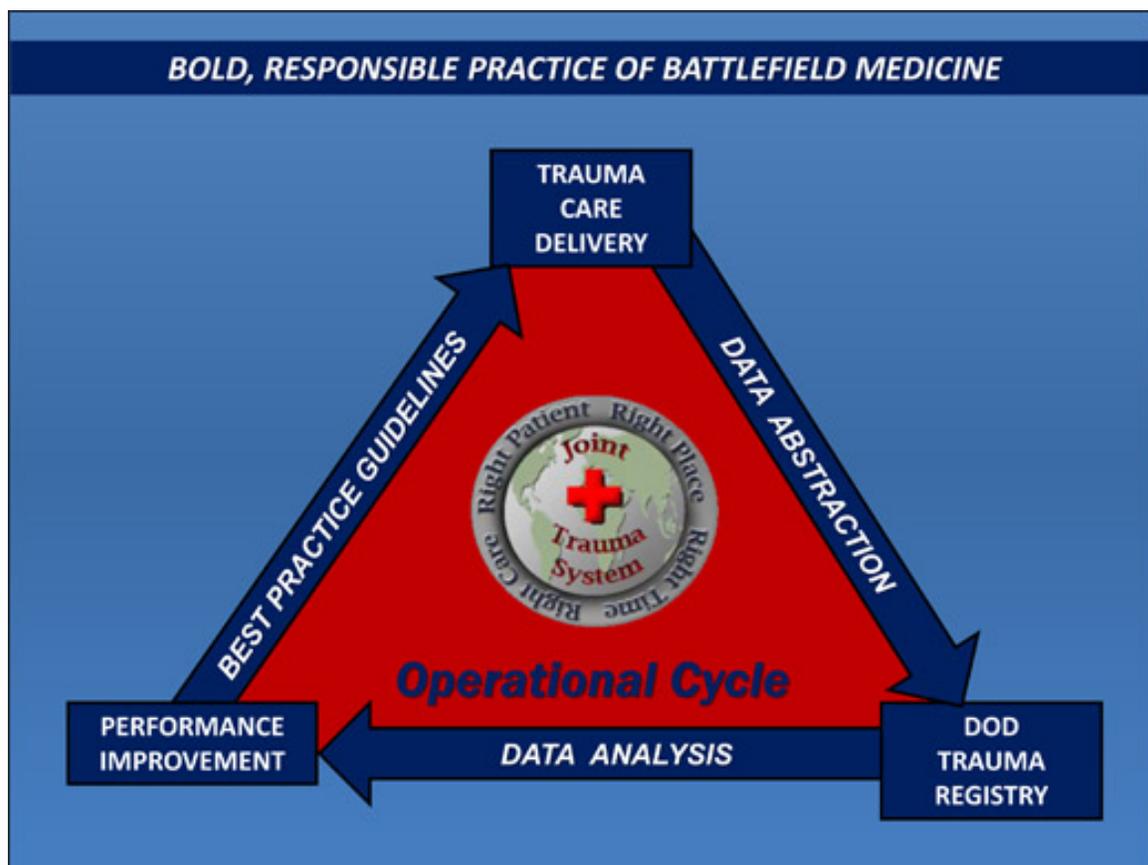


# Committee on Surgical Combat Casualty Care (CoSCCC)



**Journal Watch**

**4<sup>th</sup> Quarter**

**2016**

## Journal Watch Key Terminology Searched:

Afghanistan  
Ketamine  
Trauma

Amputation  
Military  
TXA

Battlefield  
Pre-Hospital  
War

Blast injuries  
REBOA  
Wounds

Combat  
Surgery

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## A prospective study of ketamine versus haloperidol for severe prehospital agitation.

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### Abstract

**CONTEXT:** Ketamine is an emerging drug for the treatment of acute undifferentiated agitation in the prehospital environment, however no prospective comparative studies have evaluated its effectiveness or safety in this clinical setting.

**OBJECTIVE:** We hypothesized 5 mg/kg of intramuscular ketamine would be superior to 10 mg of intramuscular haloperidol for severe prehospital agitation, with time to adequate sedation as the primary outcome measure.

