients. The mean age was 29.1 years and 89% male. Fifty-one patients did not undergo FAST exam or went directly to the operating room with high suspicion of abdominal injury and were excluded. Of the remaining 180 patients, 31 had a positive FAST associated with abdominal injuries for a PPV of 89%. Thirty-two patients had a negative FAST but abdominal injuries found on CT or exploratory laparotomy for a NPV of 78% and specificity of 97%. The sensitivity of FAST for torso GSW was 49%. A total of nine non-therapeutic laparotomies were performed, four of whom had a negative FAST exam.

Conclusion: Not all patients with a torso GSW will require laparotomy. If the SBP is greater than 90mmHg, it is safe to perform FAST. If the FAST is positive, it is prudent to go directly to the OR as there is a 97% chance of finding an injury that needs definitive care. If the FAST is negative, obtaining CT scan to identify possible injuries may avoid non-therapeutic laparotomy in a significant number of hemodynamically normal patients.

A SHOT IN THE DARK: USEFULNESS OF ULTRASOUND-GUIDED DIAGNOSTIC PERITONEAL ASPIRATION IN THE ASSESSMENT OF NON TRAUMA ACUTE SURGICAL PATIENTS

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Introduction: Abdominal free fluid or localized collections are a common findings in many acute abdominal conditions. They are usually diagnosed by ultrasonography (US) or CT scans. Fluid characteristics can orient definitive diagnosis. The aim of this study is to evaluate the impact of systematic use of US-guided diagnostic peritoneal aspiration (US-DPA) in the decisional process of acute abdominal diseases.

Methods: US-DPA was prospectively and systematically performed in all patients (pts) with spontaneous or postoperative acute abdominal conditions associated with free fluid or localized collections found on US or CT, whenever final diagnosis or therapeutic strategy remained undefined after imaging. Trauma cases were excluded. Fluid analysis was performed only when the aspect of the retrieved fluid was not decisive for decision making. US-DPA feasibility, safety and the number of clinical decisions influenced by DPA were analyzed. The procedure was performed bedside, without local anesthesia, with a 19/21 G needle, preferably with an in-plane technique. Statistical analysis was made comparing observed vs. expected cases in which DPA had a positive impact on patient management, and positive vs. negative DPA impact. The "N-1" Chi-squared test was used. Significance level was set at $\alpha = 0.05$.

Results: Fifty-nine pts (35 M, 24 F; mean age 61 y/o – range 18-92) underwent 64 US-guided DPA (Table 1). Fifty-two had free peritoneal fluid, 7 localized collections. In 5 (8.5%), DPA was performed twice at the same time in a different abdominal site, to check the aspect of the first sample. In 1/64 (1.5%) no fluid was retrieved (DPA feasibility = 98.5%). No complications were observed. Five samples were sent for chemical analysis. Management was enhanced by US-DPA as depicted in Table 2. In 1/59 patient (1.7%) DPA results interpretation (2 samples, serous-hematic fluid) was wrong, causing a one day delay of re-operation (anastomotic leak). In 17/59 (28.8%) US-DPA authorized a successful conservative management, without resorting to any other exam. In total, 39 pts (66.1%, $p < 0.001$) had treatments (conservative, procedural, surgical) favorably driven by US-DPA results, with a clear change on clinical decisions in 23 (39%, $p = NS$). Positive impact of US-DPA resulted statistically significant vs. negative impact ($p < 0.001$). In 16/59 pts (30.5%) US-DPA was performed after CT.

Conclusion: Uncertainty about the qualitative characteristics of free fluid or collections is not uncommon managing acute surgical pts. Our study shows that US-DPA is a safe procedure. The risk of mismanagement due to US-DPA results was very low (1,7%). US-DPA is a simple and safe bedside procedure. It enhances the clinical decision: further imaging, surgical/procedural treatment, safer patient observation. US-DPA can be diriment in the assessment of acute surgical patients.

| Clinical problem/suspicion | # | % |
|-----------------------------|----|------|
| Abdominal colic | 2 | 3.4% |
| Ascitis of unknown etiology | 1 | 1.7% |
| Epigastric pain | 1 | 1.7% |
| Appendicitis | 2 | 3.4% |
| Terminal ileitis | 3 | 5.1% |
| Cholecystitis | 2 | 3.4% |
| Diverticulitis | 4 | 6.8% |
| Postop. complications | 39 | 66% |
| Postop. bleeding | 1 | 1.7% |
| Gynecological disorders | 2 | 3.4% |
| Intestinal ischemia | 2 | 3.4% |
| <i>Total</i> | 59 | |

Table 1 – Indications for US-DPA

| Clinical decision | # | % |
|--|----|-------|
| Conservative treatment* | 25 | 42.4% |
| Microbial cultural exam | 9 | 15.2% |
| Other diagnosis (gynecological disorder) | 2 | 3.4% |
| Drainage | 8 | 13.5% |
| Emergency surgery (without further CT) | 4 | 6.8% |
| Emergency surgery (with further CT) | 1 | 1.7% |
| Delayed surgery (without further CT) | 1 | 1.7% |
| Discharge | 2 | 3.4% |
| Further CT | 2 | 3.4% |
| Not relevant | 5 | 8.5% |
| <i>Total</i> | 59 | |

Table 2 – Decision making after US-DPA
* 17/25 driven by DPA w/o further imaging

BOWEL ISCHEMIA SCORE (BIS) CORRELATES WITH THE NEED FOR OPERATION IN PATIENTS WITH ADHESIVE SMALL BOWEL OBSTRUCTION

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Introduction: Nonoperative management of adhesive small bowel obstruction (SBO) is successful in up to 80% of patients. Current recommendations advocate for computed tomography (CT) scan in all patients with SBO to supplement surgical decision making. It is unknown how CT findings influence need for surgery in patients without immediate clinical operative indications. We hypothesized that a Bowel Ischemia Score (BIS) predicts the need for operative intervention in the setting of SBO.

Methods: This was a retrospective analysis of a retrospectively and prospectively collected adhesive SBO database over a 6-year period. A BIS was developed based on the Eastern Association for the Surgery of Trauma (EAST) guidelines for CT findings suggestive of bowel ischemia. One point was assigned for each of the six variables (see table). Early operation was defined as within 6 hours of CT scan.

Results: Of the 296 patients in the database, 262 (88.5%) underwent axial imaging. The operative rate was 30.9% with a median time from CT to operation of 21 hours (IQR 5.2-59.2 hours).

| EAST guidelines for CT findings of bowel ischemia: | | 1. Reduced bowel wall enhancement 2. Bowel wall thickening 3. Mesenteric venous congestion 4. Mesenteric fluid 5. Unusual course of mesenteric vasculature 6. Ascites | | | | | |
|--|------------------------------|--|------------|-------------|----------------------|------------------|--|
| Bowel ischemia score | Surgery within 6 hours of CT | Surgery >6 hours after CT | No surgery | Total | OR (95% CI) | P-value | |
| 0 | 2 (1.8%) | 20 (17.5%) | 92 (80.7%) | 114 (38.5%) | | | |
| 1 | 9 (8.7%) | 24 (23.3%) | 70 (68.0%) | 103 (34.8%) | 6.76 (1.42, 32.17) | 0.016 | |
| 2 | 7 (20.6%) | 11 (32.4%) | 16 (47.0%) | 34 (11.5%) | 18.52 (3.64, 94.32) | <0.001 | |
| 3 | 4 (36.4%) | 4 (36.4%) | 3 (27.3%) | 11 (3.7%) | 36.04 (5.51, 235.90) | <0.001 | |
| Total | 22 | 59 | 181 | 262 | | <0.001 | |

BIS \geq 1 was present in 148 (56.5%) patients. Most (162 / 217, 74.6%) with a BIS of 0 or 1 were successfully managed nonoperatively, whereas the majority of those with a BIS of 3 required operative intervention (8 / 11, 72.7%). The odds ratio for early operative intervention was 18.5 and 36 for those with a BIS of 2 and 3, respectively. With a BIS of 0, 1, 2, and 3, small bowel resection was performed in 3.5%, 8.7%, 17.6%, and 36.4% of patients, respectively.

Conclusion: The cumulative signs of bowel ischemia on CT scan, rather than the presence or absence of any one finding, correlate with the need for operative intervention. Further work will be done to validate this scoring system and analyze the weight of each variable, as well as establish comprehensive clinical factors that predict operation.

BLUNT CEREBROVASCULAR INJURY: HAVE WE GOTTEN CARRIED AWAY WITH SCREENING CTA?

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Introduction: Over the past several decades, blunt cerebrovascular injury (BCVI) screening criteria have expanded in the hope of minimizing the incidence of stroke. Recommended indications for computed tomographic angiography (CTA) of the neck include cervical spine fractures, complex facial and skull base fractures, traumatic brain injury, and major thoracic injuries. We hypothesized that there would be specific characteristics of patients with cervical spine fractures such as age, mechanism of injury, and fracture patterns, in whom CTA of the neck could be safely deferred.

Methods: Blunt trauma patients ≥ 15 years old admitted from January 2009-June 2015 who sustained occipital condyle and/or cervical spine fractures were included. Patient demographics, mechanism of injury, cervical spine fracture patterns, and associated injuries as they related to the rate of BCVI were recorded. Fracture patterns were classified between upper (C1-3) and lower (C4-7) cervical spine, as well as at each individual cervical spine level. Fractures were characterized as lateral mass, vertebral body, lamina, pedicle, transverse process, or spinous process. A matched case-control analysis was performed based on age and mechanism of injury. Low energy mechanism of injury was defined as either a same level fall or assault. High energy mechanisms included motor vehicle collision, motorcycle/ATV collision, fall from height, and auto-pedestrian collision. Elderly patients were defined as those 65 years and older.

Results: A total of 1275 patients with occipital condyle or cervical spine fractures were identified. Nine hundred and eight (71.2%) underwent BCVI screening, which established the analyzed population. Mean age was 57.5 ± 23.2 years, and 55.4% were male. BCVIs were identified in 9.3% (n=84). BCVI was identified at all cervical levels. When evaluating fracture types, lateral mass fractures were significantly associated with BCVI in the upper (35.7%) and lower (41.7%) cervical spine. Within the total screened population, low energy mechanism, when compared with higher energy mechanism, was the only factor associated with lower rates of BCVI (5.9% vs 10.7%, $p=0.024$). No additional injuries were associated with a lower rate of BCVI. Evaluation of fracture pattern was performed via case-control by matching age and mechanism of injury. Elderly patients were found to have a 5.7% BCVI rate. No fracture patterns were associated with a lower rate of BCVI. Elderly patients with high energy mechanisms had a BCVI rate of 10.7%, and no fracture patterns were associated with not having a BCVI. Similarly, young patients with low energy mechanism had a BCVI rate of 6.9%, compared with a 10.9% rate in those with high energy mechanism. Fracture patterns were not identified to be associated with a lower rate of BCVI.

Conclusion: Within a screened population of patients with cervical spine fractures, age, mechanism of injury, and fracture pattern were not associated with a lower rate of BCVI. Thus, in this high-risk population, no patient should be excluded from BCVI screening based on age, mechanism of injury, or specific fracture pattern. However, special attention is warranted for lateral mass fractures as they have a significantly higher rate of BCVI.

THE USE OF A NEW GENERATION MULTICHANNEL TEG® 6S ANALYZER IN A MODERN SURGICAL INTENSIVE CARE UNIT: MORE IS LESS!

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Introduction: The use of thromboelastography (TEG) in critically ill, surgical and trauma patients has expanded over the last decade. Several technical variations, however, including the addition of anticoagulants and/or activators to the blood sample, may complicate its use. In addition, the TEG instrument requires daily calibration and is recommended to be used only by trained personnel. We recently initiated the use of a new generation, multichannel TEG analyzer (6S) in our surgical intensive care unit (SICU) that utilizes an innovative all-in-one cartridge and simplifies the process of obtaining a full coagulation profile. It remains unclear, however, whether the combination of all assays could provide a better understanding of the patient's coagulation profile. The purpose of this study was to evaluate the importance of the additional information derived from these comprehensive coagulation analyses and explore the variation in stratifying patients as coagulopathic based on the results from each assay.

Methods: Over a 6-month study period ending in 02/2018, data from all patients admitted to the SICU who had a TEG analysis performed were prospectively collected. A citrated multichannel cartridge developed for the TEG® 6S analyzer was utilized and the following assays were performed simultaneously: (1) Kaolin (CK), (2) rapid TEG (CRT), (3) Kaolin with heparinase (CKH) and (4) functional fibrinogen (CFF). TEG values from all assays were stratified as indicative of coagulopathy based on elevated R-time, elevated K-time, decreased MA, decreased angle, prolonged TEG-ACT and decreased FLEV based on accepted ranges. Samples were accordingly classified as potentially requiring transfusion of fresh frozen plasma (FFP), platelets (PLTs), or cryoprecipitate (Cryo).

Results: Overall, 417 TEG samples from 207 patients were analyzed. Almost half of the samples (49.2%) were classified as indicative of coagulopathy based on at least one component of the four assays. Overall, 24.6% of patients had a potential indication for FFP transfusion per either a prolonged R-time from the CK assay (14.6%) and/or a prolonged TEG-ACT from the CRT assay (11.9%). The proportion of samples with both studies indicating FFP transfusion, however, was only 2.9%. Over a third of the patients (33.8%) had a potential indication for PLT transfusion based on a decreased MA: 31.6% with CRT and 23.5% with CFF. However, a decreased MA was consistently noted in both assays 22.3% of the time. Lastly, 40.5% had a potential indication for Cryo based on prolonged K-time, decreased angle and FLEV. More specifically, decreased K-time was observed in 28.3% based on CK; decreased angle was noted in 20.7% with CK and 12.4% with CRT; decreased FLEV was noted in 26.2%. However, only 6.0% of relevant studies were all simultaneously indicative for the need for Cryo transfusion.

Conclusion: In addition to being easier to use and less labor intensive, the new generation multichannel TEG® 6S analyzer provides a complete coagulation assessment of the critically ill surgical patient. The additional information obtained simultaneously from the four different assays may impact clinical decision making as they allow for increased specificity and correlations between assays. Further studies will focus on whether this may lead to improved and more targeted correction of coagulopathy, potentially saving blood products, factors, and cost.

USING qSOFA AS SCREENING CRITERIA FOR SEPSIS AND SEPTIC SHOCK DELAYS IDENTIFICATION AND TREATMENT IN PATIENTS PRESENTING THROUGH THE EMERGENCY DEPARTMENT

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Introduction: Enhancing the efficiency of identification and treatment of severe sepsis has been shown to improve the outcomes of septic patients. Timely diagnosis is essential to early institution of empiric antibiotics and fluid resuscitation. Quick Sequential Organ Failure Assessment (qSOFA) scoring has been suggested as a useful screening tool in septic patients at higher risk death. We hypothesize that qSOFA is a poor screening tool for sepsis and significantly decreases accuracy and delays timeliness of detection in emergency department (ED) patients.

Methods: We evaluated the records of 116,227 ED patients from a large, urban teaching hospital between January and December 2014. The qSOFA Criteria (SBP \leq 100 mm Hg, RR \geq 22, and/or GCS \leq 14) were compared to SIRS criteria for sepsis prediction. There were 1991 patients with discharge diagnoses of sepsis, severe sepsis, and/or septic shock.

Results: Variations in three presenting variables, respiratory rate, systolic BP and mental status were not determined to be primary early predictors of sepsis with a 7.94% (158/1991) accuracy compared to 33% (657/1991) using SIRS criteria ($p < 0.0001$) in confirmed septic patients. Only 5.37% (508/9463) to the total ED population met \geq 2 qSOFA criteria.

Conclusion: Using qSOFA decreases the accuracy and expediency of sepsis identification and treatment in septic ED patients. This initial screening approach may lead to delayed sepsis workup and hinder life-saving interventions in ED patients to a greater extent than using SIRS vital signs criteria due its poor diagnostic sensitivity.

Bioelectrical Impedance Analysis Guided-Fluid Management Promotes Fascial Closure of Open Abdomen: A Retrospective Cohort Study

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Introduction: High volume fluid therapy in open abdomen (OA) trauma patients contributes to excessive visceral edema, delayed fascial closure, and prolonged parenteral nutrition. Thus, we investigated whether bioelectrical impedance analysis-directed resuscitation reduced postoperative fluid overload, promoted earlier fascial closure, and improved outcomes in OA trauma patients.

Methods: A retrospective cohort study was performed for all trauma patients requiring OA admitted between 05/2013–04/2015 to a national gastrointestinal referral center. Patients were divided into two groups: BIA-directed fluid resuscitation (BIA) and traditional fluid resuscitation (TRD). Data for patients were collected and retrospectively analyzed.

Results: Forty-eight patients were included (N=30, BIA; N=18, TRD). Fluid resuscitation with BIA allowed cumulative fluid balance and fewer complications. BIA patients were significantly more likely to achieve primary fascial closure (PFC) [HR 8.73 (95 % CI, 2.70-28.26); $p < 0.001$] and survive [HR 0.03 (95 % CI, 0.001-0.81); $p = 0.036$] than TRD patients did. Resuscitation guided by BIA reduced time to PFC, enteral nutrition (EN) initiation and volume of postoperative 7-day cumulative fluid balance, by an average of 4.28 days ($p < 0.001$), 6.01 days ($p < 0.001$), and 6775.94 ml ($p < 0.001$), respectively.

Conclusion: For trauma patients undergoing OA, BIA-directed fluid resuscitation is associated with lower postoperative fluid overload and 30-day mortality, higher 30-day PFC, earlier fascial closure and initiation of EN. Thus, BIA may be routinely used for OA trauma patients.

TO FEED OR NOT TO FEED: ENTERAL FEEDING AND PREOPERATIVE NPO STATUS AMONG ADULT TRAUMA ICU PATIENTS

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Introduction: For patients in the intensive care unit (ICU), the prevalence of malnutrition has been estimated at 38-78% and has been independently associated with increased ICU lengths of stay (LOS), ICU readmissions, infection, and mortality. Nutrition therapy is an important component of in-hospital treatment but is often interrupted prior to surgical procedures to prevent perioperative pulmonary aspiration and subsequent complications, such as pneumonia and respiratory compromise. Guidelines on enteral feeding and preoperative fasting in the trauma ICU patient vary by hospital. Our objective was to compare the safety of enteral feeding protocols among trauma ICU patients undergoing surgical procedures at four Level I Trauma Centers.

Methods: Adult (≥ 18 years) trauma patients admitted to the ICU were included in this multicenter, retrospective cohort study if they had a cuffed endotracheal tube/tracheostomy and received tube feedings prior to operative management of a traumatic injury (June 2016 - May 2017). Patients were excluded if their surgical procedure was on the abdomen, in the prone position, a manipulation of the airway, or a tracheostomy or percutaneous endoscopic gastrostomy at the bedside. Hospitals A and B fed patients until being called to the operating room, Hospital C kept patients nil per os (npo) for at least 4 hours prior to surgery, and Hospital D did not have a formal enteral feeding protocol, but on average kept patients npo for 8 hours before surgery. Clinical characteristics and outcomes (primary: aspiration; secondary: hospital and ICU LOS, in-hospital mortality) were obtained from each hospital's trauma registry and through chart review. An intent-to-treat analysis was conducted using Chi-square and Kruskal Wallis tests to examine differences between patients at each hospital.

Results: Fifty-seven patients were included in the study, of which 18 (32%), 14 (25%), 19 (33%), and 6 (11%) were from Hospitals A, B, C, and D, respectively. Patients had a median age of 57 years, were primarily male (77%) and had a median injury severity score (ISS) of 22. Surgical procedures were primarily orthopedic/spine (37%) followed by neurosurgery (12%) and open reduction internal fixation of the face (11%). There were no differences in age, sex, ISS, the number of days with a feeding tube or the number of days on a ventilator between hospitals. Patients at Hospital C had significantly more pneumonia ($p=0.02$), but no differences were observed in aspiration, hospital and ICU LOS, or mortality (Table).

Conclusion: Continuing enteral feeding up until a surgical procedure in patients with a cuffed endotracheal tube/tracheostomy did not lead to more complications than in patients who were npo prior to surgery and could benefit the patient in reaching their daily nutrition goals.

Characteristics and Outcomes of Mechanically Ventilated, ICU Patients with Feeding Tubes prior to a Surgical Procedure (n=57)

| | Hospital A (n=18) | Hospital B (n=14) | Hospital C (n=19) | Hospital D (n=6) | p- value |
|--------------------------|----------------------|----------------------|----------------------|---------------------|-------------|
| Age | 52 (27-59) | 44 (33-58) | 61 (38-70) | 59 (56-67) | 0.51 |
| Male | 13 (72%) | 11 (79%) | 15 (80%) | 5 (83%) | 0.97 |
| ISS | 29 (17-38) | 18 (14-29) | 19 (13-24) | 30 (17-50) | 0.13 |
| Days with a feeding tube | 15 (9-20) | 22 (16-27) | 14 (9-21) | 14.5 (6-19) | 0.12 |
| Days on a ventilator | 11.5 (9-19) | 13.5 (10-17) | 12 (8-14) | 11 (5-21) | 0.83 |
| Aspiration | 1 (6%) | 1 (7%) | 3 (16%) | 0 (0%) | 0.78 |
| Any Pneumonia | 3 (18%) | 2 (14%) | 11 (58%) | 2 (33%) | 0.02 |
| Aspiration | 0 (0%) | 0 (0%) | 3 (27%) | 0 (0%) | |
| Ventilator Associated | 0 (0%) | 0 (0%) | 5 (45%) | 1 (33%) | |
| Hospital Acquired | 1 (33%) | 2 (100%) | 3 (27%) | 0 (0%) | |
| Community Acquired | 2 (67%) | 0 (0%) | 0 (0%) | 2 (67%) | |
| ICU Length of Stay | 15.5 (11-21) | 19.5 (13-28) | 15 (10-21) | 14.5 (11-21) | 0.37 |
| Hospital Length of Stay | 30.5 (17-50) | 27.5 (24-33) | 22 (15-27) | 18.5 (16-21) | 0.09 |
| In-hospital Mortality | 5 (28%) | 1 (7%) | 3 (16%) | 0 (0%) | 0.35 |

*Data are presented as n (%) or median (IQR)

The usefulness of diameter and collapse index of inferior vena cava as a clinical indicator of resuscitation for critically ill hypotensive patients.

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Introduction: Fluid therapy is one of the most important management for critically ill hypotensive patients. Diameter of inferior vena cava and collapse index (DCIIVC), how much it is collapsed during respiratory cycle that is checked by ultrasound, is known to reflect patient's intravascular volume status and fluid responsiveness well. We wanted to evaluate the clinical outcomes of using DCIIVC as a tool of point of care for resuscitation in critically ill hypotensive patients by prospective observational study. **Methods:** Hypotensive patients admitting to ICU between May 2017 and October 2017 were enrolled. The inclusion criteria were age between 17 and 70, systolic blood pressure < 90 mmHg and abnormal DCIIVC. DCIIVC group used DCIIVC as a guide for resuscitation until DCIIVC became normal. The total amount and infusion rate of resuscitation was 20 ml/kg and 300 ml/hour. In Non DCIIVC group fluid therapy was done by physician's decision. Clinical outcomes were compared. **Results:** Among 612 patients, 30 patients were allocated to each group. The average age of DCIIVC vs Non DCIIVC group was 64 vs 66 years old. Male and female ratio was 17:13 vs 19:11. Main causes of admission were pneumonia, exacerbation of chronic obstructive lung disease, cerebrovascular accident, post-major surgery, abdominal infection, major trauma, unknown hypotension, heart failure, Dengue fever, major burn and complication of liver cirrhosis. There were six major trauma patients; two epidural hematoma, one liver injury, one spleen injury, one pelvic bone fracture and one multiple long bone fracture. Injury severity score of each group was 17.2 vs 18.1. Mean systolic pressure at admission was 83 vs 81 mmHg. Mean diameter of IVC was 18.9 vs 18.3 mm. Mean collapse index of IVC was 67 vs 64%. Total amount of fluid input (TAFI) in 24 hours was 3,560 vs 4,130 ($p<0.05$). TAFI in 48 hours was 6,910 vs 8,420 ($p<0.01$). Lactate at admission, 24 hours and 48 hours after admission were 3.8 vs 4.1, 3.1 vs 3.2 and 2.1 vs 1.9 respectively. Mean duration of mechanical ventilation, ICU stay, hospital stay was 4.5 vs 4.1, 6.3 vs 7.2, 17.2 vs 18.1 respectively. Overall mortality was 13.3 vs 16.7 % (Table 2). Except TAFI, there was no statistical difference. **Conclusion:** DCIIVC can be checked easily and used as a tool of point of care of resuscitation for critically ill hypotensive patients. Using DCIIVC as a guide of resuscitation helps physician to infuse fluid restrictively without adverse outcomes.

| Characteristics | DCIIVC group (N=30) | Non DCIIVC group (N=30) | P |
|--|---------------------|-------------------------|-------|
| Total amount of fluid input in 24 hours (ml) | 3,560 | 4,130 | <0.05 |
| Total amount of fluid input in 48 hours (ml) | 6,910 | 8,420 | <0.01 |
| Lactate at admission (mmol/L) | 3.8(2.5-4.4) | 3.5(2.1-4.2) | NS |
| Lactate in 24 hours (mmol/L) | 3.1(2.1-3.2) | 3.2(2.2-3.6) | NS |
| Lactate in 48 hours (mmol/L) | 2.1(0.6-2.8) | 1.9(0.7-2.8) | NS |
| Duration of mechanical ventilation (days) | 4.5(1-14) | 4.1(1-11) | NS |
| Duration of ICU stay (days) | 6.3(2-21) | 7.2(2-19) | NS |
| Duration of hospital stay (days) | 17.2(7-35) | 18.1(11-45) | NS |
| Mortality (%) | 4(13.3) | 5(16.7) | NS |

Table 2. Clinical outcomes. DCIIVC diameter and collapse index of inferior vena cava; ICU intensive care unit;

THE POSITIVE PHYSICAL EXAMINATION DOES NOT ALWAYS INDICATE THE REQUIREMENT OF ENDOTRACHEAL TUBE INTUBATION IN PATIENTS WITH FACIAL BURN

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Introduction: The non-objective standards such as “physical examination”, “burn sites” as well as “clinical evaluation” are usually used to determine the necessity of airway protection for facial burn patients in the emergency department (ED). However, the possibility of unnecessary intubation or delayed dyspnea after admission exists. The objective criteria for airway protection of facial burn patients are required.

Methods: A large series of facial burn patients between January 2013 and May 2016 was reviewed. These patients’ findings of physical examinations and laboratory data were analyzed. All intubated patients received routine bronchoscopy for evaluation of the airway injury. The comparisons were performed in patients with and without proved airway injury. The reasons of intubation in patients without airway injury were also delineated.

Results: During the study period, there were 335 facial burn patients. A total of 121 patients received intubation in ED, 73 of them were later proved to have suffered airway injury by bronchoscopy. In other words, there were 40% (48/121) intubated patients without evidence of airway injury. Although patients with airway injury had significantly higher TBSA (27% vs. 9%), higher ISS (16 vs. 6), higher probability of positive physical examination and higher probability of abnormal laboratory test than patients without airway injury. Multivariate logistic regression revealed that only TBSA, injury severity score (ISS) and PH of arterial blood gas have independently relevance to necessity of airway protection. Elevation of one unit of TBSA and ISS independently results in elevation of intubation requirement at 2.8% and 11.9% respectively.

Conclusion: In the management of the patients with facial burn, the conventional indication which based on physical examination should be reconsidered. The TBSA and other associated injuries (ISS) play important roles in the decision of the patients who required endotracheal tube or not in ED.

Facial burn patients with and without airway injury (proved by bronchoscopy)

| | Airway injury | | | Multivariate logistic regression | |
|--------------------------------------|---------------|-----------------|---------------------|----------------------------------|------------------|
| | With (N=121) | Without (N=214) | <i>p</i> -value | Odds ratio | <i>p</i> -value* |
| SBP in ED (mmHg) | 154 | 155 | 0.652 [§] | - | - |
| GCS in ED | 14 | 15 | <0.001 [§] | - | 0.609 |
| TBSA (%) | 27 | 9 | <0.001 [§] | 1.028 | <0.05 |
| ISS | 16 | 6 | <0.001 [§] | 1.119 | <0.05 |
| Confined space (N, %) | 24(69%) | 11(31%) | <0.001 [#] | - | 0.091 |
| Laboratory test | | | | | |
| PH | 7.3 | 7.4 | <0.001 [§] | 0.025 | <0.05 |
| PaCO ₂ (mmHg) | 38.2 | 36.5 | 0.175 [§] | - | - |
| PaO ₂ (mmHg) | 157.7 | 93.5 | <0.001 [§] | - | 0.352 |
| Sat (%) | 90.5 | 96.4 | 0.315 [§] | - | - |
| HCO ₃ ⁻ (mm/L) | 21.2 | 23.4 | <0.001 [§] | - | 0.942 |
| HbO ₂ (%) | 88.4 | 89.7 | 0.537 [§] | - | - |
| HbCO ⁺ (%) | 3.4 | 2.2 | 0.08 [§] | - | - |

§ Student T test

Chi-square test

* Multivariate logistic regression

ECHO IS A GOOD, NOT PERFECT, MEASURE OF CARDIAC OUTPUT IN CRITICALLY ILL SURGICAL PATIENTS

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Introduction: Measurement of cardiac output (CO) is integral to the management of critically ill patients. In comparison to a pulmonary artery catheter (PAC) critical care transthoracic echo (TTE) has been shown to have excellent agreement in the measurement of CO in non-surgical populations. Our hypothesis is that the feasibility and accuracy of TTE CO relative to PAC is different in surgical and non-surgical patients.

Methods: Surgical Intensive Care Unit (ICU) patients (SP) with a PAC placed for hemodynamic monitoring and nonsurgical patients (NSP) undergoing PAC right heart catheterization in the echocardiography lab were prospectively enrolled. CO was measured simultaneously by PAC thermodilution and TTE. For TTE, pulsed wave Doppler of the left ventricular outflow tract (LVOT) velocity time integral (VTI) and LVOT diameter (LVOTd) are used to assess CO. Pearson coefficients are used to assess correlation. Bland-Altman analysis is used to determine agreement. Bias, limits of agreement (LOAs), and percentage error (PE) are determined.

Results: Over 18 month period 81 patients were enrolled (50 SP, 31 NSP). In SP CO be measured in 68% (34/50) vs 78% (26/38) $p < 0.002$ in NSP. Inability to measure LVOTd was the primary reason for failure to measure CO (15/16, 5/7, $p = 0.69$). VTI could be measured in all patients. The correlation between PAC and TTE measurement is strong in both groups; SP (r 0.76, $p < 0.001$), NSP (r 0.86, $p < 0.001$). In SP and NSP agreement was moderate and similar between groups. Bland-Altman analysis demonstrated a bias of -0.1 L/min, LOAs of -2.5 and 2.3 L/min, and PE of 40% for SP. For NSP Bland-Altman analysis demonstrated a bias of 0.4 L/min, LOAs of -1.8 and 2.5 L/min, and PE of 40%.

Conclusion: TTE demonstrates strong correlation and only moderate agreement in both surgical and non-surgical patients. The feasibility is lower in SP primarily because of inability to measure the LVOTd. Currently, it is reasonable to use TTE as a measure of CO in surgical ICU patients. Further research is needed to simplify, automate, and remove the need to measure LVOTd to advance the critical care TTE in the Surgical ICU.

MODULATION OF THE α -7 NICOTINIC ACETYLCHOLINE RECEPTOR CONTRIBUTES TO VARIABILITY IN THE HUMAN INFLAMMATORY RESPONSE TO INJURY

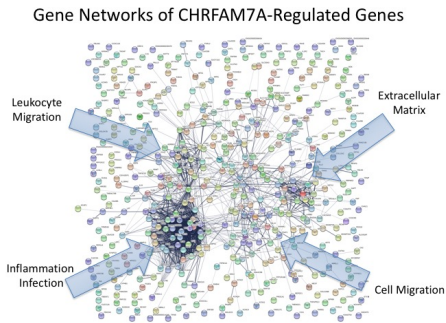
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Introduction: The α -7 nicotinic acetylcholine receptor (α 7nAChR), encoded by the CHRNA7 gene, mediates the anti-inflammatory response to injury. Only humans possess the CHRFAM7A gene that acts to inhibit α 7nAChR-mediated anti-inflammatory signaling. We have previously shown that there is significant individual variability in CHRFAM7A expression in human leukocytes. The ability of CHRFAM7A to alter the macrophage inflammatory response is unknown. Here, we hypothesized that expression of CHRFAM7A alters macrophage inflammatory gene expression.

Methods: THP-1 cells were differentiated with PMA and cultured to form mature macrophages *in vitro*. Lentiviral transfection of the human CHRFAM7A gene was performed prior to differentiation. CHRFAM7A expressing macrophages (n=6) were compared to vector macrophages (n=6) using RNA sequencing analysis for changes in global gene expression, clustering analysis, and enriched pathway analysis to identify changes in relevant biological pathways.

Results: CHRFAM7A expression in cultured macrophages altered the expression of over 5,000 genes. Heat map analysis demonstrated changes in global gene expression in CHRFAM7A transfected cells compared to vector. Gene expression pathways related to focal adhesion and cell-cell adhesion were most significantly upregulated in CHRFAM7A expressing cells. Clustering network analysis demonstrated that forced expression of CHRFAM7A regulates biological pathways related to inflammation, extracellular matrix, and leukocyte migration.

Conclusion: The uniquely-human gene CHRFAM7A alters macrophage gene expression in pathways related to the injury response. Based on human variability in CHRFAM7A expression, CHRFAM7A may contribute to individual variability in the inflammatory response to injury.



MULTIMODAL ANALGESIA DECREASES OPIOID USE IN CRITICALLY ILL TRAUMA PATIENTS

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Introduction: Opioids are the mainstay of treatment for pain in critically ill trauma patients. However, the risks of opioid use, including over-sedation, respiratory depression, and the development of chronic dependence, mandate a different approach. Multimodal analgesia employs a combination of narcotic and non-narcotic agents with different mechanisms that have synergistic effects in treating pain. This study examines the effect of implementing a multimodal pain management order set on the opioid requirements of critically ill trauma patients.

Methods: This was a pre-post cohort study of adult trauma ICU patients before and after the implementation of a multimodal pain management order set. The pre-group and post-group included consecutively admitted patients from September to December in 2015 and 2017, respectively. Patients were excluded if their hospital stay was less than five days, head abbreviated injury scale score was greater than one, or pre-injury medications included methadone or buprenorphine. The total oral morphine equivalent (OME) dose was calculated for each 24-hour period on the 2nd through 5th days of admission and the last 24 hours prior to discharge using standardized ratios.

Results: There were 65 patients in the pre-group and 62 in the post-group. There were no differences between groups in injury severity score (14.3 ± 1.2 vs 13.3 ± 1.3 , $p=0.58$), sequential organ failure assessment score (4.2 ± 0.4 vs 4.8 ± 0.4 , $p=0.29$), or number of surgeries within the initial five days of hospitalization (1 ± 0.1 vs 1 ± 0.2 , $p=0.74$). As shown in the table, patients on multimodal pain management had significantly lower median OME doses on hospital days two through five. There was also a trend towards significance in the 24-hour period prior to discharge. More patients in the post-group received scheduled acetaminophen, gabapentin, lidocaine patches, and methocarbamol compared to patients in the pre-group. There was a trend towards lower mean pain scores in the post-group during hospital day five (4.5 ± 0.3 vs 3.5 ± 0.4 , $p=0.06$) although there was no difference in mean pain scores at hospital discharge between the groups (3.4 ± 0.3 vs 3.6 ± 0.3 , $p=0.79$).

| | Median Oral Morphine Equivalent Dose, mg | | | | | Number of Patients on Multimodal Medication, n (%) | | | |
|----------------|--|--------|--------|-------|--------------------|--|------------|-----------------|---------------|
| | Day 2 | Day 3 | Day 4 | Day 5 | Prior to Discharge | Scheduled Acetaminophen | Gabapentin | Lidocaine Patch | Methocarbamol |
| Pre-Group | 114 | 114 | 100 | 105 | 47 | 21 (32%) | 12 (18%) | 6 (9%) | 0 (0%) |
| Post-Group | 40 | 33 | 26 | 30 | 30 | 59 (95%) | 38 (61%) | 34 (55%) | 8 (13%) |
| <i>p</i> Value | 0.006 | <0.001 | <0.001 | 0.017 | 0.067 | <0.001 | <0.001 | <0.001 | 0.003 |

Conclusion: The implementation of a multimodal pain management order set significantly reduced the total daily OME dose in critically ill trauma patients without compromising patient comfort. Multimodal analgesia is an important tool to reduce opioid exposure in this patient population.

THE ANTI-INFLAMMATORY EFFECT OF LMWF5A AND N-ACETYLY KYNURENINE ON MACROPHAGES: INVOLVEMENT OF ARYL HYDROCARBON RECEPTOR IN MECHANISM OF ACTION

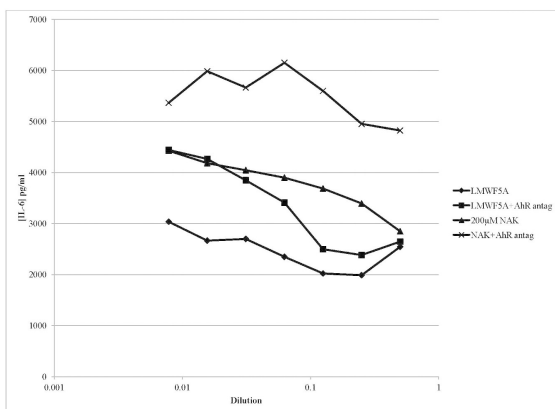
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Introduction: After a traumatic insult, macrophages can become activated leading to general inflammation at the site of injury. Activated macrophages are partially regulated by the aryl hydrocarbon receptor (AhR) which when activated suppresses inflammation by limiting the secretion of pro-inflammatory cytokines and promoting the over expression of immuno-modulatory mediators. This study aims to determine whether the low molecular weight fraction of 5% human serum albumin (LMWF5A) and N-acetyl kynurenine (NAK), a breakdown product in LMWF5A, can regulate inflammation by inhibiting macrophage activation through the AhR.

