Oral #1

NOVEL SILICON-BASED HEMOSTATIC MATRIX IMPROVES VESSEL PATENCY RATES IN A COAGULOPATHIC PORCINE MODEL WITH PENETRATING ARTERIAL INJURY

Lauren Heyda, MD; Adelle Dagher, DO; John Mares, MPH;
Justin Hutzler, BS; Jason Radowsky, MD; Matthew Bradley, MD;
Patrick Walker, MD; David Burmeister, PhD
Walter Reed National Military Medical Center

Introduction: Although traumatic hemorrhage is the leading cause of preventable death on the battlefield hemostatic agents can improve survival. We evaluated a novel silicon dioxide-based universal combat matrix (UCM) compared to the gold-standard Quick-Clot® Combat gauze (QCC) in treating a junctional arterial injury in a porcine model of uncontrolled hemorrhage under coagulopathic conditions.
Methods: Vascular access was obtained in 16 anesthetized swine, and hemodilution performed by 50% blood exchange with saline. A 5mm arteriotomy was made in the proximal common femoral artery. After 30 seconds of free bleeding, UCM or QCC was applied, and pressure held for 5 minutes. After 1h of monitoring, an angiogram and a movement test of flexion and extension at the knee and hip was performed. Blood was drawn at baseline, after hemodilution, after injury and treatment, and after 1h of monitoring. The animal was euthanized, and artery collected for histology.
Results: All animals (n=8 per group) survived. Hemodilution induced a significant difference in hematocrit, platelets, clot formation time, and maximum clot firmness ($p<0.0001$). There was no difference in white blood cells, neutrophils, creatinine, sodium, potassium, or chloride ($p=0.81$-0.99 for all) between the groups at euthanasia. UCM had an average of 1.25 applications and QCC 1.13 ($p>0.99$). UCM had significantly less blood loss (106.2 ± 66.6mL) versus QCC (189.6 ±78.9mL, $p=0.038$). Angiography revealed full patency with distal limb perfusion in 8/8 UCM treated animals, and arterial occlusion without distal perfusion in 8/8 QCC animals ($P<0.01$). All animals remained hemostatic after the movement test.
Conclusions: UCM and QCC had comparable hemostatic efficacy, and no difference in number of applications required, despite UCM containing ~1g material per package and QCC containing ~20g. There was no evidence of significant lab abnormalities at the end of the study. Taken together, UCM appears to be an appropriate hemostatic agent for traumatic injury, with less weight and space requirement. Treatment with UCM maintained vessel patency unlike QCC, suggesting UCM may have implications for decreased tissue ischemia and improved limb salvage in vascular injuries not amenable to tourniquet use.

Oral #2

A COMPARISON OF MANAGEMENT STRATEGIES AND OUTCOMES OF MILITARY AND CIVILIAN MODERATE - AND HIGH-GRADE LIVER INJURIES

Phillip Kemp Bohan, MD; Justin Hatchimonji, MD;
Jonathan Stallings, PhD; Jeremy Cannon, MD;
Jennifer Gurney, MD; Jay Yelon, DO
Penn Medicine

Introduction: Many tools utilized at civilian trauma centers for management of moderate- and high-grade (AAST grade III-VI) liver injuries are unavailable in a deployed military setting. We retrospectively evaluated national and military datasets to compare management and outcomes of liver injuries in these two populations.
Methods: Patients with Grade III-VI liver injuries were identified in the Department of Defense Trauma Registry (DoDTR) from 2001-2022 and the Trauma Quality Improvement Project (TQIP) from 2017-2021. Demographic, injury, operative, and survival data were compared. Propensity score matching (PSM) was used to compare outcomes of similar cohorts of DoDTR and TQIP patients.
Results: Compared to civilian patients (n=10,827), military casualties (n=2,465) were more frequently injured by penetrating mechanisms (77.0% vs 25.9%), sustained less severe liver injuries (median Abbreviated Injury Score [AIS] 3.0 vs 3.0), were less injured overall (median Injury Severity Score [ISS] 17.0 vs 26.0), and more frequently underwent laparotomy (49.3% vs 34.2%; all $p<0.01$). Mortality between unmatched groups was similar (11.4% DoDTR vs 12.3% TQIP, $p=0.2$). PSM analysis matched 472 TQIP and 472 DoDTR patients, with no differences between groups in liver AIS, ISS, injury mechanism, or laparotomy rate (all $p>0.05$). Mortality was significantly higher for military patients (14.6% vs 5.5%, $p<0.01$).
Conclusions: Grade 3+ liver injuries sustained in deployed settings are associated with a higher mortality rate when comparable civilian injuries. Future research is needed to determine if the difference in mortality between populations is secondary to lack of civilian-level resources or surgical course.

Oral #3

BATS: BATTLEFEILD AERIAL TRANSFUSION SYSTEMS

Sneha Singh, MD; Jason Brill, MD; Jimmy Grandinette, MD
Tripler Army Medical Center

Introduction: Using blood for initial resuscitation in the setting of trauma has been shown to decrease overall morbidity and mortality when compared to fluid resuscitation. The expectation should not be any different for service members in conflict zones. The ability to readily transfer medical equipment, especially blood, by air and land has been available in recent conflicts. However, this will be a contested space in upcoming wars with near peer threats. In large scale combat operations (LSCO). The availability of air superiority is not guaranteed. Therefore, other alternatives for transportation of medical equipment should be investigated and validated in a real time training environments. Unmanned Aerial Vehicles (UAVs) have been used in recent conflicts and can provide a reliable means of delivering blood to soldiers on the battlefield without sacrificing irreplaceable equipment or additional personnel for a convoy. There are currently a few Department of Defense (DoD) initiatives like Project Crimson that focus on UAV transport of massive transfusion products. They have been successful in transporting large quantities of blood in isolated test scenarios. However testing blood delivery conditions during a real life training environment offers invaluable information on how our resources may fair in complex scenarios. The Rim of the Pacific Exercise (RIMPAC) is a large-scale naval combat exercise and will take place during the 2nd week of July where 3 separate drone companies: Shield AI, L3 Harris, and Skyways UAV will be flying ship-to-ship and ship-to-shore with deidentified blood products as part of our experiment to verify drone weight capacity, delivery times, and blood quality upon arrival. The information received in a dynamic training event such as RIMPAC will offer invaluable insight into future medical operations planning. The purpose of this experiment is to evaluate the manufacture specifications of drone weight capacity and flight duration in real life training scenarios (RIMPAC ship-to-ship and ship-to-shore flights) and evaluate the effectiveness of drone delivery in maintaining the cold chain integrity of blood products during transportation routes.

