Committee on Surgical Combat Casualty Care (CoSCCC)

Journal   Watch

1st Quarter

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Journal Watch Key Terminology Searched:

Microcirculation	Trauma Management	Haemorrhage
Shock	Sublingual	Ethics committees
Human subject research	IDF	Institutional review board
Haemorrhagic shock	Multiple trauma	Shock index
Traumatic brain injury	Coagulopathy	Diagnostic accuracy
Plasma	Pre-hospital	Thrombelastography (TEG)
Transfusion	Trauma	Imaging
RBCs	Resuscitation	Severe trauma
Stability	Ultrasound	Afghanistan
Blast	Facial trauma	War
Amputation	Multiple	Transfusion
Traumatic Clinical outcomes	Clinical parameters	Damage control Surgery
Injury	Pelvic fracture	Battlefield Trauma
Coagulopathy	Cryoprecipitate	Fibrinogen
Fibrinogen concentrate	Massive transfusion	ABO
Viscoelastic haemostatic assays	Angiography	External fixation
Guidelines	Internal fixation	Pelvic ring
Fractures	X-ray	Pre-peritoneal pelvic packing
REBOA	Antibiotic prophylaxis	Long bone fractures
Orthopaedic trauma	Perioperative antibiotics	Surgical site infection
Wound ballistics	Faecal diversion	Primary repair
Cause of injury	Head injuries	Poly-trauma
Damage Control Resuscitation	Battlefield Injury	Prolonged field care
Tension pneumothorax	Thoracotomy	Military Medicine
Blast Injury	Died of Wounds	Killed in Action
Combat casualty care	Medical treatment facility	Mortality
Surgical skills	Emergency surgery	Infection prevention
Novel Coronavirus	COVID-19	Hypocalcemia
Predictions	Vital Signs	Global Surgery
Limb Salvage	Temporary Shunts	Ukraine
Whole Blood	Walking Blood Bank	

The SWiFT trial (Study of Whole Blood in Frontline Trauma)-the clinical and cost effectiveness of pre-hospital whole blood versus standard care in patients with life-threatening traumatic haemorrhage: study protocol for a multi-centre randomised controlled trial

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Abstract

Background: Early blood transfusion improves survival in patients with life-threatening bleeding, but the optimal transfusion strategy in the pre-hospital setting has yet to be established. Although there is some evidence of benefit with the use of whole blood, there have been no randomised controlled trials exploring the clinical and cost effectiveness of pre-hospital administration of whole blood versus component therapy for trauma patients with life-threatening bleeding. The aim of this trial is to determine whether pre-hospital leukocyte-depleted whole blood transfusion is better than standard care (blood component transfusion) in reducing the proportion of participants who experience death or massive transfusion at 24 h.

Methods: This is a multi-centre, superiority, open-label, randomised controlled trial with internal pilot and within-trial cost-effectiveness analysis. Patients of any age will be eligible if they have suffered major traumatic haemorrhage and are attended by a participating air ambulance service. The primary outcome is the proportion of participants with traumatic haemorrhage who have died (all-cause mortality) or received massive transfusion in the first 24 h from randomisation. A number of secondary clinical, process, and safety endpoints will be collected and analysed. Cost (provision of whole blood, hospital, health, and wider care resource use) and outcome data will be synthesised to present incremental cost-effectiveness ratios for the trial primary outcome and cost per quality-adjusted life year at 90 days after injury. We plan to recruit 848 participants (a two-sided test with 85% power, 5% type I error, 1-1 allocation, and one interim analysis would require 602 participants-after allowing for 25% of participants in traumatic cardiac arrest and an additional 5% drop out, the sample size is 848).

Discussion: The SWiFT trial will recruit 848 participants across at least ten air ambulances services in the UK. It will investigate the clinical and cost-effectiveness of whole blood transfusion versus component therapy in the management of patients with life-threatening bleeding in the pre-hospital setting.