Methods: A human peripheral blood monocyte cell line (THP-1) was differentiated into macrophages using phorbol 12-myristate 13-acetate (PMA). After a 3 day differentiation period, macrophages were pre-treated with 2-fold dilutions of LMWF5A or synthetic NAK (200 μ M) with or without an AhR antagonist (10 μ M CH223191) for 1 hour prior to overnight stimulation with lipopolysaccharide (LPS). Supernatants were assayed by ELISA for the pro-inflammatory cytokines IL-6 and CXCL-10.

Results: THP-1 cells were differentiated for 3 days into macrophages as evidenced by adherence to tissue culture plates and other morphological changes such as increases in size and development of vesicles associated with phagocytosis. More importantly, treatment of LPS-stimulated, differentiated THP-1 cells with LMWF5A caused a 50-60% decrease in IL-6 release throughout the dilution series. A dose-response inhibition of IL-6 release was observed for NAK with maximal inhibition (50%) seen at the highest NAK concentration of 200 μ M. Finally, an AhR antagonist partially blocked the anti-inflammatory effect of LMWF5A while completely blocking the effect of NAK. A similar effect was observed for CXCL-10, but the AhR antagonist was not as effective suggesting additional mechanisms for CXCL-10 release.

Conclusion: These findings suggest that LMWF5A and a breakdown component (NAK) partially promote the suppression of activated macrophages via the AhR receptor. Known AhR agonists include kynurenine and kynurenic acid. Therefore, LMWF5A, which contains NAK, is potentially a useful therapeutic in medical conditions where inflammation is prevalent such as trauma, sepsis, and wound healing.



CERVICAL SPINE FRACTURES AND SWALLOWING DYSFUNCTION IN TRAUMA PATIENTS TREATED WITH SEMI-RIGID COLLARS: OUR INSTITUTIONAL EXPERIENCE

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Introduction: The decision to feed patients with cervical spine injuries necessitating cervical spine immobilization is something that each provider must decide. In this study, we set out to investigate the rates of dysphagia and aspiration in the presence of cervical spine semi-rigid collars. We hypothesize that the presence of cervical collars will increase the incidence of dysphagia and aspiration in patients with cervical spine injuries.

Methods: Trauma patients at a level 1 trauma center from January 1, 2013 – December 31, 2015 were analyzed retrospectively via the trauma registry. We included patients with isolated cervical spine injuries treated with semi-rigid cervical collar and evaluated by speech-language pathologist (SLP) for dysphagia and aspiration. This resulted in 319 patients. We excluded patient with head injuries, those less than 18years old, penetrating trauma, and gravid patients.

Results: Of the 319 patients with cervical spine fracture who met the inclusion criteria, 268(84%) were evaluated by SLP prior to collar removal. 158(62%) of patients meeting the inclusion criteria and were evaluated by SLP prior to collar removal were found to have dysphagia on evaluation. 37% of patients meeting the inclusion criteria and were evaluated by SLP prior to collar removal were found to have aspiration during evaluation. Dysphagia is associated with longer hospital stay ($p < 0.001$) and longer ICU stay ($p < 0.005$). Other variables associated with increased dysphagia and aspiration rates include increased age and injury severity score (ISS).

Conclusion: Patients with cervical spine fractures treated with semi-rigid cervical collars show high rate of dysphagia (62%) and aspiration (37%). This outlines the need for formal swallowing assessments in this population by SLP. In addition, as these resources can often be limited those patients with higher ISS and advanced age should be high priority for screening. If dysphagia and aspiration risk can be identified and mitigated sooner it is possible ICU and overall hospital length of stay could be affected.

USING ARTERIAL PRESSURE INDEX TO PREDICT ARTERIAL INJURIES IN PENETRATING TRAUMA TO THE UPPER EXTREMITIES

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Introduction: In trauma patients, arterial pressure indexes (API) are used to predict the need for computed tomography angiogram (CTA) to evaluate for lower extremity vascular injuries. Due to collateral circulation in the upper extremities (UE), the diagnostic algorithm for UE is less clear. We hypothesized that unlike its use in the lower extremities, API cannot be used to predict arterial injury in the UE.

Methods: A multi-institutional retrospective review of adults with penetrating UE trauma (defined as injury from the deltopectoral groove to wrists) and documented APIs from 2006 to 2016 was performed at three, urban, level I trauma centers. Patient demographics, injury severity score (ISS), APIs, CTA results, and operative findings were recorded. CTA was used as the gold standard and was considered positive for injury if thrombus, occlusion, dissection, extravasation, pseudoaneurysm or arteriovenous fistula (AVF) was identified. Sensitivity, specificity, positive and negative predictive values (PPV and NPV) of API <0.9 in detecting UE arterial injuries were calculated.

Results: 222 patients met inclusion criteria. 88.5% were male and median age was 27.5 years (IQR 22–37). Gunshot wounds comprised 76.6%, stab wounds 17.9%, and other mechanisms, such as dog bites, 5.5%. The median ISS was 9 (IQR 2–10) and median API was 1 (IQR 0.93-1). 35 (16.1%) patients had signs of vascular injury, 53 (24.3%) had associated fractures, and 26 (11.9%) had concomitant nerve or tendon injuries. Injuries seen on CTA included thrombus or occlusion (9.7%), transection (4.2%), dissection (2.8%), extravasation (1.4%), pseudoaneurysm (1.4%), or AVF (1.4%). Vascular injuries on operative exploration included ulnar (34.4%), brachial (25%), and radial artery (12.5%). Sensitivity and specificity of API <0.9 for identifying arterial injury was poor (69% and 69%, respectively).

Conclusion: API should be used with caution to determine arterial injury in UE after penetrating trauma.

Table 1. Sensitivity, specificity, PPV, NPV of API <0.9 in detecting named upper extremity arterial injuries

| | Sensitivity (95% CI) | Specificity (95% CI) | PPV (95% CI) | NPV (95% CI) |
|--------------------|----------------------|----------------------|------------------|------------------|
| All injuries, % | 69.2 (38.6-90.9) | 69.5 (56.1-80.8) | 33.3 (22.8-45.9) | 91.1 (81.7-95.9) |
| Brachial artery, % | 66.7 (9.4-99.2) | 63.8 (51.3-75) | 7.4 (3.3-15.9) | 97.8 (89.8-99.6) |
| Radial artery, % | 66.7 (9.4-99.2) | 63.8 (51.3-75) | 7.4 (3.3-15.9) | 97.8 (89.8-99.6) |
| Ulnar artery, % | 60 (14.7-94.7) | 64.2 (51.5-75.5) | 11.1 (5.4-21.5) | 95.6 (87.9-98.5) |

IN THEIR OWN WORDS: PERSPECTIVES FROM THE SENIOR VISITING SURGEON PROGRAM

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Introduction: In an effort to facilitate military and civilian collaboration, the American Association for Surgery of Trauma (AAST) and American College of Surgeons (ACS) developed the Senior Visiting Surgeons (SVS) Program. Civilian experts in trauma surgery worked alongside military surgeons at Landstuhl Regional Medical Center (LRMC) in Landstuhl, Germany. We attempted to elucidate and codify the benefits of the program through an oral history from the program's participants.

Methods: A qualitative study was conducted with civilian SVS and their military counterparts. Civilian surgeons were identified through the AAST/ACS database. Military surgeons were identified through interviews with civilian surgeons. A single semi-structured interview was conducted with SVS. All interviews were recorded. A thematic array was constructed and relevant themes were organized into categories.

Results: There were 46 SVS identified. Each visiting surgeon went to LRMC for an average of two weeks between 2006 and 2014. Eleven (24%) civilian surgeons agreed to be, and were, interviewed. Five military surgeons were also interviewed. Four common themes were identified through the civilian interviews. The first and most common was humility. Humility was best exemplified through the quote: "I thought I knew trauma but I was humbled but the efforts of the military given the catastrophic injuries". The second theme was admiration. "The young military surgeons and their teams were motivated and delivered high quality care". The third theme was identifying techniques which were taken and implemented into civilian practice. "I ended up adopting the blood transfusion strategies I saw in Landstuhl at my hospital". Finally there was a strong desire to do more for the military. "If they would have me, I would put on the uniform and serve". The military perspective was predominately one of appreciation for the support and input from the SVS. "It was great to have these well known surgeons there just helping out". A downside was the feeling that the SVS could occasionally disrupt the normal workflow.

Conclusion: The SVS program strengthened the historical relationship that has long existed between military and civilian surgeons and emphasized the importance of continued clinical collaboration. The program allowed the civilian surgeons to gain a better understanding of the challenges military surgeons face, fostered a sense of appreciation and resulted in valuable clinical exchanges. Sustaining the SVS program not only benefits military and civilian surgeons, but can help lead the way for future partnerships in direct support of the Misson Zero Act.

CHANGING OUTCOMES IN ABDOMINAL VASCULAR INJURIES OVER TIME

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Introduction: The incidence of major vascular injury in patients presenting with abdominal trauma ranges from 5% to 25% and is frequently the ultimate cause of death in this patient population. The management of abdominal vascular trauma is complex and is currently determined by both the severity of the injury and the anatomic location of the injured blood vessel. Furthermore, patients with an abdominal vascular injury oftentimes present hypotensive with significant physiologic derangements secondary to acute blood loss and numerous associated injuries. The purpose of this study was to evaluate the current epidemiology and management patterns of traumatic abdominal vascular injuries at an urban level I trauma center.

Methods: This was a retrospective chart review of all patients presenting to an urban level I trauma center with an injury to a named intra-abdominal blood vessel from 2009 to 2017. This cohort of patients was then compared to a previous cohort of patients from our institution who presented between 1989 and 1998. Data collected included demographics, type and location of injury, and management strategies. Outcome measures included mortality and post-operative complications.

Results: A total of 321 patients met inclusion criteria for this study. Of these, the vast majority of patients were male (261/321, 81.3%) and the average age was 34.8 ± 15.1 years of age. Overall mortality was 29.9% (96/321) and 33 patients (34.4%) died prior to definitive vascular repair. Similar to previously published data out of our institution, 40.5% (130/321) of patients presented with injuries to more than one named abdominal blood vessel. Within the current cohort, the incidence of various types of trauma included 177 gunshot wounds (55.1%), 62 motor vehicle crashes (19.3%), and 32 stab wounds (10.0%). The most common post-operative complications included pneumonia (74/321, 23.1%), organ space infections (60/321, 18.9%), and sepsis (56/321, 17.4%). The most commonly injured vessels continue to include the inferior vena cava (77/508, 15.2%), common iliac vein (49/508, 9.6%), aorta (43/508, 8.5%), and external iliac vein (30/508, 5.9%). When considering trends in mortality over time, patients in the current cohort who presented with an arterial injury demonstrated an improvement in survival (69.4% vs. 46.0%) whereas patients with venous injuries have demonstrated similar survival over time (65.6% vs. 64.0%). Interestingly, while there are similar rates of exsanguination prior to repair in arterial injuries (10.2% vs. 13.3%), venous injuries appear to be associated with an increase in death prior to repair in the current cohort (12.8% vs. 5.0%).

Conclusion: To our knowledge, this represents one of the largest reviews of intra-abdominal vascular trauma in the current era. Although intra-abdominal vascular injuries remain a significant source of morbidity within the trauma population, mortality from these injuries appears to be improving over time, a trend which may be the result of both improved pre-hospital care and resuscitation practices.

MAJOR VENOUS INJURY AND LARGE VOLUME CRYSTALLOID RESUSCITATION: A LIMB THREATENING COMBINATION

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Introduction: After major venous injury (MVI), there is still a risk of late compartment syndrome (LCS). The contribution of intraoperative resuscitative efforts in patients with hemorrhagic shock to the development of LCS are not well defined. We hypothesized that initial hemodynamic instability, intraoperative large volume crystalloid resuscitation (LVR) or massive transfusion (MT) does not increase the risk of LCS or amputation after MVI.

Methods: We conducted a multi-institutional retrospective review of patients with injury to the Inferior Vena Cava, External Iliac Vein, Common Iliac Vein and/or Femoral Vein from 2005-2015 at seven centers. The outcome of interest was the development of LCS and need for amputation

Results: 478 patients met inclusion criteria. 214 (44.8%) patients underwent lower leg fasciotomy at the index procedure of which 107 (50%) had LVR, 97 (45.3%) had MT, 99 (46.3%) had an abnormal heart rate, and 76 (35.5%) were hypotensive. LCS of the lower leg occurred in 26 (9.8%) of the remaining 264 patients. LVR (OR=1.55, p=0.39), MT (OR=1.03, p=1.00), abnormal HR (OR=1.39, p=0.49), and hypotension (OR=1.03, p=1.00) did not significantly increase risk for LCS. Only non-African American race (OR=2.95, p=0.01) was found to be a predictor of LCS. Overall, 31 patients with MVI required amputation. LVR (p<0.001), combined arterial/venous injury (p=0.001), and associated fracture (p=0.001) were individual risk factors for amputation, while penetrating wound and abnormal HR were implicated as well (p=0.06 and 0.09, respectively). MT was not shown to increase risk (p=0.44). A multiple logistic regression model demonstrated that patients receiving LVR (OR (95% CI): 9.7 (2.9-33.0); p<0.001), with combined arterial/venous injury (3.6 (1.4-9.2); p=0.006), and with an associated fracture (3.2 (1.4-7.1); p=0.004) were more likely to require amputation.

Conclusion: Patients presenting in hemorrhagic shock, or who undergo LVR or MT do not have a significantly increased risk of LCS after MVI. Patients who receive LVR, have combined arterial/venous injuries and have associated fractures are more likely to require amputation. Further prospective studies are warranted to clarify the role of resuscitation in the development of LCS.

THE SIXTY MINUTE MYTH OF FIRST PHASE DAMAGE CONTROL SURGERY

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Introduction: Damage Control Surgery (DCS) traditionally involves limiting operating room (OR) time for patients with multiple life-threatening injuries and coagulopathy who are reaching physiologic exhaustion. However, in the modern era of hemostatic resuscitation, there is a paucity of evidence to support a survival benefit with shorter OR times. The objective of this study was to determine the practice habits of trauma surgeons in the modern era of DCS and to determine if operation length affects mortality in trauma patients with abdominal injuries.

Methods: An 8-year retrospective review of consecutive adult patients with DCS for penetrating abdominal trauma at a Level I trauma center was conducted. Patient demographics, injury severity score (ISS), and penetrating abdominal trauma index (PATI) scores were obtained. Average operating room times for initial DCS were determined. Patient outcomes were analyzed with a t test for univariate analysis and a Cox proportional hazard ratio modeling was used to predict factors for survival.

Results: A total of 193 patients were identified. The majority of patients were male with penetrating trauma. Overall mortality was 14.0% (n=27/193). Average OR time was 168.7 min (range, 59-573 min). One patient had an initial DCS that was less than 60 min. Only 2.1% patients (n=4/193) had missed injuries with an average OR time of 117.5 min (range 86-157 min) for this group. In addition, 13.0% patients (n=25/193) had an early, unexpected return to the OR. On multivariate analysis, OR time was not an independent risk factor for mortality (OR 1.0, 95%CI 0.98-1.0, p=0.48).

Table 1. Patient demographics and outcomes for patients with first phase damage control surgery

| | Alive (n = 166) | Dead (n = 27) | p |
|------------------------------------|--------------------|-------------------|---------|
| Demographics | | | |
| Age, median (IQR) | 27 (23-36) | 33 (26-40) | 0.19 |
| Male sex, n (%) | 148 (89.2) | 25 (92.6) | 0.75 |
| PATI, median (IQR) | 25 (15-41) | 29 (20.8-41.3) | 0.17 |
| ISS, median (IQR) | 22 (16-33) | 25 (18.5-33.5) | 0.07 |
| Initial SBP, median (IQR) | 113.5 (100-136) | 88.5 (66.8-111.8) | 0.96 |
| Shock Index at admit, median (IQR) | 0.9 (0.7-1.2) | 1.2 (0.9-1.9) | 0.001 |
| Outcomes | | | |
| Missed injury, n (%) | 4 (2.4) | 0 | <0.0001 |
| Early return to OR, n (%) | 18 (10.8) | 7 (25.9) | 0.06 |
| PRBCs in OR, median (IQR) | 5.0 (0.7) | 11 (6.5-23) | <0.0001 |
| OR time (minutes), median (IQR) | 157 (124.8-201.3) | 167 (136-193) | 0.96 |

Conclusion: Modern damage control practices should focus on early surgical hemorrhage control in combination with effective intra-op resuscitation efforts and not on the amount of time required to accomplish resuscitative goals. These findings suggest that in the era of modern DCS, the old tenet of 60 minutes may not be applicable to the updated era of trauma surgery and hemostatic resuscitation.

STOP THE BLEED: A “GAP” ANALYSIS AND GEOGRAPHICAL EVALUATION OF INCIDENT LOCATIONS

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Introduction: Stop the Bleed (STB) is a national campaign to encourage bystanders to become trained, equipped, and empowered to help in a bleeding emergency. STB training discusses mass casualty events while also recognizing the benefit to those injured in more usual circumstances. The aim of this study was 1) to conduct a gap analysis to determine potential benefit from STB interventions on a day-to-day basis; and 2) to conduct a geographical analysis of a major metropolitan area, to determine whether such incidents might be clustered, facilitating the prioritization of training and locating of kits.

Methods: We performed a retrospective analysis of trauma registry and medical examiners' data from a single county, 2013-2017. Incidents potentially amenable to STB were defined in terms of full (7-digit, pre- and post-dot) AIS codes. Medical examiners' data were reviewed manually to identify prehospital fatalities who might have survived if STB interventions had been applied. Incident location data and, where not available, place of residence, were geocoded by ZIP code area, and analyzed using QGIS, an open-source geographical information systems software package.

Results: We identified 159 patients who were admitted to our level I trauma center, who might have benefitted from STB. 101 had suffered blunt trauma, and 58 penetrating injuries. 137 survived to discharge, and 22 died in hospital. 12 patients with injuries potentially amenable to STB died prior to accessing the trauma system. In total, approximately 3 patients per month could benefit from STB intervention. Geographical analysis was limited by small numbers of incidents per area, but did not reveal evidence of clustering.

Conclusion: Aside from preparation for mass casualty events, STB training can potentially benefit the community for isolated incidents associated with bleeding. The number of patients who could benefit from STB, in this analysis, is relatively small. Furthermore, the locations of these incidents did not show evidence of geographical clustering, although the small number of incidents per area precluded a formal geostatistical analysis. This analysis could be used by other communities to determine if this information would inform STB activities.

NARROW PULSE PRESSURE IS INDEPENDENTLY ASSOCIATED WITH MASSIVE TRANSFUSION AND EMERGENT SURGERY IN HEMODYNAMICALLY STABLE TRAUMA PATIENTS

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Introduction: ATLS® considers narrow pulse pressure (NPP) a sign of Class-II hemorrhage and a precursor of hemodynamic instability. However, the true clinical implication of NPP in hemodynamically stable trauma patients remains unknown. We hypothesized that NPP is associated with massive transfusion and the need for emergent surgery in hemodynamically stable trauma patients.

Methods: All hemodynamically stable (systolic blood pressure ≥ 90 mmHg) trauma patients admitted to our Level-I trauma center (2010-2016) were reviewed. Patients with NPP (< 40 mmHg) at presentation were compared to those with normal pulse pressure (≥ 40 mmHg). Primary outcomes were need for massive transfusion (≥ 10 units) and emergent cavitory surgery.

Results: Over 7 years, 18,978 hemodynamically stable trauma patients were admitted and 13% (2,486) had NPP. NPP patients more often required massive transfusion (5% vs. 1%, $p < 0.0001$), emergent surgery (7% vs. 2%, $p < 0.0001$), and the combination of both (3% vs. 0.4%, $p < 0.0001$). NPP patients had higher mortality (4% vs. 2%, $p < 0.0001$) and longer hospital stay (7 vs. 5 days, $p < 0.0001$) and ICU stay (1.4 vs. 0.75 days, $p < 0.0001$). After logistic regression controlling for age, gender, mechanism, ISS, and GCS, NPP was independently associated with massive transfusion, emergent surgery, and the combination of both.

Conclusion: In hemodynamically stable trauma patients, a narrowed pulse pressure at presentation is independently associated with a three-fold increase in the need for massive transfusion and two-fold increase in emergent surgery need.

SHOULD ALBUMIN SOLUTION BE CONSIDERED AS AN ALTERNATIVE FLUID FOR PREHOSPITAL RESUSCITATION IN AUSTERE MILITARY ENVIRONMENTS?

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Introduction: Damage control resuscitation (DCR) goals include control of hemorrhage and hemostatic resuscitation (HR); i.e. early administration of blood or blood components (1:1:1 ratio) to increase blood pressure to a permissible hypotensive level for treating hemorrhagic shock. The in-hospital DCR protocol has been extended to prehospital care for treating combat casualties. We studied the advantages of HR using blood or plasma vs albumin in surviving rabbits subjected to severe hemorrhagic shock (HS).

Methods: Laparotomy (soft tissue trauma) was performed on IV-anesthetized spontaneously breathing NZW rabbits (3.1-3.5 kg). Next, 40% of circulating blood volume was removed from a venous line to produce HS (MAP=20-25 mmHg). 15 min later, rabbits were randomly resuscitated with a small volume (12.5 ml/kg) of rabbit fresh whole blood (FWB), rabbit thawed plasma (FFP), or 5% human albumin solution (ALB) to a hypotensive target pressure (MAP) of 60 mmHg (n=9/grp) and monitored for 2hr (i.e., prehospital period). Subsequently, animals received full resuscitation using autologous blood and LR, surgically repaired, recovered and assessed over 1 week. An untreated control group (no fluid, n=6) was also included. Blood samples were collected at baseline, post-HS, post HR, day 0, 2, 4 and 8 post-operatively and analyzed for ABG, CBC, chemistry and coagulation values. Tissue samples were collected and examined histologically.

Results: Following hemorrhage lactate and base deficit levels were increased to 9.2 ± 0.3 and 12.2 ± 2.5 mM, respectively (i.e. class III/IV shock) with no difference among groups. FWB resuscitation required less volume to raise MAP to 60 mmHg ($p < 0.05$ vs. albumin) and similar to FFP, but unlike albumin MAP gradually declined during the 2hr prehospital period. FWB administration also resulted in a higher % hematocrit but this advantage did not treat shock faster than other fluids. Changes in coagulation measurements (PT, aPTT, fibrinogen, and bleeding time) after surgery indicated a mild hypocoagulation that was more evident in the ALB group. Untreated rabbits all died within two hrs after hemorrhage. The resuscitated rabbits lived overnight but 2 of 9 in each group had to be euthanized on day 1 due to poor recovery associated with abnormal blood chemistry and histological evidence of multiple organ failure. All other rabbits recovered well and had normal blood tests and histology at 1 week.

Conclusion: In this model of hemorrhagic shock with 2hr of prehospital hypotensive resuscitation, no clinically significant advantage was found between early resuscitation with rabbit blood or plasma versus a human albumin solution that is readily available, stable at room temperature and compatible with all blood types. Albumin solution deserves a consideration.

THE IMPACT OF PRE-HOSPITAL TOURNIQUET USE ON RESUSCITATION IN EXTREMITY ARTERIAL TRAUMA

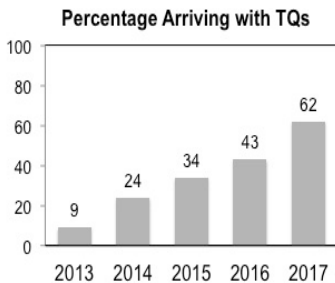
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Introduction: This study evaluated if pre-hospital tourniquet placement altered the initial management and transfusion needs in peripheral arterial injuries.

Methods: Extremity arterial injuries were queried from our Level I Trauma Center registry from 2013-17. Groups were defined by pre-hospital tourniquet use (TQ+) or not (TQ-) and location of injury, upper (UE) versus lower extremity (LE). Variables included tourniquet duration, initial heart rate (HR), systolic blood pressure (SBP), hematocrit and severity scores. The primary outcome was transfusion within the first 24 hours, with secondary outcomes of morbidity (rhabdomyolysis, acute kidney injury, compartment syndrome), amputation (initial vs. delayed) and length of stay (LOS). Statistical tests included t-test and Chi-square for continuous and categorical variables, respectively, with $p < 0.05$ significant.

Results: Injuries occurred in 192 patients with 152 (79%) males at a mean age 35.9 ± 14.4 years. TQs were placed in 69 (36%) for 78 ± 52 minutes. TQ use increased significantly over time. TQ+ had higher initial HR, AIS extremity score (3.2 vs. 3.0, $p = 0.03$), MESS score (5.8 vs. 5.1, $p = 0.02$) and more near amputations (30% vs. 17%, $p = 0.03$). Despite similar admission hematocrit, more of the TQ+ required transfusion. TQ+ had more initial amputations; however delayed amputations, complications and LOS were not different. UE injuries occurred in 100 with 43 (43%) having TQs in place for 72 ± 44 minutes. TQ+ had higher admission HR (112 vs. 99, $p < 0.01$) and more initial amputations (12% vs. 0, $p < 0.01$). Transfusions, LOS and morbidity were not different. Ninety-two had LE injuries with 26 (28%) having TQ for 88 ± 64 minutes. TQ+ had higher MESS scores (6.8 vs. 5.6, $p = 0.01$), more initial amputations (42% vs. 9%, $p < 0.01$), higher frequency of transfusion (77% vs. 53%, $p = 0.04$) and longer LOS. Frequency of morbidity and mortality was not different in TQ+.

Conclusion: Limbs receiving TQs had more severe injuries (higher injury scores, near amputations and increased HR), required a higher frequency (but not volume) of blood transfusion and initial amputation, without an increase in complications. The equivalent complication and mortality rates, despite higher injury severity supports the field application of TQs in severe extremity trauma.



| | TQ+ (n=69) | TQ- (n=123) |
|-------------------------------|------------|-------------|
| HR (bpm) * | 110±29 | 100±25 |
| SBP (mmHg) | 126±32 | 129±24 |
| Hematocrit (%) | 37.0±7.5 | 37.4±5.7 |
| Received transfusion, n (%) * | 46 (67) | 59 (48) |
| pRBCs (units) | 3.5±4.1 | 2.6±5.4 |
| Initial amputation, n (%) ** | 16 (23) | 6 (5) |
| Delayed amputation, n (%) | 6 (9) | 14 (11) |
| Hospital-free days (30d) | 17.4±10.0 | 19.4±8.9 |
| ICU-free days (30d) | 25.8±5.6 | 26.3±5.0 |

* $p < 0.05$ ** $p < 0.01$

DEFINING INDICATIONS FOR MASSIVE TRANSFUSION: NOT AS SIMPLE AS LEARNING YOUR ABCS

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Introduction: Massive transfusion protocols (MTP) have been developed to expedite treatment of substantial hemorrhage. However predicting who will require MTP can be elusive. Recently, the Trauma Quality Improvement Program has added an Assessment of Blood Consumption Score (ABCs) ≥ 2 to the triggers to initiate MTP. We hypothesize that this addition will lead to overuse of MTP activation without significant improvement in patient identification.

Methods: A retrospective review was performed of adult trauma patients with ISS >15 presenting to our trauma center over 2 years. ABC was computed and transfusion needs were assessed for the first 24 hours. Massive transfusion (MT) was defined as needing ≥ 10 units packed red blood cells (PRBC) in the first 24 hours.

Results: 380 patients met inclusion criteria of which 35 (9%) required MT. Prior triggers for MTP including transfusion in the emergency room, persistent hemodynamic instability, or active bleeding requiring intervention identified 30 patients (86%) who required MT. The addition of ABCs ≥ 2 identified one additional patient who required MT and 41 patients who did not, including 16 patients that required no PRBCs during the first 24 hours. Overall, the positive predictive value of ABCs ≥ 2 in identifying patients needing MT was only 39%. In addition, it failed to identify 9 of the 35 patients (26%) who ultimately requiring MT.

Conclusion: Use of ABCs ≥ 2 as a trigger for MTP will lead to a high over triage rate without significant improvement in patient selection over previously defined indications.

TRANEXAMIC ACID SUPPRESSES THE RELEASE OF mtDNA AND ACTIVATION OF THE CALCIUM SENSING ENZYME CaMKII IN HUMAN PLATELETS

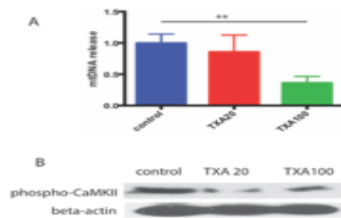
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Introduction: Activated platelets are a major source of Damage Associated Molecular Patterns (DAMPs) particularly mitochondrial DNA (mtDNA). Released systemically during and after hemorrhagic shock, DAMPs are responsible for the development of the endotheliopathy of trauma and the associated release of pro-inflammatory cytokines. Tranexamic acid (TXA), a known anti-fibrinolytic used to ameliorate the effects of hemorrhagic shock, has a host of additional functions such as the release of anti-inflammatory cytokines. We hypothesized that TXA may prevent activation of platelets by inhibiting the calcium sensing enzyme CaMKII and limiting the damage caused by DAMPs release into the systemic circulation.

Methods: Platelet-rich plasma devoid of leukocytes and erythrocytes was prepared from the blood of a healthy donor by low speed centrifugation. It was incubated for 2h at 37°C in presence or absence of TXA at 20 or 100 mg/ml. Platelets were then precipitated by high-speed centrifugation. MtDNA content in platelet-free plasma was determined by qPCR. Electrophoresis and Western blotting were applied to detect the phosphorylation of stress signaling kinases p38, MAPK and JNK, and the calcium sensing enzyme CaMKII in platelets.

Results: TXA at 100 mg/ml strongly suppressed the release of mtDNA from platelets. Both concentrations of TXA significantly decreased the phosphorylation of CaMKII (Figures A and B) but did not change the phosphorylation of p38 MAPK and JNK (data not shown).

Conclusions: The observed TXA-induced suppression of mtDNA release from platelets and the decreased phosphorylation of CaMKII, the enzyme involved in platelet activation, increases our knowledge of the method of action of TXA in hemorrhagic shock. Additional studies are necessary to fully elucidate the signaling pathways upon which TXA acts, thereby advancing understanding of the various potential uses of TXA in the critically injured and ill patient.



EMPIRIC USE OF TRANEXAMIC ACID HAS NO BENEFIT IN URGENT ORTHOPEDIC TRAUMA CASES.

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Introduction: The orthopedic literature has demonstrated a significant decrease in post-operative transfusion requirements when tranexamic acid (TXA) is given during elective joint arthroplasty. In some institutions, this practice has spread with empiric administration of TXA during semi-urgent orthopedic procedures in injured patients. Injured patients are at elevated risk of venous thromboembolic events (VTE) and no literature exists regarding the use of TXA in this manner, in this patient population. The purpose of this study was to evaluate the empiric use of TXA in semi-urgent orthopedic procedures. The hypothesis was that TXA would be associated with increased rates of VTE and have no effect on transfusion requirements.

Methods: Patients who empirically received TXA during a semi-urgent orthopedic or spine surgery following injury (TXA+) from 2014-2016 were matched using propensity score matching to historical controls (CONTROL) from 2011-2013 who did not receive TXA. Data were collected regarding injury characteristics, TXA administration, operative details and incidence of VTE. Outcome variables included incidence of VTE within 6 months of injury and packed red blood cell (PRBC) utilization. Multivariable logistic regression was used to determine odds of VTE and transfusion. A $p \leq 0.05$ was considered significant.

Results: 200 patients were included in each group. There were no differences between groups regarding age, ISS, extremity AIS, gender or mechanism of injury. CONTROLS had a significantly shorter ICU and hospital length of stay compared to TXA+. There was no difference in mortality between groups (Table 1). There was no increase in VTE in TXA+ patients with logistic regression (OR 0.804 95% CI 0.310, 2.087). However, TXA+ patients had a significantly

higher odds of being transfused during their hospital stay (OR 1.757 95% CI 1.057, 2.920) when controlling for fracture site, ISS, admission directly to the OR, need for damage control, use of a tourniquet in surgery and total number of surgeries needed. Overall transfusion was also significantly higher in the TXA+ group (CONTROL 0 units (IQR 0, 3) vs TXA+ 2 units (IQR 0, 5), $p \leq 0.0001$).

Conclusion: The empiric use of TXA in semi-urgent orthopedic and spinal surgeries did not increase the odds of VTE, the incidence of which was low. Despite the elective literature, TXA+ patients had a significantly higher odds of transfusion compared to controls and received a significantly higher volume of PRBCs compared to control. While VTE risk is static, lack of a benefit related to transfusion needs would indicate that empiric TXA use is not indicated in injured patients.

Table 1. Cohort characteristics

| | CONTROL | TXA+ | p-value |
|----------------------------|---------------------|---------------------|---------|
| Age (years)* | 51.4 (21.4) | 49.8 (20.9) | 0.4344 |
| BMI* | 28.7 (23.95, 34.05) | 28.60 (25.3, 34.15) | 0.4514 |
| Gender (% male) | 53.5% | 57% | 0.5463 |
| Mech. (% blunt) | 3.5% | 1.5% | 0.3375 |
| ISS* | 10 (9, 22) | 12.5 (9, 22) | 0.1590 |
| Extremity AIS* | 2.49(0.9) | 2.64 (1.01) | 0.1177 |
| Total PRBC† | 0 (0, 3) | 2 (0, 5) | <0.0001 |
| Total FFP† | 0 (0, 0) | 0 (0, 0) | 0.0082 |
| Total Platelets† | 0 (0, 0) | 0 (0, 0) | 0.0018 |
| Massive transfusion (%) | 2% | 4.5% | 0.2589 |
| Damage control surgery (%) | 10% | 11.62% | 0.6312 |
| Hospital LOS† | 6 (3, 10) | 7 (4.5, 12) | 0.0006 |
| ICU LOS† | 0 (0, 3) | 0 (0, 5) | 0.0191 |
| Mortality (%) | 0% | 1% | 0.4987 |

* mean with standard deviation † median with interquartile ranges

ALL FIBRINOLYSIS IS NOT CREATED EQUAL – MORTALITY DIFFERENCES ACROSS THE SPECTRUM

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Introduction: The discovery of increased mortality associated with hypofibrinolysis with thromboelastography (TEG) has altered our perception of the spectrum of fibrinolysis. However, this has not been identified with rotational thromboelastometry (ROTEM). Previous studies have also identified subtypes of hyperfibrinolysis. However, no single study has examined the mortality rates of the full fibrinolytic spectrum. Our aim is to describe the distribution of fibrinolysis, as measured by ROTEM; and identify associated mortality rates.

Methods: Clinical and thromboelastometry data were analyzed on trauma patients evaluated at an urban, Level 1 trauma center from May 2014 to May 2017. ROTEM analysis was performed during initial evaluation and resuscitation. Hyperfibrinolysis (HF) was defined as maximum lysis >15% in EXTEM and an enzymatic fibrinolysis index (EFI) greater 10%. Fulminant HF occurs in less than 20 min, intermediate at 21-40 min, late at 41-60 min.

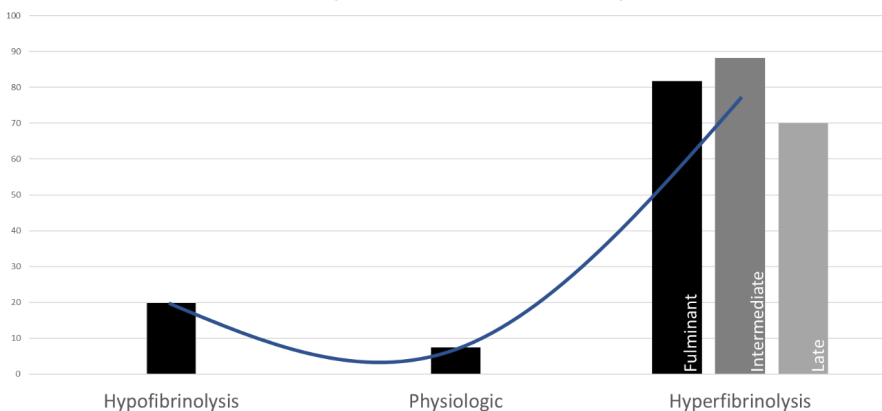
Descriptive statistics were compared using Chi-square analysis and the Kruskal-Wallis test for categorical and continuous variables, respectively. Kaplan-Meier survival curves were compared using the log-rank and Wilcoxon tests.

Results: ROTEM results from 1053 patients were included in our study, 40 patients were excluded due to incomplete ROTEM assay data. Median age was 38 years (IQR 26-55), 76.5% were male and 22.1% had penetrating injuries. Median ISS was 17 (IQR 9-27). 61 patients had EXTEM ML >15%, and HF was confirmed by EFI in 58 patients.

Using a receiver operating characteristic curve with mortality as outcome the cutoff for hypofibrinolysis was defined as maximum lysis on EXTEM < 3%. Distribution of fibrinolysis was: hypofibrinolysis, 28.6%; physiologic, 65.7%; and hyperfibrinolysis, 5.7%. Mortality was significantly different between the groups: 20.0%, 7.4% and 77.6%; respectively, at 28 days post-hospitalization ($p < 0.0001$). Among the hyperfibrinolysis subtypes, a significant difference in survival was found in a Kaplan-Meier curve. Mortality for fulminant, intermediate and late HF was 81.8%, 88.2% and 70%, respectively ($p = 0.0223$).