**METHODS:** This was a prospective open label study of all patients in an urban EMS system requiring chemical sedation for severe acute undifferentiated agitation that were subsequently transported to the EMS system's primary Emergency Department. All paramedics were trained in the Altered Mental Status Scale and prospectively recorded agitation scores on all patients. Two 6-month periods where either ketamine or haloperidol was the first-line therapy for severe agitation were prospectively compared primarily for time to adequate sedation. Secondary outcomes included laboratory data and adverse medication events.

**RESULTS:** 146 subjects were enrolled; 64 received ketamine, 82 received haloperidol. Median time to adequate sedation for the ketamine group was 5 minutes (range 0.4-23) vs. 17 minutes (range 2-84) in the haloperidol group (difference 12 minutes, 95% CI 9-15). Complications occurred in 49% (27/55) of patients receiving ketamine vs. 5% (4/82) in the haloperidol group. Complications specific to the ketamine group included hypersalivation (21/56, 38%), emergence reaction (5/52, 10%), vomiting (5/57, 9%), and laryngospasm (3/55, 5%). Intubation was also significantly higher in the ketamine group; 39% of patients receiving ketamine were intubated vs. 4% of patients receiving haloperidol.

### CONCLUSIONS:

Ketamine is superior to haloperidol in terms of time to adequate sedation for severe prehospital acute undifferentiated agitation, but is associated with more complications and a higher intubation rate.

## Operative management of complex lumbosacral dissociations in combat injuries.

[Formby PM](#)<sup>1</sup>, [Wagner SC](#)<sup>1</sup>, [Kang DG](#)<sup>2</sup>, [Van Blarcum GS](#)<sup>1</sup>, [Lehman RA Jr](#)<sup>3</sup>.

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### Abstract

**BACKGROUND CONTEXT:** As war injury patterns have changed throughout Operations Iraqi and Enduring Freedom (OIF and OEF), a relative increase in the incidence of complex lumbosacral dissociation (LSD) injuries has been noted. Lumbosacral dissociation injuries are an anatomical separation of the spinal column from the pelvis, and represent a manifestation of severe, high-energy trauma.

**PURPOSE:** This study aimed to assess the clinical outcomes of combat-related LSD injuries at a mean of 7 years following operative treatment.

**STUDY DESIGN:** This is a retrospective review.

**PATIENT SAMPLE:** We identified 20 patients with operatively managed LSDs.

**OUTCOME MEASURES:** Time from injury to arrival in the United States, operative details, fixation methods, postoperative complications, time to retirement from military service, disability, and ambulatory status at latest follow-up.

**METHODS:** We performed a retrospective review of outcomes of all patients with operatively managed combat-related LSD from January 1, 2003 to December 31, 2011.

**RESULTS:** Twenty patients met inclusion criteria and were treated as follows: posterior spinal fusion (12, 60%), sacroiliac screw fixation (7, 35%), and combined anterior-posterior fusion for associated L3 burst fracture (1, 5%). The mean age was 28.2±6.4 years old. The most common mechanism of injury was mounted improvised explosive device (IED, 55%). On average, 2.2 spinal regions were injured per patient. Neurologic dysfunction was present in 15 patients. Three patients underwent operative stabilization of their injuries before evacuation to the United States. Four patients had a postoperative wound infection and two patients underwent reoperation. Mean follow-up was 85.9 months (range: 39.7-140.8 months). At most recent follow-up, seventeen patients were no longer on active duty military service. Eight patients had persistent bowel dysfunction and nine patients had persistent bladder dysfunction. Fifteen patients reported chronic low back pain. Seventeen were ambulating and five had documentation of running following surgery.

**CONCLUSIONS:** This is the largest series of operatively managed LSD in patients currently reported. Our series suggests that combat-related LSD injuries frequently result in persistent, long-term neurologic dysfunction, disability, and chronic pain. Operative management carries a high postoperative risk of infection. However, a select group of patients are highly functional at latest follow-up.

Published by Elsevier Inc.

## 180 Early Deep Vein Thrombosis Chemoprophylaxis in Traumatic Brain Injury.

[Frisoli F](#), [Huang PP](#), [Frangos S](#).