Keywords: Emergency medicine; Major haemorrhage; Major trauma; Pre-hospital; Transfusion; Whole blood.

Data-Driven Blood Transfusion Thresholds for Severely Injured Patients During Blood Shortages

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Abstract

Introduction: Crises like the COVID-19 pandemic create blood product shortages. Patients requiring transfusions are placed at risk and institutions may need to judiciously administer blood during massive blood transfusions protocols (MTP). The purpose of this study is to provide data-driven guidance for the modification of MTP when the blood supply is severely limited.

Methods: This is a retrospective cohort study of 47 Level I and II trauma centers (TC) within a single healthcare system whose patients received MTP from 2017 to 2019. All TC used a unifying MTP protocol for balanced blood product transfusions. The primary outcome was mortality as a function of volume of blood transfused and age. Hemoglobin thresholds and measures of futility were also estimated. Risk-adjusted analyses were performed using multivariable and hierarchical regression to account for confounders and hospital variation.

Results: Proposed MTP maximum volume thresholds for three age groupings are as follows: 60 units for ages 16-30 y, 48 units for ages 31-55 y, and 24 units for >55 y. The range of mortality under the transfusion threshold was 30%-36% but doubled to 67-77% when the threshold was exceeded. Hemoglobin concentration differences relative to survival were clinically nonsignificant. Prehospital measures of futility were prehospital cardiac arrest and nonreactive pupils. In hospital risk factors of futility were mid-line shift on brain CT and cardiopulmonary arrest.

Conclusions: Establishing MTP threshold practices under blood shortage conditions, such as the COVID pandemic, could sustain blood availability by following relative thresholds for MTP use according to age groups and key risk factors.

Keywords: Blood transfusion; Massive transfusion protocol; Mortality; Patient outcomes; Traumatic injury.

Assessment of Machine Learning Methods to Predict Massive Blood Transfusion in Trauma

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Abstract

Background: Accurately predicting which patients are most likely to benefit from massive transfusion protocol (MTP) activation may help patients while saving blood products and limiting cost. The purpose of this study is to explore the use of modern machine learning (ML) methods to develop and validate a model that can accurately predict the need for massive blood transfusion (MBT).

Methods: The institutional trauma registry was used to identify all trauma team activation cases between June 2015 and August 2019. We used an ML framework to explore multiple ML methods including logistic regression with forward and backward selection, logistic regression with lasso and ridge regularization, support vector machines (SVM), decision tree, random forest, naive Bayes, XGBoost, AdaBoost, and neural networks. Each model was then assessed using sensitivity, specificity, positive predictive value, and negative predictive value. Model performance was compared to that of existing scores including the Assessment of Blood Consumption (ABC) and the Revised Assessment of Bleeding and Transfusion (RABT).

Results: A total of 2438 patients were included in the study, with 4.9% receiving MBT. All models besides decision tree and SVM attained an area under the curve (AUC) of above 0.75 (range: 0.75-0.83). Most of the ML models have higher sensitivity (0.55-0.83) than the ABC and RABT score (0.36 and 0.55, respectively) while maintaining comparable specificity (0.75-0.81; ABC 0.80 and RABT 0.83).

Conclusions: Our ML models performed better than existing scores. Implementing an ML model in mobile computing devices or electronic health record has the potential to improve the usability.

Combat ocular trauma in counterinsurgency operations

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Abstract

Purpose: To identify the pattern, distribution, and causes of ocular injuries among the security personnel participating in counterinsurgency operations (CIOps).

Methods: This was a multicentric, retrospective review of chart records of patients reporting to three hospitals located in the geographic region affected by CIOps. The hospital registry was examined for all patients diagnosed with any type of ocular trauma between January 1, 2016, and December 31, 2019. A standardized proforma was filled out using the case records, and entries were validated.