Methods: This is an experimental study to be conducted in two main phases. The first phase is protocol development. This will first involve the selection of blood products. The products to be used during this study are in-date and deidentified and include fresh whole blood (FWB), packed red blood cells (pRBCs), and cold stored platelets (CSP). These will be provided by the Tripler Army Medical Center (TAMC) blood bank during the RIMPAC exercises. The second part of phase 1 is drone selection. There are 3 drone companies The first is the V-BAT operated by Shield AI which can accommodate 6 units of cooled blood and 12 units of uncooled blood per the manufacture specifications. The drone also uses single-use temperature indicators during each test flight. The second drone is the FVR-90, operated by L3 Harris which can accommodate 8 units of cooled blood per the manufacture specifications. This vehicle is capable of maintaining blood between 1-10C or 2 hours. The final drone is the Skyways Air Transportation Systems which have a validated flight path of 312 miles, 6 hour flight, with 10 units of blood. The second phase of the experiment is implementation. This will begin with pilot testing of all 3 systems on ground for weight and flight duration. This will be done with saline filled blood bags to prevent waste. Once validated, the drone systems will fly a total of 4 to 6 runs in their designated path specified below. There will be 2 runs per day for a total of 3 days, weather permitting. the approximate distance for each run is between 10 and 15 miles. Deidentified blood products (FWB/pRBCs/CSP) will be used. The Shield AI and L3 Harris will participate in ship-to-shore exercises. Skyways will be conducting ship-to-ship exercises during transit from San Diego to Hawaii. All three operators and experiments will not overlap. Preflight blood testing will include a qualitative analysis of product integrity, looking for signs of hemolysis or clotting, as well as quantitative values of lactated dehydrogenase (LDH), potassium, and platelet volumes. The same values will be tested post flight. there will be temperature monitoring throughout the duration of the flight. The temperature probes will be disposable and provided by TAMC, in addition to any temperature probes the drone companies require. The expected flight duration/ speed will be compared with the actual flight duration/ speed. The quantitative lab values will be analyzed for statistical significance paired T tests. Any significant difference in temperature variance will be evaluated with an R2 value. the expected vs actual flight durations and speed will be evaluated with two-sample T- tests.

Results: Pending live testing during RIMPAC July 8th-12th

Conclusion: The ability to transport blood products, an invaluable resource in trauma resuscitation, via UAVs during real life training will promote overall military readiness in dealing with near-peer threats in a LSCO environment.

BRIDGING THE GAP IN WARTIME HEMORRHAGE CONTROL: ENDOVASCULAR DETECTION AND TREATMENT OF NON-COMPRESSIBLE TORSO HEMORRHAGE IN A SWINE MODEL

CPT Ashley N. Flinn Patterson, MD; CPT Maria E. Navarro, MD;
Anna Rogalska, DO, Jason Rall, PhD; Stephanie S. Combs, RN;
MAJ Theodore G. Hart, MD; LTC(P) Marlin W. Causey, MD
San Antonio Military Medical Center

Introduction: The landmark paper Death on the Battlefield 1 highlighted that 24% of fatal battlefield injuries are potentially survivable, 91% of which resulted from lethal hemorrhage. The challenge in modern combat casualty care lies in stabilizing and sustaining casualties until they can reach definitive treatment at a Role 3 Facility (or Field Hospital). Resuscitative endovascular balloon occlusion of the aorta (REBOA) revolutionized the temporization of vascular injuries in the torso or pelvis, broadly referred to as non-compressible torso hemorrhage (NCTH); however, REBOA ultimately serves as a non-targeted means of hemorrhage control and is a bridge to invasive open cavitary surgery via laparotomy or thoracotomy to definitively treat the injury. Our research laboratory focuses on advancing effective hemorrhage control techniques closer to the point of injury using minimally invasive, easily transportable endovascular diagnostic and treatment modalities in deployed environments.
Methods: A 12-animal pilot study was initiated to both develop a reproducible NCTH model in swine (Sus scrofa) and to test the feasibility of endovascular localization of an aortic injury using intravascular ultrasound (IVUS) and a novel prototype multi-sensor pressure catheter (MSPC) consisting of equally spaced pressure sensors that report intravascular pressures along its length. This was followed by a 10-animal treatment study performed without fluoroscopic guidance utilizing IVUS or MSPC techniques to deploy a covered stent(s) to obtain hemostasis after localization. In each case, the supraceliac aorta was exposed via laparotomy incision and splenectomy performed to prevent red blood cell sequestration. Baseline pre-injury data was gathered from each endovascular device prior to creation of an aortic injury with aortic punch biopsy. In the treatment group, IVUS or MSPC was used to localize aortic injury and deploy a stent at the injury site. Data was collected from the IVUS or MSPC until the animal met death criteria and was euthanized. In the case of stent placement, the thoracic aorta was explanted to evaluate the accuracy of stent placement.
Results: Twelve animals entered the pilot study weighing an average of 82 kilograms. At injury, mean arterial pressure was 58mmHg with an arteriotomy size averaging 3mm. Heparinization was routinely added to the model to prevent thrombosis of intravascular sheaths and catheters. The 3.6mm aortic punch biopsy was preferred given thrombosis of smaller sizes (2.8mm) and rapid hemodynamic collapse in larger 4.8-6mm sizes. IVUS imaging demonstrated several diagnostic clues to free hemorrhage to include aortic wall disruption and the ability to confirm aortic control using Chromaflo on the 0.018" platform. MSPC demonstrated the ability to detect a difference in pressure between sensors above and below the known site of injury including real-time calculation utilizing pulse pressure differences between sensors. In the treatment group, all injuries were able to be visualized on IVUS as a disruption in the hyperechoic aortic wall. The metal stent grafts could be visualized on the IVUS output as a "crown-like" array of hyperechoic lines. The stent was successfully placed over the aortic injury in 5 out of 6 stent placements of the 5 animals in the IVUS group based on confirmatory fluoroscopy and posthumous visual inspection. In the MSPC group, 5 stents were deployed in 5 animals with 3 covering the injury.
Conclusions: Our study demonstrates the feasibility of two portable endovascular technologies to localize and guide treatment of lethal hemorrhage. These findings highlight the potential to advance from the non-targeted control of REBOA and to expand treatment of hemorrhage in the absence of fixed-imaging fluoroscopic guidance which is highly applicable in forward surgical or austere settings. The ability to deliver less invasive surgical approaches would mirror treatment of similar injuries in civilian trauma. The treatment portion of our study was limited by the use of these technologies in parallel. However, we observe that the development of a single, streamlined device combining visualization of an injury with IVUS guided by real-time hemodynamic measurements above and below the injury with MSPC would overcome these limitations and allow for targeted balloon occlusion and/or stent treatment localized to an aortic injury. Future investigations will focus on applicability of this approach to other forms of NCTH such as solid organ injuries and branch-vessel injuries commonly treated by embolization or catheter-directed techniques typically requiring fixed imaging in civilian trauma.

