

# Committee on Surgical Combat Casualty Care (CoSCCC)



**Journal Watch**

**2nd Quarter**

**FY 2021**

## 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

# Freeze-dried plasma for major trauma - Systematic review and meta-analysis

Garrick Mok<sup>1</sup>, Richard Hoang, Montaha Wajid Khan, Dylan Pannell, Henry Peng, Homer Tien, Avery Nathens, Jeannie Callum, Keyvan Karkouti, Andrew Beckett, Luis Teodoro da Luz

## Abstract

**Background:** Treatment of acute trauma coagulopathy has shifted toward rapid replacement of coagulation factors with frozen plasma (FP). There are logistic difficulties in providing FP. Freeze-dried plasma (FDP) may have logistical advantages including easier storage and rapid preparation time. This review assesses the feasibility, efficacy, and safety of FDP in trauma.

**Study design and methods:** Studies were searched from Medline, Embase, Cochrane Controlled Trials Register, ClinicalTrials.gov, and Google Scholar. Observational and randomized controlled trials (RCTs) assessing FDP use in trauma were included. Trauma animal models addressing FDP use were also included. Bias was assessed using validated tools. Primary outcome was efficacy, and secondary outcomes were feasibility and safety. Meta-analyses were conducted using random-effect models. Evidence was graded using Grading of Recommendations Assessment, Development, and Evaluation profile.

**Results:** Twelve human studies (RCT, 1; observational, 11) and 15 animal studies were included. Overall, studies demonstrated moderate risk of bias. Data from two studies (n = 119) were combined for meta-analyses for mortality and transfusion of allogeneic blood products (ABPs). For both outcomes, no difference was identified. For mortality, pooled odds ratio was 0.66 (95% confidence interval, 0.29-1.49), with I<sup>2</sup> = 0%. Use of FDP is feasible, and no adverse events were reported. Animal data suggest similar results for coagulation and anti-inflammatory profiles for FP and FDP.

**Conclusion:** Human data assessing FDP use in trauma report no difference in mortality and transfusion of ABPs in patients receiving FDP compared with FP. Data from animal trauma studies report no difference in coagulation factor and anti-inflammatory profiles between FP and FDP. Results should be interpreted with caution because most studies were observational and have heterogeneous population (military and civilian trauma) and a moderate risk of bias. Well-designed prospective observational studies or, preferentially, RCTs are warranted to answer FDP's effect on laboratory (coagulation factor levels), transfusion (number of ABPs), and clinical outcomes (organ dysfunction, length of stay, and mortality).

# Prehospital and hospital shock indices as predictors of massive blood transfusion during the initial treatment of polytrauma patients

[Article in Spanish, English]

Laura Pariente Juste<sup>1</sup>, Maylin Koo Gómez<sup>1</sup>, Antonia Bonet Burguera<sup>1</sup>, Raquel Reyes García<sup>1</sup>, Lourdes Pérez García<sup>1</sup>, Irene Macía Tejada<sup>1</sup>

## Abstract

**Objectives:** To explore a possible association between the shock index and a need for massive blood transfusion, duration of hospital stay in the critical care unit, and mortality.

**Material and methods:** Observational study of data for all patients over the age of 18 years with multiple high-energy injuries included in the TraumCat Registry who were treated in Hospital Universitario de Bellvitge between 2012 and 2016. We calculated shock index values before hospital emergency department arrival, on arrival at the hospital, and on admission to the critical care unit for resuscitation. The amount of blood transfused in the first 24 hours was also obtained from the registry.

**Results:** Of 184 polytrauma patients, 75 (41%) received blood transfusions. Median (interquartile range) shock indices were as follows: prehospital, 0.77 (0.61-1.01); on hospital arrival, 0.78 (0.64-1); and on critical care admission, 0.92 (0.76-1.13). Forty-six patients (25%) died. A prehospital shock index of 0.9 was significant, differentiating the amount of blood transfused. The specificity and sensitivity of the cutoff were 73% and 66%, respectively, at the prehospital recording and 74% and 80% on hospital arrival. The areas under the receiver operating characteristic curve and 95% CIs were as follows for prehospital and on-arrival shock indices: 68% (61%-75%) and 72% (65%-79%). Mortality and hospital stay were not significantly associated with shock indices.

**Conclusion:** The shock index is a useful, easy-to-obtain predictor to identify polytrauma patients who need early blood transfusion for optimal treatment. Hospital stay and mortality might be better predicted by other indicators.