### Abstract

**INTRODUCTION:** Venous thromboembolism (VTE) is a common complication of traumatic brain injury (TBI) with an estimated incidence of 25% when chemoprophylaxis is delayed. The timing of initiating prophylaxis is controversial given the concern for hemorrhage expansion. The objective of this study was to determine the safety of initiating VTE chemoprophylaxis in patients with TBI within 24 hours of presentation.

**METHODS:** We performed a retrospective analysis of a prospectively maintained database for all patients with traumatic intracranial hemorrhage presenting to a level I trauma center between July 2011 and September 2013. Patients receiving early chemoprophylaxis (<24 hours) were compared with the matched cohort of patients who received heparin in a delayed fashion (>48 hours). The primary outcome of the study was radiographic expansion of the intracranial hemorrhage. Secondary outcomes included VTE, use of intracranial pressure monitoring, delayed decompressive surgery for refractory elevated intracranial pressure, and all-cause mortality.

**RESULTS:** Of the 282 patients in our study, 94 (33%) received chemoprophylaxis within 24 hours of admission. The cohorts were evenly matched across all variables. The primary outcome occurred in 18% of patients in the early cohort compared with 17% in the delayed cohort ( $P = .83$ ). Fifteen patients (16%) in the early cohort underwent an invasive procedure in a delayed fashion. This compares to 35 patients (19%) in the delayed cohort ( $P = .38$ ). Five patients (1.7%) in our study had a VTE event (ie, deep vein thrombosis or pulmonary embolism) during their hospitalization. Two of these patients received early chemoprophylaxis ( $P = .75$ ). The rate of mortality from all causes was similar in both groups (4.1% vs 3.7%,  $P = .83$ ).

**CONCLUSION:** Early (<24 hours) initiation of VTE chemoprophylaxis in patients with traumatic intracranial hemorrhage appears to be safe. Further prospective studies are needed to validate this finding.

PMID:27399459 DOI:[10.1227/01.neu.0000489749.74661.15](#)

[Shock](#). 2016 Sep;46(3 Suppl 1):104-7. doi: 10.1097/SHK.0000000000000683.

## Tactical Study of Care Originating in the Prehospital Environment (Tacscope): Acute Traumatic Coagulopathy on the Contemporary Battlefield.

[Gerhardt RT](#)<sup>1</sup>, [Glassberg E](#), [Holcomb JB](#), [Mabry RL](#), [Schreiber MB](#), [Spinella PC](#).

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### Abstract

**BACKGROUND:** Uncontrolled major hemorrhage and delayed evacuation remain substantial contributors to potentially survivable combat death, along with mission, environment, terrain, logistics, and hostile action. Life-saving interventions and the onset of acute traumatic coagulopathy (ATC) may also contribute.

**OBJECTIVE:** Analyze US casualty records from the DoD Trauma Registry, using International Normalized Ratio (INR) of 1.5 for onset of ATC.

**METHODS:** Retrospective cohort study from September 2007 to June 2011, inclusive. Independent variable was INR. Primary dependent variables were transfusion volume, massive transfusion (MT) defined as >10 units RBC/fresh whole blood in first 24h, and 30-day survival. We used T test and chi-square analysis. Our IRB reviewed and exempted this study.

**RESULTS:** In total, 8,913 cases were available. Fifty one percent had complete data with INR. Of excluded cases, 98.9% survived, average injury severity scales (ISS) was 7 (IQR 1-8), and less than 1% received MT. Among included cases, 98.5% survived, average ISS was 10 (IQR 2-14), average INR was 1.16 (CI95 1.14-1.17), and 2.7% received MT. There were 383 cases with ATC (8.4%). After stratification, we found that ATC cases were more likely to die (odds ratio (OR) 28, CI 16-48), receive MT (OR 9.6, CI 6.4-14.4), and were acidotic (pH 7.27 (7.24-7.31) vs. 7.38 (7.38-7.39)). Other significant differences included Injury Severity Score, Revised Trauma Score, blast mechanism, and penetrating injury.

### CONCLUSION:

ATC is substantially associated with greater injury severity, MT, and mortality. Prehospital identification of MT casualties may expedite triage and evacuation, and enable remote damage control resuscitation to delay ATC onset and improve outcomes.