Oral #5

DEVELOPING A MILITARY UNIQUE CURRICULUM: PRELIMINARY RESULTS FROM MILITARY SURGERY SUBJECT MATTER EXPERTS UTILIZING A MODIFIED DELPHI STUDY

Emily Baird, MD; Joshua Dilday, DO; Jennifer Gurney, MD;
Eric Elster, MD; Jan Jansen, MBBS, PhD; John Holcomb, MD
University of Alabama at Birmingham

Introduction: Military general surgery trainees have the unique requirements of needing to meet Accreditation Council for Graduate Medical Education (ACGME) and American Board of Surgery (ABS) standards, in addition to being able to serve as combat surgeons upon residency completion. Despite these unique military requirements, no formal military GME curricula exists for training surgery residents. This purpose of this Delphi study was to convene a panel of military GME Subject Matter Experts (SME) to identify elements of a military unique curriculum (MUC) that may be integrated into residency programs.

Methods: We recruited military operational and GME SMEs to identify and rate potential elements of a MUC from April – May 2024. We developed a list of MUC elements from a literature review and input from senior military leadership. Panelists had the opportunity to provide additional MUC elements for consideration and subsequently rated MUC elements for inclusion using a 5-point Likert scale. The Delphi study was conducted over 2 online rounds. Consensus was defined a priori as 80% agreement.

Results: From an initial panel of 23 experts 14 (61%) rated 61 elements for potential inclusion into a MUC, of which 16 (26%) reached the consensus threshold after the second round. Respondents included 8 (38%) from the Army, 7 (33%) Navy, 4 (19%) Air Force and 2 (10%) were in the Army or Air Force Reserves. Most were senior officers with the ranks of Colonel or Lieutenant Colonel and routinely worked with residents at military hospitals. All but one respondent had deployed to a combat zone as a military surgeon. The highest-rated consensus-reaching elements included additional vascular and burn surgery and critical care training, anesthesia, urology, obstetrics/gynecology and orthopedic subspeciality training, participation in a military journal club, Joint Trauma System clinical practice guidelines review and military grand rounds, access to courses including Advanced Surgical Skills for Exposure in Trauma (ASSET +) and ultrasound, and having a assigned military mentors and training with military surgical faculty with combat experience.

Conclusions: A panel of military surgical experts with significant operational, teaching, and surgical experience provided preliminary identification of a number of potential elements to include in a MUC including subspeciality surgical training, skills courses and mentoring by military faculty. Additional studies may also identify areas where other surgical subspecialties may improve GME training to better prepare all military surgeons to treat combat casualties.

DICHLOROACETIC ACID (DCA) IS ASSOCIATED WITH CARDIOPROTECTIVE EFFECTS AND INCREASED LACTIC ACID CLEARANCE IN A PORCINE MODEL OF HEMORRHAGIC SHOCK

Luke Pumiglia, MD; Bobby Z. Zhang, MD; Oladapo O. Akinmoladun, MD;
Molly K. Lonneman, MD; John C. Van Eaton, DO;
James M. Williams, Jonathan S. Lutgens, MD; MD;
Michael S. Lallemand, MD; Erik Q. Roedel, MD;
Jacob Glaser, MD; Jason R. Bingham, MD
United States Army Medical Corps - Madigan Army Medical Center

Introduction: Hemorrhagic shock from trauma is a leading cause of morbidity and mortality for Americans under the age of 44 and is the leading cause of death for casualties on the battlefield. The depth of shock directly relates to oxygen debt, where the body's demand for oxygen is greater than the supply, leading to preferential anaerobic metabolism and lactic acidosis. This in turn accelerates the lethal triad of acidosis, hypothermia, and coagulopathy which, if not rapidly corrected, further increases mortality. Dichloroacetic Acid (DCA) is a modified chlorinated acetic acid compound which has been shown to increase substrate availability for the Krebs Cycle, creating a favorable cellular milieu for aerobic metabolism and may act to mitigate oxygen debt. Prior murine models of hemorrhagic shock have shown DCA to be associated with improved cardiac function and metabolism, however no large animal studies investigating DCA in isolated hemorrhagic shock and resuscitation exist. We hypothesized that DCA as a resuscitative adjunct would ameliorate shock in a swine hemorrhage model.

Methods: Following IACUC approval, a 30% volume-controlled hemorrhage, splenectomy, and prolonged shock model using Yorkshire Swine (Sus scrofa) was performed. 5 animals received 10 mg/kg DCA, 5 received 25 mg/kg DCA, and 5 animals serving as controls received an equivalent volume of 50 mL of comparably osmolar normal saline. Immediately following hemorrhage animals received either DCA or control and were observed for 90 minutes prior to resuscitation with autologous shed blood. This was followed by an additional observation period of 90 minutes, followed by humane euthanasia. Primary endpoints were clinical vital signs and laboratory data. Results were compared with independent samples t-tests with $\alpha=0.05$.

Results: When compared with control animals, the 25 mg/kg DCA group showed decreased heart rates (HR) (132 vs 165; $p=0.048$) and improved cardiac output (CO) (4.1 vs 3.2; $p=0.007$) at the end of the shock period prior to resuscitation. The 25 mg/kg DCA group also showed a 61% decrease in lactic acid level from immediate post-hemorrhage to end of shock period compared to a 29% increase in control animals ($p=0.019$). There was no significant difference in pH or markers of coagulopathy.

Conclusions: 25 mg/kg DCA showed improvements in cardiac function (HR, CO), as well as improved lactic acid clearance in this pilot study of a porcine model of hemorrhagic shock. DCA may have cardioprotective and metabolic effects in hemorrhagic shock, specifically mitigating lactic acidosis. While no significant differences were observed in pH levels or markers of coagulopathy, our initial results warrant further investigation with larger sample sizes and longer observation periods to better characterize DCA's ability to mitigate oxygen debt in hemorrhagic shock.