Conclusion: Different mortality rates are found across the spectrum of the fibrinolytic pathway. Similar to the TEG results, we found that ROTEM can detect a unique entity of hypofibrinolysis that has an increased mortality and can easily be differentiated from physiologic and hyperfibrinolytic states. Furthermore, among hyperfibrinolysis subtypes, there are significant mortality differences. These results have significant implications in the treatment of severely injured patients and suggest potential different biologic mechanisms exist within the fibrinolytic pathways.

Mortality Distribution in Fibrinolysis



EARLY CHEMOPROPHYLAXIS FOLLOWING TRAUMATIC BRAIN INJURY DOES NOT INCREASE MORBIDITY

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Introduction: There is no standard of care regarding timing to initiation of pharmacologic prophylaxis for venous thromboembolism (VTE) in traumatic brain injury (TBI) patients. The aim of this study is to evaluate the safety of an early strategy for start of VTE chemoprophylaxis in a select cohort of TBI patients. We hypothesize that early administration is safe.

Methods: A retrospective study was performed at two Level 1 Trauma Centers. Inclusion criteria included: age 18 years or older, blunt mechanism of injury, and head Abbreviated Injury Score (AIS) > 1. Exclusion criteria included craniectomy prior to 24 hours, progression of bleed on 6 hour follow-up CT scan, and patients that did not have a follow-up head CT. Patients were divided in early (≤ 24 hours) and late (> 24 hours) cohorts based on time to initiation of chemoprophylaxis. Progression of bleed was the primary outcome. Secondary outcomes included need for craniectomy, incidence of VTE, and mortality. Multivariate regression testing was performed to control for age, head AIS, and ISS.

Results: 289 patients were enrolled (table 1). Chemoprophylaxis used was 30 % vs 70% heparin vs low molecular weight heparin, respectively. Progression of bleed after VTE chemoprophylaxis administration was 4.5 % in the early group vs 7 % in the late group ($p=0.5$). Craniectomy rate after 24 hours was 2.8% vs 15.9% (Odds Ratio 0.2, Confidence Interval 0.04-0.5, $p < 0.01$) in the early vs late group, respectively. There were no VTE events in the early group vs 2.8% in the late group ($p=0.08$). There was no difference in mortality.

Conclusion: Early initiation of VTE chemoprophylaxis is safe in TBI patients with a stable head CT 6 hours following injury. Delay in start of chemoprophylaxis may be associated with an increased VTE risk.

Table 1: Demographics

| | <24 (n=107) | >=24 (n=182) | p-value |
|----------|-------------------|-------------------|---------|
| Age | 55.20 \pm 21.71 | 58.79 \pm 21.56 | 0.1739 |
| ISS | 15.43 \pm 7.47 | 18.41 \pm 8.57 | 0.0030 |
| Head AIS | 3.36 \pm 0.87 | 3.57 \pm 0.94 | 0.0527 |

EVOLVING PRACTICE PATTERNS IN THE USE OF PHARMACOLOGIC VENOUS THROMBOEMBOLISM PROPHYLAXIS AFTER BLUNT SOLID ORGAN INJURY

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Introduction: The use of pharmacologic venous thromboembolism (VTE) prophylaxis in patients undergoing non-operative management for blunt solid organ injury (BSOI) must balance the risk of bleeding with that of VTE. Prior studies have examined the safety of VTE prophylaxis at 48 and 72 hours, but limited evidence exists regarding earlier administration. Despite its role in prevention of VTE, guidelines for the administration of VTE prophylaxis in BSOI remain unclear. We sought to answer if standardized practice management guidelines (PMG) existed, if these PMG recommendations differ from what is practiced clinically and if there is a trend toward earlier VTE prophylaxis without an increase in failure of non-operative management.

Methods: A nationwide sampling of PMG for VTE prophylaxis after BSOI were compiled and the recommended timing of prophylaxis was compared with clinical data reported through the Trauma Quality Improvement Program (TQIP) database from 2013-2016. Adult patients with blunt injury to the spleen, liver or kidney undergoing initial non-operative management without concomitant TBI or pre-hospital anticoagulation were included. Timing of VTE prophylaxis and need for intervention related to the BSOI were the outcomes of interest. Data was analyzed using chi-squared, ANOVA single factor analysis, and two sample t-tests.

Results: Institutional guidelines were solicited from 31 level I trauma centers nationwide. 26 institutions responded of which 12 (46%) had no formal PMG. The remainder had a wide range of practices from immediate initiation to initiation after 48 hours with evidence of stable hemoglobin. 22,549 patients met inclusion criteria in the TQIP database. There was a statistically significant increase in the percentage of patients receiving VTE prophylaxis before 24 hours from 23% in 2013 to 26% in 2016 ($p=0.003$). There was a significant decrease in the mean time to VTE prophylaxis initiation from 66 hours in 2013 to 53 hours in 2016 ($p < 0.001$). Earlier administration (< 24 hours) did not increase the rate of failure of non-operative management ($p < 0.001$).

Conclusion: Since 2013, there has been a significant trend toward earlier administration of VTE prophylaxis in patients undergoing non-operative management for BSOI, though institutional guidelines vary widely. With an increasing percentage of patients receiving VTE prophylaxis at < 24 hours, there is a need for a multi-institutional trial directly examining optimal timing for VTE prophylaxis in this population.

TRAUMA INDUCED PLATELET DYSFUNCTION IS NOT CORRECTED BY TRANSFUSION

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Introduction: Although trauma induced coagulopathy is a common problem following severe injury, the contribution of platelet dysfunction (PD) remains unclear. We hypothesize that while PD frequently occurs following trauma and persists despite platelet transfusion, it does not impact outcome.

Methods: Trauma patients ≥ 18 years old were evaluated between March and December 2017. Only patients with injuries requiring ICU admission were included. Blood samples were collected on arrival (T0), at 3h (T3), 6h (T6), 12h (T12), and 24h (T24) and assayed by thromboelastography and platelet mapping (Haemonetics TEG6s). Patient demographics, anti-platelet therapy, mechanism of injury (MOI), ISS platelet count, blood products transfused, length of stay, and mortality were recorded. Mann-Whitney, Chi-square, and Spearman's tests were used where appropriate, ($P < 0.05$, significant).

Results: Forty-eight patients were enrolled with demographics as described in the table. 53.5% of patients had low MA at T0, which peaked at T3 (81.1%). During the first 24 hours, when maximally stimulated with thrombin (HKH MA), only 18 pts demonstrated platelet inhibition whereas 38 demonstrated ADP pathway inhibition (ADP MA). ISS and ADP MA were negatively correlated at T3 ($r_s = -0.353$, $p = 0.041$). This was more pronounced following blunt trauma ($r_s = -0.571$, $p = 0.04$). Those with low ADP MA at T3 received significantly more platelet, blood, and FFP transfusions between T0 and T3 than normal ADP MA patients (0.5 vs 0, $p = 0.021$, 4 vs 0, $p = 0.002$, 3 vs 0, $p = 0.004$, respectively). Platelet transfusion, however, did not significantly improve platelet function in those with low MA. PD did not impact LOS or mortality.

Conclusion: PD is common in trauma patients and appears to impact both maximal thrombin stimulation and ADP pathway activation. Although more blood products are required in trauma patients with PD, current platelet resuscitation strategies are either insufficient or the platelets being transfused are ineffective.

| | All patients (n=48) | Normal MA (n=5) | Low MA (n=39) | P- value |
|---------------------------|------------------------|--------------------|------------------|-------------|
| Male, % | 89.6 | 80 | 89.7 | 0.47 |
| Age, median (IQR) | 33.5 (23.3-45) | 66 (47-77) | 28 (21-52) | 0.011 |
| Race | | | | |
| Caucasian | 31.3 | 80 | 25.6 | 0.029 |
| African American | 68.6 | 20 | 74.4 | |
| ISS, median (IQR) | 16 (10-29) | 14 (7-22) | 17 (13-33) | 0.171 |
| Blunt mechanism, % | 43.8 | 29.4 | 70.6 | 0.008 |
| ADP receptor inhibitor, % | 0 | 0 | 0 | |
| ICU LOS, median (IQR) | 4 (2-8) | 2 (2-19) | 4 (2-9) | 1 |
| HLOS, median (IQR) | 7 (4.3-19.3) | 5 (4-19) | 8 (4-21) | 0.504 |
| Mortality at 24hr, % | 4.2 | 0 | 5.1 | 1 |
| Mortality at 30d, % | 16.7 | 20 | 17.9 | 1 |

MA=maximum amplitude; IQR=interquartile range; ISS=injury severity score; ADP=adenosine diphosphate; ICU=intensive care unit; LOS=length of stay; HLOS=hospital length of stay

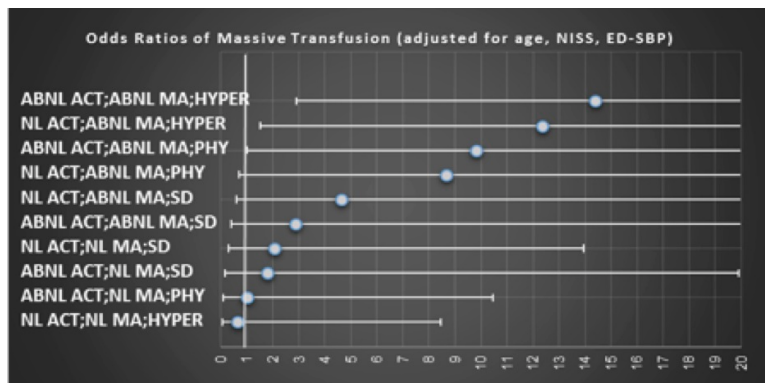
Epidemiology of Trauma-Induced Coagulopathy (TIC): Thrombelastography Phenotypes

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Introduction: Thrombelastography (TEG)-guided resuscitation has been shown to reduce TIC-related deaths. TEG comprehensively assesses the coagulation process through different indices: 1) Activated clotting time (ACT): clot formation; 2) Maximum amplitude (MA): clot strength; 3) LY30: fibrinolysis. Although fibrinolysis' impact has been extensively studied, the significance of combinations of TEG indices remains elusive. We studied the impact of phenotypes defined by TEG indices combinations.

Methods: Trauma activation patients admitted to a Level 1 Trauma Center 2014-2017 were prospectively enrolled and a rapid TEG obtained within 1hr post-injury. Abnormal (ABNL) TEG values were: ACT \geq 128 sec; MA<55mm; Lysis was categorized as Hyperfibrinolysis (**HYPER**: LY30 \geq 3%), Physiologic (**PHY**: LY30 0.9-2.9%); Shutdown (**SD**: LY30<0.9%). Multinomial logistic regression (LR) identified predictors of phenotypes and binomial LR the impact of phenotypes.

Results: 409 patients were included; median age 32 years; median New Injury Severity Score (NISS) 22; 55% suffered blunt injuries. Overall, 7% required massive transfusion (MT: >10 RBC units or death/6 hours), and 14% died. The most common TIC phenotype was Normal (NL) ACT/NL MA/PHY, and the most lethal was ABNL ACT/ABNL MA/SD. MT was associated with ABNL ACT/ABNL MA/HYPER. Among the tested specific injuries, pelvic fractures were predictive of NL ACT/ABNL MA/PHY (Adjusted OR= 12.4; 95%CI: 2.3-66.7) and of ABNL ACT/ABNL MA/HYPER (Adjusted OR=6.1; 95%CI: 1.9-19.4). No other specific injury tested was predictive of TIC phenotypes. When indicators of injury severity/shock were added, NISS, age, ED-SBP were the only significant predictors of TIC phenotypes (all p<0.009). The adjusted OR of MT for the distinct TIC phenotypes are shown in the figure below. The phenotype independently associated with death was ABNL ACT/ABNL MA/HYPER (Adj OR=5.7; 95%CI: 1.4-23.3).



Conclusion: The combinations of TEG indices are associated with specific risk factors and outcomes. These phenotypes can be used to further assist in hemostatic resuscitation.

THE DYNAMICS OF ANTITHROMBIN III AND ITS ROLE IN POST-TRAUMATIC VENOUS THROMBOEMBOLISM

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Introduction: Trauma patients exhibit a complex balance of coagulopathy and thrombosis that, if left untreated, leads to deep vein thrombosis (DVT) rates as high as 60%. The American College of Chest Physicians (ACCP), therefore, recommends chemoprophylaxis with heparin or low-molecular weight heparin (LMWH). Despite prophylaxis, rates of DVT remain unacceptably high. Our lab has shown that up to 67% of trauma patients are found to be antithrombin III (ATIII) deficient. Previous studies have suggested that trauma patients have depressed levels of ATIII and this deficiency predisposes them to increased rates of DVT. We hypothesize that ATIII deficiency is associated with increased rates of DVT and pulmonary embolism (PE).

Methods: This was a prospective, observational, single institution study performed at a Level I trauma center. Data were collected on 293 trauma patients at the following time points: baseline, 8 hours, 16 hours, 24 hours, 48 hours, and days 3, 4, 5, 6 following the initial sample collection. Antithrombin III levels were measured via chromogenic functional assay and reported as a percentage with a reference range of 80-120%. Chemoprophylaxis strategy, DVT, and PE screening were conducted per institutional protocol and were not influenced by this study. Subjects were followed to discharge to assess for DVT/PE.

Results: In our cohort, 12.8% (38/287) of subjects were antithrombin III deficient at baseline and a total of 44.1% (131/293) of subjects were deficient at any time point across the first six days of admission. Antithrombin III deficiency was associated with increased length of stay 10.2 d vs 6.2 d ($p < 0.01$), increased ICU length of stay 4.3 d vs 2.2 d ($p < 0.01$), increased number of ventilator days 2.2 d vs 0.4 d ($p = 0.01$), increased ISS 19 vs 15 ($p < 0.01$), and increased mortality 9.2% vs 1.2% ($p < 0.01$). After multivariate analysis, antithrombin III deficiency was not found to be associated with a significantly increased rate of DVT 10.7% vs 5.6% ($p = 0.1$) or pulmonary embolism 1.5% vs 0% ($p = 0.2$). Average antithrombin III levels were only significantly different between VTE and no-VTE groups at hour 8 and remained above 80% at all but one time point for both groups.

Conclusion: ATIII deficiency is associated with increased severity of illness and worse hospital outcomes. The current study failed to detect a difference in thromboembolic complications in patients with ATIII deficiency but this could be related to inadequate power.

EARLY INITIATION OF PHARMACOLOGICAL VENOUS THROMBOEMBOLISM PROPHYLAXIS IN PATIENTS WITH HIGH-GRADE BLUNT LIVER AND SPLENIC INJURIES IS NOT ASSOCIATED WITH AN INCREASED RISK OF BLEEDING

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Introduction: Nonoperative management (NOM) is the standard of care for hemodynamically stable patients with traumatic blunt solid organ injuries. Management of these patients is challenging as the risk of venous thromboembolism (VTE) and bleeding (failure of NOM) must be balanced. Current guidelines for the management of these injuries do not define the time at which pharmacological VTE prophylaxis (VTEp) can be initiated safely but suggest that VTEp should be considered within 48 hours if no contraindications exist. We aimed to compare the safety of early versus delayed initiation of VTEp in patients with high-grade (AAST grades ≥ 3) blunt liver and spleen injuries undergoing initial NOM.

Methods: All patients 16 years and older admitted to a level 1 trauma center with high-grade (AAST grades 3, 4, and 5) blunt liver and spleen injuries between January 2008 and October 2017 were included. Patients with an indication for therapeutic anticoagulation, requiring massive transfusion upon presentation, or undergoing operative intervention for their abdominal organ injuries within the first 24 hours were excluded. Patients were divided into three groups based on the timing of the first-dose of VTEp: early (≤ 48 hours), intermediate (49-71 hours), and late (≥ 72 hours) after presentation. Bleeding was defined as the need for one or more units of blood product and/or surgical or interventional radiology (IR) intervention for their solid organ injury after initial resuscitation. The primary endpoint was the incidence of bleeding after initiation of VTEp. The rate of VTE during the index admission was also evaluated.

Results: The study population included 232 patients. There were 75 grade 3 injuries (25 liver, 52 spleen), 145 grade 4 injuries (63 liver, 82 spleen), and 15 grade 5 injuries (7 liver, 8 spleen). Twenty-seven patients (11.6%) received early VTEp, 42 patients (18.1%) intermediate, 51 patients (22.0%) late, and 112 patients (48.3%) never received VTEp. Baseline demographic, physiologic, and laboratory variables were similar across groups, with the exception of a lower ISS and higher GCS score in the early VTEp group. The overall rate of IR intervention within the first 24 hours was 18.9% and was not different across groups ($p = 0.32$). Early VTEp was not associated with an increased risk of bleeding when compared to those receiving intermediate and late VTEp (7.4% early vs. 11.9% intermediate vs. 5.8% late, $p = 0.84$). The incidence of bleeding in patients who never received VTEp was 8.9%. VTE developed in 10% of those who received VTEp ($n = 12$) as compared to 1.8% ($n = 2$) of those who never received VTEp.

Conclusion: In this retrospective study of patients with high-grade blunt abdominal solid organ injuries, early initiation of VTEp within 48 hours of admission did not lead to an increase in delayed bleeding. Prospective studies should be conducted to further define the optimal timing of VTEp in this patient population.

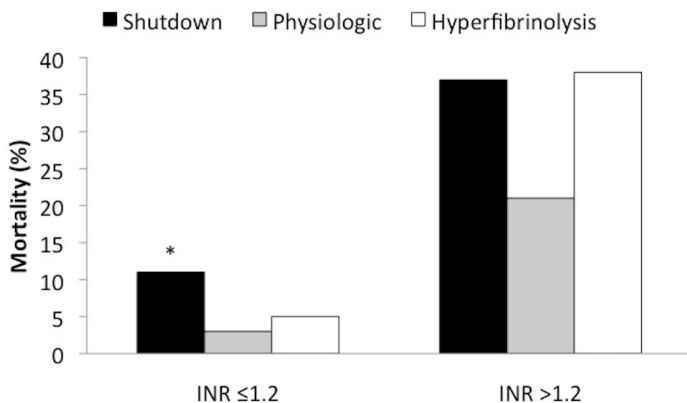
IDENTIFYING FIBRINOLYSIS SUBPHENOTYPES THAT GUIDE ANTIFIBRINOLYTIC THERAPY

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Introduction: Dysregulated fibrinolysis after injury is associated with increased mortality. The debate over antifibrinolytic therapy is complicated by the lack of a physiologic parameter or laboratory test, including thromboelastography (TEG), to direct treatment. Recent work has described fibrinolysis subphenotypes based on tissue plasminogen activator (tPA) sensitivity; however, no conventional assay exists. Since tPA is released from ischemic endothelium and international normalized ratio (INR) reflects coagulation initiated by tissue damage, we hypothesized that INR combined with TEG would identify patients in hyperfibrinolysis (HYP) or fibrinolysis shutdown (SD) with highest mortality, guiding therapy.

Methods: Blood samples were collected prospectively from critically injured patients upon arrival at an urban Level I trauma center. TEG and INR were used to classify patients by fibrinolysis subphenotype. Outcomes were compared.

Results: During a six-year period, 657 patients (median ISS 10, mortality 11%) were enrolled. Overall mortality was 15% for SD, 5% for physiologic fibrinolysis, and 19% for HYP ($p=0.001$). In the normal-INR cohort, SD had highest mortality (11%, 3% physiologic, 5% HYP; $p=0.003$; figure), fewer ventilator-free days ($p=0.001$), and longer ICU and hospital stays ($p=0.001$) as well as increased ISS ($p=0.001$) and severe head injury (37%, 15% physiologic, 16% HYP; $p<0.001$). In the elevated-INR cohort, HYP trended toward highest mortality. After controlling for injury severity, SD and elevated INR remained significant predictors of mortality.



Conclusion: Fibrinolysis subphenotypes can guide antifibrinolytic therapy. In patients with normal INR, SD is associated with traumatic brain injury and increased mortality compared with other fibrinolysis phenotypes. Empiric use of antifibrinolytic therapy would likely not benefit these patients and should be avoided.

Complications in Low-Risk Elderly Trauma Patients: A Case-Control Study

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Introduction: The proportion of trauma patients 65 years and older is rising. Major inpatient complications tracked in the Trauma Quality Improvement Program (TQIP) in this population include unplanned return to the intensive care unit (ICU), unplanned intubation, pneumonia, and unplanned return to the operating room (OR). Data on risk factors for these common complications among elderly trauma patients thought to be low-risk are limited. We sought to determine the association between comorbidities, home medications, inpatient opioids, and inpatient benzodiazepines with risk of common inpatient complications in low-risk elderly trauma patients.

Methods: Cases were trauma patients 65 years or older admitted to a Level I trauma center from January 2015 to August 2016 with a TQIP predicted probability of complication <20% and who experienced an unplanned return to the ICU, unplanned intubation, pneumonia, or unplanned return to the OR. Two age-matched controls for each case were randomly selected from within the same time period and same TQIP predicted probability of complication. We generated estimated odds-ratios for any complication using multivariable conditional logistic regression.

Results: We identified 94 (9.6%) unique cases from 983 trauma patients 65 years and older with a TQIP predicted probability of complication <20%. Some cases had >1 complication: 51 unplanned returns to the ICU, 27 pneumonias, 18 unplanned intubations, and 12 unplanned returns to the OR. There were 188 randomly selected age-matched controls from the remaining 889 patients that did not experience a complication. Median age for cases and controls was 78 (IQR=70, 85), 56.4% were male, and 74.5% were falls. Half of patients had traumatic brain injury (TBI), and 31.6% had a chest injury with no difference in proportions between cases and controls. Cases were more often intubated (34.0% vs 22.3%, Chi-squared $p=0.04$) and had higher median Injury Severity Score (ISS) (cases = 17 (IQR 10, 25), controls = 14 (IQR 10, 19)). After adjustment for age, sex, intubation, undergoing an operation, TBI, ISS, and chest injury, the risk of complication was higher for those on home beta blocker and home anticoagulants (aspirin, Plavix, Coumadin, direct thrombin, and Xa inhibitors) compared to patients not on these medications (beta blocker OR= 2.3, 95%CI 1.2,4.3 and anticoagulants OR=2.2, 95%CI 1.2, 4.1). Patients with a history of diabetes and dementia also had higher odds of complication (OR=2.0, 95%CI 1.1, 3.7, and OR=2.0, 95%CI 1.0, 4.3, respectively). The odds of complication were 10% higher for each additional 10 morphine-equivalents-per-hospital-day, although the confidence interval included 1 (OR=1.1, 95%CI 1.0, 1.2, $p=0.2$). There was no association between lorazepam-equivalents-per-hospital-day and risk of complication in adjusted models.

Conclusion: Low-risk elderly trauma patients on home beta blockers and anticoagulants may be at elevated risk for unplanned return to ICU, unplanned intubation, pneumonia, or unplanned return to the operating room. History of diabetes and dementia are also associated with greater risk. There may be an association between additional opioid administration and risk for complications. Pre-existing co-morbidities appear to have the strongest association with complications in low-risk elderly trauma patients.

THE FINANCIAL IMPACT OF GERIATRIC TRAUMA ON THE TRAUMA SYSTEM: ANALYSIS OF MEDICARE DATA

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Introduction: Trauma is a significant and increasing contributor to the burden of disease in the Medicare population. We analyzed Medicare data to determine geriatric trauma volumes and expenditures and their impact on the trauma system

Methods: Using the 100% Medicare Standard Analytic File for inpatients and outpatients for 2012-2015, we selected claims with trauma diagnoses and extracted patient demographics, admission type, payments, utilization rates for 068x revenue codes, high cost outliers and treating hospital descriptors.

Results: 253,948 patients and 259,995 claims were identified with an average inpatient payment of \$18,619 and an outpatient payment of \$2,082. The total annual Medicare expenditure for trauma was \$982,022,622 in 2012, \$1,030,003,625 in 2013, \$1,081,868,535 in 2014 and \$1,151,419,712 (annualized) in 2015, representing a 17% increase over 4 years. 3812 hospitals had at least 25 trauma inpatients: 174 level 1, 277 level 2, 397 level 3, 490 Level 4, 6 Level 5 and 2,468 non-trauma center. 77.9% of patients were treated at a teaching hospital. According to the CMS CPT cost statistics file, payment for outpatient claims for trauma activation (HCPCS G0390) were as follows: 2012: 2,653, 2013: 3,009, 2014: 3,131, 2015: 4,257. This suggests that either most geriatric trauma activations become inpatients (their activation fee rolls into the inpatient DRG) or centers are not charging activation fees.

Conclusion: Medicare expenditures for trauma increased 17% over the 4 years of this study and represent approx. 0.65% of Medicare expenditures. 77.9% of geriatric trauma inpatients were treated at teaching hospitals. A relatively small number of payments were made for trauma activation. These data show that costs for geriatric trauma are increasing and suggest that there may be opportunities for better triage of injured geriatric patients in the trauma system.

AGE SHOCK INDEX: A VALID PREDICTOR OF MORTALITY IN GERIATRIC TRAUMA PATIENTS

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Introduction: Shock index (SI=Heart rate/Systolic Blood Pressure) and age are both well known predictors of mortality in trauma patients. However, it is often postulated that due to the dampened physiologic responses in elderly trauma patients, traditional vital signs including SI may have higher false negative rate for predicting mortality. The aim of our study was to evaluate if age shock index (ASI= age x SI) may be a better predictor of early mortality in geriatric trauma patients.

Methods: We abstracted two years of NTDB for all patients ≥ 65 years of age and Injury Severity Score (ISS) >15 with complete data. Transferred patients and patients dead on arrival were excluded. Patient demographics, injury parameters, and traditional vital signs were recorded and SI, and ASI were calculated. Our outcome measure was early mortality (≤ 24 hours). Area under receiver operating curve (AUROC) was calculated for each vital signs and index and compared.

Results: A total of 18,736 patients were included. Mean age was 74 ± 6 years, 58.7% were male, median ISS [IQR] was 21 [17 - 26], and the overall early mortality rate was 4.1%. HR, SBP, SI, and ASI were all significant predictors of early mortality ($p < 0.001$). AUROC [95% CI] for SBP and HR was 0.43 [0.42-0.45] and 0.58 [0.56-0.60] respectively. SI had an AUROC of 0.61 [0.59-0.63]. Highest AUROC was noted for ASI 0.62 [0.60-0.64]. Even in the subgroup of patients with normal traditional vital signs, patients with $ASI > 50$ had 30% higher odds of early mortality (OR [95% CI] : 1.3 [1.1-1.6]). SI was unable to predict mortality in this subgroup of patients.

Conclusion: Traditional vital signs significantly underperforms in predicting early mortality in geriatric trauma patients. ASI has the highest predictive power followed by SI. ASI may be a better tool for effective triage of seriously injured geriatric trauma patients.

SATISFACTION OF OLDER ADULT TRAUMA PATIENTS AND THEIR CAREGIVERS BEFORE IMPLEMENTATION OF THE PALLIATIVE CARE TQIP GUIDELINES ACROSS THREE TRAUMA CENTERS: CAN WE DO BETTER?

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Introduction: Palliative care has been suggested to improve patient and family communication, satisfaction with care, and decrease time to identification of poor prognosis and hospital length of stay. Studies examining patient satisfaction and palliative care in trauma patients are limited. The purpose of this study was to compare satisfaction and in-hospital outcomes of older adult trauma patients and their primary caregivers with our current palliative care services.

Methods: This prospective cohort study enrolled trauma patients aged ≥ 55 and their primary caregiver, from 11/2016-10/2017, across three ACS-verified trauma centers (three Level I). Patients were subject to usual care, including ad hoc palliative care interventions. Consented patients and caregivers were administered satisfaction surveys prior to decision to discharge; patients took the Family Satisfaction with Advanced Cancer Care Scale (FAMCARE-P13, 65 possible points), while caregivers took the FAMCARE survey (100 possible points); higher scores indicate higher satisfaction. Both surveys were divided into four structures: Information Giving, Availability of Care, Physical Care, and Psychosocial Care. Study outcomes were overall mean (SD) satisfaction, satisfaction $< 85\%$ versus $\geq 85\%$, and satisfaction by survey structure. Univariate differences between satisfaction groups ($< 85\%$ vs. $\geq 85\%$) and conceptual structures were assessed using chi-squared tests and Student's t-tests, respectively.

Results: There were 273 patients and 295 primary caregivers included in this study. The overall mean (SD) satisfaction was 85.2% (11.0%) for patients and 86.6% (11.0%) for caregivers. 53% of patients and caregivers had overall satisfaction scores $\geq 85\%$. Compared to patients with satisfaction $< 85\%$, a greater proportion of patients with satisfaction $\geq 85\%$ were discharged home versus an outside facility (51% vs. 39%, $P=0.04$), and a smaller proportion had a mental illness (5% vs. 13%, $P=0.04$). The structure with the highest (mean, SD) patient satisfaction was Psychosocial Care (87.8%, 14.0%), and Availability of Care (88.6%, 13.5%) for caregivers. Information Giving was the structure with the lowest (mean, SD) satisfaction for patients (84.2%, 13.5%) and caregivers (84.2%, 13.5%). Caregivers were significantly more satisfied with Availability of Care (88.6% vs. 86.2%, $P=0.001$) and Physical Care (86.7% vs. 85.5%, $P=0.008$) than patients.

Conclusion: These data suggest that on average, patients and caregivers were more than "satisfied" with overall care, and highly valued coordination of care and inclusion of family in care decisions. Similar to other studies, there is room for improvement in communication of information sharing among clinicians, patients and families, which may also account for the lower patient satisfaction scores in Availability of Care. Moving forward, these baseline data will help us best determine the impact of the new TQIP guidelines on patient and caregiver satisfaction with trauma care.

OLD AGE WITH A SUSPICIOUS MECHANISM OF INJURY SHOULD BE A TRAUMA TEAM ACTIVATION CRITERION

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Introduction: Trauma Team Activation (TTA) criteria have been described by the Committee on Trauma (COT). Although age is not included in the standard criteria, many believe that the vital signs in elderly patients are often unreliable, and many severely injured patients may have normal vital signs initially, only to deteriorate rapidly a short time later. This undertriage may affect outcomes. In addition, elderly patients are an at risk population even after fairly moderate trauma. Based on outcome data, our institution has included age \geq 70 in patients with certain mechanisms of injury, as a TTA criterion. The purpose of this study was to determine if this TTA criterion appropriately identifies patients in need of additional resources without significantly impacting overtriage rates.

Methods: Retrospective study of all TTAs from Jan 2012-Dec 2016. Demographics, injury and admission data, ISS, ER intubation, direct ICU or OR admission from ER, and interventions were collected. Primary outcome was mortality, secondary outcomes, ICU and hospital LOS. Patients were stratified into those meeting standard criteria (TTA-S), and those that were activated based on age alone (TTA-A). TTA patients with ISS $>$ 15, ED intubation, ICU admission, direct transfer to OR, immediate catheter based intervention, hospital length of stay (HLOS) $>$ 48 hours, and mortalities were considered appropriately triaged.

Results: During the study period there were 5436 total TTAs. Of the 739 TTAs in patients age \geq 70, there were 198 (26.8%) who met the standard criteria for TTA, and 541 (73.2%) were had TTA based on only age \geq 70. In the TTA-A group, despite activation solely based on age, 49 (9%) died. More than a quarter of the TTA-A patients had ISS $>$ 15 (n=149; 27.5%), 65 (12%) underwent immediate OR or catheter-based intervention, 72 (13%) required ED intubation, and 306 (56.6%) required direct admission to the ICU. Only 50% of TTA-A patients were discharged home. After exclusion of the pre-designated criteria above, overtriage rate of the TTA-A subgroup was 33.5%, well within the recommended range.

Conclusions: Elderly patients with severe trauma patients often do not meet the standard TTA criteria, which might result in potentially dangerous undertriage. Addition of the age (\geq 70 years) criterion for trauma team activation, reduces undertriage and at the same time does not result in unacceptable overtriage.

| | TTA-S N=198 | TTA-A N=541 | |
|------------------------------|----------------|----------------|----------|
| Mortality | 120 (60.6%) | 49 (9.1%) | p<0.0001 |
| ICU admission | 151 (76.3%) | 306 (56.6%) | p<0.0001 |
| ER intubation | 146 (73.7%) | 72 (13.3%) | p<0.0001 |
| Immediate OR | 58 (29.3%) | 40 (7.4%) | p<0.0001 |
| Catheter Intervention | 9 (4.5%) | 25 (4.6%) | p=1 |
| HLOS>48 hours | 110 (55.6%) | 295 (54.5%) | p=0.86 |
| ISS>15 | 130 (65.7%) | 149 (27.5%) | p<0.0001 |

Are We More Willing to Make Dad Comfortable after Trauma?

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Introduction: The American College of Surgeons (ACS) Trauma Quality Improvement Program's Palliative Care Best Practice Guidelines highlights the need to focus on patient comfort at the end of life. Within our analysis, we hypothesize male sex plays a significant role to continue medical interventions rather than transition to Comfort Measures Only (CMO) status with further analysis looking at specific factors that might be associated with transition to CMO.

Methods: This is a 2 year retrospective review of adult (age > 18years) patients from a level 1 trauma center. Data extracted included age, sex, injury severity score (ISS), mechanism of injury (MOI), and medical comorbidities. Patients were considered to be CMO if support was withdrawn in hospital or if patients were discharged to hospice. Logistic regression analysis was performed to identify significant predictors of CMO status. Case-control matching was then performed matching for age, ISS, and MOI. Repeat regression analysis was performed.

Results: 6803 patients were identified; 367 in the CMO group. CMO patients were older ($p < .001$), had higher ISS ($p < .001$) and were more likely to be white ($p < .001$). CMO patients were more likely to have hypertension ($p < .001$), diabetes (DM) ($p < .001$), congestive heart failure (CHF) ($p < .001$), chronic obstructive pulmonary disease (COPD) ($p < .05$), and functionally dependent health status (FDHS) ($p < .001$) CMO patients were less likely to abuse alcohol, tobacco or other drugs ($p < .001$). Regression analysis revealed independent predictors of CMO status: older age ($p < .05$), male sex ($p < .001$), non-white race ($p < .05$), higher ISS ($p < .001$), DM ($p < .05$), CHF ($p < .001$), FDHS ($p < .001$). Case-control matching yielded a cohort of 706 patients, 353 were CMO. CMO patients were still more likely to be men ($p < .05$) and to be white ($p < .05$), but there were no differences in age or ISS. Repeat regression analysis in this cohort revealed male sex ($p < .05$) and non-white race ($p < .05$) as significant predictors of CMO status.

Conclusion: Previous studies found that non-white race was associated with a shift towards life-sustaining care but sex has never been determined to have an impact on CMO. Our findings highlight that sex may in fact play a role in CMO decisions. Additional analysis should be done with regards to cultural and religious beliefs as well as bias within physicians guiding decisions to transition patients to CMO.

HOSPITAL-LEVEL TENDENCY TO ADMIT ELDERLY TRAUMA PATIENTS WITH ISOLATED RIB FRACTURES TO AN INTENSIVE CARE UNIT IS NOT ASSOCIATED WITH IMPROVED OUTCOMES

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Introduction: Despite the known morbidity and mortality associated with isolated rib fractures in the elderly, there are no widely accepted guidelines for intensive care unit (ICU) admission. We sought to characterize any inter-hospital variability in emergency department disposition of elderly patients with rib fractures. We hypothesized that greater use of ICU admission would be associated with improved outcomes.

Methods: We used the 2015 National Trauma Data Bank to identify patients 65 years or older with isolated rib fractures who were admitted to an ICU, step-down unit, or ward. We excluded patients with a significant injury [Abbreviated Injury Scale (AIS) score >1] other than the chest wall injury, those with GCS <9, and those who were intubated. We categorized hospitals into quartiles based on the proportion of eligible patients admitted to an ICU, excluding hospitals with <10 eligible patients in 2015. The primary outcome was a composite of unplanned intubation, pneumonia, or death. We used logistic regression to evaluate whether hospital-level quartile of ICU-use was associated with outcomes, accounting for clustering of observations within hospitals and patient- and hospital-level characteristics as potential confounders.

Results: Among 10,382 patients at 420 facilities, the mean age was 77±7 years, mean ISS was 8±3, and mean thoracic AIS 2.6±0.8. 31% of patients had 1-2 fractured ribs, 28% had 3-5 fractures, and 14% had >5 fractures; 26% were characterized only as having “multiple” fractures. The median proportion of patients admitted to the ICU per hospital was 17% (IQR 7-31%, range 0-88%). Trauma center level, university affiliation, and Southern or Western geographic region were associated with greater ICU use. Hospital-level quartile of ICU use was not associated with a reduction in the composite adverse outcome (Table), and greater ICU use was associated with increased risks of death and unplanned intubation. Unplanned ICU transfer was no more likely among hospitals with less ICU use. None of the available patient or hospital characteristics confounded these associations.

| Hospital-level ICU Use | Composite Outcome | Death | Unplanned Intubation | Pneumonia | Unplanned ICU Admission |
|------------------------|-------------------|------------------|----------------------|------------------|-------------------------|
| | OR (CI 95%) | OR (CI 95%) | OR (CI 95%) | OR (CI 95%) | OR (CI 95%) |
| 1st Quartile – Lowest | Reference | Reference | Reference | Reference | Reference |
| 2nd Quartile | 1.30 (0.95-1.78) | 1.40 (0.87-2.25) | 1.35 (0.77-2.35) | 1.03 (0.64-1.65) | 1.13 (0.69-1.85) |
| 3rd Quartile | 1.18 (0.86-1.61) | 1.59 (1.03-2.46) | 1.13 (0.66-1.93) | 0.73 (0.46-1.16) | 1.03 (0.63-1.71) |
| 4th Quartile – Highest | 1.28 (0.95-1.73) | 1.62 (1.07-2.47) | 1.79 (1.05-3.06) | 1.03 (0.65-1.62) | 1.40 (0.89-2.21) |

Conclusions: Admission disposition of elderly patients with isolated rib fractures is highly variable across centers. Hospitalization at a facility that admits a high proportion of such patients to an ICU is not associated with improved outcomes, and may be associated with greater risk of death. Hospitalization at a facility that admits a low proportion of patients to the ICU is not associated with increased risk of unplanned transfer to the ICU. Further research is needed to identify which patients benefit from ICU admission.