PMID:27405067 DOI:[10.1097/SHK.0000000000000683](#)

## **Integrating eFAST in the initial management of stable trauma patients: the end of plain film radiography.**

[Hamada SR](#)<sup>1</sup>, [Delhaye N](#)<sup>2</sup>, [Kerever S](#)<sup>3,4,5</sup>, [Harrois A](#)<sup>6</sup>, [Duranteau J](#)<sup>6</sup>.

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### **Abstract**

**BACKGROUND:** The initial management of a trauma patient is a critical and demanding period. The use of extended focused assessment sonography for trauma (eFAST) has become more prevalent in trauma rooms, raising questions about the real "added value" of chest X-rays (CXRs) and pelvic X-rays (PXR), particularly in haemodynamically stable trauma patients. The aim of this study was to evaluate the effectiveness of a management protocol integrating eFAST and excluding X-rays in stable trauma patients.

**METHODS:** This was a prospective, interventional, single-centre study including all primary blunt trauma patients admitted to the trauma bay with a suspicion of severe trauma. All patients underwent physical examination and eFAST (assessing abdomen, pelvis, pericardium and pleura) before a whole-body CT scan (WBCT). Patients fulfilling all stability criteria at any time in transit from the scene of the accident to the hospital were managed in the trauma bay without chest and PXR.

**RESULTS:** Amongst 430 patients, 148 fulfilled the stability criteria (stability criteria group) of which 122 (82 %) had no X-rays in the trauma bay. No diagnostic failure with an immediate clinical impact was identified in the stability criteria group (SC group). All cases of pneumothorax requiring chest drainage were identified by eFAST associated with a clinical examination before the WBCT scan in the SC group. The time spent in the trauma bay was significantly shorter for the SC group without X-rays compared to those who received any X-ray (25 [20; 35] vs. 38 [30; 60] min, respectively;  $p < 0.0001$ ). An analysis of the cost and radiation exposure showed savings of 7000 € and 100 mSv, respectively.

**CONCLUSIONS:** No unrecognized diagnostic with a clinical impact due to the lack of CXR and PXR during the initial management of stable trauma patients was observed. The eFAST associated with physical examination provided the information necessary to safely complete the WBCT scan. It allowed a sensible cost and radiation saving.

### **KEYWORDS:**

Diagnostic accuracy; Imaging; Resuscitation; Severe trauma; Stability; Ultrasound

PMID:27401440 PMID:[PMC4940356](#) DOI:[10.1186/s13613-016-0166-0](#)

## Noninvasive Continuous Hemoglobin Monitoring in Combat Casualties: A Pilot Study.

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### Abstract

**OBJECTIVE:** To describe the accuracy and precision of noninvasive hemoglobin measurement (SpHb) compared with laboratory or point-of-care Hb, and SpHb ability to trend in seriously injured casualties.

**METHODS:** Observational study in a convenience sample of combat casualties undergoing resuscitation at two US military trauma hospitals in Afghanistan. SpHb was obtained using the Masimo Rainbow SET (Probe Rev E/Radical-7 Pulse CO-Oximeter v 7.6.2.1). Clinically indicated Hb was analyzed with a Coulter or iStat and compared with simultaneous SpHb values.

**RESULTS:** Twenty-three patients were studied (ISS  $20 \pm 9.8$ ; age  $29 \pm 9$  years; male 97%; 100% intubated). Primary injury cause: improvised explosive device (67%) or gunshot (17%). There were 49 SpHb-Hb pairs (median 2 per subject). Bias:  $0.3 \pm 1.6$  g/dL (95% LOA -2.4, 3.4 g/dL). The SpHb-Hb difference  $< \pm 1$  g/dL in 37% of pairs. Eighty-six percent of pairs changed in a similar direction. Using an absolute change in Hb of  $>1$  g/dL, a concurrent absolute change in SpHb of  $>1$  g/dL had a sensitivity: 61%, specificity 85%, positive predictive value: 80%, and a negative predictive value: 69%. The SpHb signal was present in 4643 of 6137 min monitored (76%).

**CONCLUSIONS:** This was the first study to describe continuous SpHb in seriously injured combat casualties. Using a threshold of 1 g/dL previously specified in the literature, continuous SpHb is not precise enough to serve as sole transfusion trigger in trauma patients. Further research is needed to determine if it is useful for trending Hb changes or as an early indicator of deterioration in combat casualties.