INSIGHTS INTO THE GLOBAL LANDSCAPE OF CIVILIAN-MILITARY TRAUMA SYSTEM INTEGRATION THROUGH A COMPREHENSIVE SURVEY

Joseph Aryankalayil, MD; Emad Madha, MD;
Matthew Arnaouti, MBBS, MA; Ghassan Alswaiti, MBBS;
Aldo Ayvar, MD; Dellali Adzigbli, MBChB; Dabota Buowari, MBBS; Rolando Dela Cruz, MD;
John Whitaker, PhD; Wendy Williams, JD; Amila Ratnayake, MBBS;
Tamara Worlton, MD; Michelle Joseph, MBBS, MS, PhD
Walter Reed National Military Medical Center

Introduction: Integration of military and civilian trauma systems may offer a viable route to constructing comprehensive trauma systems, reduce duplication of services and expand cost-effective quality care. However, existing frameworks for integration, such as the "Blue Book," an American College of Surgeons guide to the development of civilian-military partnerships, have limited generalizability to low- and middle-income country (LMIC) settings. In order to provide a more equitable approach for LMICs, an international survey was conducted to identify key components and recommendations for building an integrated trauma system.

Methods: The survey was designed by a research collaborative, representing all six of the World Health Organization regions in order to ensure wide generalizability and applicability- especially to LMICs. The survey was also translated into six different languages to promote inclusivity. Responses to the survey were collected from July 2022 to December 2023 to assess the integration between civilian and military trauma systems across the globe. Based on expert consensus, the study collaborative created a standardized scoring system to quantitatively measure levels of integration, allowing classification into three distinct groups/tertiles, ranging from minimal (Type I) to robust (Type III). A Tau-b correlation analysis was utilized in order to quantify the strength of increased civilian-military integration with variables related to trauma care. Within this analysis each country held equal weight. In order to manage diversity of responses within a country, a consensus threshold of 50% was applied to the survey response analysis.

Results: Responses were collected from 77 individual countries. We assessed the potential for increased integration status to improve resource availability. Components such as ambulance personnel (Tau-b= +0.228, p= 0.035) and ambulance resource availability (Tau-b= +0.225, p= 0.037) were found to have a statically significant correlation with increased integration. Life-saving resources such as blood products were more closely examined. There was a statistically significant correlation between increased integration status and rapid (<15 minutes) massive transfusion protocol availability (Tau-b= +0.215, p= 0.047). There was also a significant correlation between availability of packed red blood cells in less than an hour and increased integration status (Tau-b= +0.215, 0.047). Of note, resource and personnel availability findings were not associated with country income status- integration status and World Bank income status were independent of one another.

The physical and organizational infrastructure underpinning integrated trauma systems were also evaluated. There was a slight positive correlation with national coordination for emergency medical services and higher integration status (Tau-b= +0.167, p= 0.122). In comparison, inter-hospital coordination of emergency services was not observed to have a significant correlation or clearly observed trend (Tau-b = +0.043, p=0.690. Type I: 60%, Type II: 57.7%, Type III: 65.4%). The presence of a national body to accredit and designate trauma centers was found to have a statistically significant correlation with increased integration status (Tau-b = +0.298, p=0.006). The financial infrastructure required to support an integrated trauma system was also explored through the survey. Universal healthcare payments did not demonstrate a significant correlation with higher integration status but a slight positive correlation was noted (Tau-b = +0.165, p=0.126). However, out of pocket payments for healthcare were found to have a statistically significant negative correlation with higher integration status (Tau-b = -0.287, p=0.008).

Conclusion: The survey findings advance understanding of the global landscape of civilian-military trauma system integration, especially within LMICs. Results demonstrate correlation with increased integration status and improved resource efficiency. The survey also informs the development of future frameworks for integration based on input regarding financing, health technology infrastructure, and organization, potentially guiding international trauma system development.

Oral #8

QUALITY MEASUREMENT IN MILITARY CIVILIAN PARTNERSHIPS: ASSESSING SITE PERFORMANCE IN MAINTAINING MILITARY TRAUMA SURGEON READINESS

Olivia G. Parry, DO; Justin Fox, MD; Ryan Earnest, MD
San Antonio Uniformed Services Health Education Consortium/Brooke Army Medical Center/Army Institute for Surgical Research

Introduction: Military-civilian partnerships (MCP) play a critical role in maintaining the deployment readiness of military trauma surgeons. Per Department of Defense policy, MCPs should be evaluated for their ability to maintain deployment readiness of participating military providers annually. Therefore, we conducted this study to describe the nature of military trauma surgeon practice working in MCPs and to evaluate potential MCP-level metrics to assess the readiness value of each partnership.
Methods: We utilized deidentified MCP clinical workload data submitted to the Joint Trauma System/Joint Knowledge, Skills, and Abilities (JKSA) Program Management Office (PMO) between January 1, 2023 and December 31, 2023. First, we identified all clinical workload for military trauma surgeons working in civilian Level 1 trauma centers. Next, to describe military surgeon's practice, we summarized the most common diagnoses (based on ICD-10 diagnostic codes), procedures (based on CPT procedural coding), and the frequency of readiness related skills overall. Then, we calculated a series of potential MCP-level metrics including the percentage of providers over minimum JKSA readiness thresholds; aggregate JKSA scores; JKSA scores/assigned surgeon; and JKSA scores/assigned surgeon/billable work day. Finally, all metrics were compared across MCP sites.
Results: The final sample included data for 34 military trauma surgeons at 13 MCP sites with most sites having 2-3 surgeons. Overall, military trauma surgeons worked 3,581 clinical days and performed 38,791 patient evaluations; 5,556 critical care encounters; and 8,503 procedures, including 1,921 readiness related skills. The most common diagnoses were injuries to the head (12.1%), thorax (11.9%), or abdomen (7.9%) with 56.1% of encounters having at least one diagnostic code indicating trauma. The most common procedures included arterial line (7.4%), central line (6.5%), and chest tube placement (5.7%), which were also the most common readiness-related skills performed. At the MCP-level, 30.7% of sites maintained all assigned providers above JKSA readiness thresholds; however, this metric appeared to be heavily influenced by the number of assigned providers and their level of engagement. When the JKSA metric was standardized to the number of assigned surgeons and billable work days, the average MCP site generated 137 procedural JKSA points/surgeon/day (minimum=30, maximum=317).
Conclusions: Military trauma surgeons engaged at MCP sites perform clinical work that would prepare them for deployment. By aggregating surgeon metrics to the MCP-level, several metrics can be assessed to determine the strength of an MCP. Future efforts should aim to compare MCP-site readiness performance with MTF readiness performance.