Results: A total of 131 ocular injuries fulfilled the criteria of the study. The mean age of the patients was 32.46 ± 10.2 years. All the patients were males. The causes of the injuries were explosive blasts in 60 eyes (45.80%), gunshot wounds in 15 eyes (11.42%), stone pelting in 16 eyes (12.21%), training-related causes in 26 eyes (29.84%), vehicular accidents in 13 eyes (9.92%), and battery blast in one eye (0.76%). Among the type of injuries, open globe injuries included 66 eyes (50.38%), closed globe injuries included 35 eyes (26.72%), isolated lid lacerations included 14 eyes (10.68%), and isolated chemical injury was seen in two eyes (1.52%). Optic nerve head avulsion was seen in two eyes (1.52%).

Conclusion: The study revealed a considerable number of ocular injuries related to combat, with explosive bursts being the leading cause. The incidence of ocular injuries was found to be highest in zone 1. This study emphasizes the importance of the need for soldiers deployed in active CIOps regions to wear protective eyewear, such as ballistic goggles or military combat eye protection, to reduce the risk of ocular injuries.

Analysis of tourniquet pressure over military winter clothing and a short review of combat casualty care in cold weather warfare

Raimund Lechner [1], Yannick Beres [1], Amelie Oberst [1], Kristina Bank [1], Markus Tannheimer [2], Martin Kulla [1], Bjoern Hossfeld [1]

Abstract

Cold weather warfare is of increasing importance. Haemorrhage is the most common preventable cause of death in military conflicts. We analysed the pressure of the Combat Application Tourniquet® Generation 7 (CAT), the SAM® Extremity Tourniquet (SAMXT) and the SOF® Tactical Tourniquet Wide Generation 4 (SOFTT) over different military cold weather clothing setups with a leg tourniquet trainer. We conducted a selective PubMed search and supplemented this with own experiences in cold weather medicine. The CAT and the SAMXT both reached the cut off value of 180mmHg in almost all applications. The SOFTT was unable to reach the 180mmHg limit in less than 50% of all applications in some clothing setups. We outline the influence of cold during military operations by presenting differences between military and civilian cold exposure. We propose a classification of winter warfare and identify caveats and alterations of Tactical Combat Casualty Care in cold weather warfare, with a special focus on control of bleeding. The application of tourniquets over military winter clothing is successful in principle, but effectiveness may vary for different tourniquet models. Soldiers are more affected and impaired by cold than civilians. Military commanders must be made aware of medical alterations in cold weather warfare.

Keywords: Tactical Combat Casualty Care; arctic warfare; cold weather warfare; critical bleeding; hemostatic dressing; hypothermia.

A Data-Driven Method to Discriminate Limb Salvage from Other Combat-Related Extremity Trauma

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Abstract

Introduction: The aim of this study was to address and enhance our ability to study the clinical outcome of limb salvage (LS), a commonly referenced but ill-defined clinical care pathway, by developing a data-driven approach for the identification of LS cases using existing medical code data to identify characteristic diagnoses and procedures, and to use that information to describe a cohort of US Service members (SMs) for further study.

Methods: Diagnosis code families and inpatient procedure codes were compiled and analyzed to identify medical codes that are disparately associated with a LS surrogate population of SMs who underwent secondary amputation within a broader cohort of 3390 SMs with lower extremity trauma (AIS > 1). Subsequently, the identified codes were used to define a cohort of all SMs who underwent lower extremity LS which was compared with the opinion of a panel of military trauma surgeons.

Results: The data-driven approach identified a population of n = 2018 SMs who underwent LS, representing 59.5% of the combat-related lower extremity (LE) trauma population. Validation analysis revealed 70% agreement between the data-driven approach and gold standard SME panel for the test cases studied. The Kappa statistic (κ = 0.55) indicates a moderate agreement between the data-driven approach and the expert opinion of the SME panel. The sensitivity and specificity were identified as 55.6% (expert range of 51.8-66.7%) and 87% (expert range of 73.9-91.3%), respectively.

Conclusions: This approach for identifying LS cases can be utilized to enable future high-throughput retrospective analyses for studying both short- and long-term outcomes of this underserved patient population.