PMID:27501120 DOI:[10.1097/SHK.0000000000000654](#)

## **Efficacy of Hemostatic Agents in Humans With Rotational Thromboelastometry: An in-vitro Study.**

[Lechner R](#)<sup>1</sup>, [Helm M](#)<sup>2</sup>, [Mueller M](#)<sup>1</sup>, [Wille T](#)<sup>3</sup>, [Friemert B](#)<sup>1</sup>.

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### **Abstract**

**OBJECTIVES:** Hemorrhage is the leading cause of preventable death in military conflicts. Different types of hemostatic dressings have been compared in animal studies for their ability to control bleeding. However, the effects of hemostatic agents in animals may be different from those in humans. The aim of this study was to assess the efficacy of hemostatic dressings in human blood.

**METHODS:** Clotting time, clot formation time,  $\alpha$ -angle, maximum clot firmness, and lysis index of human blood incubated with QuikClot Gauze, Celox Gauze, QuikClot ACS+, and standard gauze, were compared using rotational thromboelastometry (ROTEM). Nonactivated, intrinsically activated, extrinsically activated, and fibrin-based ROTEM were used to elucidate different mechanisms of action of those dressings.

**RESULTS:** QuikClot Gauze was the most efficacious hemostatic dressing, followed by Celox Gauze and standard gauze. QuikClot ACS+ was clearly outperformed.

**CONCLUSIONS:** Modern hemostatic dressings such as QuikClot Gauze and Celox Gauze should be preferred to previous generations of hemostatic dressings, such as QuikClot ACS+. In vitro studies like ROTEM can provide valuable information about the mechanisms of action of hemostatic dressings. A combination of different mechanisms of action may increase the efficacy of hemostatic dressings.

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PMID: 27483532 DOI:[10.7205/MILMED-D-15-00417](#)

## **Saving the Military Surgeon: Maintaining Critical Clinical Skills in a Changing Military and Medical Environment.**

[Edwards MJ](#)<sup>1</sup>, [Edwards KD](#)<sup>2</sup>, [White C](#)<sup>2</sup>, [Shepps C](#)<sup>3</sup>, [Shackelford S](#)<sup>4</sup>.

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PMID:

27185158

DOI:

[10.1016/j.jamcollsurg.2016.03.031](https://doi.org/10.1016/j.jamcollsurg.2016.03.031)

## Targeted stimulation of retinoic acid receptor- $\gamma$ mitigates the formation of heterotopic ossification in an established blast-related traumatic injury model.

[Pavey GJ](#)<sup>1</sup>, [Qureshi AT](#)<sup>2</sup>, [Tomasino AM](#)<sup>2</sup>, [Honnold CL](#)<sup>3</sup>, [Bishop DK](#)<sup>4</sup>, [Agarwal S](#)<sup>5</sup>, [Loder S](#)<sup>5</sup>, [Levi B](#)<sup>5</sup>, [Pacifci M](#)<sup>6</sup>, [Iwamoto M](#)<sup>6</sup>, [Potter BK](#)<sup>1</sup>, [Davis TA](#)<sup>7</sup>, [Forsberg JA](#)<sup>1</sup>.

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### **Abstract**

Heterotopic ossification (HO) involves formation of endochondral bone at non-skeletal sites, is prevalent in severely wounded service members, and causes significant complications and delayed rehabilitation. As common prophylactic treatments such as anti-inflammatory drugs and irradiation cannot be used after multi-system combat trauma, there is an urgent need for new remedies. Previously, we showed that the retinoic acid receptor  $\gamma$  agonist Palovarotene inhibited subcutaneous and intramuscular HO in mice, but those models do not mimic complex combat injury. Thus, we tested Palovarotene in our validated rat trauma-induced HO model that involves blast-related limb injury, femoral fracture, quadriceps crush injury, amputation and infection with methicillin-resistant *Staphylococcus aureus* from combat wound infections. Palovarotene was given orally for 14 days at 1 mg/kg/day starting on post-operative day (POD) 1 or POD-5, and HO amount, wound dehiscence and related processes were monitored for up to 84 days post injury. Compared to vehicle-control animals, Palovarotene significantly decreased HO by 50 to 60% regardless of when the treatment started and if infection was present. Histological analyses showed that Palovarotene reduced ectopic chondrogenesis, osteogenesis and angiogenesis forming at the injury site over time, while fibrotic tissue was often present in place of ectopic bone. Custom gene array data verified that while expression of key chondrogenic and osteogenic genes was decreased within soft tissues of residual limb in Palovarotene-treated rats, expression of cartilage catabolic genes was increased, including matrix metalloproteinase-9. Importantly, Palovarotene seemed to exert moderate inhibitory effects on wound healing, raising potential safety concerns related to dosing and timing. Our data show for the first time that Palovarotene significantly inhibits HO triggered by blast injury and associated complications, strongly indicating that it may prevent HO in patients at high risk such as those sustaining combat injuries and other forms of blast trauma. Published by Elsevier Inc.