**Keywords:** Estancia hospitalaria; Hemorragia masiva; Hipovolemia; Hospital length of stay; Hipovolemia; Massive blood transfusion; Massive hemorrhage; Mortalidad; Mortality; Multiple trauma; Politrauma; Shock index; Transfusión masiva; Índice de Shock.

# Longitudinal mental health outcomes of combat-injured service members

Lauren E Walker<sup>1</sup>, Jessica Watrous<sup>2</sup>, Eduard Poltavskiy<sup>1</sup>, Jeffrey T Howard<sup>3</sup>, Jud C Janak<sup>4</sup>, Warren B P Pettey<sup>5,6</sup>, Lee Ann Zarzabal<sup>7</sup>, Alan Sim<sup>7</sup>, Adi Gundlapalli<sup>5,6</sup>, Ian J Stewart<sup>8</sup>

## Abstract

**Background:** The relationship between traumatic injury and subsequent mental health diagnoses is not well understood and may have significant implications for patient screening and clinical intervention. We sought to determine the adjusted association between traumatic injury and the subsequent development of post-traumatic stress disorder (PTSD), depression, and anxiety.

**Methods:** Using Department of Defense and Veterans Affairs datasets between February 2002 and June 2016, we conducted a retrospective cohort study of 7,787 combat-injured United States service members matched 1:1 to combat-deployed, uninjured service members. The primary exposure was combat injury versus no combat injury. Outcomes were diagnoses of PTSD, depression, and anxiety, defined by International Classification of Diseases 9th and 10th Revision Clinical Modification codes.

**Results:** Compared to noninjured service members, injured service members had higher observed incidence rates per 100 person-years for PTSD (17.1 vs. 5.8), depression (10.4 vs. 5.7), and anxiety (9.1 vs. 4.9). After adjustment, combat-injured patients were at increased risk of development of PTSD (HR 2.92, 95%CI 2.68-3.17), depression (HR 1.47, 95%CI 1.36-1.58), and anxiety (HR 1.34, 95%CI 1.24-1.45).

**Conclusions:** Traumatic injury is associated with subsequent development of PTSD, depression, and anxiety. These findings highlight the importance of increased screening, prevention, and intervention in patients with exposure to physical trauma.

**Keywords:** anxiety; depression; injury; military health; post-traumatic stress disorder; risk factors; veterans.

# Clinical Utilization of Deployed Military Surgeons

Andrew Hall<sup>1</sup>, Iram Qureshi, Jennifer Gurney, Stacy Shackelford, Jonathan Taylor, Christopher Mahoney, Scott Trask, Avery Walker, Ramey Wilson

## Abstract

**Background:** Combat casualty care has been shaped by the prolonged conflicts in Southwest Asia, namely Afghanistan, Iraq, and Syria. The utilization of surgeons in austere locations outside of Southwest Asia and its implication on skill retention and value have not been examined. This study hypothesizes that surgeon utilization is low in the African theater. This lack of activity is potentially damaging to surgical skill retention and patient care.

**Methods:** Military case logs of surgeons deployed to Africa under command of Special Operations Command Africa (SOCAF) between 1 January 2016 to 1 January 2020 were examined. Cases were organized based on population served, general type of procedure, current procedural terminology (CPT Codes), and location.

**Results:** Twenty deployment caseloads representing 74% of the deployments during the period were analyzed. In 3294 days, 101 operations were performed, which included 45 on combat/terrorism related injuries, and 19 on US personnel. East and West African deployments, combat, and non-combat zones respectively, were compared. East Africa averaged  $4.1 \pm 3.8$  operations per deployment and West Africa  $7.3 \pm 8.0$  ( $p=.2434$ ). In East Africa, 56.1% of total operations were related to combat/terrorism, compared to 29.6% of total operations in West Africa ( $p=0.0077$ ). West Africa had a significantly higher proportion of elective ( $p=0.0002$ ) and humanitarian cases ( $p<.0001$ ).

**Conclusions:** Surgical cases for military surgeons were uncommon in Africa. The low volumes have implications for skill retention, morale, and sustainability of military surgical end-strength. Reduction in deployment lengths, deployment location adjustments, and/or skill retention strategies are required to ensure clinical peak performance and operational readiness. Failure to implement changes to current practices to optimize surgeon experience will likely decrease surgical readiness and could contribute to decreased retention of deployable military surgeons to support global operations.