Keywords: Abbreviated Injury Scale; amputation; military medicine; musculoskeletal injuries; wound and injuries.

Temporary intravascular shunts and limb salvage in civilian vascular trauma

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Abstract

Background: Temporary intravascular shunts (TIVS) may allow quick revascularization and distal reperfusion, reducing the ischemic time (IT) when an arterial injury occurs. Furthermore, TIVS temporarily restore peripheral perfusion during the treatment of concomitant life-threatening injuries or when patients require evacuation to a higher level of care. Notwithstanding, there are still disputes regarding the use of TIVS, in view of the paucity of evidence in terms of potential benefits and with regard to the anticoagulation during the procedure. The present study aimed to assess TIVS impact, safety, and timing on limb salvage in complex civilian vascular traumas.

Patients and methods: Data were retrieved from the prospective database of our department, which included all patients hospitalized with a vascular injury of the extremities between January 2006 and December 2022. Patients undergoing TIVS during vascular injury management were included in group A, and those who could not postpone immediate care for TIVS insertion were included in group B (control group). Data concerning the times required for extremity revascularization or other surgical procedures such as orthopedic interventions and the time of limb ischemia were compared between the two groups. A comparison of the postoperative course between the two groups was also performed.

Results: A total of 53 patients were included: group A (TIVS insertion, $n = 31$) and group B (control, $n = 22$). Revascularization time significantly differed ($p = 0.002$) between the two groups, which is lower in group A (4.17 ± 2.37 h vs. 5.81 ± 1.26 h). TIVS positively affected the probability of limb salvage ($p = 0.02$). At multivariate analysis, the factors independently associated with limb salvage were TIVS usage, the necessity of hyperbaric oxygen therapy, and the total IT. In group A, there were three deaths and one major amputation, and in group B, there were two deaths and four major amputations.

Conclusions: The use of TIVS minimizes revascularization time and improves limb salvage probability. A multidisciplinary approach is recommended, and correct surgical timing is key to ensure the best outcome.

Keywords: amputation; limb salvage; trauma; vascular injury; vascular shunt.

Addition of aspirin to venous thromboembolism chemoprophylaxis safely decreases venous thromboembolism rates in trauma patients

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Abstract

Background: Trauma patients exhibit a multifactorial hypercoagulable state and have increased risk of venous thromboembolism (VTE). Despite early and aggressive chemoprophylaxis (CP) with various heparin compounds ("standard" CP; sCP), VTE rates remain high. In high-quality studies, aspirin has been shown to decrease VTE in postoperative elective surgical and orthopedic trauma patients. We hypothesized that inhibiting platelet function with aspirin as an adjunct to sCP would reduce the risk of VTE in trauma patients.

Methods: We performed a retrospective observational study of prospectively collected data from all adult patients admitted to an American College of Surgeons Level I Trauma center from January 2012 to June 2015 to evaluate the addition of aspirin (sCP+A) to sCP regimens for VTE mitigation. Cox proportional hazard models were used to assess the potential benefit of adjunctive aspirin for symptomatic VTE incidence.

Results: 10,532 patients, median age 44 (IQR 28 to 62), 68% male, 89% blunt mechanism of injury, with a median Injury Severity Score (ISS) of 12 (IQR 9 to 19), were included in the study. 8646 (82%) of patients received only sCP, whereas 1886 (18%) patients received sCP+A. The sCP+A cohort displayed a higher median ISS compared with sCP (13 vs 11; p<0.01). The overall median time of sCP initiation was hospital day 1 (IQR 0.8 to 2) and the median day for aspirin initiation was hospital day 3 (IQR 1 to 6) for the sCP+A cohort. 353 patients (3.4%) developed symptomatic VTE. Aspirin administration was independently associated with a decreased relative hazard of VTE (HR 0.57; 95% CI 0.36 to 0.88; p=0.01). There were no increased bleeding or wound complications associated with sCP+A (point estimate 1.23, 95% CI 0.68 to 2.2, p=0.50).