STRATIFYING EARLY RISK OF DEATH FROM HEMORRHAGE IN THE ERA OF WHOLE BLOOD

Jeffrey Conner, MD; Andrew Nunn, MD; Martin Avery, MD;
Mary Alyce McCullough, MD; Jason Hoth, MD;
Bethany Bouldin, MD; Gregory Stettler, MD
Wake Forest Baptist Health

Introduction: Definitions of massive transfusion (MT) following injury are used to help identify patients with the greatest risk of death. Traditional definitions were developed primarily using blood component therapy. Recently, the use of whole blood (WB) transfusion protocols has seen a resurgence, with evidence of improved clinical outcomes compared to component therapy. Therefore, our aim was to define MT in WB resuscitation and stratify risk of death based on volume of blood products transfused utilizing a predominant WB resuscitation protocol.
Methods: Patients that received at least one unit of whole blood following injury between January 2016 - November 2021 were identified. Receiver operating characteristic (ROC) curves to predict death based on volume of blood products transfused were constructed. Using positive likelihood ratios (+LHR), patients were stratified to low (+LHR for death <5x), intermediate (+LHR for death 5x-10x), and high risk (+LHR for death >10x).
Results: A total of 785 patients received at least one unit of WB following injury during the study period. Based on ROC curve analysis, death was associated with volume of whole blood plus packed red blood cells (PRBC) in the first hour (AUC 0.66, $p<0.001$). Low risk of mortality was defined as WB+PRBC volume <3400 cc in the first hour (14.9% mortality), intermediate risk 3400-5100 cc in the first hour (39.1% mortality), and high risk >5100 cc in the first hour (66.7% mortality).
Conclusion: The combination of WB+PRBC volume within the first hour following injury is the best predictor of death. Furthermore, volumes of WB+PRBC transfused within the first hour can be used to stratify patients' risk of death. Future studies are needed to firmly define the definition of MT with regards to WB volumes

Oral #10

SURGICAL SYMBIOSIS: A NOVEL MODEL FOR PARTNERSHIP BETWEEN A MILITARY TREATMENT FACILITY AND COMMUNITY PARTNERS FOR TRAUMA AND ACUTE CARE SURGERY

Luke Pumiglia, MD; Oladapo O. Akinmoladun, MD;
Molly K. Lonneman, MD; John Van Eaton, DO; Paul Inouye, MD;
John Horton, MD; Jason R. Bingham, MD; Erik Q. Roedel, MD
United States Army Medical Corps - Madigan Army Medical Center

Introduction: A shortage of general surgeons and corresponding barriers to surgical care in the community has been well documented. Some models predict a 21% deficit in the surgical workforce by 2050. Simultaneously, surgical volume at military treatment facilities (MTFs) has decreased over the last 10 years. The complexity of surgical cases managed at MTFs has correspondingly decreased. Accordingly, there have been concerns that this decline in total volume and complexity will decrease the readiness for deployment of military surgeons stationed at MTFs, as measured by the Knowledge, Skills and Abilities (KSA) metric. MTF surgeons are also responsible for the care of active-duty personnel and beneficiaries, requiring surgeons to continue to be stationed at MTFs. Our MTF has a long history of integration into the local trauma system as a state verified level II trauma center since 1995. Our team sought to expand our partnership with adjacent civilian level II trauma centers to allow for increased trauma and acute care surgery case volume and complexity for MTF surgeons to support readiness. This partnership allowed uninterrupted support of beneficiary and active-duty care at the MTF and provided additional experience and increased readiness for MTF surgeons while providing highly trained surgeons to support an underserved community.
Methods: A Military Training Agreement (MTA) was developed with a surgical practice covering a high-volume level II trauma system split between two adjacent centers in the local community. These centers have a significant and growing trauma burden including a growing proportion of penetrating trauma, and high-volume complex emergency general surgery (EGS) services. 10 MTF surgeons currently participate in this MTA, covering shifts as their place of duty for the trauma and EGS services at these community partners.
Results: As a result of this organized MTA partnership and the large amount of surgeon participation, MTF surgeons are able to be a consistent and reliable partner without compromising surgical capability and access at the MTF. In addition to bringing valuable military surgical knowledge and perspective to the civilian institution, the consistent coverage has resulted in vital cost savings to the civilian institutions through avoidance of the high costs associated with locum tenens coverage. Our MTF and beneficiaries have greatly benefitted from this partnership as well. The additional repetitions and experience results in our ability to support more surgical capability at the MTF and provide more comprehensive surgical care at our MTF because we can recruit, retain, and keep ready more surgeons than comparable MTFs without similar valuable partnerships.
Conclusions: Partnerships between MTFs and busy community trauma centers for trauma and EGS coverage through MTA agreements have broad benefits to both MTF surgeons, the military health system, and community. While ongoing challenges in medical malpractice coverage and billing exist, these partnerships should be further expanded and KSA metrics more closely tracked to support optimal readiness for deploying MTF surgeons.

Oral #11

AN ANALYSIS OF JUNCTIONAL TOURNIQUET USE WITHIN THE DEPARTMENT OF DEFENSE TRAUMA REGISTRY

Hailey B. Reneau, MD; Brit Long, MD; Julie A. Rizzo, MD;
Andrew D. Fisher, MD; Michael April, MD; Steven Schauer, DO
San Antonio Uniformed Services Health Education Consortium/Brooke Army Medical Center/Army Institute for Surgical Research

Introduction: Junctional hemorrhage is a significant cause of preventable death in military combat trauma. Multiple FDA approved junctional tourniquet (JTQ) models exist, which have shown to effectively control hemorrhage with minimal complications in the controlled laboratory setting. However, there is a lack of real-world use cases and further research is needed to determine the efficacy of junctional tourniquets on critically injured patients in the combat setting. This study aims to bridge this gap by analyzing data from real-world use cases in the military combat setting.
Methods: We analyzed data from 2007-2023 from the Department of Defense Trauma Registry (DODTR) for casualties that had documentation of junctional tourniquet application.
Results: Within our primary dataset, there were 48,301 encounters, of which 39 received a JTQ. The SAM™ junctional tourniquet brand was listed for 3, with the rest remaining unspecified. Of those with a location of placement available, 19 were placed at the point-of-injury, 3 were placed during transport, 1 was placed at the battalion aid station, with the rest unknown. Partner force (28%) followed by US military (26%) were the most frequent recipients. Explosives were the most common mechanism of injury (59%) followed by firearms (38%). The most common serious injuries by body region were the extremities (58%) followed by the abdomen (10%) and skin (10%). Only one died before discharge. The most common concomitant prehospital interventions were warming (54%), limb tourniquet application (41%), intravenous fluids (28%), tranexamic acid (21%), and intraosseous access (18%). The most common associated diagnoses were testis avulsion or amputation (28%), lower extremity amputation (28%), and tympanic membrane rupture (23%). The most common hospital procedures were a focused assessment with sonography in trauma (82%), laparotomy (51%), chest tube (33%), fasciotomy (33%), and arterial line access (33%).
Conclusion: JTQ application in the combat setting is rare. When it is performed, it is frequently in the setting of polytrauma. Survival was high, but this was likely confounded by DODTR survival biases.