LIFE AFTER 90: OUTCOMES AND PREDICTORS OF MORTALITY IN 4,724 NONAGENARIAN PATIENTS UNDERGOING EMERGENCY GENERAL SURGERY

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Introduction: The decision to emergently operate on nonagenarian patients (NONAs) can be complex due to the uncertainty about outcomes and goals of care at this advanced age. We sought to: 1) determine the outcomes and predictors of mortality for NONAs undergoing emergency general surgery (EGS) and 2) test the performance of the ACS-NSQIP surgical risk calculator in this subgroup of patients.

Methods: Using the 2007-2015 ACS-NSQIP database, all patients 90 years of age or older who underwent an emergent operation, as defined by ACS-NSQIP, with a CPT code for “digestive system”, were included. Multivariable logistic regression analyses were performed to identify independent predictors of 30-day mortality. NONAs mortality rates for different combinations of risk factors were also studied. The actual mortality rates were compared to those predicted by the ACS-NSQIP risk calculator.

Results: Out of a total of 4,456, 809 patients, 4,724 NONAs were included; 67.2% were female and 81.5% were white. The overall 30-day patient mortality and morbidity rates were 21% and 45%, respectively. In multivariable analyses, the key independent predictors of 30-day mortality included recent history of weight loss, history of steroid use, smoking, functional dependence, hypoalbuminemia and sepsis/septic shock. A diagnosis of diabetes, heart failure, or COPD did not independently correlate with 30-day mortality. NONAs with a history of weight loss with either steroid use or sepsis had a 100% and 93% mortalities, respectively. The ACS-NSQIP consistently underestimated the mortality of all NONAs, especially those at the highest risk [Table 1].

| Population | Actual 30-day mortality (%) | ACS-NSQIP predicted mortality (%) |
|-------------------------------------|-----------------------------|-----------------------------------|
| All NONAs | 21.0 | 12.0 |
| Recent weight loss and steroid use | 100.0 | 49.0 |
| Recent weight loss and septic shock | 93.3 | 68.0 |
| Steroid use and septic shock | 81.3 | 64.0 |

Conclusions: Most NONAs undergoing EGS survive the hospital stay, but the ACS-NSQIP calculator underestimated their risk. The combination of recent weight loss with either steroid use or septic shock nearly ensures mortality and should be used in the discussions with patients and families before a decision to operate is made.

COAGULOPATHY IS ASSOCIATED WITH INCREASED MORTALITY IN GERIATRIC EMERGENCY GENERAL SURGERY PATIENTS

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Introduction: Coagulopathy is a well-known risk factor for mortality in trauma surgery. It is unknown whether coagulopathy carries a similarly increased risk of mortality for emergency general surgery (EGS). Our aim was to apply a data-driven approach to study mortality associated with coagulopathy, both alone, and in combination with other comorbidities.

Methods: We performed a cross-sectional study of patients aged 65 and older from the 2011 Nationwide Inpatient Sample who underwent EGS, utilizing the AAST ICD-9 classification. Coagulopathy, including inherited and acquired coagulopathy, and other comorbidities, were defined via the Elixhauser comorbidity index. We utilized Association Rule Mining to determine common comorbidity combinations. We calculated adjusted odds of in-hospital mortality for one, two, and three-way comorbidity combinations.

Results: We identified 992,892 encounters, with an overall mortality rate of 5.2%. The most common procedures performed were gastrointestinal (30.3%) and soft tissue (29.8%). Coagulopathy was associated with the highest adjusted mortality rate compared with all other individual comorbidities (adjusted odds ratio [OR]: 3.52, 95% confidence interval [CI]: 3.34 – 3.72, $p < .001$). Two- and three-way comorbidity combinations with the highest adjusted mortality also included coagulopathy (Table).

Conclusion: For elderly patients undergoing EGS, coagulopathy is the strongest comorbidity risk factor for death, both alone and in combination with other comorbidities. Further studies to examine whether targeted treatment of coagulopathy can improve outcomes should be undertaken.

| One-way, Two-way, and Three-way Comorbidity Combinations with the Highest Odds of Death | Adjusted Odds Ratio | 95% Confidence Interval |
|---|---------------------|-------------------------|
| One-way combination | | |
| Coagulopathy | 3.52 | (3.34 – 3.72) |
| Fluid and Electrolyte Disorders (FED) | 2.79 | (2.67 – 2.91) |
| Weight Loss | 2.36 | (2.25 – 2.47) |
| Liver Disease | 1.98 | (1.78 – 2.20) |
| Congestive Heart Failure | 1.83 | (1.74 – 1.92) |
| Two-way combination | | |
| Coagulopathy & FED | 4.36 | (4.10 – 4.64) |
| Coagulopathy & Weight Loss | 4.34 | (3.97 – 4.74) |
| Coagulopathy & Peripheral Vascular Disorders | 3.83 | (3.44 – 4.26) |
| Coagulopathy & Other Neurological Disorders | 3.45 | (2.94 – 4.05) |
| Coagulopathy & Congestive Heart Failure | 3.33 | (3.02 – 3.67) |
| Three-way combination | | |
| Coagulopathy & FED & Peripheral Vascular Disorders | 5.10 | (4.50 – 5.79) |
| Coagulopathy & Renal Failure & Weight Loss | 4.59 | (3.97 – 5.30) |
| FED & Weight Loss & Arrhythmias | 2.78 | (2.58 – 2.99) |
| Renal Failure & Weight Loss & Arrhythmias | 2.73 | (2.46 – 3.03) |
| Chronic Pulmonary Disease & Weight Loss & Arrhythmias | 2.72 | (2.45 – 3.02) |

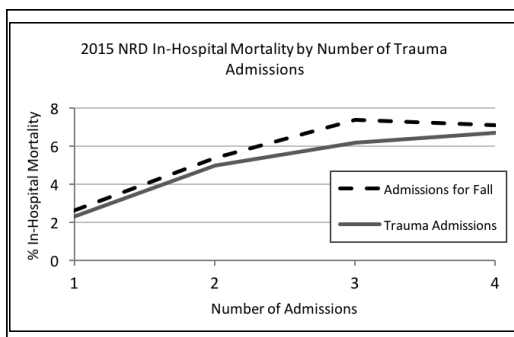
TRAUMA RECIDIVISM IN THE ELDERLY: A NATIONAL AND LOCAL CRISIS

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Introduction: As the population ages, injury prevention efforts are needed to target elderly patients requiring trauma center readmission after multiple falls. Prior studies on elderly trauma recidivism were limited to single institutions. The goal of this study was to measure rates of elder trauma recidivism nationally and identify potentially modifiable risk factors.

Methods: The Nationwide Readmission Database (NRD) for 2015 and the trauma registry at an urban, Level 1 trauma center (2000-2016) were queried for all patients aged 65 and older who were admitted with a primary diagnosis of trauma. Patients with more than one admission in the database with a primary diagnosis of trauma were labeled recidivists. The index admission for recidivists was compared with non-recidivist admissions with respect to demographics, mechanism of injury (MOI), discharge destination, and mortality.

Results: In the 2015 NRD, there are 373,413 elderly trauma patients, representing a 50% national sample. 16,108 (4.3%) patients were identified as trauma recidivists. Compared to non-recidivists, elderly trauma recidivists were more likely to be initially admitted for a fall (78% vs 68%, $p < 0.001$). Recurrent falls were common in recidivists, with 63% having least one additional admission for a fall in the same year. Mortality within the year was doubled for recidivists (5.0% vs 2.3%, $p < 0.001$) and continued to increase with each subsequent trauma admission (see Figure). 70% of recidivists presented to the same hospital for all of their trauma admissions. At our institution, a total of 4219 unique patients aged 65 or older were admitted to the trauma center, of which 210 (5.0%) were recidivists. The local rate of recidivism has increased every year since 2010. Modifiable risk factors associated with recidivism at the institution level were alcohol abuse and homelessness.



Conclusion: Trauma recidivism in the elderly is rapidly increasing and is associated with increased mortality. Single institution data for our trauma center shows that alcohol abuse and homelessness are modifiable risk factors. Nationwide data demonstrates that a majority of recidivists will return to the same hospital for subsequent trauma admissions, providing an opportunity for targeted intervention and injury prevention efforts.

THE UNDERAPPRECIATED FINANCIAL BURDEN OF NON-ADMITTED FIREARM INJURIES.

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Introduction: Firearm injuries result in significant societal cost burden and individual morbidity and mortality. Large databases compiled from trauma registries and inpatient admissions often neglect to include patients sustaining injuries that are treated in the emergency department but not admitted. These injuries represent a significant portion of overall injuries and are associated with costs not generally recovered by hospitals.

Methods: All firearm injuries evaluated at a Level 1 trauma center from January to December 2017 were prospectively collected and retrospectively analyzed. All patients treated in the ED and not admitted to an observation or inpatient bed were identified, and demographic, hospital cost, and aggregate hospital reimbursement were collected. Hospital cost was calculated based on department specific cost-to-charge ratios based on the most recently filed Medicare Cost Report. Financial cost (dollars, \$) were standardized to December 2017 value, and univariate and multivariate analyses were performed. Values are expressed with +/- standard error (SEM) and Standard Deviation (SD).

Results: Over the study interval, 268 firearm injuries were treated in the emergency department and not admitted. Of the 268 patients, 33 died in the ED prior to admission. Of the survivors, 11% were re-evaluated in the ED at some point following their initial evaluation. The average hospital cost to treat a non-admitted firearm injury was \$1,535 (SD +/- \$2041, SE +/- \$99). Patients who died during treatment in the ED prior to admission had a much higher cost of treatment than those discharged home (\$2853 +/- X vs \$938 +/- X, p<0.001). Total hospital cost to treat non admitted firearm injuries was \$524,005. Aggregated reimbursement for the 268 non-admitted patients was \$389,080, which represented a \$134,925 shortfall. Five year financial modeling of trauma admissions, cost and payments was performed (table 1). Modeling predicted an estimated hospital loss of \$674,072 over the next 5 years to care for these injuries.

Conclusion: There is a paucity of data regarding actual hospital reimbursement for care following firearm injury. Patients sustaining firearm injuries that do not require admission are generally excluded from trauma registries and inpatient databases. This group comprised over forty percent of the total number of firearm injuries evaluated at our institution. In addition to significant patient morbidity and mortality, these injuries represent an underappreciated and growing financial burden on urban trauma centers.

| | 2017 | 2018 | 2019 | 2020 | 2021 | Total Five Year |
|--------------------------------------|-----------|-----------|-----------|------------|------------|-----------------|
| Trauma Admissions | 3526 | 3833 | 4166 | 4404 | 4611 | |
| Non -Admitted GSW | 268 | 298 | 324 | 354 | 386 | |
| Non- Admitted GSW Total Cost | \$524,005 | \$456,770 | \$497,879 | \$ 543,186 | \$ 592,073 | \$2,613,913 |
| Estimated Aggregate Hospital Payment | \$389,080 | \$338,923 | \$369,476 | \$ 403,044 | \$ 439,318 | \$1,939,841 |
| Estimated Hospital Loss | \$134,925 | \$117,847 | \$128,403 | \$ 140,142 | \$ 152,755 | \$ 674,072 |

THE EPIDEMIC OF MASS CASUALTY INCIDENTS IN THE UNITED STATES: A CALL FOR ACTION

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Introduction: A mass casualty incident (MCI) is defined by the National Incident Management System (NIMS) as an incident in which the number of patients requiring pre-hospital emergency services overwhelms the local resources. MCIs related to active shooter incidents in the United States have been reported with increasing frequency, which has prompted a call for major changes to how EMS and hospital systems manage MCIs. Most studies of MCIs analyze large-scale events, such as earthquakes, plane crashes, or mass shootings. However no study has provided an analysis of the characteristics of all national MCIs. The aim of this study was to provide a descriptive analysis of MCIs in order to provide guidance for the allocation of resources to these devastating events.

Methods: A retrospective review of the prospectively maintained National EMS Information System (NEMIS) database was performed. All MCIs from Jan 1, 2010 through Dec 31, 2015 were identified and data was stratified by injury mechanism and separated into blunt and penetrating trauma subgroups. Demographic information and on scene mortality was obtained. Results were analyzed for statistical significance.

Results: A total of 61,789 patients were identified. 60,294 of MCIs were blunt trauma from motor vehicle collisions (97.6%). Although only 2.4% of MCIs were due to penetrating mechanism; the incidence of compressible injuries: extremity (36.1% vs. 30.2%, $p=0.0001$) and non-compressible injuries: abdominal (10.7% vs. 5.8%, $p<0.001$) and chest (16.2% vs 12.4%, $p=0.03$) were higher when compared to blunt trauma MCIs. Penetrating MCIs had higher mortality rate as well, with most of them occurring in the pre-hospital arena (12.9% vs. 2.0%, $p<0.001$) when compared to blunt MCIs.

Conclusion: Blunt trauma continues to be the most common mechanism in MCIs, though penetrating trauma results in a six-fold higher rate of pre-hospital mortality. Given an increasing surge in MCIs related to penetrating trauma, results from this study raises the awareness for improvement in pre-hospital interventions that could potentially improve on scene mortality.

Table 1: Mass Casualty Incidents in the United States: A National Six Year Analysis

| | Total MCI (n = 61789) | Blunt (n = 60868) | Penetrating (n = 930) | p value |
|------------------------------------|--------------------------|----------------------|--------------------------|---------|
| Race, n (%) | 50826 | | | |
| White | 31923 (62.8) | 31572 (63.1) | 351 (45.1) | < 0.001 |
| African American | 11618 (22.9) | 11303 (22.6) | 315 (40.4) | < 0.001 |
| Location of Incident, n (%) | 58841 | | | |
| Home | 1844 (3.1) | 1372 (2.4) | 472 (60.9) | < 0.001 |
| Street | 55860 (94.9) | 55692 (95.9) | 168 (21.7) | < 0.001 |
| Public building | 368 (0.6) | 323 (0.6) | 45 (5.8) | < 0.001 |
| Recreational place (clubs) | 254 (0.4) | 239 (0.4) | 15 (1.9) | < 0.001 |
| Restaurant/Bar | 515 (0.9) | 440 (0.8) | 75 (9.7) | < 0.001 |

IS OPIOID PRESCRIBING DRIVING TRAUMA RECIDIVISM OR IS TRAUMA DRIVING OPIOID USE?

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Introduction: Opioids are commonly used to treat pain after trauma. In the past 30 years, opioid prescription rates have quadrupled and hospital admissions for opioid overdose are rising. Previous studies have focused on alcohol use and trauma recidivism. However, there are no studies looking at recidivism and opioid use. We hypothesized that there is an association between opioid use and trauma recidivism.

Methods: We retrospectively reviewed patients admitted more than once for trauma from 2007-2017. Demographics, opioid toxicology screen (TS) on each admission, and injury characteristics were collected. Statistical analysis was performed with Chi-square and Poisson regression models.

Results: 1649 patients (age ≥ 18) had multiple trauma admissions. 61% were non-black, 82% male, and 34% were between the ages of 18–29, which was the most represented age group. The mean duration between first and second admissions was 18 months. 25% had an ISS >15 on their 2nd admission. 11% sustained penetrating trauma on their 1st admission which increased to 19% on the recidivist admission. 12% of recidivists had a diagnosis of alcohol dependency and 15% a diagnosis of drug abuse. Of the 709 who had opioid screening on both admissions, 31% (218) were TS-positive on the 1st admission compared to 34% (244) on their 2nd admission. 17% of patients who were TS-positive on 1st admission were positive on their 2nd, while 18% who were TS-negative on 1st admission were subsequently positive on their 2nd admission ($p < 0.0001$). Patients who were TS+ on the subsequent admission were less severely injured than those who were TS- (ISS >15 , 26.3% vs 22.3%, $p = 0.04$). The only significant risk factor for TS+ on the 2nd admission was TS+ on the 1st admission (RR 2.18, $p < 0.001$). However, age >60 (RR=0.67, $p = 0.08$) and ISS >25 trended toward a protective effect (RR 0.62, $p = 0.13$).

Conclusion: A previous history of opioid use is the strongest predictor of recurrent use in recidivists. However, nearly 20% of our patients were opioid negative on 1st admission but subsequently opioid positive on their 2nd. The opioid epidemic is ravaging the US and opioid prescribing practices are clearly contributing to this issue. Acute pain associated with trauma is often treated with opioids and may be inadvertently contributing to injury recidivism.

MULTIMODALITY THERAPY DECREASES OPIOID USE WHILE MAINTAINING PAIN CONTROL AND PATIENT SATISFACTION IN INPATIENT PAIN MANAGEMENT FOR TRAUMA PATIENTS

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Introduction: Prescription opioids are often used to control pain after injury or surgery. Unfortunately, opioid addiction and its sequelae have reached epidemic proportions in the United States, and sales of prescription opioids have nearly quadrupled between 1999 and 2014. Opioid prescribing has played a major role in today's opioid epidemic and 40% of opioid deaths in the United States are due to prescription opioids. Acknowledging this worsening crisis, our trauma service created a pain management protocol (PMP) for patients admitted to the trauma service. Our goal was to decrease opioid use while maintaining pain control and patient satisfaction.

Methods: A multidisciplinary team (trauma, orthopedics, anesthesiology, psychiatry, pharmacy, and information technology) designed the PMP to standardize opioid prescribing on the inpatient trauma service. The PMP provided a step wise approach to pain control: Acetaminophen or ibuprofen for mild pain, 5 mg oxycodone/ 325 mg acetaminophen every 6 hours as needed for moderate to severe pain (maximum of 8 tablets/24 hour period), and tramadol (50 mg to 100 mg) every 6 hours as needed for breakthrough pain. The opioid containing oral medications were staggered to allow administration of oral pain medications every 3 hours as needed. Long acting oral opioids such as extended release oxycodone or extended release morphine were added as needed. We also encouraged use of adjunct pain medications (gabapentin, pregabalin) that would address neuropathic pain. We performed a retrospective review to compare the amount of opioid medication (converted to morphine milligram equivalents –MME) given during their inpatient stay before and after the implementation of the PMP. The study period covered 2 years with initiation of the PMP at the halfway point. The Wilcoxon Rank Sum Test was used to compare means and chi-squared test was used to compare categorical variables.

Results: Between January 1, 2015 and December 31, 2016, 3696 patients were managed on the inpatient trauma service; 1670 in the before arm(B) and 2026 in the after(A) arm. The average total opioid dose per patient was higher in the B as compared to the A group (B: 700.67 MME, A: 558.11 MME, $p < 0.0001$). The mean opioid dose per patient per day showed a similar pattern (B: 95.63 MME, A: 82.71 MME, $p < 0.0001$). Increased use of acetaminophen ($p < 0.0001$) and neuropathic pain agents ($p < 0.0001$) was associated with the decreased opioid use. The Press Ganey scores for pain control (B: 49%, A: 53% $p < 0.07$) and overall patient satisfaction (B: 94%, A: 91% $p < 0.33$) did not worsen after implementation of the protocol.

Conclusion: A PMP for the trauma service created by a multidisciplinary team was associated with decreased opioid use while maintaining patient satisfaction and the patient's perception of pain control. We hope that this protocol may serve as a bridge to decreased overall opioid use in this difficult population.

DECREASED OPIOID USE FOLLOWING IMPLEMENTATION OF A PILL-BASED, MULTI-MODAL PAIN REGIMEN IN TRAUMA PATIENTS

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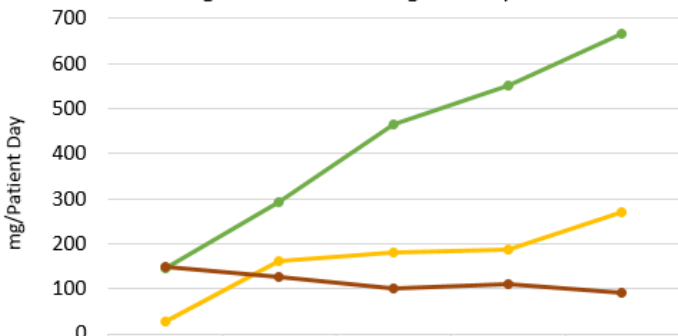
Introduction: In 2013, our level-1 trauma center implemented an oral multi-modal pain (MMP) regimen based on best available evidence to decrease opioid consumption. The MMP regimen scheduled non-opioid medications as first-line agents, supplemented by oral/intravenous opioids as needed. This study describes the pattern of opioid administration to trauma patients following implementation of MMP. We hypothesized that the MMP regimen resulted in decreased opioid consumption in trauma patients.

Methods: We retrospectively reviewed administrative data from 2013 - 2017. Oral and intravenous opioids were converted to oral morphine milligram equivalents (MME) based upon Center for Disease Control guidelines. The number of opioid vials delivered to patient controlled analgesia (PCA) devices was also collected. However, the quantity of MMEs used per PCA vial could not be determined as unfinished vials were discarded.

Results: Total patients-days during the study period were as follows: 30,681 (2013), 31,777 (2014), 30,144 (2015), 32,736 (2016), and 30,898 (2017). Acetaminophen use appeared constant (ranging from 75,814,115 to 93,954,729 mg/year). The number of PCA vials distributed to trauma patients dropped from 2,908 in 2013 (8 vials per day) to 317 in 2017 (< 1 vial per day). Over the six year period, non-steroidal anti-inflammatory drugs (NSAIDs) and gabapentinoid prescribing increased dramatically. The MME/patient-day fell from 148 in 2013 to 90 in 2017, a 39% decrease (**Graph**).

Conclusion: Implementation of a pill-based, MMP regimen reduced opioid use by 39% in hospitalized trauma patients. Further research is warranted to better understand the economic and social impact of a multi-modal approach to pain management in trauma populations.

Trend in Drug Use after MMP Regimen Implementation



| | 2013 | 2014 | 2015 | 2016 | 2017 |
|----------------------------|------|------|------|------|------|
| NSAIDs/Patient Day | 27 | 160 | 181 | 186 | 271 |
| Gabapentinoids/Patient Day | 146 | 293 | 464 | 550 | 665 |
| MME/Patient Day | 148 | 127 | 101 | 110 | 90 |

THE ROLE OF HIV IN POST-INJURY COAGULATION

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INTRODUCTION: HIV infection is known to produce a chronic hypercoagulable and pro-inflammatory state; viral replication leads to decreases in several anti-coagulant factors and increases in pro-coagulant factors. Although antiretroviral therapy (ART) decreases replication, low-level inflammation and immune activation persist. However, the impact of HIV on post-injury coagulation milieu is unknown.

METHODS: Data were collected on 1349 injured patients from 2005-2016; thromboelastography, coagulation factor activity, and standard coagulation measures were measured. Multiple regression analysis was performed to determine the independent association of HIV on post-injury coagulation.

RESULTS: Thirty-nine (3%) HIV patients were identified. 18 (46%) were on ART, with 24 (69%) having history of ART treatment; the median CD4 count was 399 (227-536 cells/mm³). HIV-infected patients trended towards being older (43 vs 37 years, $p=0.051$) and had significantly lower BMI (24 vs 26 kg/m² $p=0.007$), WBC (7.8 vs 9.8 10³/μL, $p=0.011$), hemoglobin (13 vs 14 g/dL, $p<0.001$), and platelet counts (239 vs 269 10³/μL, $p=0.005$). HIV patients were hypercoagulable by citrated rapid TEG (CRT) (alpha angle 77 vs 74°, $p=0.001$; K time 0.95 vs 1.4 sec, $p=0.005$) and had lower antithrombin activity (77 vs 90%,

$p=0.049$). On

multivariate analysis, HIV was independently associated with a hypercoagulable state including significantly increased CRT-alpha angle (mean +4.90°, $p=0.021$) and lower antithrombin activity (mean -17.64%, $p=0.046$).

Table: Multivariate Associations of HIV on Coagulation

| | Mean Difference | SE | p-value |
|----------------------------------|-----------------|--------------|--------------|
| CRT R-time (min) | -0.217 | 0.268 | 0.418 |
| CRT K-time (min) | -0.550 | 0.375 | 0.143 |
| CRT alpha angle (°) | 4.900 | 2.112 | 0.021 |
| CRT MA (mm) | 0.113 | 2.653 | 0.966 |
| CRT ly30 (%) | 0.285 | 1.143 | 0.804 |
| Antithrombin (% activity) | -17.642 | 8.850 | 0.046 |

*All TEG multivariate comparisons controlling for age, gender, injury severity, initial WBC and initial platelet count on admission

CONCLUSION: The impact of HIV on post-injury coagulation is unknown and our findings suggest that following injury HIV infection independently contributes to laboratory evidence of hypercoagulability. Further investigations of this study population may help elucidate the complex crosstalk between coagulation and inflammation following injury.

THE IMPACT OF MARIJUANA LEGALIZATION ON RISK OF TRAUMATIC INJURY

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Introduction: The medical legalization of marijuana has been shown to result in an increased risk of injuries. In Colorado, marijuana was effectively legalized for commercial sale on January 1, 2014, resulting in rapid proliferation of its availability. The objective of this study was to determine the association between commercial marijuana legalization and drug test results following traumatic injury.

Methods: This retrospective cohort study included all patients admitted with a traumatic injury to two Colorado trauma centers between 1/1/2012-12/31/2015, two years before and two years after legalization of marijuana in Colorado. Generalized linear models (GLM) and Pearson chi-square tests were used to examine changes (pre/post and across eight six-month periods) in the prevalence of urine drug screen (UDS) testing, a positive UDS for marijuana (+THC [tetrahydrocannabinol]), a positive UDS for other drugs (+Drugs; amphetamines, cocaine, opiates, benzodiazepene, barbiturates, or PCP), and a positive blood alcohol content (+BAC, ≥ 80 mg/dl). The analyses were performed for all trauma admissions and the subset that required a full trauma team activation.

Results: There were 14,345 admissions over the study period, including 2,939 trauma activations. The rate of UDS testing did not change over time ($p=0.66$), and was greater in activated patients than all admissions (25% vs. 11%). The prevalence of +THC was borderline significantly higher after legalization of marijuana (table 1). The increasing rate of +THC was significantly greater post-legalization ($p=0.02$) in activated patients, whereas the rate of increase was similar across time periods in the overall population ($p=0.78$). There was a significant decrease in +Drugs findings post-vs. pre-legalization; however, the rate of change demonstrated decreasing rate of +Drugs pre-legalization and an increased rate of +Drugs post-legalization ($p<0.001$). There was a significant decrease in +BAC post-legalization; however, this rate of decrease was similar pre- and post-legalization. The characteristics of +THC patients were similar pre-vs. post-legalization, except an increase in males (72% vs. 80%, $p=0.04$) and a decrease in MVCs (54% vs. 44%, $p=0.02$). There were no other differences in demographics, injury characteristics, or outcomes.

Conclusion: With the growing number of trauma patients testing positive for marijuana in Colorado, these data suggest that commercial legalization was associated with an increased rate of marijuana use with traumatic injury, but only for those requiring full trauma activation. A larger study is underway to add additional years and to compare Colorado and non-Colorado hospitals.

Table 1. Change in Urine drug screen findings (UDS) before and after legalization of marijuana in Colorado

| UDS finding | Overall (14,345) | | | | Full activation (2,939) | | | |
|-------------|--------------------------|---------------------------|-----------------------------|-----------------------------|--------------------------|---------------------------|-----------------------------|-----------------------------|
| | Pre-legalization (7,110) | Post-legalization (7,235) | <i>p</i> value ¹ | <i>p</i> value ² | Pre-legalization (1,507) | Post-legalization (1,352) | <i>p</i> value ¹ | <i>p</i> value ² |
| +THC | 26.6% | 30.6% | 0.07 | 0.78 | 27.3% | 32.9% | 0.10 | 0.02 |
| +Drugs | 50.4% | 44.2% | 0.01 | <0.001 | 48.8% | 45.0% | 0.30 | <0.001 |
| +BAC | 39.7% | 29.9% | 0.05 | >0.99 | 43.0% | 32.4% | 0.005 | 0.10 |

¹Chi-square test.

²Generalized linear model (rate of change, pre vs. post)

+THC, tetrahydrocannabinol (marijuana); +Drugs, amphetamines, cocaine, opiates, benzodiazepine, barbiturates, or PCP; +BAC, blood alcohol content ≥ 80 mg/dl.

MENTAL HEALTH SERVICE CONSULTATION FOR PTSD SYMPTOM REDUCTION AFTER INJURY: MORE IS BETTER

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Introduction: Between 20-40% of trauma patients report high levels of posttraumatic stress disorder (PTSD) symptoms. Although mental health services have shown promise in reducing PTSD symptoms, little is known regarding the impact of these services when provided during the index trauma hospitalization. We hypothesized that increases in both the diversity of services and the number of visits patients receive across all services are associated with a decrease in PTSD symptom severity.

Methods: We conducted a retrospective cohort study of 207 patients who participated in a randomized mental health intervention trial between 04/2006-09/2009 at an urban Level I trauma center. The primary exposures were the type of mental health consultation service provided to patients and the number of times patients were visited by each service as documented in the patient medical record. Service types evaluated included social work, addiction intervention, rehabilitation psychology, and consult-liaison psychiatry. The primary outcome was a reduction in PTSD symptoms at follow-up compared with baseline as assessed by the PTSD Checklist-Civilian Version (PCL-C). Multiple linear regression was used to assess the association between types of mental health consultation services received and the number of visits the services provided versus PCL-C score change.

Results: Patients were young (mean: 38.5 years), 52% male, had a mean ISS of 13.6, and an average hospital length of stay of 9 days. Consult service utilization was 89% for social work, 22% for addiction intervention, 17% for rehabilitation psychology, and 8% for consult-liaison psychiatry. After multivariable adjustment, neither service type nor diversity of services received was associated with PCL-C reductions. However, a higher number of visits provided across all services was significantly associated with reductions in PCL-C (0.3 point reduction per visit). This association remained significant even after adjusting for covariates including the number of prior traumas.

Conclusion: An increased number of consultation visits across all services was significantly associated with PTSD symptom reduction. Trauma centers should consider this when developing PTSD symptom management guidelines. : An increased number of consultation visits across all services was significantly associated with PTSD symptom reduction. Trauma centers should consider this when developing PTSD symptom management guidelines.

| Variable | β Coefficients | SE | 95% CI | <i>p</i> |
|--|----------------------|-------|----------------|----------|
| Initial PCL-C Score | 0.433 | 0.066 | 0.303, 0.562 | 0.000 |
| Total number of visits across all services | -0.301 | 0.129 | -0.555, -0.047 | 0.020 |
| Number of prior episodes of trauma | 0.552 | 0.241 | 0.076, 1.028 | 0.023 |

SE, standard error; CI, confidence interval

OUTCOME AND ECONOMICS OF FIREARM INJURY BY BODY REGION AND THE FINANCIAL TOLL ON AN URBAN TRAUMA CENTER.

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Introduction: Firearm injuries result in significant societal cost burden and individual morbidity and mortality. Outcomes and cost following firearm injury are intuitively associated with the location of injury but limited data are available. Although charges and cost are commonly reported, there is a paucity of data regarding actual hospital reimbursement.

Methods: Firearm injuries at a Level 1 trauma center from Jan 2012-November 2017 were examined retrospectively. Demographic data and injury patterns were abstracted from the registry and charts. Hospital cost was calculated from department specific cost-to-charge ratios based on the most recently filed Medicare Cost Report. Financial costs (dollars, \$) were standardized to 2017 value, and univariate and multivariate analysis was performed. Values are expressed with +/- standard error (SEM) and Standard Deviation (SD).

Results: During the study interval, 19,102 patients were admitted following trauma of which 1,430 were firearm injuries (7.5%). 1075 injuries (75 %) involved single GSWs to an isolated body region. Demographic, cost, and outcome data are noted in Table 1. Overall, average total hospital cost of treating all firearm injuries was \$17,545 (SEM +/- \$949; SD +/- \$20410). Patients who survived initial injury had significantly higher costs than those succumbing to injuries (\$28,230 +/- 5260 vs \$6836 +/- 5011, p=0.001). Rank sum ANOVA identified GSW location (Head P<0.001; Abdomen P<0.01, and Chest P<0.01) as predictors of increased cost, however ISS (p=0.506) and LOS (p=0.167) did not predict total cost in regression modeling. GSW location significantly predicted depression scores [b = -0.0000195, t(0.0001) = -6.261, p < .001] and total cost [b = 1.578, t(0.179) = 8.829, p < 0.001]. Additionally, GSW location explained a proportion of variance in both variables [R²=0.426, F=(3,283) 87.168, p < .001]. Overall cost of care for firearm injuries was \$25.1 million. Aggregated payments to the hospital were \$22,253,182. Over the study period, the hospital lost \$2,846,818 (\$474,470/ annually) to care for firearm injuries.

Conclusion:

In the setting of isolated body region firearm injuries, there are significant differences with regard to survival and cost dependent upon location of injury. Overall, aggregate hospital payments did not cover the cost of care. Given increasing prevalence, the cost for caring for firearm injury will soon become prohibitive for urban trauma centers.

| Body Region (n) | Mortality (%) | LOS (Days) | ICU LOS (Days) | ISS | Urgent (Day 0) Operation (%) | # Blood Products (Units) | Hospital Cost per Injury (2017\$) |
|-----------------|---------------|------------|----------------|------|------------------------------|--------------------------|-----------------------------------|
| Head (254) | 58 | 6.4 | 3.4 | 21.8 | 21 | 2.7 | 22,091 |
| Chest (162) | 22 | 6.6 | 2.2 | 14.9 | 39 | 5.9 | 16,363 |
| Abd (176) | 11 | 9.6 | 2.9 | 11.9 | 86 | 5.7 | 25,532 |
| Extremity (385) | 0.01 | 3 | 0.3 | 7.4 | 78 | 0.8 | 10,947 |

POST-OPERATIVE OPIOID PRESCRIBING IN EMERGENCY GENERAL SURGERY – THE SURGEON’S ROLE IN REDUCING OPIOID EXPOSURE

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Introduction: Here we report post-operative narcotic administration in-hospital and on-discharge for opioid naïve patients who underwent laparoscopic emergency surgery at an academic health sciences center. The purpose of this study was to develop guidelines for narcotic administration that would reduce exposure without compromising pain management.

Methods: NSQIP data for 2015-2017 was used to identify patients (N=138 patients) who were managed surgically for either acute appendicitis or cholecystitis. Medication administration, pain scores and prescription information was abstracted from patient charts and opioid doses were converted to oral-morphine-equivalents (OME).

Results: The total quantity of opioids administered in hospital was 12.2 OME in the 24-hrs following surgery; approximately one-third of patients did not require any opioids. Non-narcotic adjuvant medications were administered to 67.4% of patients; all of these included management with acetaminophen while 5.1% were also treated with NSAIDs. Upon discharge, patients were prescribed an average total of 81.3 OME. All discharge prescriptions included opioids and over half of were for opioids alone, the remainder included acetaminophen. The average daily maximum prescribed was three-times that which was required in hospital. Further, the amount prescribed at discharge did not correlate with either the average in-hospital pain score (Pearson=0.05, p=0.71) or in-hospital opioid-consumption (Pearson= -0.02, p=0.42).

| | N | Ward first 24hrs -total dose (OME) | Ward, first 24hrs - % multimodal | Rx- % multimodal | Rx total (OME) |
|------------------------|-----|---------------------------------------|--|------------------|----------------|
| Appendectomy | 90 | 10.8(12.0) 32% required no opioids | 68.9% 68.9% Acetaminophen 5.6% NSAIDs | 36.7% | 78.0(34.6) |
| Cholecystectomy | 48 | 13.8(21.9) 29% required no opioids | 65.0% 65% Acetaminophen 4% NSAIDs | 48.0% | 87.6(32.7) |
| Average | 140 | 12.2(16.1) 31% required no opioids | 67.4% 67.4% acetaminophen, 5.1% NSAIDs | 40.6% | 81.3(34.2) |

Conclusion: Non-narcotic pain medication was not consistently provided as a first line treatment and there was an underutilization of NSAIDs. Prescriptions were frequently for narcotics alone and the high variability in the amount prescribed was not associated with actual patient need. Based on the results of this study, we recommend a default pain management plan that includes non-narcotic pharmacotherapy, including NSAIDs, as a first line therapy. Further, we recommend a standardized prescription that includes separately prescribed non-narcotic adjuvants and discharge instructions that educate patients to reserve opioids for break-through pain.

IMPACT OF PATIENT FRAILTY ON MORBIDITY AND MORTALITY AFTER COMMON EMERGENCY GENERAL SURGERY OPERATIONS

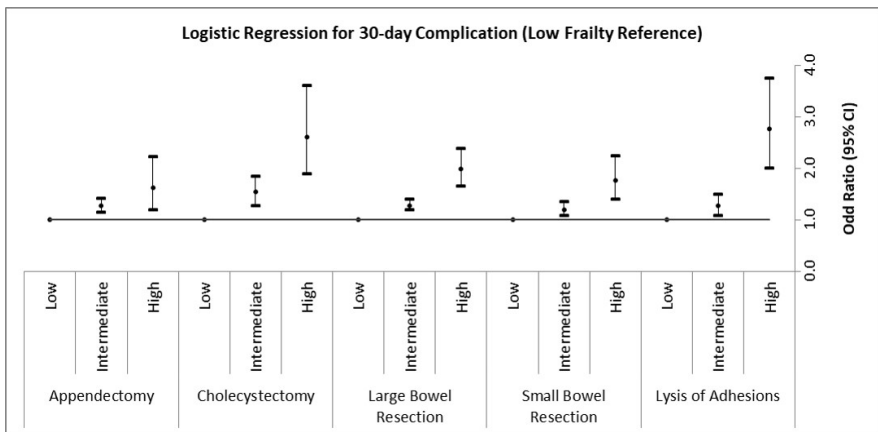
Patrick B. Murphy MD,MPH, MSc, Stephanie A. Savage* MD, MS, Ben L. Zarzaur* MD,MPH, Indiana University School of Medicine

Introduction: Frailty has been increasingly recognized as a modifiable risk factor prior to elective general surgery. There is limited evidence regarding the association of frailty with peri-operative outcomes after specific emergency general surgery procedures. Our objective was to determine the association between patient frailty and 30-day morbidity, mortality and discharge destination in adult patients undergoing emergency general surgery.