Conclusion: In this large trauma cohort, adjunctive aspirin was independently associated with a significant reduction in VTE and may represent a potential strategy to safely mitigate VTE risk in trauma patients. Further prospective studies evaluating the addition of aspirin to heparinoid-based VTE chemoprophylaxis regimens should be sought.

Keywords: Antiplatelet; Aspirin; Chemoprophylaxis; Platelet; Venous thromboembolism.

Damage Control Surgery and Transfer in Emergency General Surgery

Carlos A Fernandez [1]

Abstract

Selective non traumatic emergency surgery patients are targets for damage control surgery (DCS) to prevent or treat abdominal compartment syndrome and the lethal triad. However, DCS is still a subject of controversy. As a concept, DCS describes a series of abbreviated surgical procedures to allow rapid source control of hemorrhage and contamination in patients with circulatory shock to allow resuscitation and stabilization in the intensive care unit followed by delayed return to the operating room for definitive surgical management once the patient becomes physiologic stable. If appropriately applied, the DCS morbidity and mortality can be significantly reduced.

Balloons on the battlefield: REBOA implementation in the UK Defence Medical Services

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Abstract

Established in 2018, the Defence Endovascular Resuscitation (DefER) group recognised that resuscitative endovascular balloon occlusion of the aorta (REBOA) offered an option to improve survival in battle casualties dying from haemorrhage, particularly in remote and austere surgical settings. Following a successful jHub opportunity assessment, DefER purchased training and operational kit at pace. By 1 April 2019, the first forward surgical group undertook a bespoke endovascular training and assessment package. Results of the pilot were presented back to a jHub 4* Innovation Board, which initially awarded £500 000 to fund the project to full implementation. Med Op Cap provided a solution to establish REBOA as a core capability on to the 370 modules. REBOA catheters and arterial access kit are now available to deployed Role 2 facilities across defence as an adjunct to damage control resuscitation in specific circumstances. REBOA has, from a standing start, gained pan-Defence Medical Services (DMS) endorsement and has been integrated into deployed damage control resuscitation. To establish a new resuscitation capability across all Role 2 platforms within 15 months of inception represents implementation at pace. This agility was unlocked by empowering clinicians to develop the platform in conjunction with commercial procurement. This article describes how this innovative pathway facilitated the rapid introduction of a lifesaving haemorrhage control technique to equip DMS clinicians.

Keywords: organisational development; protocols & guidelines; risk management; trauma management.

Sudden-Onset Disaster Mass-Casualty Incident Response: A Modified Delphi Study on Triage, Prehospital Life Support, and Processes

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Abstract

The application and provision of prehospital care in disasters and mass-casualty incident response in Europe is currently being explored for opportunities to improve practice. The objective of this translational science study was to align common principles of approach and action and to identify how technology can assist and enhance response. To achieve this objective, the application of a modified Delphi methodology study based on statements derived from key findings of a scoping review was undertaken. This resulted in 18 triage, eight life support and damage control interventions, and 23 process consensus statements. These findings will be utilized in the development of evidence-based prehospital mass-casualty incident response tools and guidelines.

Keywords: disaster; mass casualty; prehospital; trauma.

Targeted metagenomic assessment reflects critical colonization in battlefield injuries

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Abstract

Microbial contamination in combat wounds can lead to opportunistic infections and adverse outcomes. However, current microbiological detection has a limited ability to capture microbial functional genes. This work describes the application of targeted metagenomic sequencing to profile wound bioburden and capture relevant wound-associated signatures for clinical utility. Ultimately, the ability to detect such signatures will help guide clinical decisions regarding wound care and management and aid in the prediction of wound outcomes.

Keywords: antimicrobial resistance; combat injury; infection diagnostic; microbial genomics; military medicine; targeted sequencing; virulence; wound infection.