DOES HYPERTONIC SALINE AFTER DAMAGE CONTROL LAPAROTOMY IMPROVE PRIMARY FASCIAL CLOSURE? A MULTI-CENTER RANDOMIZED CONTROL TRIAL

Tesserae Komarek, MD; Mayar Osman, MD; Patrick McCarthy, MD; Julie A. Rizzo, MD; James Aden, PhD; Martin Schreiber, MD; Reagan Bollig, MD; Mark Muir, MD; Edgardo Salcedo, MD; Stephen Cohn, MD; Valerie Sams, MD
San Antonio Uniformed Services Health Education Consortium/Brooke Army Medical Center/Army Institute for Surgical Research

Introduction: The inability to close the abdominal wall following initial damage control laparotomy (DCL) and the resultant open abdomen has led to new therapeutic challenges. Hypertonic saline (HTS) use after DCL may reduce bowel edema and resuscitation volumes, leading to improved frequency of fascial closure. Our primary objective was to determine if there was a higher rate of primary fascial closure (PFC) in patients who undergo a DCL when using HTS versus normal saline resuscitation.
Methods: All consenting trauma patients requiring a DCL were randomized to receive 30 ml/hr of either 3% HTS or 0.9% normal saline for 72 hours in a multi-center, double-blinded, prospective study. Demographics, vital signs, laboratory values, surgical procedures, blood transfusions, PFC, and outcomes were compared.
Results: We enrolled 163 patients. Patients in the HTS group (n=81) were similar to the normal saline group (n=82) concerning patient demographics and injury characteristics, including injury severity score, and revised trauma score. There was no statistical difference between HTS and NS groups in mean values of lactate (2.1 vs 2.5, p=0.134), INR (1.3 vs 1.3, p=0.424), and thromboelastography component mean values. There was no difference in crystalloid fluid administration between the two groups (6530+3700 vs 7855+4148, p=0.9804). The HTS group had a lower incidence of intra-abdominal abscesses (1.2% vs 9.8% p=0.018). Overall failure of primary fascial closure was 8% and was not different between groups (7.4% HTS vs. 8.6% NS). As expected, the HTS cohort had statistically significantly more patients with hypernatremia (16% vs 4.9%, p=0.018) and hyperchloremia (8.6% vs 1.2%, p=0.027), but this did not result in a greater incidence of acute kidney injury (11.1% vs 14.6%, p=0.52).
Conclusions: We demonstrated that hypertonic saline use was safe and feasible after damage control laparotomy. However, there appeared to be no benefit in this resuscitation strategy in the rate of primary fascial closure when compared to normal saline.

Disclaimer:
The views expressed here are not necessarily the official views of, or endorsed by, the U.S. Government, the Department of Defense, or the Department of the Air Force.

ENDOVASCULAR VS OPEN MANAGEMENT OF TRAUMATIC ILIAC ARTERY INJURIES: A REVIEW OF THE AAST PROSPECTIVE OBSERVATIONAL VASCULAR INJURY TREATMENT (PROOVIT) REGISTRY

Anthony Brusnahan, DO; Justin Robbins, MD; Jason Miner, MD
Wright State University

Introduction: Non-compressible torso hemorrhage continues to have a high rate of mortality. The AAST PROspective Observational Vascular Injury Treatment (PROOVIT) registry has been collecting prospective data on vascular trauma since 2013. The aim of this study is to report outcomes between open versus endovascular management of traumatic iliac artery injuries.
Methods: A retrospective cohort study was performed of all patients in the PROOVIT registry suffering iliac artery injury from March 2013 to January 2024. Patients with missing data points were excluded from relevant analyses only. The primary outcome was in-hospital mortality. Secondary outcomes were unplanned re-intervention, amputation rate, and number of days in the ICU.
Results: Ninety-four trauma patients were found to have iliac artery injuries. The majority of patients were male (68.9%), had a blunt mechanism of injury (71.3%), and underwent an endovascular approach (50%). Penetrating injuries and patients undergoing open repair were associated with greater resuscitative requirements. Patients with hard signs of vascular injury were more likely to have suffered from a penetrating mechanism and undergone open repair. Penetrating injuries had shorter time from injury to initial open or endovascular intervention, longer operative times, greater likelihood of ligation of injury, use of temporary shunt, definitive open repair at index operation, anti-coagulation used during the index case, and fasciotomies performed. By comparison to endovascular repair, open intervention was associated with longer operating times. Patients with soft signs of vascular injury and dislocations more frequently underwent endovascular repair. Iliac artery occlusion was associated with a blunt mechanism of injury but was predominantly managed with an open approach. Meanwhile, iliac artery transections were more often managed via an endovascular approach. In-hospital death occurred more frequently following an open approach, but there was no statistical difference between blunt and penetrating mechanisms. No statistically significant differences were noted in any secondary outcomes.
Conclusion: A review of PROOVIT registry data reveals endovascular repair has become the most common approach to the management of iliac artery injuries. Open repair was associated with greater in-hospital mortality, but no statistical significance was observed based on the mechanism of injury. Furthermore, no differences were observed in unplanned re-interventions, amputations, or ICU days.

Oral #14

USING KSA METRICS TO DETERMINE THE EXPEDITIONARY READINESS VALUE OF ACUTE CARE SURGERY FELLOWSHIP

Elise Fannon, MD, MPP; Rachel Russo, MD;
Kyle Remick, MD; Stephen McIntyre, PhD; Margaret Knudson, MD;
Marc Demoya, MD; Gregory Jurkovich, MD; Jennifer Gurney, MD;
Joseph Galante, MD; Eric Elster, MD
University of California, Davis