Methods: A retrospective cohort study of 57 173 patients older than 40 years of age from 2010-2014 American College of Surgeons National Surgical Quality Improvement Program (NSQIP) who underwent appendectomy, cholecystectomy, partial large bowel resection, total large bowel resection, small bowel resection or lysis of adhesions on an emergent basis. The modified frailty index (mFI) using a composite of 11 NSQIP variables was used to stratify patients into low (≤ 0.18), intermediate (0.18-0.35) and high (≥ 0.36) frailty states. Multi-variable regression modeling included age, sex, mFI, tobacco use, renal failure, steroid use, pre-operative sepsis and outside transfer status.

Results: A total of 57 173 patients underwent appendectomy (n = 26 067), cholecystectomy (n = 8 138), large bowel resection (n = 12 107), small bowel resection (n = 6 503) or lysis of adhesions (n = 4 358) on an emergent basis. Of these patients, 25.0% experienced a complication, 3.2% died in hospital and 5.1% died within 30 days. The majority of the population (52.3%) had low frailty and 3.6% were identified as highly frail. On univariate analysis frailty was related to complication rate (low mFI, 17.5%, intermediate, 31.5% and high, 55.5% complication rate) and inversely related to discharge destination (70.5%, 62.3% and 29.7% discharged home respectively). On multivariable regression, regardless of procedure, intermediate and high mFI were independent predictors of any complication, serious complication, death within 30-days and discharge to a destination other than home, Figure 1.

Conclusion: Frailty is associated with worse outcomes after common emergency surgeries independent of age, co-morbidities and pre-operative sepsis. Assessment of frailty prior to emergency surgery can inform patients and surgeons on expected post-operative outcomes, including discharge disposition, and may impact decision making to proceed with intervention.



READMISSION AFTER EMERGENCY GENERAL SURGERY

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Introduction: Readmission rates are an important metric both because they enable an evaluation of care and because they affect Medicare funding. Patients undergoing emergency general surgery procedures are an important and not fully studied subset of surgical patients. This study evaluates factors contributing to readmission after emergency general surgery.

Methods: The Virginia Health Information database was used to identify patients that had undergone one of the seven most common emergency general surgery procedures in the state of Virginia from January 2011-June 2016. Records were excluded if there was insufficient data about insurance or readmission status, if patients were already readmitted or had been transferred, were <16 years of age, were admitted for trauma, or were military, research, jail, foreign or hospice patients. Demographic, admission, discharge and readmission data were compiled. Comorbidity information was collected for patients from Oct 2015-June 2016. Bivariate and multivariate analyses were performed assessing for both 30 and 90 day readmission.

Results: There were 121,223 records that met initial inclusion criteria. After exclusions there were 83,266 records. The number of readmissions in 30 days was 7995 (9.6%) and in 90 days was 12,329 (14.8%). In multivariate analysis the factors found to be significant ($p<0.05$) in contributing to 30 day readmission were government assistance vs private insurance, longer length of stay, emergent admission (compared to urgent or elective), discharge to rehab, skilled nursing facility, or intermediate medical care facility or with home health, congestive heart failure, liver disease, metastatic cancer, rheumatoid arthritis, coagulopathy, weight loss and anemia. For 90 day readmission the same factors were all significant with the addition of the following significant factors: transfer to psychiatric facility, renal failure, solid tumor without metastasis, weight loss and alcohol abuse.

Conclusion: This study has identified several factors that contribute to readmission after emergency general surgery. Inclusion of both 30 and 90 day readmission enables assessment of late patient morbidity that is otherwise missed by only assessing for 30 day readmission. By identifying these factors interventions can be directed towards those patients at greatest risk for readmission.

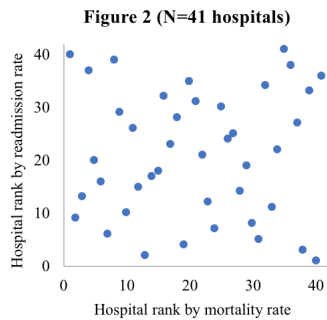
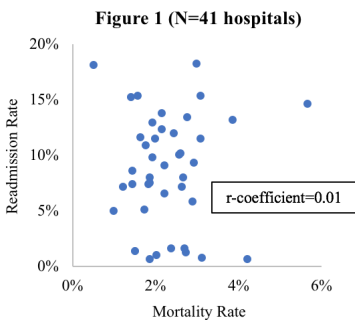
WHICH HOSPITAL METRIC SHOULD WE TRUST FOR EMERGENT SURGERIES: MORTALITY OR READMISSIONS?

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Introduction: The Centers of Medicare and Medicaid Services publicly reports hospital mortality and readmission rates for elective services. However, little data exists regarding the efficacy of these quality metrics for emergent surgeries. The purpose of this study was to identify any correlation between hospital mortality and readmission rates from emergent surgeries.

Methods: Using the 2005-2015 Maryland Health Services Cost Review Commission (HSCRC) database, we identified patients undergoing one of 12 emergency general surgeries (EGS), as established by AAST criteria. The HSCRC database captures all readmissions, both to index and non-index hospitals. Hospitals performing fewer than 100 EGS procedures annually were excluded. After dividing hospitals into quartiles by their risk-adjusted in-hospital mortality rates, we used a multivariable logistic regression to compare 30-day readmission rates between the quartiles. We also calculated the association between each hospital's risk-adjusted in-hospital mortality and 30-day readmission rates and then assessed whether hospital rankings differed when using in-hospital mortality rates versus 30-day readmission rates. All analyses adjusted for patient factors, EGS procedures, surgeon volume, and hospital clustering.

Results: We identified 169,135 EGS operations performed at 41 hospitals. The overall in-hospital mortality rate was 2.1% and 30-day readmission rate was 10.0%. After risk-adjustment, the lowest mortality quartile of hospitals did not also have a statistically lower rate of 30-day readmissions relative to the highest mortality quartile (8.2% vs 11.4%, aOR 0.83 [95%-CI 0.55-1.26], P=0.38). Similarly, there was no association (r-coefficient=0.01) between each hospital's mortality rate and its readmission rate (Figure 1). There also existed significant variation among hospitals when ranking was performed by either in-hospital mortality rates or 30-day readmission rates (Figure 2). Only 3 hospitals (7.3%) were ranked in the top ten by both mortality and readmission rate.



Conclusion: Risk-adjusted in-hospital mortality and 30-day readmission rates for individual hospitals did not correlate for EGS procedures. These findings highlight the need to develop a standardized set of quality metrics that universally recognize the same high-performing hospitals and that distinct performance improvement initiatives will be required to address each of these two critical clinical outcomes.

MOBILE REDCAP SYSTEM FOR DOCUMENTATION OF AAST ACUTE CARE SURGERY FELLOWSHIP SUPERVISION

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Introduction: A graded increase in independence is a vital component of AAST Acute Care Surgery (ACS) fellowship training and mandates the ability to appropriately document trainee supervision and competence. There is currently no standard for documenting supervision of ACS fellows. The objectives of this study were (1) to demonstrate a mobile app system used for document a supervision of ACS fellows, (2) to demonstrate a reproducible assessment tool for proctoring and supervision, and (3) to report initial results of our proctoring system.

Methods: All AAST ACS fellows in our program are proctored, instructor-level faculty. Supervision was defined as: type 1 direct face-to-face, type 2a immediately available in-house, type 2b available after notification via phone with remote electronic medical record access, and type 3 retrospective review. Our proctoring system provides type 1 or 2a supervision for all trauma resuscitations and trauma/EGS operative cases during an initial period, defining our focused physician practice evaluation (fPPE) system. Using research electronic data capture system (REDCap) a database was created to document proctoring in 6/2016. Data collected were patient identification number and clinical summary, ACS fellow, proctoring faculty, service (trauma vs emergency general surgery [EGS]) and type of supervision. The database was updated in 2017 for the next cycle of trainees to include qualitative fields using a Zwisch scale to assess level of autonomy, and operative vs nonoperative data. fPPE data were collated and reviewed by a clinical competency committee after completion of the proctoring period. As fellows are deemed competent, they are graduated to an ongoing physician practice evaluation system (oPPE) that allows type 2b and 3 supervision at faculty discretion. All data were collected by 11 supervising faculty using mobile devices on the REDCap mobile app and uploaded to the database. Data were analyzed using REDCap reporting tools. An online search was performed to identify REDCap partners and approved AAST ACS fellowships.

Results: In 2016 we recorded a total of 203 proctoring events during the fPPE period. The majority of supervision was type 1 or 2a (98.5%). Trauma comprised 68% of events; EGS made up 32%. After updating the database in 2017, we recorded a total of 176 proctoring events. Type 1 or 2a supervision comprised 97% of proctoring events. Trauma events were 62% compared to EGS 38%. 51% of the proctoring events were operations; the remaining 49% were trauma resuscitations. Guidance provided was supervision only in 89% of cases vs 11% requiring some degree of faculty input. Fellows' performance was graded as average in 62% of cases and above average in 38% with one critical deficiency. Case complexity was: Easiest (6, 3.4%), Average (137, 78.3%), Hardest (32, 18.3%).

Conclusion: A REDCap mobile data collection tool is well-suited for documentation of ACS fellows' proctoring and was able to be utilized by all of our ACS faculty to record supervision. A combination of clinical and objective data are useful to determine ACS Fellows' autonomy as a basis for promotion from fPPE to oPPE. This tool helps target remediation and education by identifying below average performance in individual clinical cases. While most proctoring activities were supervision only, 11% required faculty input indicating the benefit of faculty involvement in our proctoring system.

EFFECT OF TRANSFER STATUS ON OUTCOMES OF EMERGENCY GENERAL SURGERY PATIENTS

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Introduction: Transferred emergency general surgery (EGS) patients are a vulnerable, high acuity population. Outcomes among transferred (TRAN) vs directly admitted (DA) patients have primarily been studied using single institution or hospital system data limiting generalizability. We evaluated outcomes among these EGS patients using a large national dataset.

Methods: We identified patients aged ≥ 18 years with an American Association for the Surgery of Trauma-defined EGS diagnosis in the 2008-2013 Nationwide Inpatient Sample (NIS). Multivariable regression analyses determined if transfer status independently predicted in-hospital mortality (by logistic regression), morbidity (number of complications; by Poisson regression), cost (by log-linear regression), and length of stay (LOS; by log-linear regression) accounting for the NIS sampling design.

Results: We identified 434,186 TRAN and 14,513,806 DA patients. On univariate analysis, TRAN patients were more likely to have a higher Charlson comorbidity index, Medicare insurance, and a lower median household income compared to DA patients ($p < 0.0001$). Mortality was significantly higher in the TRAN vs DA groups (4.5% vs 1.7%; $p < 0.0001$). Morbidity (presence of any complication) was also higher among TRAN patients (41.8% vs 29.0%; $p < 0.0001$). Morbidity among TRAN patients was primarily due to urinary- (15.4%), gastrointestinal- (14.7%), and pulmonary-related (14.0%) complications. Median LOS was 4.3 days for TRAN vs 3.0 days for DA ($p < 0.0001$) patients. Median cost was higher for TRAN patients (\$8,935 vs \$7,167; $p < 0.0001$). Regression analyses determined that TRAN patients after adjustment had significantly higher mortality, morbidity, and cost as well as longer length of stay. (Table)

Conclusions: Interhospital transfer of EGS patients is associated with increased mortality, morbidity, cost, and LOS. As the EGS population grows and ages while the EGS workforce declines, identifying risk factors of worse outcomes among transferred EGS patients can inform the design of specific performance improvement initiatives.

| | Mortality | Morbidity | Cost, (log(\$)) | Length of stay, (log(days)) |
|-----------------------------------|------------------------------|--------------------|-----------------|-----------------------------|
| Predictor | Adjusted Odds Ratio (95% CI) | Percent Change | Percent Change | Percent Change |
| Transfer status | | | | |
| Transferred (TRAN) | 1.91 (1.79-2.03) | 26.21* | 10.76* | 19.02* |
| Directly Admitted (DA) | Ref | Ref | Ref | Ref |
| Gender | | | | |
| Male | 1.21 (1.18-1.23) | 12.65* | 0.56* | 101.02* |
| Female | Ref | Ref | Ref | Ref |
| Age | 1.05 (1.05-1.05) | 1.29* | 0.30* | 0.47* |
| Primary Insurance | | | | |
| Medicare | 1.01 (0.97-1.05) | 14.72* | 7.13* | 8.05* |
| Medicaid | 1.42 (1.34-1.51) | 16.66* | 7.80* | 9.30* |
| Self-pay | 1.22 (1.13-1.32) | -2.64 ^b | 0.06 | -0.14 |
| No charge | 0.91 (0.71-1.16) | -6.55 ^b | 2.81* | 1.39* |
| Other | 1.49 (1.34-1.66) | 5.12* | 2.40* | 4.29* |
| Private | Ref | Ref | Ref | Ref |
| Charlson Comorbidity Index | | | | |
| 1 | 1.53 (1.48-1.59) | 34.06* | 11.98* | 9.81* |
| 2 | 2.16 (2.08-2.24) | 58.59* | 21.81* | 17.48* |
| 3 | 3.49 (3.36-3.62) | 81.79* | 32.81* | 25.55* |
| 0 | Ref | Ref | Ref | Ref |
| Hospital location | | | | |
| Rural | 1.01 (0.95-1.07) | -13.06* | -1.55 | -8.82* |
| Urban, non-teaching | 0.93 (0.89-0.97) | -3.30 ^b | -1.30 | -1.26 ^b |
| Urban teaching | Ref | Ref | Ref | Ref |

^a $p < 0.01$, ^b $p < 0.05$, * variables included in models but not displayed include race, household income, EGS diagnosis, EGS procedures, day of week of admission, hospital bed size, total number of discharges, hospital region, and hospital ownership. Ref: Reference

ELEVATED BODY MASS INDEX AND ACUTE PULMONARY EMBOLISM FOLLOWING EMERGENCY GENERAL SURGERY: AN ACS-NSQIP DATABASE ANALYSIS

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Introduction: Obesity represents a known risk factor for venous thromboembolism (VTE) following elective surgery and is well reported among surgical specialties. VTE pharmacologic agents at standard dosing can result in high VTE rates in these subset of patients. Following a review of the American College of Surgeons National Surgery Quality Initiative Program (ACS-NSQIP) database nearly a decade ago, a heightened awareness by surgeons demonstrated a reduction in VTE. The current efficacy of VTE prophylaxis in emergency general surgery is unknown. We hypothesize that increasing body mass index (BMI) observed in emergency general surgery (ES) is associated with increased risk of acute pulmonary embolism (PE) and death.

Methods: ACS-NSQIP database was queried (January 2015-December 2015) for all patients undergoing ES. The incidence of PE was reviewed for 5 BMI (kg/m^2) groups greater than $20\text{kg}/\text{m}^2$. Univariate comparisons was completed between normal weight (NW) ($18.5\text{-}24.9\text{kg}/\text{m}^2$), overweight (OW) ($\text{BMI } 25\text{-}29.9\text{ kg}/\text{m}^2$), obesity (O) ($30\text{-}39.9\text{ kg}/\text{m}^2$), morbidly obese (MO) ($\text{BMI } 40\text{-}50\text{kg}/\text{m}^2$), super obese (SO) ($>50\text{kg}/\text{m}^2$). Demographics, ES type, length of surgery, length of stay (LOS), ASA scoring, deep vein thrombosis (DVT), and mortality reviewed. All elective surgery cases and $\text{BMI} < 18.5\text{kg}/\text{m}^2$ were excluded.

Results: 36,565 patients identified undergoing ES at >800 participating ACS-NSQIP hospitals. Of those, 494 (1.3%) were diagnosed with a PE. Mean age was 65.9 ± 14.7 years, (range, 18-90+ years) 49.2% male, and a mean BMI of $29.5 \pm 7.4\text{ kg}/\text{m}^2$ (range, $15.6\text{-}57.6\text{ kg}/\text{m}^2$). Population was predominately group O (30.6%). The presence of a PE was directly related to patient's BMI ($p=0.015$). When compared to NW, MO ($p=0.010$) and SO ($p=0.023$) groups were more likely to experience a PE following ES. Mean postoperative day of PE diagnosis was 11.2 ± 7.6 days, an ASA of 3.2 ± 0.8 , and a mean operative time of 121.8 ± 72.6 min. Overall mean LOS was 17.6 ± 13.2 days. Patient groups O ($p<0.001$) and MO ($p<0.001$) had longer operative times compared to NW patients. Length of operation was found statistically significant. Perioperative PE following emergent appendectomy ($p=0.005$) and other abdominal surgery ($p=0.004$) were related to BMI in O and SO groups. 54 PE (10.9%) deaths ($\text{BMI } 28.1 \pm 8.6\text{ kg}/\text{m}^2$) occurred, 14 (25.9%) patients with concomitant DVT and PE. PE mortality was directly related to patient's BMI ($p < 0.001$), with SO group being 7 times more likely to expire from a PE after ES.

Conclusion: These findings suggest that an increasing BMI observed in ES amplifies the PE risk in these subset of patients. Surgeon education and strict perioperative VTE prophylaxis guideline adherence with ES can potentially decrease VTE events. Further prospective studies are needed to reiterate the importance of a weight-based prophylactic dosing regimen for hospitalized obese emergency surgical patients. A multi-institutional, randomized controlled trial is necessary to conclusively determine if a standardized weight-based prophylactic dosing regimen will improve the incidence of PE events.

| | BMI < 20 (n= 32) | BMI 20 to 24.9 (n= 102) | BMI 25 to 29.9 (n= 147) | BMI 30 to 39.9 (n= 151) | BMI 40 to 49.9 (n=41) | BMI 50+ (n=6) | p- value |
|---------------------------------------|---------------------|----------------------------|----------------------------|----------------------------|--------------------------|------------------|-------------|
| PE, n (%) | 32 | 102 | 147 | 151 | 41 | 6 | - |
| DVT, n (%) | 4 (12.5) | 23 (22.5) | 42 (28.6) | 50 (33.1) | 10 (24.4) | 0 (0.0) | 0.079 |
| OR time, mean \pm SD | 100.6 \pm 55.9 | 100.8 \pm 44.4 | 119.0 \pm 71.2 | 136.2 \pm 89.7 | 132.8 \pm 41.7 | 127.0 \pm 51.1 | 0.002 |
| Albumin, mean \pm SD | 2.8 \pm 0.8 | 3.0 \pm 0.8 | 3.3 \pm 0.8 | 3.2 \pm 0.8 | 3.3 \pm 0.8 | 2.4 \pm 0.3 | 0.003 |
| LOS, mean \pm SD | 17.5 \pm 11.7 | 17.6 \pm 11.9 | 18.5 \pm 15.3 | 17.8 \pm 13.3 | 14.0 \pm 6.9 | 10.0 \pm 5.0 | 0.342 |
| ASA, mean \pm SD | 3.6 \pm 0.7 | 3.4 \pm 0.8 | 3.0 \pm 0.8 | 3.2 \pm 0.8 | 3.4 \pm 0.7 | 3.3 \pm 0.5 | 0.506 |
| Transfusion, n (%) | 4 (12.5) | 12 (11.8) | 14 (9.5) | 23 (15.2) | 4 (9.8) | 0 (0.0) | 0.640 |
| Died, n (%) | 4 (12.5) | 24 (23.5) | 10 (6.8) | 12 (7.9) | 2 (4.9) | 2 (33.3) | < 0.001 |
| CPT Code: Surgical Procedure Location | | | | | | | |
| Abdomen, n (%) | 2 (6.3) | 7 (6.9) | 7 (4.8) | 15 (9.9) | 9 (22.0) | 2 (33.3) | 0.004 |
| Appendix, n (%) | 0 (0.0) | 4 (3.9) | 16 (10.9) | 14 (9.3) | 0 (0.0) | 2 (33.3) | 0.005 |
| Biliary Tract, n (%) | 0 (0.0) | 6 (5.9) | 8 (5.4) | 8 (5.3) | 0 (0.0) | 0 (0.0) | 0.466 |
| Esophagus, n (%) | 0 (0.0) | 2 (2.0) | 4 (2.7) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0.317 |
| Intestines, n (%) | 26 (81.3) | 72 (70.6) | 102 (69.4) | 96 (63.6) | 26 (63.4) | 2 (33.3) | 0.155 |
| Stomach, n (%) | 2 (6.3) | 8 (7.8) | 8 (5.4) | 8 (5.4) | 12 (7.9) | 4 (9.8) | 0 (0.0) |
| *Other, n (%) | 2 (6.3) | 3 (2.9) | 2 (1.4) | 6 (4.0) | 2 (4.9) | 0 (0.0) | - |

RECURRING EMERGENCY GENERAL SURGERY: CHARACTERIZING A VULNERABLE POPULATION

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Introduction: Limited data exists for long-term outcomes after emergency general surgeries (EGS) in the United States. The purpose of this study was to characterize the incidence of inpatient readmissions within 6-months and subsequent operations after an initial EGS procedure.

Methods: Adult patients (≥ 18 years old) undergoing one of seven common EGS procedures (appendectomies, cholecystectomies, small bowel resections, large bowel resections, control of GI ulcers and bleeding, peritoneal adhesiolysis, and exploratory laparotomies) were identified in the 2010-2015 National Readmissions Database. Patients who died during their index hospitalization were excluded. The rates of all-cause inpatient readmission and of undergoing a second EGS procedure within 6-months were calculated. Risk-factors of undergoing a second EGS procedure were identified using a multivariable logistic regression model. All analyses adjusted for patient factors, clinical factors and hospital clustering.

Results: There were 1,343,166 patients who underwent one of seven EGS procedures. Among patients with available postoperative data, 94,577 (14.9%) had an inpatient readmission within 6-months, occurring at a median of 41 days (IQR: 16-95 days). One-in-eight (16.3%) readmissions occurred at a different hospital than the index hospitalization. Among the 94,577 patients who had an inpatient readmission, 9,936 (10.5%) underwent a second EGS procedure, the most common of which included control of GI ulcer and hemorrhage (46.3%) and peritoneal adhesiolysis (18.7%) (Table). After adjustment, the following were associated with undergoing a second EGS procedure: number of comorbidities (adjusted odds ratio [aOR] 1.07 [95%-CI 1.06-1.09]), private center relative to a governmental hospital (aOR 1.11 [1.02-1.23]), discharge to home health care (aOR 1.30 [1.22-1.39]), and initial EGS procedures of control of GI ulcer and bleeding (aOR 16.8 [15.5-18.2]), laparotomy (aOR 11.6 [10.4-13.0]), and peritoneal adhesiolysis (aOR 6.8 [6.3-7.4]).

| | Index EGS procedure | Second EGS procedure |
|------------------------------|---------------------|----------------------|
| | N=1,344,166 | N=9936 |
| Large bowel resections | 5.0% | 5.1% |
| Small bowel resections | 3.6% | 6.9% |
| Cholecystectomies | 42.3% | 9.4% |
| Control of GI ulcer/bleeding | 10.6% | 46.3% |
| Peritoneal adhesiolysis | 9.1% | 18.7% |
| Appendectomy | 27.3% | 4.8% |
| Laparotomy | 2.1% | 8.8% |

Conclusion: Nearly 15% of patients undergoing an EGS procedure have an inpatient readmission within 6-months. One-in-ten readmitted patients underwent a second EGS procedure. As half of all second EGS procedures occurred within six weeks of the index procedure, carefully monitoring patients for at least two months postoperatively may help surgeons preemptively identify patients at risk for subsequent procedures.

COMPARISON OF SCORING SYSTEMS (LRINEC, AAST IMAGING GRADE, FGSI) TO DIAGNOSE NECROTIZING SOFT TISSUE INFECTIONS (NSTI) AND THEIR ASSOCIATION WITH CLINICAL OUTCOMES

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Introduction: Efforts to improve management of NSTI depend on early diagnosis and characterization of its severity. This study aims to compare the diagnostic sensitivity of pre-operative scoring systems, including the Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC), the American Association for the Surgery of Trauma (AAST) imaging grade, and Fournier's Gangrene Severity Index (FGSI) and their ability to associate with key clinical outcomes.

Methods: A single institution review from 2004-2017 was performed. We included adult patients (≥ 18 years) with AAST operative grade (IV, V) disease severity. Baseline demographics, Charlson comorbidity index, and clinical outcomes (30-day mortality, intensive care admission (ICU), Clavien-Dindo ≥ 3 complication severity) were analyzed. Pairwise comparison of each scoring system was performed for selected outcomes and quantified using area under curve (AUC) with 95% confidence intervals (CI).

Results: In this study, 114 patients were diagnosed with NSTI with a mean age (\pm SD) of 57 (± 14) years, 68% male. With respect to diagnostic sensitivity, AAST imaging grade was most accurate (67%) compared to FGSI (62%) and LRINEC (41%). In patients with NSTI, FGSI demonstrated improved accuracy compared to the AAST imaging grade to discern which patients required ICU admission (AUC 0.68 versus 0.52; $p = 0.04$) as well as 30-day mortality (0.74 vs 0.55; $p = 0.03$). All systems had comparable accuracy for other key outcomes studied and no significant differences using pairwise comparison, Table.

Conclusion: Pre-operative scoring systems provide valuable information to evaluate disease severity and outcomes. The AAST imaging grade was the most sensitive for NSTI diagnosis; however, FGSI was more accurate for ICU admission and 30-day mortality. All scoring systems demonstrated limited ability to associate with other outcomes in patients with NSTI.

Table

| Outcome | FGSI | LRINEC | AAST Imaging | P value |
|--|---------------------|---------------------|---------------------|---------|
| Mortality | 0.74 (0.65-0.82) | 0.60 (0.50-0.69) | 0.55 (0.45-0.64) | 0.02 |
| 30-day readmission | 0.52 (0.43-0.62) | 0.59 (0.50-0.69) | 0.64 (0.55-0.73) | 0.25 |
| ICU admission | 0.68 (0.58-0.76) | 0.64 (0.55-0.73) | 0.52 (0.42-0.61) | 0.03 |
| Total number of operations | 0.56 (0.47-0.66) | 0.52 (0.43-0.62) | 0.51 (0.41-0.60) | 0.51 |
| Clavien-Dindo ≥ 3 | 0.60 (0.51-0.69) | 0.57 (0.47-0.66) | 0.55 (0.46-0.65) | 0.51 |
| Extended duration of stay | 0.50 (0.41-0.60) | 0.52 (0.42-0.61) | 0.58 (0.48-0.67) | 0.46 |
| Values reported using area under the curve (AUC) with 95% confidence intervals | | | | |

ASSOCIATION BETWEEN EMERGENCY GENERAL SURGERY VOLUME AND OUTCOMES IN MILITARY HOSPITALS

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Introduction: Low Emergency General Surgery (EGS) hospital volume is associated with worse patient outcomes in the civilian setting. The military maintains treatment facilities in remote locations to provide healthcare access to service personnel and their families. Our objective was to determine if low volume military treatment facilities (MTF) are associated with worse EGS outcomes, compared to high volume MTFs.

Methods: Analysis of the TRICARE database from 2006 to 2014. TRICARE provides healthcare coverage to 9.5 million military personnel and families. Patients were identified using the AAST defined ICD-9 CM codes for EGS and ages 18-64 years. MTFs were divided into quartiles based on yearly volume. Outcomes of interest were 30-day mortality, complications and readmissions. Logistic regression models adjusted for age, sex, race, socio-economic status, geographic region, EGS condition category, surgical intervention and comorbid conditions were used to determine the effect of volume on outcomes.

Results: A total of 106,915 patients were treated for an EGS condition at 79 MTFs during the study period. The overall mortality rate was 0.21%, complication rate was 8.55% and readmissions rate was 4.45%. Highest volume quartile MTFs treated 61.1% of the patients while lowest volume quartile MTFs treated only 1.1%. In risk adjusted analysis lowest volume quartile MTFs were not associated with mortality (OR: 2.02, CI: 0.45-9.06) or readmissions (OR: 0.77, CI: 0.54-1.11), while they were associated with lower odds of complications (OR: 0.76, CI: 0.59-0.98), compared to the highest volume quartile.

Conclusion: EGS patients treated at low volume MTFs did not have worse patient outcomes when compared to high volume MTFs. Remote location MTFs provide adequate care to service personnel and their dependents for acute conditions and triage complex cases appropriately.

| Volume Quartile | 30-day Mortality | 30-day Complications | 30-day Readmissions |
|--------------------|------------------|----------------------|---------------------|
| | OR* (CI) | OR* (CI) | OR* (CI) |
| 1 (Highest) | Reference | | |
| 2 | 0.64 (0.44-0.94) | 0.86 (0.82-0.91) | 0.91 (0.84-0.98) |
| 3 | 1.01 (0.62-1.65) | 0.81 (0.75-0.88) | 0.83 (0.74-0.92) |
| 4 (Lowest) | 2.02 (0.45-9.06) | 0.76 (0.59-0.98) | 0.77 (0.54-1.11) |

OR= Odds Ratio, CI=Confidence Interval

**Adjusted for age, sex, race, geographic region, socio-economic status, EGS categories, Charlson comorbidity index and operative intervention*

LAPAROSCOPIC VERSUS OPEN ADHESIOLYSIS FOR ADHESIVE SMALL BOWEL OBSTRUCTION: A 12-YEAR SINGLE CENTER RETROSPECTIVE STUDY

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Introduction: Laparoscopic adhesiolysis has become a widely accepted technique for treating adhesive small bowel obstruction (ASBO). Aim of this study is to evaluate its efficacy and safety.

Methods: Patients undergoing surgery for ASBO between 2005 and 2017 were included in this study, in presence of a preoperative CT scan and a confirmed intraoperative diagnosis of ASBO. The outcomes were postoperative length of stay (LOS), overall complication rate, operative time. In univariate analysis, Kaplan-Meier estimator and log-rank test were used to compare the outcomes of interest between patients treated laparoscopically vs. open surgery. A multivariable Cox regression model was carried out. CT scans of patients with ASBO caused by either surgically confirmed single band or matted adhesion were analyzed. CT findings were compared to develop a predictive model based on logistic regression to estimate the risk of ASBO caused by a single band adhesion. The predictive ability of the model was quantified by ROC curve.

Results: 116 patients were included in the study (males 53.5%, median age 68 ys). 68 patients (54.3%) were approached laparoscopically, with a conversion rate of 44%, which increased to 61.9% in case of matted adhesion ASBO, compared to 35.7% in single band ASBO ($p=0.05$). Two skilled surgeons preferred laparoscopic approach in 85% of cases, with an overall conversion rate of 30%, which decreased to 7% when considered only single band ASBO. LOS and operative time were significantly lower in laparoscopic group, without evident differences in terms of peritoneal tears, iatrogenic perforations and postoperative complications. Patients treated traditionally had a triplicated risk of being discharged later than those successfully treated laparoscopically (HR=3.43, 95% CI: 2.07-5.69). Intraoperative findings demonstrated single band ASBO in 65.5% of cases. By multivariable analysis, risk of single band ASBO was positively associated with two CT findings: presence of a complete obstruction (HR=4.14, 95% CI: 1.43-11.93) and “fat notch” sign (HR=7.40, 95% CI: 1.64-33.28). Using 0.5 as cut-point probability of single band for the predictive model, the sensibility was 85.5% and the specificity of 70.0%, the positive and negative predictive values were 84.4% and 71.8% respectively, the area the ROC curve was 0.86.

Conclusion: Laparoscopic adhesiolysis is a safe and effective technique, associated with shorter LOS and characterized by lower conversion rate when performed by skilled surgeons for single band adhesion ASBO. Analysis of CT findings becomes extremely helpful by predicting whether ASBO is caused by single band or matted adhesion.

THE IMPACT OF PRIOR LAPAROTOMY AND INTRA-ABDOMINAL ADHESIONS ON BOWEL AND MESENTERIC INJURY FOLLOWING BLUNT ABDOMINAL TRAUMA

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Introduction: Identifying patients with bowel and mesenteric injuries following blunt abdominal trauma is hindered by the suboptimal accuracy of initial physical exam and CT scan findings. We hypothesized that patients with intra-abdominal adhesions from prior laparotomy would be subjected to visceral sheering forces and increased risk for bowel and mesenteric injury following blunt abdominal trauma.

Methods: We performed a multicenter retrospective cohort analysis of 267 consecutive adult trauma patients who underwent operative exploration following moderate-critical (abdominal injury score 2-5) blunt abdominal trauma, comparing patients with prior laparotomy (n=31) to patients with no prior laparotomy (n=236). Multivariable regression was performed to identify predictors of bowel or mesenteric injury.

Results: There were no significant differences between groups for injury severity scores or preoperative CT scan findings. The prior laparotomy cohort had greater incidence of full thickness bowel injury (26% vs. 9%, $p=0.010$) and mesenteric injury (61% vs. 31%, $p=0.001$). Considering all patients with bowel or mesenteric injuries, the no prior laparotomy group had a greater proportion of injuries occurring at the ligament of Treitz or ileocecal region (52% vs. 25%, $p=0.003$). On multivariable regression, prior laparotomy was an independent predictor of bowel or mesenteric injury (OR 5.1, 95% CI 1.6-16.8) along with history of prior intra-abdominal inflammation and CT evidence of free fluid without solid organ injury (model AUC: 0.81, 95% CI 0.74-0.88).

Conclusion: Patients with a prior laparotomy are at increased risk for bowel and mesenteric injury following blunt abdominal trauma. The distribution of bowel and mesenteric injuries among patients with no prior laparotomy favors embryologic transition points tethering free intraperitoneal structures to the retroperitoneum.

VARIABILITY IN MANAGEMENT OF BLUNT SPLENIC INJURY AT LEVEL 1 TRAUMA CENTERS

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Introduction: Nonoperative management (NOM) for blunt splenic injury (BSI) is common in the adult injured patient. Nationally, the incidence of splenectomy for BSI is around 20% and there is no standardized protocol for the management of BSI. There is a high discordance in the incidence of splenectomy (15-35%) regardless of grade at various institutions. Our hypothesis is that certain institutions more likely perform splenectomies than others without a concordant increase in the grade of BSI or overall injury severity score (ISS).

Methods: National Trauma Data Bank was evaluated for the years 2012-2014 with respect to BSI. Centers with more than 212 admissions for BSI were used for the study, which represented the upper tertile of all facilities. Facilities were then assigned to be either LOW or HIGH with respect to their overall splenectomy incidence by the median cut point of 21.3%. Univariate analysis was performed to evaluate for differences between these facilities.

Results: The incidence of splenectomy was 21.3% (3,941 with splenectomy out of 18,527 admissions with BSI). Splenectomy at LOW vs HIGH facilities is 15.4% vs 27.4%. ISS of LOW was significantly greater than HIGH, 23.8 ± 13.7 vs 22.7 ± 13.8 $p < 0.001$. Mean age (39.7 ± 18.1 vs 39.9 ± 17.9 $p = 0.41$) and the incidence of angiography (7.6% vs 7.9% $p = 0.45$) were similar between the facilities. Table 1 demonstrates the incidence of splenectomy by grade.

| Grade of BSI | LOW FAC n=9,467 | HIGH FAC n=9,060 | p Value |
|--------------|-----------------|------------------|---------|
| 1,2 | 4.2% n=3,930 | 7.8% n=3,605 | <0.001 |
| 3 | 12.6% n=1,987 | 28.2% n=1,900 | |
| 4 | 32.6% n=1,338 | 56.4% n=1,275 | |
| 5 | 61.9% n=591 | 78.8% n=646 | |
| NFS* | 14.8% n=1,621 | 26.9% n=1,634 | |

*Uncharacterized BSI

Conclusion: There is a higher incidence of splenectomy, not driven by ISS or age, for BSI occurring in some institutions. The use of angiography and Grade of BSI does not explain the discrepancy of operative intervention between the two groups. There appears to be an institutional preference for performance of splenectomy for BSI. A national protocol for BSI is needed to determine the best practice or guideline of NOM for BSI.

COLON AND SEVERE LIVER INJURIES PREDICT ABDOMINAL COMPLICATIONS AFTER DAMAGE CONTROL LAPAROTOMY FOR GUNSHOT WOUNDS

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Introduction: Damage control laparotomy (DCL) has improved mortality in unstable trauma patients undergoing laparotomy, but an open abdomen is associated with considerable morbidity. Previous studies of open abdomen complications have been dominated by patients with blunt injuries. It is unclear whether these studies apply to patients who suffer penetrating trauma. We therefore examined if rates of open abdomen-associated complications differ by mechanism of injury, and identified risk factors for complications after DCL in patients who suffered gunshot wounds (GSW).

Methods: Patients who underwent DCL between May 2015 and December 2017 were identified from a prospectively-compiled trauma database. Demographics, initial physiologic parameters, injury patterns, and use of intraabdominal packing were noted. Severe liver injuries were defined as grade IV or V injuries or injuries that required arterial embolization. Variables of interest related to abdominal complications included: superficial wound infection, dehiscence, intraabdominal abscess, anastomotic leak, and enteric fistula. Our primary aim was to assess whether mechanism of injury is associated with the development of any of these complications. Our secondary aim was to assess rates of each type of abdominal complication as well as the need for re-exploration after fascial closure or for percutaneous drain placement, and intensive care unit (ICU) and hospital length of stay (LOS). Descriptive statistics, Fisher exact tests, Mann Whitney U tests, and Kruskal-Wallis tests were performed when appropriate.