**Level of evidence:** Level III Economic/Decision.

# Hypocalcemia in Military Casualties From Point of Injury to Surgical Teams in Afghanistan

Jeffrey R Conner<sup>1</sup>, Linda C Benavides<sup>1</sup>, Stacy A Shackelford<sup>2</sup>, Jennifer M Gurney<sup>2</sup>, Edward F Burke<sup>3</sup>, Michael A Remley<sup>2</sup>, Ricky M Ditzel<sup>4</sup>, Andrew P Cap<sup>2</sup>

Affiliations expand

## Abstract

**Introduction:** Hypocalcemia is a known sequela of citrated blood product transfusion. Civilian data suggest hypocalcemia on hospital admission is associated with worse outcomes. Initial calcium levels in military casualties have not previously been analyzed. The objective of this retrospective review aimed to assess the initial calcium levels in military trauma casualties at different Forward Surgical Teams (FST) locations in Afghanistan and describe the effects of prehospital blood product administration on arrival calcium levels.

**Materials and methods:** This is a retrospective cohort analysis of military casualties arriving from point of injury to one of two FSTs in Afghanistan from August 2018 to February 2019 split into four locations. The primary outcome was incidence of hypocalcemia (ionized calcium < 1.20 mmol/L).

**Results:** There were 101 patients included; 55 (54.5%) experienced hypocalcemia on arrival to the FST with a mean calcium of 1.16 mmol/L (95% confidence interval [CI], 1.14 to 1.18). The predominant mechanism of injury consisted of blast patterns, 46 (45.5%), which conferred an increased risk of hypocalcemia compared to all other patterns of injury (odds ratio = 2.42, P = .042). Thirty-eight (37.6%) patients required blood product transfusion. Thirty-three (86.8%) of the patients requiring blood product transfusion were hypocalcemic on arrival. Mean initial calcium of patients receiving blood product was 1.13 mmol/L (95% CI, 1.08 to 1.18), which was significantly lower than those who did not require transfusion (P = .01). Eight (7.9%) of the patients received blood products before arrival, with 6/8 (75%) presenting with hypocalcemia.

**Conclusions:** Hypocalcemia develops rapidly in military casualties and is prevalent on admission even before transfusion of citrated blood products. Blast injuries may confer an increased risk of developing hypocalcemia. This data support earlier use of calcium supplementation during resuscitation.

# The diamond of death: Hypocalcemia in trauma and resuscitation

Jesse P Wray<sup>1</sup>, Rachel E Bridwell<sup>1</sup>, Steven G Schauer<sup>2</sup>, Stacy A Shackelford<sup>3</sup>, Vikhyat S Bebarta<sup>4</sup>, Franklin L Wright<sup>4</sup>, James Bynum<sup>5</sup>, Brit Long<sup>6</sup>

Affiliations expand

## Abstract

**Introduction:** Early recognition and management of hemorrhage, damage control resuscitation, and blood product administration have optimized management of severe trauma. Recent data suggest hypocalcemia exacerbates the ensuing effects of coagulopathy in trauma.

**Objective:** This narrative review of available literature describes the physiology and role of calcium in trauma resuscitation. Authors did not perform a systematic review or meta-analysis.

**Discussion:** Calcium is a divalent cation found in various physiologic forms, specifically the bound, inactive state and the unbound, physiologically active state. While calcium plays several important physiologic roles in multiple organ systems, the negative hemodynamic effects of hypocalcemia are crucial to address in trauma patients. The negative ramifications of hypocalcemia are intrinsically linked to components of the lethal triad of acidosis, coagulopathy, and hypothermia. Hypocalcemia has direct and indirect effects on each portion of the lethal triad, supporting calcium's potential position as a fourth component in this proposed lethal diamond. Trauma patients often present hypocalcemic in the setting of severe hemorrhage secondary to trauma, which can be worsened by necessary transfusion and resuscitation. The critical consequences of hypocalcemia in the trauma patient have been repeatedly demonstrated with the associated morbidity and mortality. It remains poorly defined when to administer calcium, though current data suggest that earlier administration may be advantageous.

**Conclusions:** Calcium is a key component of trauma resuscitation and the coagulation cascade. Recent data portray the intricate physiologic reverberations of hypocalcemia in the traumatically injured patient; however, future research is needed to further guide the management of these patients.