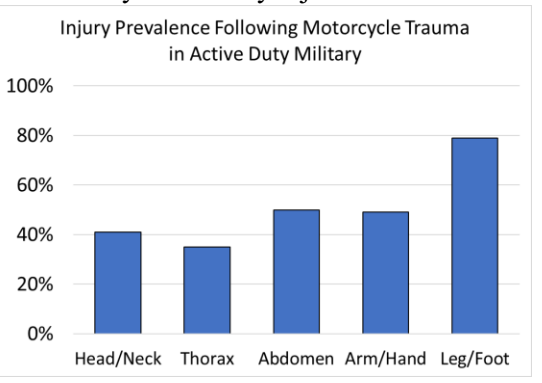
Introduction: The current clinical volume in the Military Health System (MHS) is not sufficient to maintain critical wartime expeditionary skillsets, leading to less than 37% of general surgeons meeting readiness standards by Knowledge, Skills, and Clinical Activity (KSA-CA) metrics. Several critical domains from the Expeditionary General Surgery (EGS) scope of practice defined by the KSA Clinical Currency Program align well with the American Association for the Surgery of Trauma's (AAST) Acute Care Surgery (ACS) fellowship curriculum. We aimed to assess fellows' EGS readiness using KSA-CA metrics to determine if this established curriculum could support the MHS in maintaining currency for general surgeons.
Methods: Procedural case logs for fellows enrolled in the AAST ACS fellowship were scored using EGS KSA-CA metrics. The number of fellows above and below readiness thresholds were identified. Variation by procedure, KSA-CA category, and program was analyzed.
Results: 24,493 procedures were performed by 103 fellows at 26 programs during the 2021-2022 academic year. Eight AAST ACS approved sites logged no cases. There were 2,969 documented procedures that did not meet KSA-CA scoring criteria. Forty-three (42%) fellows met the threshold for KSA-Clinical Activity readiness, including 30 (95%) graduating fellows. Critical Care, Universal Domains, and Transfusion and Resuscitation were the domains with the highest diversity scores. Head and Spine Injury were the domains with the lowest diversity scores. Five high outlier programs and 3 low outlier programs were identified among those with cases logged.
Conclusions: The AAST ACS fellowship offers a curriculum that enhances readiness for an expeditionary scope of practice that general surgeons might experience in a deployed environment. Meeting the KSA-CA threshold for readiness can be reliably achieved at the conclusion of a full year of participation in many but not all AAST/ACS approved programs. These findings have implications for selection of programs by military trainees to assure optimal training for deployment.

Oral #15

ON TWO WHEELS AND IN HARM'S WAY: MORBIDITY OF MOTORCYCLE INJURIES IN ACTIVE DUTY MILITARY

Dyllan Griffiths, MD; Andrea Krzyzaniak, MA;
Bryan Campbell, DO; Richard Calvo, PhD; Vishal Bansal, MD;
Michael Sise, MD; Michael Krzyzaniak, MD
Scripps Mercy Hospital

Introduction: The incidence and morbidity of motorcycle trauma within the active duty military population is unknown. We sought to describe morbidity from major motorcycle trauma in active duty patients at our Level I trauma center and to characterize this injury burden.
Methods: Patients with motorcycle-specific ICD-10 injury codes and identified as active duty military personnel via retrospective chart review from 1/1/2016 – 12/31/2023 were included. Outcomes of hospital length of stay (HLOS), injury severity (ISS), injury diagnoses, and toxicology and alcohol screen results for the overall cohort and by discharge location (routine discharge (RD) vs. discharge to higher level of care (HD)) were evaluated.
Results: The 123 patients included were primarily male (97%), moderately injured (ISS=5), with a median age of 26 years and median HLOS of 1 day. Toxicology and alcohol screens were positive in 60% and 21% of patients, respectively. Injuries of the lower extremity and abdominal wall and scrotum/testes were most prevalent (Figure). There were no patient deaths, however 19% of patients were discharged to a higher level of care (HD). Compared to the RD group, HD was significantly more injured (ISS=17) with a longer HLOS (median 5 days) (both $p<0.001$). HD more commonly suffered head, thorax, abdominal injuries while upper and lower extremity injuries were more frequent in RD (all $p<0.05$).
Conclusion: Motorcycle trauma obligates a minimum one-day hospital stay and results in injuries that likely impact functioning status with substantial longer-term disability for those moderately to severely injured. These preventable injuries with their associated subsequent disability may negatively impact military readiness.

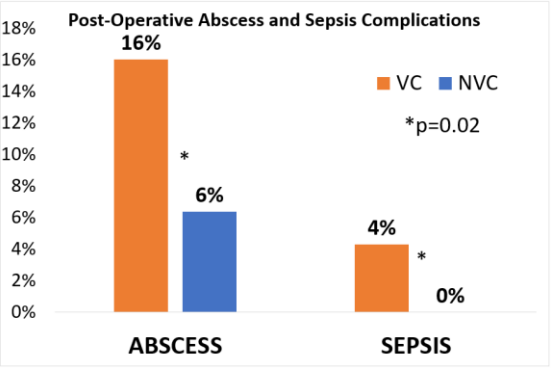


Oral #16

METHAMPHETAMINE, COCAINE, AND TRAUMATIC BOWEL INJURY: A DANGEROUS COMBINATION

Laurinda Jackson, MD; Alyssa Carroll, MPH;
Bryan Campbell, DO; Casey Erwin, MD; Andrea Krzyzaniak, MA;
Alexandra Rooney, MPH; Michael Sise, MD; Michael Sise, MD;
Walter Biffl, MD; Vishal Bansal, MD
Scripps Mercy Hospital

Introduction: Methamphetamine and cocaine are vasoconstrictive drugs that cause splanchnic and visceral vasoconstriction straining potential bowel anastomosis and immune function. We hypothesized that patients positive for these drugs (VC) would have an increased rate of intra-abdominal abscess and post-operative complications.
Methods: Retrospective chart review at two Level 1 Trauma Centers from 1/1/2016-10/31/2023 was conducted. Patients >16 years with a hospital stay of >72 hours and traumatic abdominal injury requiring operative intervention were included. Patients transferred from another hospital or expiring from non-abdominal trauma were excluded. Procedures, trauma registry reportable outcomes including LOS, ICU days, comorbidities, mortality, readmissions, and post-operative infectious complications were compared using non-parametric analysis.
Results: The sample included 234 patients: 93 VC and 141 patients negative on toxicology screen for methamphetamine or cocaine (NVC). Groups had comparable age, smoking status, and injury severity (ISS 14, abdominal AIS 3). Diabetes was present in 4% NVC and 0% VC (p=0.044). VC patients had significantly more males, penetrating injury, Black or African American patients, and were more likely to have a higher wound class at initial operation (ps<0.05). Outcomes were not different with the exception of VC had a significantly higher rate of post-operative abscess and sepsis (Figure).
Conclusion: Methamphetamine or cocaine use is associated with higher occurrence of postoperative abscess and sepsis in abdominal trauma patients compared to non-use. Surgeons must anticipate these complications when operating on patients using vasoconstrictive drugs.