Results: A total of 112 patients underwent DCL. Of those, 93 patients (83%) were male, with a median age of 29 ± 10 years. 91 patients (81%) sustained GSW. 59% of GSW patients (54 of 91) developed abdominal complications, compared to 29% of patients (6 of 21) injured by another mechanism ($p = 0.01$). Among GSW patients, the rate of abdominal complications was increased in patients with colon (OR: 2.92, $p = 0.02$) and severe liver injuries (OR: 3.09, $p = 0.03$). Patients with colon injuries were more likely to develop wound dehiscence (OR: 13.4, $p < 0.01$) and require re-exploration after fascial closure (OR: 7.34, $p = 0.01$). Patients with severe liver injuries were more likely to develop intraabdominal abscesses (OR: 3.01, $p = 0.03$) and require percutaneous drainage (OR: 3.75, $p = 0.01$), and those who underwent liver embolization were more likely to have a prolonged hospital LOS (median 35 days vs 21 days, $p = 0.04$).

Conclusions: GSW patients are more likely than other trauma patients to develop abdominal complications after damage control laparotomy. Among GSW patients, colon injuries and severe liver injuries are associated with an increased risk of abdominal complications after damage control laparotomy, despite adherence to antibiotic prophylaxis. Further investigation into optimal strategies to prevent these complications in high-risk patients is required.

ANALYSIS OF OVER 2 DECADES OF COLON INJURIES IDENTIFIES OPTIMAL METHOD OF DIVERSION: DOES AN END JUSTIFY THE MEANS?

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Introduction: Conflicting evidence exists regarding the definitive management of destructive colon injuries. While some advocate resection plus anastomosis for the majority of patients, others employ the routine use of a diverting ostomy in select cases. In fact, although diversion with an end ostomy can theoretically decrease initial complications, it mandates a more extensive reversal procedure. Conversely, anastomosis with proximal loop ostomy diversion, while simplifying the reversal, increases the number of suture lines and potential initial morbidity. Nevertheless, for those purporting diversion, there is little data comparing end ostomy to anastomosis plus proximal diversion. Thus, the purpose of this study was to evaluate the impact of diversion technique on morbidity and mortality in patients with destructive colon injuries.

Methods: Consecutive patients with destructive colon injuries managed with diversion over a 21-year period were stratified by age, gender, severity of shock and injury, operative management, and timing of reversal. Deaths within 24 hours and patients with rectal injuries were excluded. Outcomes, including ostomy-related complications (obstruction, ischemia, readmission) and reversal-related complications (obstruction, abscess, suture line failure, fascial dehiscence), were compared between patients managed with a loop ostomy and those managed with an end ostomy.

Results: 115 patients were identified: 80 received an end ostomy and 35 received a loop ostomy. 47 patients required a planned ventral hernia (PVH). Ostomy-related complications occurred in 22 patients (19%) and 11 patients suffered reversal-related complications. 71 patients (62%) underwent ostomy reversal. There was no difference in ostomy-related (2.9% vs 3.8%, $p=0.99$) or reversal-related (0% vs 0%, $p=0.99$) mortality. For patients *without* a PVH, there was no difference in ostomy-related complications between patients managed with a loop ostomy and those with an end ostomy (12% vs 18%, $p=0.72$). However, patients managed with a loop ostomy had a shorter reversal operative time (112 vs 292 minutes, $p<0.001$) and reversal length of stay (6 vs 12 days, $p=0.008$) with fewer reversal-related complications (0% vs 36%, $p=0.02$). Use of a loop ostomy reduced hospital charges by \$763,000. For patients *with* a PVH, there was no difference in ostomy-related complications, reversal operative time or length of stay, or reversal-related complications between patients managed with a loop ostomy and those with an end ostomy.

Conclusion: For patients with PVH, loop ostomy provided no additional benefit over end ostomy. However, for patients without PVH, loop ostomy reduced reversal-related complications, operative time, LOS, and hospital charges without compromising initial morbidity. Thus, for all patients, loop ostomy should be the preferred method of diversion, if required, following destructive colon injury.

**Serial Hemoglobin Monitoring in Adult Patients with Blunt Solid Organ Injury:
Less is More**

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Introduction: Patients who sustain blunt solid organ injury to the liver, spleen or kidney and are treated nonoperatively frequently undergo serial monitoring of their hemoglobin (Hgb) at set intervals as often as every four to six hours. We hypothesized that in hemodynamically stable patients with blunt splenic, hepatic or renal injuries treated without an operation, scheduled monitoring of serum hemoglobin values may be unnecessary as hemodynamic instability, not merely hemoglobin drop, would prompt intervention.

Methods: We performed a retrospective review of adult patients admitted to our urban Level 1 trauma center following blunt trauma with any grade liver, spleen or kidney injury from January 1, 2016 to December 31, 2016. Patients who were hemodynamically unstable and went directly to the operating room were excluded. Patients who required any urgent or unplanned operative or angiographic intervention were compared with patients who did not require an intervention. Routine demographic and outcome variables were obtained and bivariate and multivariate regression statistics were performed using Stata v10.

Results: A total of 141 patients were admitted with blunt hepatic, splenic, renal or combined injuries. Age distribution did not differ significantly between the two groups (39.3 vs 41.4 years, p-value=0.51). Patients who underwent an intervention, in general had a higher Injury Severity Score (ISS) (26.7 vs 22.1; p-value=0.12) and lower admission Hgb (11.9 vs 12.8 g/dL; p-value=0.06). The number of Hgb draws (9.2 vs 10; p-value=0.69) and the associated change in Hgb (3.7 vs 3.5; p-value=0.71) did not differ significantly between the two groups. Number of RBC units transfused was higher in the intervention group (3 vs 1; p-value=0.09). No patients in the non-operative group required operative intervention based on decreasing Hgb. All of the 21 patients who required laparotomy underwent surgery within 4 hours after admission.

Conclusion: Among patients with blunt solid organ injury, a need for emergent intervention in the form of laparotomy or angioembolization typically occurs within the first hours of injury. Routine scheduled hemoglobin monitoring did not alter management and is unnecessary in the management of blunt solid organ injury.

SPLENIC ARTERY ANGIOEMBOLIZATION FOR HIGH-GRADE SPLENIC INJURY: STOP WASTING TIME AND MONEY

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Introduction: Practice management guidelines advocate for non-operative management (NOM) of hemodynamically normal patients sustaining blunt splenic injuries of all grades. Splenic artery embolization (SAE) has been advocated to improve rate of splenic salvage in the setting of NOM. The purpose of this study is to determine the cost-effectiveness of SAE for high-grade splenic injuries, grade III-V.

Methods: Using TreeAge software, a cost-utility analysis was developed for a 40-year-old male base-case patient with blunt splenic injury. We compared non-operative management to non-operative management with SAE. Non-operative patients were modeled with the probability of failure requiring splenectomy, readmission, and post procedure complications. Patients managed by SAE were modeled with probability of failure leading to splenectomy, readmission, and post interventional radiology (IR) complications. Probabilistic sensitivity analysis was completed by Monte Carlo simulation with 10,000 random walks to account for variable and model uncertainties. Each high-grade injury splenic injury (III-V) was evaluated separately. Probabilities of procedural complications, readmissions requiring additional management, and splenectomy rates were extracted from published data between 2000-2017. Costs were collected from Centers for Medicare and Medicaid Services Healthcare Cost and Utilization Project and expressed in 2014 dollars. Utility outcome was quality-adjusted life years (QALY).

Results: For patients with grade III blunt splenic injury, NOM was \$32,279 with gain of 0.96 QALY compared to SAE that costs \$70,197 with gain of 0.89 QALYs, thus NOM is the dominant strategy. For patients with grade IV injury, NOM costs \$44,192 with 0.87 QALYs gained compared to SAE that costs \$70,113 with 0.89 QALYs gained. This results in an interval cost effectiveness ratio (ICER) of NOM to SAE of \$1,296,046/QALY. For patients with grade V injury, NOM costs \$56,959 with 0.78 QALYs gained compared to SAE that costs \$68,141 with 0.91 QALYs gained. The ICER comparing NOM to SAE is \$86,015/QALY. Using the standard willingness-to-pay threshold of \$50,000, NOM is the more cost-effective strategy for grade IV and V injury. In grade III injury, NOM is the dominant treatment strategy.

Conclusion: For grade III injuries, NOM without SAE results in the most cost-effective strategy yielding more quality-adjusted life years. NOM without SAE is the most cost-effective strategy for all high-grade splenic injuries. Thus, non-operative management of splenic injuries should routinely be performed without SAE.

EVALUATING THE 2009 REVISION OF THE 1989 AMERICAN ASSOCIATION FOR THE SURGERY OF TRAUMA RENAL INJURY SCALE: CAN WE IMPROVE?

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Introduction:

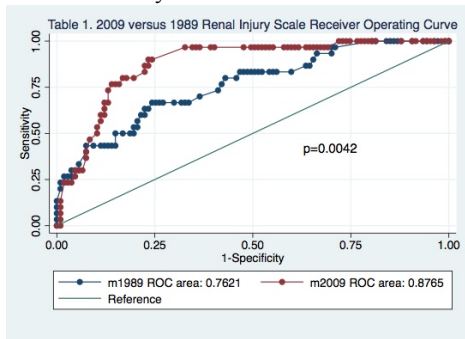
To better characterize traumatic renal injury a revision to the 1989 American Association for the Surgery of Trauma (AAST) Renal Injury Scale (RIS) has previously been proposed. The key changes proposed were: grade IV includes collecting system and segmental vein or artery injuries, and grade V omits the construct “shattered kidney” in favor of main renal hilum vascular injury or complete ureteropelvic junction disruption. We sought to validate the 2009 AAST-RIS, emphasizing grade reclassifications between the 1989 and 2009 AAST scales and subsequent management.

Methods:

Using a prospective trauma database, patient demographics and renal injury characteristics, computerized tomography imaging, radiology reports, and subsequent management were recorded. Descriptive analyses were performed with original grade, revised grade, and radiology reports; further analysis of major interventions was performed for severe injuries. Two multivariate logistic regression models for intervention were tested using 1989 and 2009 grades. We compared the models to evaluate which grading scale better accounted for the study data.

Results:

Among 256 cases of renal injury from 2004-2016, 42 (21.9%) were reclassified using the revised 2009 scale; 50 cases (19.5%) were upgraded, 6 (2.3%) were downgraded, and 200 (78.1%) were unchanged. Among cases with grades III or higher, 131 (81.4%) were managed non-operatively, 9 (5.6%) with angioembolization, 9 (5.6%) with nephrectomy, and 12 (7.5%) with renorrhaphy; management was significantly associated with original and revised grade (χ^2 , $p=0.02$ and $p<0.001$, respectively). These associations were preserved when correcting for covariates; further, the multivariate model using the 2009 grades significantly outperformed the 1989 model (Table 1).



Conclusion:

Employing the 2009 revision to the AAST-RIS led to more definitive classification of renal injury and a stronger association with renal trauma management. Applying the revised AAST criteria, which define renal trauma injuries with more clarity, may facilitate and improve the multidisciplinary care of renal trauma by urologists, trauma surgeons, and radiologists.

OPTIMAL TIMING OF DELAYED EXCRETORY PHASE CT SCAN FOR DIAGNOSIS OF URINARY EXTRAVASATION AFTER HIGH-GRADE RENAL TRAUMA

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Introduction: Delayed excretory phase CT scan is often needed to evaluate potential collecting system injuries and accurately grade renal injuries after high-grade renal trauma (HGRT). Excretory phase with adequate contrast accumulation into the collecting system allows to evaluate for urinary extravasation. However, the optimal timing to obtain the excretory phase after renal trauma is not established. We aimed to assess the association between excretory phase timing and diagnosis of urinary extravasation and also suggest a cut-off point based on multi-institutional data on HGRT.

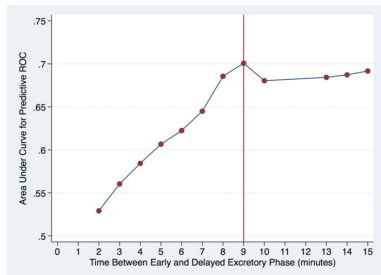
Methods: From 2014-2017, clinical and imaging data on HGRT (AAST grades III-V) were gathered from 14 Level-I trauma centers participating in the AAST Genito-Urinary Trauma Study. Patients with missing initial CT scans or those who underwent immediate surgery without imaging were excluded. Initial and follow-up CT scans were reviewed by two radiologists to extract injury details including vascular contrast extravasation, as well as urinary extravasation. The time between early (portal venous) and excretory phases was recorded. Hypotension was defined as systolic blood pressure <90 mmHg. Kruskal-Wallis and Wilcoxon ranked-sum test with Hommel’s correction for multiple comparisons were used to compare excretory phase time in different urinary extravasation diagnosis groups (Yes/No/Inconclusive). Logistic regression was used to measure the association between excretory phase timing (continuous) with diagnosis of urinary extravasation (binary outcome). Predictive receiver operating characteristic (PROC) analysis, using positive and negative predictive values (PPV and NPV) and the area under curves (AUC) were used to suggest a cut-off point optimizing detection of urinary extravasation when present.

Results: A total of 326 patients met the inclusion criteria. Of these, 243 (74%) had excretory phase CT scans for review either initially (210) or at their follow-up (33). At initial CT with excretory phase, 46 patients (22%) were diagnosed with urinary extravasation and 25 patients (12%) had inconclusive images. Median time between portal venous and excretory phases was 4 minutes (IQR: 4 –7 minutes). Time of initial excretory phase was significantly higher in those diagnosed with urinary extravasation (median: 7 minutes, IQR: 4–10) vs. those not diagnosed with urinary extravasation (median: 4 minutes, IQR: 4–6) and those with initial inconclusive images (median: 4 minutes, IQR: 4–5) [P <0.001 and 0.03, respectively]. In multivariable logistic regression, increased time to excretory phase was positively associated with finding urinary extravasation at the initial CT scan, after controlling for injury severity score, trauma mechanism, hypotension, and renal vascular contrast extravasation (Odds Ratio per minute: 1.26, 95% CI: 1.14-1.40, P<0.001). The optimal cut-off for detecting urinary extravasation in our study was 9 minutes (PPV: 56%, NPV: 84%; PROC AUC: 70%).

Conclusion: The timing of excretory phase imaging is important in diagnosis of urinary extravasation after HGRT. In our study, most excretory phases were timed about 4 minutes after the early contrast phase. We suggest a 9-minute delay between the early and excretory phases to optimize diagnosis of collecting system injuries.

| Time between early and excretory phase | PPV (%) | NPV (%) | PROC AUC | % of urinary extravasation detected at time-point * |
|--|---------|---------|----------|---|
| 3 minutes | 23.2 | 100 | 0.616 | 7.4% (2/27) |
| 4 minutes | 25.7 | 93.9 | 0.598 | 15% (11/73) |
| 5 minutes | 34.0 | 87.7 | 0.609 | 21% (5/24) |
| 6 minutes | 38.6 | 86.2 | 0.624 | 20% (3/15) |
| 7 minutes | 43.6 | 85.5 | 0.646 | 23% (4/17) |
| 8 minutes | 52.6 | 84.6 | 0.686 | 33% (2/6) |
| 9 minutes ^a | 56.3 | 83.9 | 0.701 | 62% (8/8) |
| 10 minutes ^b | 54.2 | 81.8 | 0.680 | 50% (4/8) |
| 13 minutes ^b | 56.3 | 80.4 | 0.683 | 50% (1/2) |
| 14 minutes | 57.1 | 80.1 | 0.686 | 50% (1/2) |
| 15 minutes | 58.3 | 79.8 | 0.691 | 58% (7/12) |

PPV, positive predictive value; NPV, negative predictive value; PROC, predictive receiver operating characteristic; AUC, area under curve
^a Suggested time cut-point based on highest PROC AUC and increase in % of urinary extravasation diagnosed at the time point
^b No data available for minutes 11 and 12; PPV, NPV, and PROC AUC the same as minute 13
^c Data on this column is based on specific time points with presented sample sizes; other columns use all the data dichotomized at specific cut-points.



CURRENT MANAGEMENT OF EXTRAPERITONEAL TRAUMATIC BLADDER INJURIES: RESULTS

FROM THE AMERICAN ASSOCIATION FOR THE SURGERY OF TRAUMA (AAST) GENTOURINARY TRAUMA STUDY

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Introduction: Bladder trauma is an uncommon urologic injury; research on extraperitoneal bladder injuries (EBI) is mostly limited to retrospective, single-institutional studies. Our goal is to understand current management trends and the role of surgical repair for EBI in a large contemporary multi-institutional setting.

Methods: From 2014 to 2017, data on bladder injuries were collected from 12 participating Level-1 trauma centers. Demographics, injury characteristics, acute management, complications, and need for delayed interventions were noted. Patients were excluded if they died during the first 48 hours after arrival due to non-urologic injuries. Descriptive statistics were used to report management patterns of EBI during this period.

Results: 82/160 (51%) bladder injuries were EBI. Patient and injury characteristics are summarized in Table-1. Most injuries (79%) were blunt and 87% had concomitant injuries. 65 patients (79%) had pelvic fracture, 31 (48%) of whom underwent open reduction and internal fixation (ORIF). EBI was repaired in 34 (41%) patients at a median of 8 hours (IQR 2-23 hours) from admission. The three leading reasons for EBI repair were: severity of the injury or bladder neck injury (38%), injury found during laparotomy (38%), and concerns about pelvic hardware contamination (35%). Complications in the non-operative group included UTI/sepsis (6), pelvic hardware infection and removal (3), and persistent urine leak (3). Three patients with persistent leak eventually underwent bladder repair, 2 of whom had intravesical bone fragments. Complications in the operative group included vesicocutaneous fistula and pelvic osteomyelitis (2), UTI/sepsis (2), persistent urine leak (2), and pelvic abscess (1). In patients undergoing ORIF, rates of complications or hardware infection were not different between conservative and operative bladder management groups.

Conclusion: A large proportion of EBI are currently operatively managed and role of surgery should be considered in evaluation of EBI. Both conservative and operative management of EBI is associated with high rates of complications, however, there may be significant selection bias for operative management of severe injuries, which hampers interpretation of similar complication rates.

Table-1 Demographics and management of extraperitoneal traumatic bladder injuries

| | Total (N=82) | Conservative (N=48) | Surgical Repair (N=34) | P-value |
|--|-----------------|------------------------|---------------------------|------------------|
| Age, mean (SD), y | 42.8 (18.2) | 45.7 (19.5) | 38.7 (15.6) | 0.09 |
| Male sex, No. (%) | 58 (71%) | 30 (62%) | 28 (82%) | 0.05 |
| Type of injury | | | | 0.001 |
| Blunt | 65 (79%) | 44 (92%) | 21 (62%) | |
| Penetrating | 17 (21%) | 4 (8%) | 13 (38%) | |
| ISS, mean (SD) | 26.5 (14.1) | 29.0 (14.6) | 23.0 (12.7) | 0.06 |
| Concomitant injuries, No. (%) ¹ | 72 (87%) | 45 (93%) | 27 (79%) | 0.05 |
| Pelvic fracture | 65 (79%) | 42 (87%) | 23 (68%) | 0.03 |
| Bladder neck injury | 7 (8%) | 1 (2%) | 6 (18%) | 0.02 |
| Rectal injury | 12 (15%) | 4 (8%) | 8 (23%) | 0.05 |
| Non-urologic operation | | | | |
| Exploratory laparotomy | 32 (39%) | 9 (19%) | 23 (68%) | <0.001 |
| ORIF | 31 (38%) | 15 (36%) | 16 (47%) | 0.15 |
| Length of stay, mean (SD), d | 15.1 (14.7) | 15.5 (14.6) | 14.4 (15.1) | 0.73 |
| Complications, No (%) | 19 (23%) | 12 (25%) | 7 (21%) | 0.83 |

SD, standard deviation; ISS, injury severity score; ORIF, open reduction and internal fixation

¹ Defined as presence of any concomitant injury, including: solid organ, gastrointestinal, spinal cord, major vascular, and pelvic fracture.

* comparisons made between conservative and surgical repair management groups

BLAME IT ON THE TRAUMA: INURY IS AN INDEPENDENT RISK FACTOR FOR PANCREATIC FISTULA FOLLOWING DISTAL PANCREATECTOMY COMPARED TO ELECTIVE RESECTION

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Introduction: Postoperative pancreatic fistula (POPF) remains a significant source of morbidity following distal pancreatectomy (DP), both for elective resection and following traumatic injury. There exists a lack of information regarding the impact of trauma on POPF rates when compared to elective resection. We hypothesize that trauma would be a significant risk factor for the development of POPF following DP.

Methods: All patients undergoing DP from 2000-2017 at a single-institution were retrospectively reviewed. Patients undergoing resection for trauma were compared to those undergoing elective resections for benign disease. This was done to attempt to control for pancreatic parenchymal texture, as patients with benign diagnoses and trauma are more likely to have similar gland texture compared to patients with malignant disease. However, fistula rates between all elective cases (benign and malignant) were compared to rates among trauma patients separately. Univariate and multivariable analyses were performed using SAS (version 9.4). The updated version of International Study Group for Pancreatic Fistula (ISGPF) definition of POPF was used to define a pancreatic fistula. P-values of <0.05 were considered statistically significant.

Results: Of the 203 patients who underwent DP from 2000-2017, 43 (21.2%) were due to trauma, 65 (32%) were due to benign diagnoses, and 95 (46.8%) were for malignant diagnoses. Six patients did not survive for 72 hours and were excluded from the analysis. When comparing trauma patients to patients undergoing resection for benign diagnoses, there were significant differences between groups in mean age (29.8 vs 51.6 years, $p<0.0001$), gender (71.1% male vs 41.5% male, $p=0.0008$), Body Mass Index (low/normal: 55.6% vs 16.1%, overweight: 25% vs 28.6%, Obese: 19.4 vs 55.4, $p=0.0001$), smoking status (73.7% current smokers vs 17.3%, $p<0.0001$), and the number of patients with comorbid conditions (7.9% vs 55.4%, $p<0.0001$). While significantly more trauma patients had stapled closure of their pancreas (62.2% vs 30.8%, $p=0.0020$) compared to benign-elective cases, on univariate analysis, there was no significant effect seen on the rate of developing a POPF (OR: 1.10, 95% CI: 0.47-2.56, $p=0.8257$). On multivariable analysis, after controlling for age, gender, postoperative transfusion rate, BMI, and tobacco use, the odds of developing a POPF in trauma patients were 11 times those of benign-elective patients (OR: 10.67, 95% CI: 1.31-86.92, $p=0.0270$).

Conclusion: To our knowledge, this study represents the largest cohort of patients comparing pancreatic leak rates in traumatic vs elective DP, and demonstrates that traumatic injury is an independent risk factor for developing an ISGPF grade B or C pancreatic fistula following DP. Adjusting surgical management, such as the practice of leaving intraperitoneal drains after DP, should be considered to account for this prominent risk factor.

DESIGNING A NOVEL METHOD FOR COLLECTING PATIENT-REPORTED OUTCOMES IN THE TRAUMA POPULATION: UNDERSTANDING IMPLEMENTATION CHALLENGES

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Introduction: Monitoring longitudinal patient-reported outcomes (PROs) and quality of life after injury is the next frontier of comprehensive trauma care. Current methodologies for monitoring outcomes are resource intensive with variable rates of engagement. We aimed to explore the feasibility of using a secure, internet-based survey platform to improve collection of PROs after injury.

Methods: English-speaking patients ≥ 18 years-old admitted to a Level I University Trauma Center with traumatic injuries were prospectively enrolled over three months. The following injury criteria were used for eligibility: emergency operation; or ICU length-of-stay greater than two midnights; or hospital length-of-stay greater than 4 days. A GCS of 15 was required for consent. Surveys were administered using an automated electronic survey platform taken on a tablet device provided at the time of enrollment. The survey platform utilized customized questionnaires to collect demographic details and user experience data. NIH-PROMIS tools relating to health-related quality of life, patient-reported mental health, efficacy of symptom management, and social functioning were administered via the survey platform which enables use of available computer adaptive tests. Follow-up surveys were automated to be released by the survey platform via email at 3 months with a 2-week window for completion; nonresponse generated an automatic reminder email. During enrollment, contextual field notes were recorded by research staff including information related to interruptions in care, barrier to enrollment and completion of the surveys, and challenges faced by the participants.

Results: During the 3-month pilot study, forty-seven patients were eligible for enrollment; 26 (55%) enrolled and 19 (40%) patients completed surveys. Technical constraints and declined participation were the primary barriers to enrollment (Figure 1). Twelve (26%) eligible patients could not participate either because they did not use email or had insurmountable difficulties using the tablet device. Of the 26 patients who were enrolled, 7 requested email links so they could begin the survey after discharge – none initiated the survey. Contextual field notes revealed three major obstacles to completing the survey: competing hospital tasks, issues with technology, and declining participation. Participation in this voluntary survey study was often lowest priority in the context of symptom management, team rounding, and disposition planning. Casts, splints, slings, and symptoms such as fatigue and nausea hindered use of the tablet. Some mild TBI and elderly patients struggled with the electronic interface and touchscreen. Young male trauma patients were most likely to decline participation and frequently believed they would not face issues while recovering. The final group of participants included 14 (74%) men and 5 (26%) women with an average age of 55 years (SD 19). The majority (89%) of injuries were blunt force mechanisms. For those who did complete the survey, the average completion time was 43 minutes – only 21% found this too long. Seventy-four percent of participants reported the system easy to use, 26% had “slight” issues and 0% had “major” issues with the system. Ninety-five percent of patients anticipated they would “very likely” or “definitely” respond to future surveys.

Conclusion: Patient engagement was the greatest barrier with lack of email access and technological issues contributing to over half of the reasons for not enrolling. Advancing age, foreign-language, and lower socioeconomic status is associated with reduced access to personal computers, handheld devices, and internet services in the US. These population characteristics are over-represented in the trauma population. Electronic capture of longitudinal PROs, while convenient, must consider socioeconomic barriers to its use.

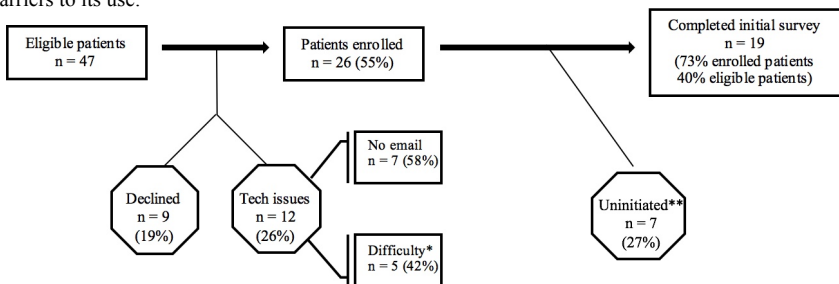


Figure 1: Dropout of eligible patients during the three-month feasibility study. *Unable to hold, read, or manipulate tablet device. **Patient requested emailed survey to initiate after impending discharge (0/7 initiated survey).

MEASURING PRE-INJURY FUNCTIONAL STATUS, WHICH INSTRUMENT?

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Introduction: Functional outcomes in the elderly after injury are as important as commonly reported morbidity and mortality. Long term functional outcome depends on pre-injury function in the aged. Measuring pre-injury functional status in the critically injured may be difficult as it requires recollection of premorbid functional status, or by report of a surrogate. Although multiple instruments are available for measuring functional status, it is unknown which, if any, will perform well when used by a surrogate. We assessed six commonly available instruments.

Methods: Elderly (≥ 65), minimally injured trauma patients or uncomplicated elective colorectal surgery patients, with a normal mental status, and had a surrogate who either provided care for or resided with the patient were enrolled within 48 hours of admission. Patient and surrogate pairs completed identical instruments and were instructed to complete the instruments considering the patient's pre-injury or pre-operative functioning. Correlation was assessed with Pearson correlation coefficients. Linear regression assessed factors potentially associated with degree of correlation.

Results: One hundred eighteen patient-surrogate pairs were enrolled with a mean age of 78.5 ± 8.4 , 68 (60.0%) were female, 110 (93.2%) were trauma patients. Surrogates were spouses (50.0%), children (42.4%), siblings (3.4%) or other (4.2%). Concordance was excellent for the Glasgow Outcome Scale, Katz's Index and the Barthel index (Table). Physical functioning, activities of daily living (ADL) and instrumental activities of daily living (I-ADL) had better surrogate correlation than measures of mental health and social interaction. Katz's index correlation was lower for siblings or children vs. a spouse ($p=0.017$, 0.001 respectively).

| Instrument | Patient Score (Mean \pm SD) | Surrogate Score (Mean \pm SD) | p-value | Pearson coefficient |
|---|----------------------------------|------------------------------------|---------|------------------------|
| Glasgow Outcome Scale - Extended SF-36 | 5.49 \pm 2.04 | 5.39 \pm 2.00 | 0.78 | 0.9422 |
| Physical Functioning | 47.03 \pm 36.71 | 43.64 \pm 37.97 | 0.62 | 0.9269 |
| Role-physical | 61.02 \pm 42.95 | 65.54 \pm 45.05 | 0.58 | 0.7689 |
| Bodily Pain | 69.03 \pm 25.27 | 69.42 \pm 21.45 | 0.93 | 0.8600 |
| General Health | 56.81 \pm 16.44 | 55.53 \pm 13.65 | 0.64 | 0.7401 |
| Vitality | 54.75 \pm 14.03 | 55.08 \pm 11.35 | 0.89 | 0.6739 |
| Social Functioning | 70.55 \pm 24.87 | 75.00 \pm 20.76 | 0.29 | 0.7253 |
| Role-emotional | 87.01 \pm 28.38 | 90.40 \pm 25.56 | 0.50 | 0.4853 |
| Mental Health | 67.05 \pm 13.94 | 68.75 \pm 12.08 | 0.48 | 0.8003 |
| Reported Health Transition | 49.58 \pm 21.01 | 51.69 \pm 17.29 | 0.55 | 0.6546 |
| CSHA Clinical Frailty Index | 0.039 \pm 0.029 | 0.035 \pm 0.028 | 0.46 | 0.9171 |
| Katz Index of Independence in ADL | 4.81 \pm 1.69 | 4.90 \pm 1.60 | 0.78 | 0.9612 |
| Functional Status Questionnaire | | | | |
| Basic ADL | 79.85 \pm 20.99 | 78.16 \pm 20.83 | 0.66 | 0.9328 |
| Intermediate ADL | 55.69 \pm 31.17 | 53.76 \pm 31.57 | 0.74 | 0.9604 |
| Mental Health | 71.59 \pm 14.59 | 76.34 \pm 10.25 | 0.043 | 0.3738 |
| Work Performance | 53.39 \pm 9.46 | 52.26 \pm 6.70 | 0.46 | 0.6838 |
| Social Activity | 78.53 \pm 27.11 | 79.00 \pm 28.35 | 0.93 | 0.9163 |
| Quality of Social Interaction | 75.12 \pm 15.33 | 76.95 \pm 12.87 | 0.48 | 0.1511 |
| Barthel Activities of Daily Living | 17.64 \pm 3.23 | 17.88 \pm 2.81 | 0.67 | 0.9559 |

Conclusion: Pre-injury physical functioning and ADL/I-ADL can be accurately assessed through a surrogate with an excellent degree of agreement. Measures of psychosocial functioning are good; however, the lower degree of concordance likely limits their use for comparing pre- and post-injury change in the mental, emotional and social domains. Katz's index performs less well when the surrogate is not the patient's spouse.

RISK FACTORS ASSOCIATED WITH POOR LONG-TERM SOCIAL FUNCTIONING AFTER TRAUMA

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Introduction: Social Functioning (SocFun), the ability to participate in organized or informal family, friend or peer groups and communal activities, is intertwined with physical and emotional health. As trauma can have a lasting effect on both physical and emotional well-being, it may also prevent injury victims from returning to their baseline SocFun norms, although little is known about these complex interactions. With this project we aim to determine risk factors associated with long-term Social Dysfunction (SocDys) after trauma.

Methods: Adults with an Injury Severity Score >9 managed at three urban academic Level I trauma centers were contacted at 6 and 12 months after injury. Phone interviews were conducted to inquire about SocDys (whether patient's physical and emotional health has interfered with their social activities, such as visiting friends and interacting with family members). Demographics, socioeconomic parameters, mechanism and severity of injury, as well as hospital course information were also obtained. Data were compared between patients who reported SocDys and those who did not. A stepwise backward logistic regression model for SocDys, adjusting for the parameters that were different between the two groups was fitted.

Results: Of the 632 screened patients, 48.1% reported SocDys. Differences in demographics, socioeconomic parameters, injury characteristics and hospital course are summarized in the table. High school (or lower) education, longer hospital stays, and African American (AA) race independently increased risk for SocDys. AA patients were more likely to be younger ($p<0.001$), Medicaid beneficiaries ($p<0.001$), penetrating injury victims ($p<0.001$), have lower education ($p<0.001$), and be discharged home ($p=0.02$).

Conclusion: Lower educational attainment, lengthy hospital stays and AA race appear to predispose to SocDys after trauma. This information should alert clinicians and caretakers of this potential long-term adverse social outcome.

| | SocDys (n=304) | No SocDys (n=328) | p-value | SocDys Independent Risk Factors [Odds Ratio (95% C.I.)] |
|----------------------------|-------------------|----------------------|----------|--|
| High school education | 181 (61%) | 117 (39%) | <0.001 | 2.43 (1.75-3.38) |
| Length of stay (days, IQR) | 5 (3-9) | 4 (3-6) | <0.001 | 1.04 (1.01-1.07) |
| African American race | 67 (65%) | 36 (35%) | <0.001 | 1.71 (1.08-2.72) |
| Medicaid Insurance | 49 (64%) | 27 (36%) | 0.002 | Not Sig |
| Mech. Ventilation | 48 (65%) | 26 (35%) | 0.002 | Not Sig |
| Age (years) | 53 \pm 20.8 | 57 \pm 20.5 | 0.016 | Not Sig |

POST-INJURY COMPLICATIONS- AN ANALYSIS OF CAUSATIVE FACTORS: WHERE DID WE ERR?

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Introduction: Injury care involves the complex interaction of patient, physician, and environment that impacts patient complications, level of harm, and failure to rescue (FTR). FTR represents the likelihood of a hospital to “rescue” patients from death after in-hospital complications. We hypothesize that error type and number of errors contribute to increased level of harm and failure to rescue.

Methods: Patient information was abstracted from weekly Trauma Performance Improvement (PI) (1/1/16 -7/19/17), where trauma surgeons determined level of harm and identified factors associated with complications. Level of harm was determined by definitions set forth by the Agency for Healthcare Research and Quality (AHRQ). Logistic regression was used to determine the impact of individual factors on FTR and level of harm, controlling for age, gender, Charlson score, ISS, error (in diagnosis, technique, or judgment), delay (in diagnosis or intervention), and need for operation.

Results: 2,216 trauma patients presented during the study period. 224 (10.1%) had complications reported at PI; of these, 31 patients (13.8%) had FTR. PI patients were more likely to be older (median 51.8 vs 44.9 years, $p = .002$) and have higher ISS (median 22 vs 8, $p < .01$). Physician-attributable errors (OR 2.59, $p < .01$), most commonly errors in technique, and nature of injury (OR 1.97, $p < .05$), were associated with higher levels of harm, while delays in diagnosis or intervention were not. Each additional factor involved increased level of harm (OR 2.08, $p < .001$) and nearly doubled likelihood of FTR (OR 1.93, $p < .05$).

Conclusion: Physician-attributable errors in diagnosis, technique, or judgment are more strongly correlated with harm than delays in diagnosis and intervention. Increasing number of errors identified in patient care correlates with an increasing level of harm and FTR.