**Keywords:** Calcium; Coagulopathy; Critical; Hypocalcemia; Resuscitation; Trauma.



# Emergency Management of Pelvic Bleeding

Simone Frassini<sup>1</sup>, Shailvi Gupta<sup>2</sup>, Stefano Granieri<sup>1</sup>, Stefania Cimbanassi<sup>1</sup>, Fabrizio Sammartano<sup>1</sup>, Thomas M Scalea<sup>2</sup>, Oswaldo Chiara<sup>1</sup>

## Abstract

Pelvic trauma continues to have a high mortality rate despite damage control techniques for bleeding control. The aim of our study was to evaluate how Extra-peritoneal Pelvic Packing (EPP) and Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) impact the efficacy on mortality and hemodynamic impact. We retrospectively evaluated patients who sustained blunt trauma, pelvic fracture and hemodynamic instability from 2002 to 2018. We excluded a concomitant severe brain injury, resuscitative thoracotomy, penetrating trauma and age below 14 years old. The study population was divided in EPP and REBOA Zone III group. Propensity score matching was used to adjust baseline differences and then a one-to-one matched analysis was performed. We selected 83 patients, 10 for group: survival rate was higher in EPP group, but not significantly in each outcome we analyzed (24 h, 7 day, overall). EPP had a significant increase in main arterial pressure after procedure (+20.13 mmHg,  $p < 0.001$ ), but this was not as great as the improvement seen in the REBOA group (+45.10 mmHg,  $p < 0.001$ ). EPP and REBOA are effective and improve hemodynamic status: both are reasonable first steps in a multidisciplinary management. Zone I REBOA may be useful in patients 'in extremis condition' with multiple sites of torso hemorrhage, particularly those in extremis.

**Keywords:** REBOA; bleeding; extra-peritoneal packing; packing; pelvic trauma; resuscitation.

# Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA): update and insights into current practices and future directions for research and implementation

Marianne A Thrailkill<sup>1,2</sup>, Kevin H Gladin<sup>3</sup>, Catherine R Thorpe<sup>2,4</sup>, Teryn R Roberts<sup>2,5</sup>, Jae H Choi<sup>2,5</sup>, Kevin K Chung<sup>6</sup>, Corina N Necsoiu<sup>7</sup>, Todd E Rasmussen<sup>6</sup>, Leopoldo C Cancio<sup>8</sup>, Andriy I Batchinsky<sup>9,10</sup>

## Abstract

**Background:** In this review, we assess the state of Resuscitative Endovascular Occlusion of the Aorta (REBOA) today with respect to out-of-hospital (OOH) vs. in-hospital (H) use in blunt and penetrating trauma, as well as discuss areas of promising research that may be key in further advancement of REBOA applications.

**Methods:** To analyze the trends in REBOA use, we conducted a review of the literature and identified articles with human or animal data that fit the respective inclusion and exclusion criteria. In separate tables, we compiled data extracted from selected articles in categories including injury type, zone and duration of REBOA, setting in which REBOA was performed, sample size, age, sex and outcome. Based on these tables as well as more detailed review of some key cases of REBOA usage, we assessed the current state of REBOA as well as coagulation and histological disturbances associated with its usage. All statistical tests were 2-sided using an alpha=0.05 for significance. Analysis was done using SAS 9.5 (Cary, NC). Tests for significance was done with a t-test for continuous data and a Chi Square Test for categorical data.

**Results:** In a total of 44 cases performed outside of a hospital in both military and civilian settings, the overall survival was found to be 88.6%, significantly higher than the 50.4% survival calculated from 1,807 cases of REBOA performed within a hospital ( $p < .0001$ ). We observe from human data a propensity to use Zone I in penetrating trauma and Zone III in blunt injuries. We observe lower final metabolic markers in animal studies with shorter REBOA time and longer follow-up times.

**Conclusions:** Further research related to human use of REBOA must be focused on earlier initiation of REBOA after injury which may depend on development of rapid vascular access devices and techniques more so than on any new improvements in REBOA. Future animal studies should provide detailed multisystem organ assessment to accurately define organ injury and metabolic burden associated with REBOA application. Overall, animal studies must involve realistic models of injury with severe clinical scenarios approximating human trauma and exsanguination, especially with long-term follow-up after injury.

**Keywords:** Non-compressible torso hemorrhage; REBOA.