Oral #17

THE EFFECTS OF GLUCOSE-6-PHOSPHATE DEHYDROGENASE DEFICIENCY ON NEGATIVE OUTCOMES AND MORTALITY IN TRAUMA

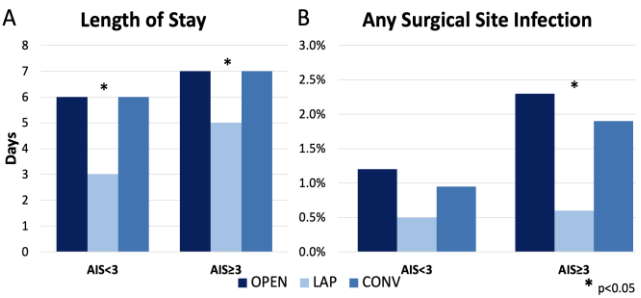
Emily Norris, MD; Chandler Jokerst, BS; Kimberly Mclaughlin;
Diana Sheldon; Scott Grey, PhD; Seth Schobel, PhD;
Eric Elster, MD; Travis Polk, MD
Naval Medical Center Portsmouth

Introduction: Glucose-6-phosphate dehydrogenase (G6PD) deficiency is the most common enzymatic disorder of red blood cells. People with the disorder are mostly asymptomatic, but oxidative stress such as trauma can lead to hemolytic anemia and further complications. This study uses data from military trauma patients in the DoD Trauma Registry (DoDTR) to test the hypothesis that G6PD deficiency will complicate the care of the traumatically wounded such that deficient patients will have a higher risk of mortality, and will need additional care.
Methods: Military trauma patient records in the DoDTR were linked to medical readiness databases to obtain G6PD deficiency status. To control for baseline and injury characteristics, cases with G6PD deficiency were propensity score matched (based on age, race, active-duty status, branch, injury type and injury severity score) to three deficiency free controls. Increased risk of negative outcomes in G6PD cases compared to controls were estimated using quasi-Poisson and negative binomial hurdle regression models controlling for injury severity upon admission.
Results: Data curation identified 28,234 patients having at least one hospital course between January 2003 to May 2018, with 662 (2.4%) possessing the G6PD deficiency. G6PD cases were a year younger, more likely to be of white race and to be Marines. G6PD cases were 10% more likely to be admitted to an ICU and 21% more likely to be placed on a ventilator. However, after controlling for injury severity in the regression models, these differences became insignificant. There were no significant differences in mortality, blood product use or length of stay.
Conclusion: This study indicates that G6PD deficiency is rare in military trauma patients, and that there is no evidence military trauma patients with the disorder will have higher mortality or require higher levels of care than trauma patients without the disorder. These results suggest that servicemembers with G6PD deficiency can continue to serve with no impact on military readiness or combat casualty care.

TO CUT IT BLUNTLY: LAPAROSCOPY SHOULD BE UTILIZED MORE FREQUENTLY IN BLUNT ABDOMINAL TRAUMA

Casey Erwin, MD; Alexandra Rooney, MPH; Andrea Krzyzaniak, MA; Bryan Campbell, DO; Laurinda Jackson, MD; Alyssa Carroll, MPH; Richard Calvo, PhD; Vishal Bansal, MD; Michael Krzyzaniak, MD; Michael Sise, MD
Scripps Mercy Hospital

Introduction: Despite the growth of laparoscopic techniques across surgery, blunt abdominal trauma largely relies on a classic open approach. Whether a laparoscopic approach would be beneficial is unknown. We hypothesized that a laparoscopic approach for stable blunt abdominal trauma patients (BAT) would have improved outcomes compared to open procedures.
Methods: Stable (SBP≥100, GCS≥13) patients ≥16 years in the Trauma Quality Programs (2016-2021) database with BAT and non-abdominal AIS<3 who underwent an abdominal operation within 24 hours of admission were included. Outcomes of unplanned return to OR, surgical site infection (SSI), and hospital length of stay (HLOS) were compared. Patients were grouped by operation type: open only (OPEN), laparoscopy only (LAP), or laparoscopy converted open (CONV). A secondary analysis was subsequently completed stratifying by abdominal AIS (ABD<3, ABD >3).
Results: A total of 14,892 patients were included: 83% OPEN, 11% LAP and 6% CONV. Patient demographics were primarily male (67%), overall age (median 36yrs), ISS and abdominal AIS (median 10 and 3 respectively). One tenth of patients underwent inspection only procedures. Although LAP increased and OPEN decreased during the study interval, these changes were not significant. However, CONV significantly increased over the six years ($p<0.05$). LAP was less likely to have an unplanned return to OR and SSI, and shortest HLOS of all three groups ($ps<0.05$). Once stratified by ABD AIS, LAP continued to have the shortest HLOS and a lower SSI for in patients with ABD >3 (see figure).
Conclusion: LAP had lower complication rates compared to OPEN and CONV patients. These outcomes and lack of significant increase in LAP use suggest additional opportunities exist to safely increase LAP use in the treatment of stable patients with BAT.



Oral #19

NO DIFFERENCES IN NON-PERFORATED PEDIATRIC APPENDICITIS BASED ON HOSPITAL TYPE IN CALIFORNIA

Ben Havko, DO; Alyssa Carroll, MPH;
Utsav Patwardhan, MD; Joseph Lee, MD; Erin West, MD;
Alexandra Rooney, MPH; Richard Calvo, PhD; Michael Sise, MD;
Andrea Krzyzaniak, MA; Pam Choi, MD
Scripps Mercy Hospital

Introduction: Given the prevalence of pediatric appendicitis, the purpose of this study is to assess management and outcome differences by hospital type using California's Department of Health Care Access and Information (HCAi) Patient Discharge Database.

Methods: Children (<17 years) with perforated or non-perforated appendicitis were identified. Patients with significant comorbidities or lacking a traceable identifier were excluded. Hospital type was defined as free-standing children's hospitals (FSCH) or Other Hospitals (OH). Patient characteristics, initial management type (operative versus non-operative), complications, and outcomes including length of stay (LOS) and readmission were assessed. Patients were divided into age groups (≤12 years or >12 years).

Results: There were 6,717 patients who met inclusion criteria (34% FSCH; 66% OH). Patients treated at FSCH had younger patients and higher rates of perforated appendicitis (42% vs. 35% p=0.001). Among patients with non-perforated appendicitis, there were no differences in initial management type, complications, or readmissions by hospital type. Patients ≤12 years with perforated appendicitis at a FSCH had higher rates of non-operative management and higher readmission rates compared to those treated at OH (Figure). For children >12 years, there was no difference in initial management or readmission rates across hospital types.

Conclusion: While treatment of perforated appendicitis in younger pediatric patients differed by hospital type, non-perforated appendicitis was managed similarly and had similar outcomes at FSCH and OH, which may have important implications for optimal resource utilization.