Walking blood bank: a plan to ensure self-sufficiency in an era of blood shortage

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Abstract

Mass casualty incidents and massive transfusion requirements continue to plague the USA with hemorrhage remaining the number one cause of death in trauma. The unfortunate reality of numerous mass shootings in Southwest Texas has led to the need for a way in which to provide blood during these events as rapidly as it is required. Multiple agencies within the Southwest Texas system have united to help provide this life-saving blood to people when they need it most. This effort began with the development of a system for safe, efficient, and now widespread use of whole blood in the region. After demonstrating the success of delivering large quantities of blood during the Uvalde shooting, we have begun to develop a walking blood bank that is similar to what the miliary uses on the battlefield. The concept behind this initiative is to have a cohort of whole blood donors who are preselected to join the program which is now dubbed 'Heroes in Arms'. These donors will be called upon to donate whole blood during a massive transfusion event. Their blood will be rapidly screened prior to transfusion to the patient. This blood will still undergo the normal rigorous testing and, should any potentially transmissible diseases by discovered post-transfusion, the individual who received that product will be treated accordingly. Given the low rate of transmissible disease among this preselected population, combined with rapid screening prior to transfusion, the risk of a person receiving a transmissible disease is insignificant in comparison to the benefit of having blood to transfuse during hemorrhage. This model is a promising collaborative effort to provide in a timely and sufficient blood product in cases of major need which will consequently minimize the number of traumatically injured civilian patients who die from hemorrhage.

Keywords: Mass Casualty Incidents; Multiple Trauma; blood transfusion; hemorrhage.

Management of severe defects of humerus in combat patients injured in Russo-Ukrainian war

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Abstract

Introduction: Russo-Ukrainian war is associated with application of high-energy weapon, causing severe multifragmental injuries to the bones an associating with severe bone defects. The aim of the study was to evaluate various methods to treat combat patients with severe defects of humerus and to demonstrate the experience of orthopedic war surgeons in managing gunshot injuries to the humerus defects in the ongoing war.

Patients and methods: A 24 patients were active-duty military personnel of Armed Forces of Ukraine. These patients were diagnosed with severe humerus defects due to gunshot injury in battlefield zone in various areas of Ukraine. Data was collected within period between February, 24th 2022 till January, 01st 2023. The following approaches were applied to replace bone defect: preoperative 3D printing with polyetheretherketone (PEEK) as orthobiological material; closed reduction, percutaneous lag screw and Ilizarov external fixation; vascularized fibula grafting.

Results: Data analyses of the segmental defects of humerus showed 5 cm defect in 3 (13 %) patients, from 5 to 10 cm in 4 (17 %) patients, over 10 cm in 17 (71 %) patients. Analyses were performed in these 17 (71 %) patients, showing 5 patients treated with 3D-printed PEEK implants, 6 patients with vascular-pedicle graft of fibula, 6 patients with closed reduction, percutaneous lag screw, Ilizarov external fixation. Osteomyelitis was diagnosed in one case (20 %) after the use of PEEK implants, requiring to remove both PEEK implant and metal implants followed by application of the antibiotic joint spacers and Ex-Fix fragments of the humerus. In our opinion, the osteomyelitis happened due to inadequate debridement of the wound and non-compliance with the conversion criteria (replacement of the fixation method). The mean length of hospital stay was 5.5 months for patients treated with 3D-printed PEEK implants.

Conclusions: Closed reduction, percutaneous lag screw and Ilizarov external fixation as well as vascularized fibula grafting are associated with good outcomes in management of the patients with severe humerus defect due to gunshot injury. 3D printing and PEEK implants could also be considered for the reconstructions of the humerus multifragmental fractures with a bone defect over 10 cm associated with gunshot injury due to high-energy weapon in the war settings.

Keywords: Bone 3D printing; Gunshot fracture; Gunshot wound; Humerus defect; Long bone gunshot fracture; Polyetheretherketone; Russo-ukrainian war; Severe bone defect; War in Ukraine.