Table:

Logistic Regression Model for Level of Harm and FTR

| | Level of Harm (OR, [95% CI]) | FTR (OR, [95% CI]) |
|-------------------|------------------------------|----------------------|
| Age | 1.01 [0.99, 1.03] | 1.00 [0.97, 1.04] |
| Male | 0.94 [0.53, 1.70] | 0.67 [0.27, 1.72] |
| Charlson Score | 0.91 [0.75, 1.1] | 1.21 [0.88, 1.65] |
| ISS | 0.98 [0.97, 0.996]* | 1.05 [1.03, 1.07]*** |
| Delay | 1.38 [0.77, 2.50] | 0.73 [0.23, 2.08] |
| Error | 2.59 [1.38, 4.92]** | 1.81 [0.59, 5.22] |
| Nature of injury | 1.97 [1.13, 3.43]* | 1.80 [0.72, 4.64] |
| Number of factors | 2.08 [1.50, 2.91]*** | 1.93 [1.15, 3.27]* |
| Any operation | 0.56 [0.33, 0.95]* | 0.98 [0.37, 2.45] |

Key: '****' = $p < 0.001$ '***' = $p < 0.01$ '**' = $p < 0.05$

Resuscitative Endovascular Balloon Occlusion of the Aorta may improve survival among severely injured unstable patients experiencing post-intubation hypotension

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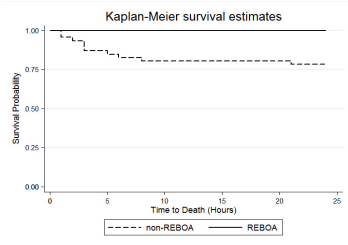
Introduction: We hypothesized that the deployment of REBOA among hemodynamically unstable (HU) trauma patients experiencing post-intubation hypotension (PIH) can result in improved survival. **Methods:** Retrospective analysis performed at a Level I Trauma Center between December, 2014 and January, 2018 of all adult torso trauma patients who 1) underwent surgery 2) developed PIH and were 3) HU (SBP<=90) upon arrival to the operating room. We excluded patients who were intubated prior to their arrival to the ER. Patients were subsequently divided into two groups: REBOA and -REBOA. All patients were treated upon arrival according to established damage control resuscitation (DCR) principles, and all REBOA's were inserted in the operating room after intubation by the treating trauma surgeon. All PIH patients were managed equally by the supervising attending anesthesiologist by means of DCR and

| TABLE | Total (n= 59) | REBOA (n=13) | non-REBOA (46) | p-value |
|---|------------------|------------------|------------------|---------|
| Male, n (%) | 47 (79.6%) | 8 (61%) | 39 (84%) | 0.08 |
| Age* | 30 (22-37) | 34 (25-45) | 29.5 (22-36) | 0.3 |
| Trauma Mechanism | | | | |
| Blunt | 8 (13.5%) | 3 (23%) | 5 (11%) | 0.3 |
| Penetrating | 51 (86.5%) | 10 (77%) | 41 (89%) | 0.3 |
| GSW | 36 | 6 | 30 | 0.3 |
| SW | 15 | 4 | 11 | 0.7 |
| ISS* | 25 (25-29) | 25 (25-41) | 25 (25-26) | 0.055 |
| Ps* | 0.96 (0.72-0.94) | 0.92 (0.72-0.94) | 0.97 (0.76-0.98) | 0.1 |
| Initial Lactate* | 5.2 (3.2-5.2) | 5.7 (4.1-5.7) | 5 (2.9-5) | 0.5 |
| PRBCs 24h* | 4 (2-7) | 6 (4-10) | 4 (2-6) | 0.2 |
| Plasma 24h* | 4 (2-8) | 6 (4-9) | 4 (0-6) | 0.052 |
| Platelets 24 h* | 0 (0-6) | 6 (0-6) | 0 (0-6) | 0.7 |
| Cryoprecipitate 24h* | 1 (0-12) | 6 (0-6) | 0 (0-10) | 0.06 |
| Crystalloids 24h* | 5760 (3849-6100) | 4715 (3849-6100) | 5850 (4090-8620) | 0.4 |
| SBP at the OR* | 70 (60-80) | 65 (50-76) | 71 (65-80) | 0.058 |
| SOFA day 2* | 5 (2-7) | 5.5 (4-8) | 4 (2-7) | 0.1 |
| Dialysis, n (%) | 6 (10%) | 2 (15%) | 4 (9%) | 0.6 |
| Mortality in first 24h | 10 (16.9%) | 0 (0%) | 10 (21.7%) | 0.09 |
| Calculated predicted survival rate (TRISS): (%) | 81.6% | 80.7% | 82% | NA |
| Real Survival Rate | 79.6% (n=47) | 92.3% (n=12) | 76% (n=35) | 0.2 |

GSW, Gunshot Wound; SW, Stab Wound; ISS, Injury Severity Score; Ps, Probability of Survival; PRBC, Packed Red Blood Cells; SBP, Systolic Blood Pressure; * = median (IQR); Continuous variables were compared the Wilcoxon ranksum test; Categorical variables were compared using chi-2 or fisher exact test

vasopressors when required. The predicted survival rate was calculated using the TRISS method and a Kaplan-Meier survival analysis of both the REBOA and the non-REBOA groups. **Results:** A total of 391 surgical torso trauma patients arrived at our institution during the study period. Of these, fifty-nine patients developed PIH and were HU upon arrival to the OR. The table presents an overview of patients' clinical characteristics and differences between groups. The predicted survival rates in the REBOA and non-REBOA groups were 80.7% and 82% respectively. However, the

actual survival rate in the REBOA group exceeded the calculated predicted survival by 11.6%. Although overall initial survival was not significantly different between the groups, REBOA patients demonstrated an improved trend for greater survival (P=0.07) (**Fig**). **Conclusion:** We were able to show that the use of a REBOA in HU trauma patients experiencing PIH may underpin these patients initial ability to survive this second hit and thus may improve on their overall survival. Our findings provide a glimpse of the possible positive effect of REBOA of ameliorating the negative effects of PIH on these patients' already physiological fragile situation. We advise that these results deserve further investigation.



EARLY OPERATIVE MANAGEMENT IS A COST-EFFECTIVE STRATEGY IN PATIENTS WITH ADHESIVE SMALL BOWEL OBSTRUCTION: A POPULATION-BASED, RETROSPECTIVE COST-EFFECTIVENESS ANALYSIS

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Introduction: Adhesive small bowel obstruction (aSBO) is a recurrent, potentially chronic surgical illness. While conservative management is often successful, operative intervention for aSBO is associated with a lower risk of recurrence. The long-term costs and benefits to patients of different management strategies for aSBO are not well understood. We sought to compare the long-term cost-effectiveness of two competing strategies for the management of aSBO: Trial of Conservative Management (TCM, the current standard of care) and Early Operative Management (EOM).

Methods: We performed a retrospective cost-effectiveness analysis using health administrative data. We identified patients admitted to hospital with their first episode of aSBO between 2005-2013 and created propensity-matched cohorts based on patients' likelihood to undergo EOM, defined as surgery the day-of or day-following admission. Patients were followed forward over a 5-year time horizon to determine the number of recurrences and adverse events as well as overall survival and accumulated inpatient-costs to the healthcare system. Utility scores were attributed to aSBO-related events and we estimated the incremental cost-effectiveness ratio (ICER) in terms of dollars per quality-adjusted life-year (QALY). Cost estimates are reported from the perspective of the health system in adjusted 2014 Canadian dollars.

Results: 25,150 patients were admitted for their first episode of aSBO and 3,174 (13%) were managed by EOM. After matching, patients in each management strategy were well-balanced with regards to age, sex, comorbidity burden, and socioeconomic status. After 5 years of follow-up, the average accumulated costs associated with EOM exceeded those of TCM (\$17,752 vs \$11,602, $p < 0.0001$). However, patients managed by TCM were 58% more likely to experience a recurrence of aSBO (20.9% vs 13.2%, $p < 0.0001$). These recurrences and the associated adverse events contributed to a long-term survival benefit and overall net effectiveness in terms of QALYs associated with EOM. The ICER associated with EOM decreased with each additional year of follow-up, representing increasing cost-effectiveness over time. After 5 years of follow-up the ICER of EOM compared to TCM was \$26,608/QALY.

Conclusion: Optimal strategies of care for aSBO should consider long-term outcomes and costs, including risks of recurrence and associated adverse events. Within 5 years following the first episode of aSBO, EOM is a cost-effective approach to care compared to TCM. Guidelines regarding the role of early surgical intervention for aSBO should be revisited in view of this evidence.

A Propensity Matched Analysis Of Outcomes In Cases Of Elderly Patients Who Fell From Ground Level At Home With Normal Vital Signs At The Scene: High Level Vs. Low Level And Unranked Trauma Center Care

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Introduction: According to the field triage criteria from the Center for Disease Control, injured elders who experience a ground level fall should be taken to a high-level trauma center if they have a history (hx) of anticoagulation use. Therefore, the purpose of the study was to evaluate whether the higher level of care significantly affected the outcomes of elderly patients who fell from ground level at home and had a normal physiological examination at the scene.

Methods: Patients aged 65 and above, with normal physiological measures at the scene (Glasgow Coma Score (GCS) = 15, systolic blood pressure (SBP) > 90 and < 160, heart rate ≥ 60 and ≤ 100) from the 2011-2014 National Trauma Data Bank (NTDB) data sets were included in the study. Patients' characteristics, existing comorbidities, and outcomes were compared between the American College of Surgeons' (ACS) Level 1 or 2 designated trauma centers (Group 1) and the ACS Level 3, 4, and Unranked designated trauma centers (Group 2). Following initial analyses, propensity score matching was performed and the rate of in-hospital mortality, median hospital length of stay, and discharge disposition was compared between the matched groups.

Results: Of the 40,800 patients who met the study inclusion criteria, 19,290 (47.3%) were transported to a Level 1 or 2 trauma center and the remaining 21,510 (52.7%) were taken to Level 3, 4, or Unranked trauma centers. There were significant baseline differences ($p < 0.05$) between the two groups regarding gender, race, the injury severity score (ISS), and existing comorbidities [hx of smoking, chronic kidney disease (CKD) requiring dialysis, hx of cerebrovascular accident (CVA), diabetes mellitus (DM), and hypertension (HTN) requiring medication]. After propensity score matching on age, gender, race, SBP, heart rate, respiratory rate, ISS, smoking status, CKD, CVA, DM, and HTN status, all characteristics except ISS (Median [IQR]: 9 [4, 9] vs 9 [4, 9], $p < 0.001$) were well balanced and 18,813 patients remained in each group. There were no significant differences regarding in-hospital mortality (2.5% vs. 2.3%, $p = 0.19$) or time to hospital discharge (Median [95% confidence interval]: 5 [5, 5] vs. 5 [5, 5], $p = 0.07$) between Groups 1 and 2 respectively. However, there was a significant increase in the proportion of patients who required services after discharge in Group 2 (78.9% vs. 81.7%, $p < 0.001$).

Conclusion: Cases of elderly patients whose physiological parameters are within normal limits at the scene of a fall from ground level have been associated with a higher risk of in-hospital mortality and significant morbidity requiring additional care after discharge from the hospital. In this study, higher levels of care failed to show any significant survival benefits or shorten the time to hospital discharge; however, a significantly higher proportion of patients who went to lesser-care facilities required follow-up services after discharge.

NECROTIZING SOFT TISSUE INFECTION (NSTI) IS ASSOCIATED WITH PERSISTENT INFLAMMATION, HIGH RESOURCE UTILIZATION AND POOR LONG-TERM FUNCTIONAL OUTCOMES.

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Introduction: Necrotizing soft tissue infection (NSTI) remains an acutely life threatening and surgically morbid condition, with aggressive debridement remaining the mainstay of care. The long-term systemic inflammatory phenotype and functional outcomes of these patients remain poorly defined.

Methods: We analyzed all NSTI within a single-center, prospective longitudinal cohort of critically ill surgical patients with sepsis. Clinical data included demographics, clinical course, procedural interventions, and organ dysfunction parameters. Circulating inflammatory biomarkers were measured serially between 0.5 and 28 days. Health-related quality of life (HRQOL) and performance status assessments were performed at 3 and 6 month follow-up visits. Surgical urosepsis (i.e., required minimally invasive sepsis source control) patients within the cohort were utilized as a comparison group.

Results: Over a 24-month period, 33 critically-ill NSTI and 25 urosepsis patients were enrolled with similar baseline characteristics. NSTI source location included perineum (42%), lower extremity (39%), torso (9%) and neck (9%). Early physiologic derangement was severe in NSTI (and similar to the urosepsis group) based on APACHE II (median 16, IQR 13-22), and max SOFA (7, IQR 4-11) scores, with 30% (n=10) requiring vasopressor support. Surgical source control required a median of 2 (IQR 1-3) debridement and 750cm² (IQR 126-1200) of soft tissue excision. Both NSTI and urosepsis (n=25) patients showed similar incidence of MOF, max SOFA score, and peak inflammatory biomarker levels (IL-6, IL-8, IL-10, CRP), which remained persistently elevated out to 28 days in both sepsis groups. However, NSTI patients had significantly longer hospital LOS (median 15 vs 7 days, p=0.004). While there were no inpatient NSTI deaths, 84% required either a post-discharge transitional facility (LTAC/Rehab/SNF; n=14, 42%), or extended home health care resources (n=14, 42%). In contrast to urosepsis patients (who returned to pre-admission baseline), NSTI patients showed persistently lower HRQOL as compared to baseline values across multiple domains at 3 months (EQ-5D utility index mean difference, -0.1270, p=005). Additionally, overall performance status remained limited and significantly worse than baseline at both three (WHO/Zubrod score 2.03±0.36, mean difference 0.786, p=0.006) and 6 months (Zubrod score 1.90±0.39, mean difference; 0.607, p=0.002) after NSTI onset.

Conclusion: Despite low inpatient mortality, NSTI remains a morbid condition with high incidence of MOF and an immunophenotype of persistent inflammation. Additionally, NSTI is associated with high resource utilization, persistent performance status deficits and decreased HRQOL out to 6 months from onset. Novel advances in early pharmacologic and long-term rehabilitation strategies are likely necessary to further improve NSTI outcomes.

HEALTH CARE UTILIZATION PORTENDS ECONOMIC DISABILITY AFTER INJURY IN CAMEROON

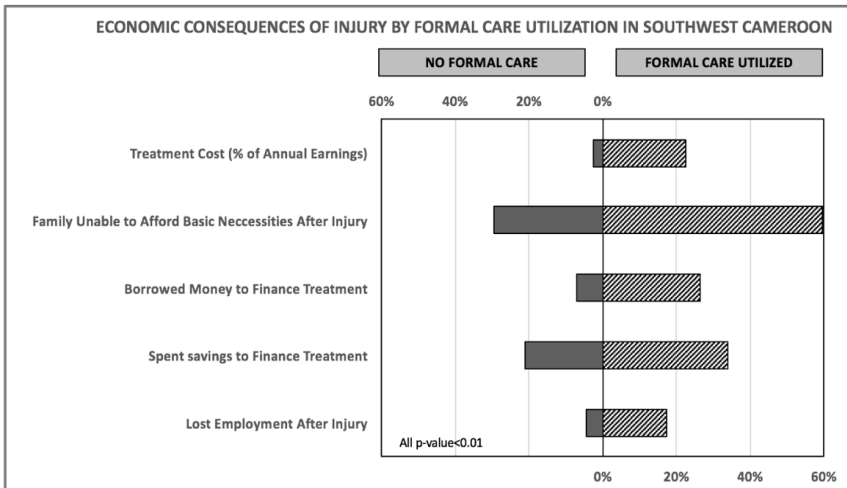
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Introduction: The United Nations has declared establishing Universal Health Coverage by 2030 to be a top health priority. Sub-Saharan Africa has among the highest rates of injury in the world but limited data suggest that many injured persons do not utilize formal medical services after injury due to cost constraints. In this study, we report the first population data on patterns, barriers, and economic consequences of care utilization after injury in Cameroon to establish targets for expanding access to care and improving trauma outcomes.

Methods: We performed a mixed-methods community based survey on injury in an urban-rural region of Cameroon. Three-stage cluster sampling was used to select target households. Data was collected on all injuries occurring in the preceding 12 months including care utilization, disability and economic outcomes. All survey data was adjusted for cluster sampling.

Results: Of 8065 individuals surveyed, 503 injuries were identified. Over 1/3 (35%) of injured persons did not utilize formal medical services. Disability affected 68% of injured persons and resulted in over 11,000 lost days of work in the sample projecting to an estimated 2 million days of work lost annually in the region. Family economic hardship after injury was substantially worse among the injured cohort who utilized formal care. Adjusted for age and severity, this group had higher treatment costs, more lost wages and employment, and more frequently resorted to economic coping strategies such as borrowing money or liquidating assets (all $p < 0.01$). Formal medical care utilization in Cameroon was found to be an independent predictor of severe economic hardship after injury, defined as new inability to afford food or rent (aOR 1.69, $p = 0.03$).

Conclusion: Injury in Southwest Cameroon leads to substantive disability and impedes regional economic growth. Formal medical services must be made economically viable to expand utilization. Financial restructuring of emergency care in Cameroon has considerable potential to mitigate poor outcomes for affected families and communities after injury.



TRAUMA PATIENTS ADMITTED TO NON-SURGICAL SERVICES – A MARKER FOR POOR OUTCOME

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Introduction: Trauma systems and trauma centers were designed to optimize outcomes post trauma. After initial trauma evaluation, trauma patients are occasionally admitted to non-surgical services. We hypothesized that trauma patients admitted to a surgical service (SS) would have lower mortality than those admitted to a non-surgical service (non-SS).

Methods: The Pennsylvania Trauma Outcome Study database was retrospectively queried from 2003-2015 for adult (age ≥ 15) trauma patients admitted to accredited trauma centers in Pennsylvania. Patients dead on arrival and burn mechanism of injury were excluded. Patients were identified based on admitting service: surgical vs. non-surgical. Baseline patient demographics and incidence of comorbidities between the two groups were determined. Multilevel mixed-effects logistic regression model controlling for demographic and injury severity covariates were utilized to determine the adjusted impact of admitting service on mortality.

Results: 379,420 patients met inclusion criteria (SS: 354,748, non-SS: 24,672). Patients admitted to SS were significantly younger, more severely injured and more likely to be male. When adjusted for demographic and clinical characteristics (Table 1), admission to SS was associated with lower odds of mortality (AOR 0.827, $p < 0.001$). Of note, patients who had delayed craniotomies had higher odds of dying on non-SS compared to SS (AOR 3.421 vs. 1.677) (Table 2).

Conclusion: Admission to non-surgical service appears to be a marker for a deleterious outcome in trauma patients. Patients with delayed craniotomies may be better managed on a surgical service because of improved neuro critical care. Trauma accrediting organizations should ensure that successful verification of trauma centers includes few trauma patients admitted to non-surgical services.

Table 1. Adjusted odds ratio for mortality in trauma patients.

| Variable | Mortality | |
|--|---------------------|--------|
| | AOR (95% CI) | p |
| Surgical service | 0.827 [0.751-0.911] | <0.001 |
| Major surgery | 2.917 [2.771-3.071] | <0.001 |
| Admission GCS | 0.750 [0.746-0.753] | <0.001 |
| AUROC: 0.9152 | | |
| *Adjusted for age, gender, ISS and ICU LoS | | |

Table 2. Adjusted odds ratio for trauma mortality based on admitting service.

| Mortality Variable | Surgical service | | Non-surgical service | |
|---|---------------------|--------|----------------------|--------|
| | AOR (95% CI) | p | AOR (95% CI) | p |
| Craniotomy | | | | |
| No craniotomy | Reference | --- | Reference | --- |
| Early (≤ 4 h) | 1.564 [1.462-1.673] | <0.001 | 0.930 [0.543-1.590] | 0.930 |
| Delayed (> 4 h) | 1.677 [1.486-1.893] | <0.001 | 3.421 [1.744-6.713] | <0.001 |
| AUROC: 0.9121 | | | AUROC: 0.9121 | |
| *Adjusted for age, gender, ISS, admission GCS and ICU LoS | | | | |

RESUSCITATIVE THORACOTOMY IN ISOLATED PENETRATING TRAUMA TO THORAX, DOES TRAUMA CENTER DESIGNATION MAKES A DIFFERENCE?

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Introduction: Patients with isolated penetrating trauma to the thorax who arrive with signs of life (SOL) and lose pulse in Emergency Department (ED) are most likely to benefit from Resuscitative Thoracotomy (RT). The aim of our study was to determine the differences in RT attempt rate and survival rate after RT between various levels of trauma center (TC) designation in patients with penetrating trauma to the thorax.

Methods: We performed 5-year (2011-2015) analysis of National Trauma Databank. All patients >18 years of age were included. Patients with isolated penetrating trauma to thorax who arrived ED with SOL were identified. Patients who lost vitals in ED were defined as those who died in ED or underwent RT. RT was defined as patients who underwent Exploratory Thoracotomy (PCODE: 34.02) within 1-hour of ED arrival. RT attempt rate was calculated as a percentage of patients who underwent RT out of all patients who lost vitals in ED. RT attempt rate and survival rate were compared.

Results: A total of 54,780 patients with isolated penetrating trauma to the thorax were identified. Mean \pm SD age was 32 ± 15 , 82% were male and 62% were white. Mechanism of injury (Gunshot: 72.3%, Stab: 27.7%). 90.4% (49,521) of the patients arrived at the ED with signs of life of which 11.9% (5917) lost vitals in ED (Died in ED: 2265, Underwent RT: 3562). Overall RT attempt rate was 60.2% which has increased from 45.2% in 2011 to 68.7% in 2015 ($p=0.002$). RT attempt rate was highest in Level-I TC at 74.4% followed by Level-II at 61.1% and was lowest in Level-III TC at 48.2% ($p<0.001$). Level-I TC had better survival rate after RT as compared to level II and III TC (42.4% vs 31.1% vs 29.2%; $p=0.013$).

Conclusion: Our analysis demonstrates a significant increase in RT attempt rate over 5 years on patients with an isolated penetrating chest injury. Level-I trauma centers had the highest RT attempt rates and the highest survival rates. Further studies are required to identify the factors influencing the decision to perform RT and to identify the factors associated with better survival in this cohort of patients.

CAN CHEST ULTRASONOGRAPHY REPLACE THE CHEST X-RAYS DURING THE INITIAL EVALUATION OF STABLE PATIENTS WITH PENETRATING THORACIC TRAUMA?

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Introduction: Recent literature suggests that chest ultrasonography (CUS) is an accurate tool for the diagnostic assessment of traumatic hemothorax and pneumothorax and thus, many consider CUS a reliable and accurate alternative to chest-Xray (CXR). However, current guidelines still recommend the use of chest-Xray for the diagnosis of these conditions. So far, there has been little discussion about the diagnostic yield of CUS in patients with penetrating chest trauma (PCT) who present stable to the trauma bay. Our objective was to evaluate the diagnostic accuracy of CUS for the emergency diagnosis of pneumothorax and hemothorax in stable patients with PCT.

Methods: A consecutive series of stable patients with PCT was prospectively included. Subjects submitted to emergent procedures and patients with trauma in the cardiac box were excluded. The initial evaluation was performed following ATLS guidelines. The findings of the CUS were registered and not used in the decision process.

Results: A total of 436 patients were included, 415(95.2%) were male. Trauma mechanisms were stab wound in 286 patients (65.6%) and gunshot in 150 (34.4%). Chest X-Rays showed hemothorax in 73 cases (16.7%), pneumothorax in 58 (13.3%) or both in 47 (10.8%) cases. One hundred seventy-six patients (40.4%) required a procedure. Sensitivity for the detection of any intrapleural collection, hemothorax alone, pneumothorax alone or the selection to a therapeutic procedure fluctuated between 0.56 to 0.86. The specificity ranged from 0.87 to 0.94. (Table)

| | Sensitivity | Specificity | LR (+) | LR (-) |
|----------------------|-------------|-------------|--------|--------|
| Abnormal chest R-Ray | 0,74 | 0,87 | 5,98 | 0,29 |
| Hemothorax | 0,56 | 0,93 | 8,15 | 0,47 |
| Pneumothorax | 0,60 | 0,94 | 10,36 | 0,42 |
| Thoracic procedure | 0,86 | 0,88 | 7,48 | 0,15 |

Conclusion: CUS obtained during the initial evaluation of stable patients with penetrating trauma is a good tool to confirm but not to rule out intrapleural collections or the need of a therapeutic procedure. Although CUS seems unable to replace CXR, it seems to be a valuable adjuvant diagnostic modality in the initial diagnostic approach of patients with PCT who present hemodynamically stable to the trauma bay.

CONTINUOUS PARAVERTEBRAL ANALGESIA - IMPROVED OUTCOMES DESPITE INCREASED RIB FRACTURES

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Introduction: Rib fractures may result in significant morbidity and mortality. Epidural analgesia provides superior pain control, but its use may be limited due to associated injuries, risk of complications, and lack of qualified personnel. Continuous local anesthetic may be provided directly to the effected intercostal nerves via a paravertebral catheter (PC). PC are widely available and easily placed at bedside. We sought to evaluate outcomes of patients with multiple rib fractures following the addition of PC to existing multimodal therapy.

Methods: Trauma patients with multiple rib fractures were reviewed retrospectively from 2015-2018 in a case-control study. All patients managed with PC were matched to controls with multiple rib fractures in a 1:2 ratio using injury severity score (ISS), age, and gender. Rib fractures were characterized by total number, laterality, and flail segments. PC placement including timing, duration, and fracture coverage was recorded. Rib fracture related morbidity was defined as the occurrence of unplanned intubation, extubation failure, tracheostomy requirement, pneumonia, and death. Multivariate regression models were used to assess the addition of PC with pulmonary morbidity.

Results: Forty-eight patients managed with PC were compared to 96 matched controls. Patients with PC had a significantly greater 30-day (15.9 ± 6.43 vs. 13.2 ± 9.94 , $p=0.048$) and 90-day (74.7 ± 12.53 vs. 63.3 ± 28.12 , $p=0.001$) hospital free days despite higher average number of rib fractures (9.3 ± 3.73 vs. 6.6 ± 4.11 , $p=0.001$) and flail segments (2.0 ± 2.94 vs. 0.8 ± 1.76 , $p=0.02$) compared to those without PC. The incidence of pneumonia (4.2% vs. 16.7%, $p=0.03$) and hospital mortality (2.1% vs. 13.5%, $p=0.03$) was significantly lower in patients managed with PC. Use of PC was significantly associated with decreased likelihood of pulmonary morbidity when controlling for age, ISS, and number of rib fractures (OR 0.27, $p=0.008$; 95 CI 0.10 – 0.71).

Conclusion: PC use is associated improved outcomes in patients with multiple rib fractures managed with standard multimodal therapy.

Don't rush to a wide-open chest when diagnosing a hemopericardium in hemodynamically stable patients with penetrating injuries to the cardiac box

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Introduction: Currently, there is growing will toward a non-operative approach in cases of patients with traumatic hemopericardium who present hemodynamically stable. However, most trauma surgeons hesitate to perform these kinds of procedures and instead rush to the operating room and perform unnecessary chest open surgeries. We sought to describe the management and outcomes of a series of patient's victims of penetrating injuries to the cardiac box and definitive evidence of hemopericardium.

Methods: This is a retrospective case series performed with data obtained from a prospectively collected database, from January 2015 to December 2017. We included patients with penetrating wounds to the precordial area that arrived hemodynamically stable to the trauma bay of our level-I trauma center and were diagnosed with hemopericardium through a pericardial window.

Results: A total of 183 patients with penetrating injuries to the precordial area and hemodynamically stable upon arrival to the trauma bay were seen at our institution during the study period. Of these, 32 had hemopericardium evidenced by a pericardial window (by thoracoscopy=9; by subxiphoid approach=23). Most patients were young [Age, median: 25 (IQR, 19-30)]. Three and twenty-nine patients were victims of gunshot wounds and stab wounds respectively. Median (IQR) of ISS was 17 (10-17), and 31 patients had serious intrathoracic injuries ($AIS \geq 3$). Fifteen patients had an associated lung injury that required tube thoracostomy placement; these patients had a median (IQR) of hemothorax of 600 (300-800). Nineteen patients underwent an open chest surgical intervention of which 17 and 3 underwent thoracotomy and sternotomy respectively. These patients presented a median (range) of Penetrating Cardiac Trauma Index (PCTI) of 10 (10-25). 12 patients underwent pericardiectomy and drainage of hemopericardium either by thoracoscopy (n=8) or by subxiphoid exploration (n=3). These patients had a median (range) of PCTI of 10 (0-10). Overall, 40% of patients did not require any cardiac repair. Of these, five patients were in the group of patients that underwent thoracotomy or sternotomy.

Conclusion: We found that almost half of patients with evidence of traumatic hemopericardium did not require therapeutic cardiac operative interventions after a definitive diagnostic pericardial window which suggests that amongst these populations mandatory thoracic incision for definitive surgical repair may not always be indicated. We advise that these findings deserve further investigation.

'PAIN'-TING A PICTURE: CHARACTERIZING CONTINUOUS INTERCOSTAL NERVE BLOCKS FOR THE PAIN MANAGEMENT OF ADULT TRAUMA PATIENTS WITH MULTIPLE RIB FRACTURES

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Introduction: Achieving satisfactory pain management among patients with multiple rib fractures (MRF) is critical to the prevention of pulmonary complications. Continuous intercostal nerve blocks (CINB) utilizing non-narcotic--based analgesia are proposed for patients with MRF, and we hypothesized that CINB would provide decreased pain during treatment compared to epidural (EPI) or intravenous analgesia (IVA).

Methods: This was a retrospective multicenter study of adult (18+ years) patients admitted for isolated MRF (3+ fractures) to four trauma centers (three Level I and one Level III) from 06/1/2012 to 06/30/2016. Patients were excluded if they had an abbreviated injury scale score >2 for body regions outside the chest, were treated solely with oral analgesia, or had no pain scores either before or during treatment. The primary outcome was change in average pain numeric rating scale (NRS; 0-10) from PRE (up to 6 hours prior to analgesic treatment initiation) to DURING (duration of treatment). We compared the mean change in pain between patients treated with CINB, EPI, and IVA. Secondary outcomes included hospital length of stay (LOS) and intensive care unit LOS (ICULOS). Univariate differences in patient characteristics were evaluated with ANOVA and chi-squared tests, and outcomes were evaluated with adjusted generalized linear models.

Results: Of the 109 patients included, 53 (49%) received CINB, 22 (20%) received EPI, and 34 (32%) received IVA. Overall, the majority of patients were male (70%), sustained an injury through a fall (47%), had a unilateral rib fracture (83%), and had a mean (SD) injury severity score (ISS) of 11.9 (3.6). CINB patients had similar demographic and clinical characteristics to EPI patients but were significantly more likely to be older (≥ 65 years, $p=0.02$) and have more rib fractures (≥ 7 , $p<0.001$) than IVA patients. Prior to treatment, mean (SD) pain NRS scores were 4.5 (3.0), 4.6 (2.4), and 5.8 (3.0) for CINB, EPI, and IVA patients, respectively ($p=0.10$). After adjustment for age and PRE pain, mean (SE) pain changes were -0.5 (0.2) for CINB, -0.7 (0.4) for EPI, and -0.8 (0.3) for IVA, suggesting no significant effect of treatment group on change in pain ($p=0.86$). Patients treated with CINB had a significantly shorter mean (SD) ICULOS (0.6 (1.0) days, $p<0.001$), but not hospital LOS, after adjustment, compared to EPI and IVA patients.

Conclusion: CINB provided comparable pain relief to EPI and IVA. Average pre-treatment pain was relatively low across all treatment groups, and change in pain was also minimal. CINB treatment was associated with significantly reduced ICULOS, in contrast to the results of a prior study comparing CINB to EPI pain management of rib fractures. With the potential for decreased rates of narcotic addiction, CINB might offer an efficient alternative for pain control in this population, even among patients with a greater number of fractures. Future research should assess pain longitudinally to characterize pain relief over time while on CINB treatment.

AMNIOTIC FLUID ALLOGRAFT ENHANCES HOST RESPONSE TO VENTRAL HERNIA REPAIR USING ACELLULAR DERMAL MATRIX

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Introduction: Ventral hernia repair (VHR) with acellular dermal matrix (ADM) is plagued by high rates of recurrence. We have previously shown that augmenting repair with allogeneic growth factors can enhance ADM incorporation and reduce recurrence. Amniotic fluid allograft (AFA), a growth factor rich fluid, has been shown to improve wound healing. We sought to assess the effect of AFA on VHR with ADM. We hypothesized that AFA would modulate the host response to improve ADM incorporation.

Methods: Lewis rats (n-36) underwent ventral hernia creation and repair with porcine non-crosslinked ADM 30 Days (d) later. AFA was applied to mesh prior to skin closure and tissue harvested at 3d, 14d, and 30d. To assess incorporation, H&E stained slides were scored using a previously validated histomorphometric score based on cellularization, presence of multinucleated giant cells, neovascularization, connective tissue organization, mesh encapsulation, and degradation. Expression of genes positively associated with wound healing (Col1, Col3, VEGF, and ACTA) was then quantified using RTPCR. To assess the host inflammatory response, expression of pro-inflammatory (iNOS, TNF α) and anti-inflammatory (Arg, IL-10, mrc) genes were similarly quantified.

Results: AFA-treated ADM showed greater histomorphometric scores at 14d (4.5 vs. 2.2, $p < 0.001$) but no difference at 3d or 30d. Col1, Col3, and VEGF expression was increased at 3d. Col3 expression was increased at 14d. Col1 and ACTA expression was increased at 30d. Expression of inflammatory genes showed a persistent increase in Arg at all time points. IL-10 and iNOS expression, while initially low, were greater at 14 and 30d. TNF and mrc expression decreased throughout the study.

Conclusion: Augmentation with AFA caused enhanced expression of wound healing genes of early vascularization to later remodeling and regeneration, which correlated histologically with improved histomorphometric scores at later time points. Collectively this correlated with a host immune response characterized by increased anti-inflammatory gene expression. The differential pattern of inflammatory gene expression underscores the complexity of the immune response in wound healing and warrants further investigation. These findings suggest AFA may have a role as an adjunct in improving ADM incorporation in VHR.

EXPLORATORY LAPAROTOMIES: ARE THEY ALL THE SAME?

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Introduction: Emergent exploratory laparotomies exhibit the highest mortality rate among all emergency general surgeries. This study aimed to characterize the most common diagnoses for which emergent laparotomies were performed and leverage these groups to improve risk-adjustment models for postoperative mortality.

Methods: We identified emergent exploratory laparotomies in the 2012-2015 Nationwide Inpatient Sample using AAST criteria. After tabulating all ICD-9 diagnosis codes within these hospitalizations associated with exploratory laparotomies, we divided them into clinically-relevant groups. We then included each diagnosis group as an individual covariate in a multivariable logistic regression for mortality. Using backwards elimination, we performed iterative regressions after removing groups not statistically associated with mortality ($P < 0.05$). We repeated our analysis using forward selection, and then selected groups that were significant for mortality in both methods. Finally, using the area under the receiver's operator curve (AUROC), we evaluated the addition of these selected groups as individual covariates in a risk-adjustment model. All regressions additionally adjusted for patient and clinical factors, hospital clustering, and the Bonferroni correction.

Results: We identified 4127 patients with exploratory laparotomy as a primary procedure (median age: 50 years, 46.0% female, 62.1% white), with an overall mortality rate of 13.4%. Among all patients, we tabulated a total of 27 distinct diagnosis codes, which were clinically consolidated into 7 diagnostic categories (Table). These diagnostic categories captured a majority of the laparotomy patients (70.4%) in our database. Both backwards elimination and forward selection led to three common diagnosis categories associated with mortality: shock, ischemia, and obstruction (Table). Adjusting for these three diagnostic groups in a multivariable logistic regression assessing mortality increased the AUROC from 72.6% to 88.3%.

| Forward selection of diagnosis groups associated with mortality | Regressions | | | |
|---|-------------|------------|------------|------------|
| | N (%) | 1st Round | 2nd Round | 3rd Round |
| Bleeding | 26.7% | 0.052 | | |
| Obstruction | 23.5% | * <0.001 | * <0.001 | * <0.001 |
| Sepsis | 24.1% | * <0.001 | 0.036 | |
| Shock | 18.4% | * <0.001 | * <0.001 | * <0.001 |
| Ischemia | 12.1% | * <0.001 | * <0.001 | * <0.001 |
| Perforation | 10.6% | 0.025 | | |
| Peritonitis | 9.1% | 0.650 | | |

*P-value depicts significance after Bonferroni correction.

Conclusion: While the procedural designation of exploratory laparotomy reflects a variety of interventions, accounting for at least three associated diagnostic categories may improve the accuracy of risk-adjustment models for mortality. Validating such analytic standardization may optimize best research practices for emergency general surgery.

DURATION OF ANTIBIOTIC THERAPY DOES NOT INFLUENCE INTRA-ABDOMINAL ABSCESS RATES FOLLOWING DAMAGE CONTROL SURGERY

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Introduction: Damage control surgery is associated with increased risk of postoperative infection, with rates of intra-abdominal abscess (IAA) formation between 10-30%. While guidelines exist recommending limited duration of presumptive antimicrobial therapy following injury, there is little data to guide duration of therapy following damage control laparotomy (DCL). We sought to determine if prolonged antimicrobial therapy, specifically with broad gram negative and anaerobic or antifungal agents, may lead to decreased rates of IAA after DCL.

Methods: Patients managed with DCL following trauma were retrospectively reviewed from 2011-2016 at an ACS verified Level 1 trauma center. Those with death within 48 hours were excluded. Demographic data, injury characteristics, antibiotic administration and duration, and outcomes were recorded. IAA was defined by positive culture or clinical identification of purulence. Antibiotics were categorized as providing broad gram positive, broad gram negative and anaerobic, or antifungal coverage. Narrow spectrum antibiotics were excluded. Patients were compared by duration of broad gram negative and anaerobic therapy, with 5 or more days considered prolonged therapy. Univariate analyses were performed and used to guide covariate selection for stepwise multivariate logistic regression.

Results: Two-hundred and thirty nine patients met inclusion criteria following DCL. The majority were male (82.0%, 196/239) and suffered penetrating injury (55.2%, 132/239). IAA complicated 33.9% (81/239) of patients. Patients with IAA were more likely to suffer gastric (19.8% vs. 7.6%, $p = 0.006$), colonic (48.1% vs. 32.9, $p = 0.02$), pancreatic (19.8% vs. 7.6%, $p = 0.006$), and renal (9.9% vs. 2.5%, $p = 0.01$) injury. There was no difference in duration of antimicrobial therapy on either univariate or multivariate analyses between patients with or without postoperative IAA following DCL.

Conclusion: Prolonged duration of antimicrobial therapy with broad gram negative and anaerobic or antifungal agents does not significantly decrease the likelihood of IAA formation following DCL. Further prospective investigation is needed to determine the utility of prolonged antimicrobial therapy in patients with significant risk of IAA.

**PATIENT CENTERED OUTCOME MEASURES ARE NEEDED FOR
TRANSFUSION – MEASURING THE INCREASED RISK OF
INFLAMMATORY COMPLICATIONS IN SPLENIC TRAUMA PATIENTS**

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Introduction: Transfusion is best seen as a blood transplant. Blood products contain exogenous proteins and other foreign particles that elicit an immune response with an acute inflammatory reaction. An acutely injured individual has an inflammatory response. Inducing more inflammation with a transfusion in the setting of this already increased inflammatory state increases complications and mortality. From this second hit, an aberrant inflammatory cascade can arise leading to inflammatory derived complications such as SIRS/CARS and ARDS. Blood transfusion performance indicators from the Joint Commission and AABB do not address patient outcomes beyond indications and transfusion reactions.

Methods: We retrospectively analyzed patients admitted to a level 1 trauma center with a splenic injury between 2006 and 2016 in the Trauma Quality Improvement Program (TQIP). Our primary parameter was transfusion status, and our secondary parameter was the development of an inflammatory complication. We defined an inflammatory complication based on availability in TQIP and as being sepsis-like syndrome or acute respiratory distress syndrome (ARDS). Statistical significance ($p < 0.005$) was established through the Pearson's Chi-Square test controlled for splenic injury treatment modality, either surgical or non-operative. We also analyzed all statistically significant results with a follow up linear logit model controlling for the injury severity scores, abbreviated injury score for the abdomen, age, gender, and comorbidities as confounders.

Results: 627 subjects were included, 237 in the population that was transfused and 390 in that population that was not transfused. Transfused patients experienced a much higher incidence proportions of inflammatory complications than those that were not transfused (0.131 vs 0.008, $p = 0.000$). The transfused population experienced higher incidence proportions of both sepsis-like syndrome (0.046 vs 0.003, $p = 0.000$) and ARDS (0.101 vs 0.005, $p = 0.000$).

Conclusion: This data confirms an increased risk of inflammatory complications in patients that are transfused. Even though the overall incidence proportions in both populations are low, the transfused population still experienced an overwhelming increase in inflammatory complications when compared to the population that was not transfused. Transfusion must be used only when necessary and hemovigilance protocols must be strictly followed. Remaining cognizant of the increased risk of these complications in patients following transfusion will help to improve morbidity and mortality. We recommend tracking inflammatory complications as a method of performance improvement in transfusion.

IDENTIFYING PATIENTS WITH TIME-SENSITIVE INJURIES: WHEN IS MORTALITY ASSOCIATED WITH INCREASING PREHOSPITAL TIME?

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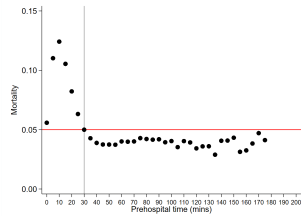
Introduction: Severe injury is a time-sensitive disease. However, recognizing which patients have time critical injuries in the field is challenging, but would prioritize those for rapid transport to definitive care. Many recent studies have failed to identify an association between increasing prehospital time (PHT) and mortality after trauma. This may occur for two reasons; first is evaluation of unselected trauma patients unlikely to have time-sensitive injuries, and second is inherent survival bias in registry data since field deaths and those dying in closer nontrauma centers are not captured, the longer the patient survives to make it to a trauma center, the more likely the patient is to survive overall. Our objective was to determine if a subset of existing trauma triage criteria can identify patients in which mortality is associated with increasing PHT after accounting for potential survival bias.

Methods: Adult patients transported by EMS from the scene with total PHT<3h in the NTDB 2007-2015 were included. To overcome survival bias, mortality rates were plotted against PHT and cubic spline analysis used to identify an inflection where mortality increases to identify a marginal population in which PHT is more likely associated with mortality. Further analysis was conducted on only these patients. Logistic regression determined the association between mortality and total PHT, adjusting for demographics, transport mode, vital signs, ISS, urgent surgery, and complications. Robust variance estimators were used to account for center clustering. Interaction terms between existing trauma triage criteria and PHT were tested, with model stratification across triage criteria with a significant interaction to determine which criteria identify patients that have increased risk of mortality associated with increasing PHT. Multiple imputation and false discovery rate correction were used to address missing data and multiple comparisons respectively.

Results: Mortality risk increased in patients with total PHT≤30min (FIG), comprising a study population of 517,863 patients. The median total PHT was 26min (IQR 22-28) with a median ISS of 9 (IQR 4-14) and 7.4% mortality. Overall, PHT was not associated with mortality (AOR 0.998; 95%CI 0.993-1.002, p=0.332). Interaction analysis was significant for PH systolic blood pressure (SBP), Glasgow Coma Scale (GCS), and penetrating injury (p<0.05). Patients with SBP<90mmHg, GCS≤ 8, or penetrating injury had increased odds of mortality associated with increasing PHT (TABLE). When stratified by transport mode, the association between mortality and increasing PHT remained for ground but not helicopter transport.

Conclusion: In patients with short total PHT, prehospital hypotension, GCS≤ 8, and penetrating injury have higher

mortality with increasing PHT. These patients may have truly time-sensitive injuries and benefit from rapid transport to definitive care. Further prospective research is necessary to refine the identification of patients with time-sensitive injuries in the field, and overcome the survival bias for patients with longer prehospital times.



Adjusted odds of mortality per 1-minute increase in total prehospital time

| Triage criterion | AOR | 95%CI | p value |
|---------------------------------|-------|-------------|---------|
| SBP<90mmHg | 1.008 | 1.001-1.016 | 0.034 |
| GCS≤8 | 1.010 | 1.004-1.015 | <0.001 |
| Penetrating injury | 1.010 | 1.003-1.018 | 0.005 |
| Penetrating injury + SBP<90mmHg | 1.014 | 1.004-1.025 | 0.012 |

Analyses of the of the self-reported confidence level of ASSET course among participants and instructors

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Introduction: ASSET (Advanced Surgical Skills for Exposure in Trauma) course is one of the Trauma Education courses developed by the American College of Surgeons, and it has been spread all over the world mainly in the United States since 2010. We conducted the ASSET courses in Japan in 2017. In this study, we analyzed the self-reported confidence level of each trauma surgical procedure using ASSET course questionnaire survey collected from participants and instructors.

Methods: A total of 16 participants were enrolled and completed the course evaluation. Participants were evaluated the self-reported confidence level using a 5-point Likert scale. 4 instructors evaluated the level of the participant they have that the participant can perform each procedure. We compared the score of the self-reported confidence level between student and instructor.

Results: The 44 items were evaluated by both participants and instructors regarding the cervical /chest / abdomen / upper limb / lower limb surgical procedure. The self-reported confidence level of the instructors (33/44/65/20/36) (median) were higher in the cervical, chest, and abdomen than that of the students (28/39/52/19/34).

Conclusion: The discrepancy of the evaluation might be influenced by several factors such as psychological element or experience. Further analyses of these factors would be an important in the future.

Comparison with aortic cross clamping and resuscitative endovascular balloon occlusion of the aorta for sever torso trauma.

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Introduction: The use of resuscitative endovascular balloon occlusion of the aorta (REBOA) has increased in recent years. Our facility has employed aortic cross-clamping (AXC) for aortic occlusion (AO) during trauma resuscitation since 2000. However, the use of REBOA remains controversial. This study aims to compare AXC with REBOA in terms of survival discharge for patients with severe torso trauma.

Methods: This retrospective study was conducted at a single trauma center in Japan between 2012 and 2015, and included patients with AO. Seventy-five eligible patients with AO (excluding those with cardiac arrest on arrival) were divided into the following two groups based on the initial treatment decision: AXC (N=58) and REBOA (N=17). The association between the initial treatment decision and patient survival was examined using multivariable logistic regression analysis.

Results: This study included 75 patients (94.7%) who sustained blunt injuries with a median age of 61 [43–74] years. Prehospital treatment, including AXC, was performed to 78.7% of the patients. The initial treatment of 50 patients (86%) in the AXC group was converted from ACX to REBOA. There was no difference in age and Injury Severity Score (ISS) between the two groups. The AXC group had significantly lower chest injury proportion (Maximum Abbreviated Injury Scale ≥ 3), Revised Trauma Score (RTS), and prothrombin time (PT) activity (PT%) than the REBOA group (AXC vs. REBOA: chest injury, 94.8% vs. 64.8%, $P=0.001$; RTS, 3.07 [2.19–5.14] vs. 5.14 [4.82–6.71], $P<0.001$; PT%, 43.7 [34.4–61.1] vs. 68.9 [55.6–77.0], $P=0.001$). Additionally, the AXC group had higher lactate values than the REBOA group (8.8 [5.9–11.7] vs. 4.2 [3.1–7.6], $P<0.001$). Patients in the AXC group had a lower probability survival rate, which was calculated using the Trauma and Injury Severity Score method, and a lower actual survival rate than those in the REBOA group (9.7% vs. 31.3%, $P=0.02$; 24.1% vs. 52.9%, $P=0.02$, respectively). Multivariate analysis, which was adjusted for risk of age, ISS, and RTS, did not show a clear benefit of REBOA as a primary treatment choice on the survival discharge of patients with AO (odds ratio, 2.01; 95% confidence interval, 0.46–9.78; $P=0.384$). REBOA procedure-related complications was observed in 10.4% of the patients (7/67; vascular injury, 2; limb ischemia, 7).

Conclusion: AXC is a reasonable treatment choice for severe trauma patients with impending cardiac arrest. Although REBOA was selected for patients with high RTS, no remarkable difference in the survival discharge was observed between the REBOA and AXC groups. So far, REBOA cannot yet replace AXC as a treatment device for patients with severe trauma.

POINT-OF-CARE ASSAY FOR THROMBIN GENERATION IN TRAUMA PATIENT AND HEALTHY DONOR FRESH BLOOD

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Introduction: Hemostatic potential in trauma patients may be assayed by measurement of viscoelastic clot strength, fibrinolysis, and quantitation of specific coagulation factors. One of these factors, thrombin, has demonstrated clinical relevance in predicting hypercoagulable events, and thrombin generation (TG) is accelerated in the presence of histones and Factor (F)XIa. There are no standard assays for measurement of thrombin generation in whole blood at the point-of-care. In this study, a new point-of-care device for measurement of TG in fresh whole blood was utilized to evaluate the contribution of histones and FXIa to procoagulant activity in trauma patients and healthy donors. Simultaneous measurement of clot formation with rotational thromboelastometry (ROTEM) methodology under identical conditions was used to confirm the nature of procoagulant activity in the trauma population.

Methods: Blood from healthy volunteers and trauma patients (both male and female) was collected into 3.2% sodium citrate. Anti-histone antibody (0.3 mg/mL) was added immediately ("0 minutes") or 15 minutes after blood draw, along with addition of corn trypsin inhibitor (CTI; 0.1 mg/mL) at 0 or 15 minutes to block contact pathway activation. Clot formation and TG were analyzed using ROTEM and point-of-care TG methodologies, respectively, in the presence and absence of an anti-FXIa antibody (0.1 mg/mL). Concentrations of FXIa were calculated using calibration curves generated from titrating purified FXIa into healthy donor blood.

Results: Whole blood samples from 6 trauma patients and 5 healthy volunteers were analyzed. Average ROTEM clotting times for the trauma patients were 8 +/- 2 minutes shorter than that of the healthy donors. Average point-of-care TG lag phases in the trauma patients were 4 +/- 1.5 minutes shorter for the same condition. Lag phases were reduced more than 4-fold if left to incubate for 15 minutes before addition of CTI, for both populations. All conditions exhibited prolonged lag phases and clot times in the presence of anti-FXIa antibody. Moreover, FXIa concentration was reduced 2 to 3-fold following addition of anti-histone antibody at 0 minutes compared to 15 minutes.

Conclusions: Trauma patients demonstrated increased procoagulant activity compared to healthy donors, in both assays. The observed increases in activity are partially related to generation of FXIa over time in citrated blood. Furthermore, histones appear to amplify FXIa generation.

The size of pelvic hematoma can be predictive factors for angioembolization in hemodynamically unstable pelvic trauma

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Introduction: Unstable pelvic fracture with bleeding can be fatal, with a mortality rate of up to 40%. Therefore, early detection and treatment are important in unstable pelvic trauma. We investigated the early predictive factors for possible embolization in patients with hemodynamically unstable pelvic trauma.

Methods: From January 2011 to December 2013, 46 patients with shock arrived at a single-hospital within 24 hours after injury. Of them, 44 patients underwent computed tomography(CT) after initial resuscitation, except for 2 who were dead on arrival. Nine patients with other organ injuries were excluded. Seventeen patients underwent embolization. Demographic, clinical, and radiological data were reviewed retrospectively.

Results: Among 35 patients with hemodynamically unstable pelvic fracture, 22 (62.9%) were men. Width ($p=0.002$) and length ($p=0.006$) of hematoma on CT scans were significantly different between the embolization and non-embolization groups. The predictors of embolization were width of pelvic hematoma (odds ratio[OR]:1.07, $p=0.028$) and female sex (OR:10.83, $p=0.031$). The cut-off value was 3.35cm. More embolization was performed (OR:12.00, $p=0.003$) and higher mortality was observed in patients with hematoma width ≥ 3.35 cm (OR:4.96, $p=0.048$).

Conclusion: Patients with hemodynamically unstable pelvic trauma have a high mortality rate. CT is useful for the initial identification of the need for embolization among these patients. The width of pelvic hematoma can predict possible embolization in patients with unstable pelvic trauma.

Preparing Japanese surgeons for potential mass casualty situations will require systematic programs.

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Introduction: The ongoing state of global geo-political instability means that it is prudent to prepare civilian surgeons to manage major military-type trauma. Many countries including Japan has experienced a prolonged period of peace and consequently it is unlikely that surgeons will have been exposed to a sufficient volume of trauma cases. This study reviews the state of trauma training and preparedness in Japan and reviews the trauma workload of a major Japanese emergency medical center and compared with a major South African trauma center with the intention of quantifying and comparing the time needed to gain adequate exposure to major trauma at the two centers.

Methods: The literature describing the surgical burden from a number of recent military missions was reviewed and the core surgical skills to manage military-type injuries were identified. We then went on to review all patients admitted to both Kurashiki Central Hospital (KCH) and Pietermaritzburg Metropolitan Trauma Service (PMTS) following trauma between the period September 2015 and August 2016. The burden of trauma at each center was quantified and the number of core surgical competencies or procedures performed at each center was then reviewed. These were then compared with the number of the core procedures which were performed on the reported military missions.

Results: Three reports on military surgical missions were reviewed. These came from the Dutch, French and British military surgical services. The most common procedures were wound debridement and orthopedic fixation, followed by trauma laparotomy, neck exploration and thoracotomy. During the 12 month study period, 309 trauma patients were admitted to KCH. There were 10 penetrating injuries and 299 blunt injuries. Of the penetrating injuries, there were no gunshot wounds. The mechanisms of injury for blunt trauma were as follows: Road traffic accidents (RTAs); 141 (47%), fall; 136 (46%) and other injuries; 22 (7%). In the same period, 2887 trauma patients were admitted by the PMTS. There were 1244 cases (43%) of penetrating trauma and 1644 cases (57%) of blunt trauma in PMTS. The mechanisms of injury for penetrating trauma were as follows: Stab wounds (SWs); 955 (77%), gunshot wounds (GSWs); 252 (20%) and other injuries; 37 (3%) and for blunt trauma were as follows: Assault; 739 (45%), RTAs; 669 (41%), fall; 166 (10%) and other injuries; 70 (4%). The exposure to all the key competencies required to manage trauma is overwhelmingly greater in South Africa than Japan. The length of time needed to obtain an equivalent trauma exposure to that achieved in South Africa, working in Japan is prohibitively long.

Conclusion: Trauma training in Japan is hamstrung by a lack of clinical material as well as by systematic factors. Training a trauma surgeon is difficult. Developing a trauma system in the country may help address some of these deficits. South Africa in contrast has a huge burden of trauma and sufficient infrastructure to ensure that surgeons working there have adequate exposure to major trauma. Developing an academic exchange program between Japan and South Africa may allow for the transfer of trauma experience and skills between the two countries.

Analysis of the Use of Anti-thrombin III in the Severe Trauma Patients..

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Introduction: Antithrombin is a potent inhibitor of thrombin and have a properties of anticoagulant with anti-inflammatory property. In trauma patients, anti-thrombin level is inversely related with the injury severity score(ISS) and low anti-thrombin III level is related with multi-organ failure(MOF). We hypothesized that antithrombin could attenuate the detrimental effects on the inflammatory process and organ function. We evaluated the influence of anti-thrombin III on the MOF and mortality in the severe trauma patients (ISS>15)

Methods: This is a retrospective study using Trauma Database of our hospital between January, 2016 and December, 2016. Major trauma patients (ISS>15) with low anti-thrombin level(<70%) were enrolled in this study. We divide the patients into antithrombin using group(AT-III(+)) vs non-using group(AT-III(-)) and compare the mortality, MOF, bleeding event between two groups.

Results: Total 99 patients were included in this study and mean ISS score of the patients was 25.1. Antithrombin level of survivor group(59.3%) was higher than non-survivor group(44.7%)($p=0.002$). All cause mortality of AT-III(+) (22%) was lower than AT-III(-) (33%)($p=0.791$). MOF of AT-III(+) was 8% and lower than that of AT-III(-)(26%)($p=0.047$)

Conclusion: Antithrombin level is inversely correlated with severity of trauma. There was no difference of mortality between antithrombin using group and non-using group. Antithrombin appear to attenuate the post traumatic response and multi organ failure.

TRAUMATIC DIAPHRAGMATIC HERNIA: HOW TO IMPROVE THE DIAGNOSIS?

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Objective: Traumatic diaphragmatic hernia (TDH) is uncommon and difficult to diagnose in trauma patients. The aim of this study is present demographics, how to improve the diagnosis, surgical treatment and outcomes.

Method: This is a retrospective trauma registry based study in a single university trauma center between 1990-2017.

Results: A total of 3.003 trauma patients were submitted to exploratory laparotomy. 425 (14.1%) had a diaphragm injury AAST grade ³ II. TDH was identified in 55 cases (12.9%), with predominance of male (46 cases - 83.6%), and age ranging from 13 to 59 years old (median 34). Blunt TDH occurred in 40 cases (72.7%; automobile accident in 26 cases) and penetrating TDH in 15 cases (27.3%; stab wound in 9 cases). Diagnosis was made mostly by chest x-ray (CXR) in the trauma bay (31 cases - 56.3%), following the intraoperative finding (13 cases - 23%). Laparotomy was performed in 54 cases (98.1%) and only one patient with stab wound was treated by laparoscopy. In two patients with chronic TDH was necessary associated thoracotomy. In 13 patients (23.6%) with hemodinamically instability the diagnosis was intraoperatively, 2 cases with diagnostic peritoneal lavage. The surgical indication was based in CRX in the trauma bay in 30 cases (54,4%). computed tomography in 7 cases (12.7%), laparoscopy in 3 cases (5,4%), in 3 cases 2 converted to laparotomy. 49 cases with left side, 5 right side and 01 bilateral. The stomach was the organ most frequently found herniating into the chest (38 cases). The rate of pulmonary complications was 18 cases (66%). The LOS average was 14 days. The mean ISS was 24. Overall mortality was 20% (11 of 55).

Conclusion: TDH was identified in few trauma patients (1.8%) admitted at our hospital, mainly after blunt trauma. Despite advances in imaging methods, CXR is still useful in the diagnosis or suspicion of TDH and the ATLS® protocol should be followed. CT is helpful for the diagnosis of TDH and identifies associated injuries. Laparoscopy was useful diagnosis in three patients but only one was treated laparoscopilly. Laparotomy remains the gold standard for the diagnosis and treatment.

**OUTCOMES OF EMERGENCY DEPARTMENT LAPAROTOMY IN
NON-RESPONDER AFTER RESUSCITATION; EARLY EXPERIENCE IN A
SINGLE CENTER**

Chan Ik Park MD, Jae Hun Kim MD, Pusan National University Hospital

Introduction: Outcomes of patients with bleeding depend on how rapid bleeding stop. Emergency department laparotomy is considered one of ways to reduce intra-abdominal bleeding. Here we evaluated the outcomes of emergency department laparotomy through the early experience of a single trauma center.

Methods: We reviewed medical records and data of patients who were non-responder after resuscitation and underwent emergency department laparotomy between January 2016 and December 2017.

Results: Twelve patients underwent emergency department laparotomy. Ten patients had sustained blunt trauma, and two were victims of abdominal stab wounds. Injuries to the small bowel, spleen, and liver were most common. One patient could not reach the operating room. Three of 12 were survived. One of three who were survived had severe neurologic sequelae.

Conclusion: Patients that underwent emergency department laparotomy showed high mortality. However, emergency department laparotomy can be considered as an option to reduce intra-abdominal bleeding for non-responder after resuscitation.

Predictive value of computed tomography in diagnosing bowel and/or mesenteric injuries after blunt trauma: Correlation with surgery findings.

Kihoon Kim MD,Ph.D., Inje University Haeundae Paik Hospital

Introduction: Bowel and mesenteric injuries occur in about 5% of blunt abdominal trauma patients. Delay in diagnosis may increase the morbidity and mortality. Computed tomography(CT) is the current accepted standard imaging modality for abdominal organ injury diagnosis and is now considered accurate in the diagnosis of bowel and mesenteric injuries. There is still controversy as to how reliably CT alone could help identify those blunt bowel and mesenteric injuries requiring surgery. Aims of this study are to review the correlation between CT signs and intraoperative finding in case of bowel and mesenteric injuries following blunt abdominal trauma and identify the diagnostic specificity of those signs found at CT with practical considerations on the following clinical management.

Methods: This is single-center retrospective study of trauma patients from March 2010 to December 2017. All patients admitted to our hospital after blunt trauma and CT scan at admission were assessed. 211 patients required operative management following blunt trauma. Data were analysed correlating operative surgical reports with the preoperative CT findings.

Results: 77 patients presented bowel and/or mesenteric injuries. The median patient age was 50 years(12-75 years), 75% of the patients were male(n=58). 78% of the patients were CT grade 5. 3% of patients(n=2) showed CT grade 1. The median length of stay and ICU were 26 days(1-254) and 4 days(0-91)

Conclusion: All images, charts and tables must be placed and uploaded in the body of your abstract exactly as you want them (please remove this line when creating your abstract).CT scan is the gold standard in the assessment of intra-abdominal blunt abdominal trauma for not only parenchymal organs injuries but also detecting bowel and/or mesentery; in the presence of specific signs it may provides an accurate assessment of hollow viscus injuries, helping the trauma surgeons to choose the correct initial clinical management.

CLINICAL SIGNIFICANCE OF CULTURE OF PAD USED FOR PACKING IN DAMAGE CONTROL LAPAROTOMY

Younggoun Jo MD, Yunchul Park MD, Jungchul Kim MD, Chonnam National University
Hospital

Introduction: Damage control laparotomy (DCL) is a technique utilized to care of massively injured trauma patient. We conducted bacterial analysis of the pad used for packing in DCL and studied its association with morbidity and mortality.

Methods: This is a retrospective review of all patients undergoing immediate laparotomy at our institute between 2011 and 2015. DCL was defined as temporary abdominal closure at the initial surgery. 18 consecutive patients undergoing DCL were analyzed. Microbiologic samples from pad used in DCL were collected.

Results: 15 microorganisms were cultured. Samples from 12 (66.7%) patients were positive by microbiologic culture and six (33.3%) patients were negative. Morbidity rate (91.7% vs. 66.7%) and mortality rate (41.7% vs. 16.7%) were higher in patients with positive culture than patients with negative culture. Infection rates such as surgical site infection (75.0% vs. 33.3%) and sepsis (41.7% vs. 16.7%) were higher in culture-positive patients. Four patients underwent two or three take back surgeries and all samples from these patients were positive for microorganism.

Conclusion: There was a high infectious complication rate in patients with positive culture of pad. And two or more frequent take back surgery seems to increase risk of infection in DCL.

A RARE CARDIAC TRAUMA BY MACHETE

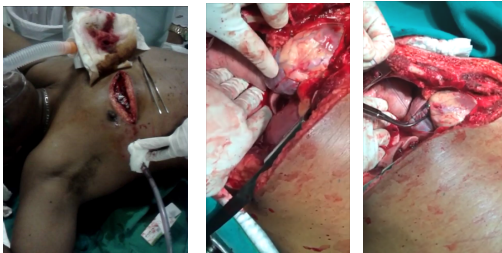
BRUNO J. MEDEIROS MD, SURGERY INSTITUTE OF AMAZONAS STATE

Introduction: Chest trauma is one of the most common causes of death corresponding to 20 to 25 % of cases. It can be blunt or penetrating trauma. The majority of the patients, 85%, can be managed only with a tube thoracostomy and only 10 to 15 % will require a trauma *thoracotomy*. Conventional indications for emergency thoracotomy are divided into acute and not acute. One of the most common indications of thoracotomy in trauma is the amount of blood immediately exiting the thoracic drain: immediate drainage of 1,500 ml of blood and deterioration of the hemodynamic status.

Methods: This was an observational study characterized by clinical inspection of a patient with chest trauma by machete.

Results: A 37-year-old man entered on our emergency room at a central hospital of Rio Branco – ACRE, Brazil, with a blunt, linear, 20-cm (Figure 1) sucking chest wound on the right side, caused by a machete. Respiratory rate was 25 per minute, saturating 90% on ambient air, blood pressure (BP) of 110x70 mmHg and heart rate of 115 per minute, he was semiconscious. After the initial care, the patient becomes better and a great question came to mind: operate or treat conservatively?

Conclusion: Noting that the machete is a very contaminated object, used in various situations in agriculture, and that we are facing a large and deep lesion with a large part in the Ziedler area and that the machete as shown must have a great impact energy. We decided to go to the surgical center thinking that a large thoracic wound could not be well cleaned without general anesthesia. In the operating room, the lesion was enlarged to the lateral side and a Finochietto retractor was used. A large transversal laceration was observed on the pericardial sac, associated with phrenic nerve lesion and right diaphragm paralysis (Figure 2). At that moment the right anterolateral thoracotomy was complemented with a transverse sternotomy with the control of the proximal and distal right mammary artery. There was a right atrial lesion of about 3 cm with a large clot. The lesion was controlled with a Satinski tweezers and a running suture with 4-0 prolene. There was also an injury to the right ventricle with associated lesion of a distal branch of the right coronary artery, controlled with U stitches. (Figure 3)



DELAYED RUPTURE OF SPLENIC PSEUDOANEURYSM AFTER BLUNT ABDOMINAL TRAUMA

Younggoun Jo MD, Yunchul Park MD, Jungchul Kim MD, Chonnam National University Hospital

Introduction: Incidence of splenic pseudoaneurysm after abdominal trauma could result in critical consequences. Here, we present a case of delayed rupture of splenic pseudoaneurysm after blunt abdominal trauma

Methods: A 68 year-old man referred to our hospital with an abdominal pain and hemodynamic instability. 3 months ago, he bumped into cultivator handle while he was moving the vehicle. At that time, he didn't undergo any examination about accident. On laboratory findings, hemoglobin was 9.1 g/dL and lactate was 2.0 mmol/L. Abdominal computed tomography(CT) showed large amount of perisplenic hematoma with irregular margin of spleen and hemoperitoneum at right paracolic gutter and pelvic cavity.

Results: An immediate angiography was performed. Superselective angiogram showed pseudoaneurysms at splenic artery branches. Coil embolization was conducted with microcoils. 1 week later follow up CT showed no remarkable change of laceration of spleen without bleeding and patient was discharged without any problems.

Conclusion: After high powered blunt abdominal injury when possible proper evaluations should be performed to prevent the occurrence of late devastating events.

Colonic stricture after angioembolization of pseudoaneurysm at left colonic artery

Jungchul Kim MD, Yunchul Park MD, Wuseong Kang MD, Yoiunggoun Jo MD,
Chonnam National University Medical School

Introduction: Rupture of pseudoaneurysm at mesentery can result in fatal consequences. Interventional radiology is one of the treatment methods. Here, we present a case of delayed stricture of left colon after angioembolization at branch of left colonic artery.

Methods: A 68-year-old man referred to our hospital after a cultivator rollover accident. Abdominal computed tomography (CT) showed liver laceration and segmental thrombotic occlusion in the left common iliac artery. Percutaneous angioplasty was done at the left common and external iliac artery. On the third day of hospitalization, the patient showed sudden signs of shock and follow-up abdomen CT showed bleeding in the left mesentery with a large amount of hemoperitoneum.

Results: An immediate angiography was performed. Selective angiogram showed pseudoaneurysms at the ascending branch of the left colic artery. Coil embolization was conducted with microcoils. 1 month later, the patient presented abdominal distension with pain and follow-up abdomen CT showed left colonic obstruction. Emergency operation was performed and subtotal colectomy was done.

Conclusion: Angioembolization at colonic artery can cause a rare complication, such as colon obstruction. Careful observation and follow-up after procedure is mandatory for rapid diagnosis and treatment.

DAMAGE CONTROL SURGERY WITH PAD PACKING FOR ACTIVE BLEEDING IN CRUSHING WOUND OF THE PERINEUM AND AMPUTATED LEG STUMP

Wuseong Kang MD,Ph.D., Wonkwang University Hospital

Introduction: We reported a case of crushing wound of the perineum and amputated leg stump which was treated by damage control surgery with pad packing.

Methods: A 67-year-old man had a crushing injury. His left leg was sucked in the wheel of a tractor. His systolic blood pressure and hemoglobin level upon admission were 50 mm Hg and 7.5 g/dL, respectively. His perineum and leg had multiple crushing open wounds and open fractures. The large defect of the leg wound was considered to require amputation above the knee, which was performed immediately with the closure of the perineal wound. However, a large volume of bloody discharge was observed in the perineal and leg stump wounds postoperatively. Massive transfusion was performed, and a second operation was performed. In the second operation, large bloody oozing of muscle and several arterial bleeders was observed. Although the bleeders were ligated, the bloody oozing continued. To control the bloody oozing, pad packing to the perineal and thigh stump wounds, and approximation with suture to compress the wound were performed. Diverting colostomy was performed to protect the wounds.

Results:After pad packing, the bloody discharge stopped and the pad was removed in the third operation. Owing to the large defects with infection of perineal and thigh stump wound, negative pressure wound therapy and repeated irrigation with debridement were performed. At 6 months after the first operation, his wound was completely healed, and colostomy repair was performed.

Conclusion: In this case, the hemodynamically unstable, crushing perineum wound and leg stumps were treated safely by damage control surgery with pad packing.

LEFT VENTRICLE INJURY ASSOCIATED WITH CARDIAC TRAUMA BY GUNSHOT WOUND: A CASE REPORT.

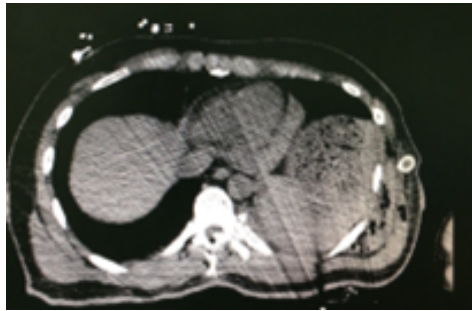
Francisco E. Silva Sr., MD, Rodrigo M. Féres Sr., MD, Ricardo J. Garcia Sr., MD, José Alfredo C. Padilha Sr., MD, Renata P. Pereira Sr., MD, Adriana M. Rangel Sr., MD, Raphael L. Coelho Sr., MD, Hospital Estadual Alberto Torres - Centro De Trauma

Introduction: The incidence of cardiac trauma is low in the universe of traumatic injuries. Right ventricle (RV) is the most affected cardiac chamber in the penetrating cardiac trauma.

Methods: R.L.R. 42, male, brought Trauma Center due to gunshot injury with an entry orifice in the left paravertebral dorsal region, with no exit orifice. During the initial clinical examination, the patient was eupneic in ambient air, vesicular murmur and pulmonary expandability reduced in the left hemithorax, O2 saturation 98%, systemic blood pressure of 210 x 110 mmHg, heart rate of 104 beats per minute. Glasgow Coma Scale 14.

Results: A left anterior thoracotomy was performed, showing hemopericardium, with left ventricular (LV) transfixing wound, with left posterolateral entry orifice and extensive anterolateral exit orifice associated with bulky bleeding. The patient was referred to the Intensive Care Center with satisfactory evolution.

Conclusion: Penetrating wounds of the left ventricle, even less common, may present a favorable outcome if approached and treated effectively.



DAMAGE CONTROL IN ABDOMINAL TRAUMA: A CASE REPORT

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Introduction: Hypothermia, coagulopathy and acidosis, a vicious cycle generally known as “the lethal triad”, contribute significantly to the increase in trauma-related mortality. Prolonged surgical time has been shown to worsen hemodynamic status, and if it is a reversible cause, such as hypovolemic shock, damage control should be the choice

Methods: A 24-year-old male patient was victim of multiples gunshot wounds in abdomen. At admission, he was unstable and in shock despite fluid resuscitation. At physical examination he presented an abdominal gunshot wound (left iliac fosse). Abdomen was flaccid and diffusely painful. On the laparotomy was evidenced lesion in 40% of the intestinal loop circumference at 80cm from the Treitz and lesion in 60% of the circumference of the sigmoid colon. Opted for damage control surgery through the raffia of small intestine lesion, sigmoid resection and burial of stumps, ureterostomy, anastomosis of the branches of the left iliac vein, using hemostats and pelvic tamponade. Referred to the ICU after 3 hours of surgery. A new reassembly was performed after 36 hours with removal of the compresses, catheterization of the ureter and terminal colostomy. He was discharged from the ICU after 13 days

Conclusion: Damage control has proven to be an important ally to the restoration of the physiological parameters of the polytraumatized patient. Due to the large number of injuries in this patient, we could not perform damage control in one hour as it is recommended. Even though it was not faithful to the ideal surgical time, the choice of controlling potentially fatal lesions was fundamental for better healing and enhance the patient’s hemodynamic status.

**TENSION PNEUMOTHORAX SECONDARY TO
EXPANDING HEMORRHAGIC PNEUMATOCELE AFTER BLUNT CHEST
TRAUMA**

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Introduction: Tension pneumothorax can lead to hemodynamic shock by impairing blood return to the heart and restricting cardiac output. Typically, this is may be due to a large pneumothorax or hemothorax. A pneumatocele is a cavity in the lung parenchyma usually filled with air that may result from pulmonary trauma. We present the first report of a hemorrhagic pneumatocele secondary to trauma resulting in a tension pneumothorax.

Methods: 18 year old male presented to trauma center in shock, complaining that 'he could not breathe'. He was subsequently intubated, and a right tube thoracosctomy placed for diminished breath sounds. Chest computerized tomography identified a large air-fluid cavity with extravasation of contrast, suggesting ongoing hemorragae into the pneumatocele. The chest tube continued with scant output. Patient's hemodynamic condition continued to deteriorate, and repeat chest XR demonstrated significant right to left mediastinal shift. Right thoracotomy was performed and massive hematoma removed from the pneumatocele.

Results: The patient's hemodynamic condition improved after the large mass occupying hemothorax was evacuated from the hemorrhagic pneumocoele contained in the right chest cavity.

Conclusion: Hemorrhagic pneumatocele is rare, and has never been described as a cause for tension pneumothorax. Do to the location of hematoma, a conventional thoracostomy tube can not release the tension -a thoracotomy is needed. We describe the first report of a tension hemorrhagic pneumatocele.

NON-OPERATIVE TREATMENT OF A TRAUMATIC GRADE V PANCREATIC LESION - CASE REPORT

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Introduction: Although pancreatic trauma is not a common injury, the mortality could be as high as 50% in complex cases. The typical mechanism of injury is the compression of the epigastric area against the vertebrae. The current treatment for grade V lesions is the Whipple procedure.

Methods: Male patient, 18 years, transferred to our trauma center level I after 48h of a blunt abdominal trauma. The first attendance and diagnosis were made at a rural Hospital after 36h of trauma. He arrived at our facility hemodinamically stable but with a persistent abdominal pain and nausea. A new abdominal CT scan was made and showed a laceration at the pancreatic head and a large amount of free abdominal fluid.

Results: The surgical team decided to perform an exploratory laparotomy. During the procedure, it was diagnosed a large hematoma of head and uncinate process of pancreas, without other lesions (duodenum, bile duct and pancreatic body were intact). It was decided to only drain the abdominal cavity. It was started TPN in the immediate postoperative and the enteral feeding was re-started 10 days after the procedure with good acceptance; no other surgical procedure was done.

Conclusion: The patient was discharged after 28 days of hospitalization with a good evolution. He is still in follow-up without any complications.

ENDOVASCULAR REPAIR FOR AXILLAR ARTERY INJURY - CASE REPORT

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The use of endovascular technique for the correction of penetrating traumatic vascular injuries is being encouraged, especially for those which the traditional approach could have a higher morbidity due to the location. Lesions at the subclavian and axillar arteries are one of these cases

The case we present is male patient, 28y, that arrived at our hospital with a gunshot wound at the right shoulder without exit. At the first attendance, he was instable due to a pneumo/hemothorax which was promptly drained. After the clinical stabilization, he still didn't have right braquial/ radial pulse, but the arm had good perfusion (no pain, good warming and capillary filling). An angiography by CT scan was performed and showed partial lesion of axillar artery but with good distal perfusion. As the patient remained stable, he was transferred for another hospital and the endovascular repair was done with a good result.

A case series study of blunt trauma causing aortic injury.

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Introduction: Aortic injury caused by blunt trauma is common but it presents various types of injury. Most cases are found dead or to have already fallen into a cardiopulmonary arrest when the patient arrives at a hospital. Some cases demonstrate progressive or delayed onset of aortic injuries, especially aortic dissections, which are sometimes difficult to treat. This study is to investigate what types of aortic injuries caused by blunt trauma are seen in one of the largest trauma centers in Japan.

Methods: Retrospective review of the patient records of blunt trauma cases with aortic injury for 10 years since 2007 in one of high volume trauma centers in Japan was performed. Each case alive on arrival was discussed in detail.

Results: Out of approximately eighty thousand ambulance cases and thirty thousand admissions for 10 years in total, only 19 cases showed an aortic injury caused by blunt trauma. A total of 11 cases presented a cardiopulmonary arrest on arrival, and 8 cases of them seemed to have died mainly of severe aortic injury and the rest died of other organ injuries. Eight cases were alive on arrival and 2 of them were initially asymptomatic. Types of aortic injury were Stanford type A aortic dissections in 3 cases, type B in 3 cases, and aortic rupture in 2 cases. Two cases of type A dissection underwent an emergency operation, whereas all 3 type B dissections went on a good course with conservative treatment.

Conclusion: Aortic injury caused by blunt trauma is rare in Japan. Stanford type B aortic dissections did not require aortic repair and showed good prognoses.