**KEYWORDS:** Animal model; Bioburden; Blast overpressure exposure; Endochondral ossification; Heterotopic ossification; Prophylaxis; Retinoic acid receptor- $\gamma$  agonist; Traumatic extremity injury

PMID:27368930 DOI:[10.1016/j.bone.2016.06.014](https://doi.org/10.1016/j.bone.2016.06.014)

## Wartime decompressive craniectomy: technique and lessons learned.

[Ragel BT](#)<sup>1</sup>, [Klimo P Jr](#), [Martin JE](#), [Teff RJ](#), [Bakken HE](#), [Armonda RA](#).

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### Abstract

**OBJECT:** Decompressive craniectomy (DC) with dural expansion is a life-saving neurosurgical procedure performed for recalcitrant intracranial hypertension due to trauma, stroke, and a multitude of other etiologies. Illustratively, we describe technique and lessons learned using DC for battlefield trauma.

**METHODS:** Neurosurgical operative logs from service (October 2007 to September 2009) in Afghanistan that detail DC cases for trauma were analyzed. Illustrative examples of frontotemporoparietal and bifrontal DC that depict battlefield experience performing these procedures are presented with attention drawn to the L.G. Kempe hemispherectomy incision, brainstem decompression techniques, and dural onlay substitutes.

**RESULTS:** Ninety craniotomies were performed for trauma over the time period analyzed. Of these, 28 (31%) were DCs. Of the 28 DCs, 24 (86%) were frontotemporoparietal DCs, 7 (25%) were bifrontal DCs, and 2 (7%) were suboccipital DCs. Decompressive craniectomies were performed for 19 penetrating head injuries (13 gunshot wounds and 6 explosions) and 9 severe closed head injuries (6 war-related explosions and 3 others).

**CONCLUSIONS:** Thirty-one percent of craniotomies performed for trauma were DCs. Battlefield neurosurgeons use DC to allow for safe transfer of neurologically ill patients to tertiary military hospitals, which can be located 8-18 hours from a war zone. The authors recommend the L.G. Kempe incision for blood supply preservation, large craniectomies to prevent brain strangulation over bone edges, minimal brain debridement, adequate brainstem decompression, and dural onlay substitutes for dural closure.

PMID: 20568936 DOI: [10.3171/2010.3.FOCUS1028](https://doi.org/10.3171/2010.3.FOCUS1028)

## Resuscitative endovascular balloon occlusion of the aorta (REBOA) in the pre-hospital setting: An additional resuscitation option for uncontrolled catastrophic haemorrhage.

[Sadek S](#)<sup>1</sup>, [Lockey DJ](#)<sup>2</sup>, [Lendrum RA](#)<sup>3</sup>, [Perkins Z](#)<sup>4</sup>, [Price J](#)<sup>5</sup>, [Davies GE](#)<sup>6</sup>.

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**Abstract** This report describes the first use of Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) in the pre-hospital setting to control catastrophic haemorrhage. The patient, who had fallen 15 meters, suffered catastrophic internal haemorrhage associated with a pelvic fracture. He was treated by London's Air Ambulance's Physician-Paramedic team. This included insertion of a REBOA balloon catheter at the scene to control likely fatal exsanguination. The patient survived transfer to hospital, emergency angio-embolization and subsequent surgery. He was discharged neurologically normal after 52 days and went on to make a full recovery. The poor prognosis in catastrophic torso haemorrhage and novel endovascular methods of haemorrhage control are discussed. Also the challenges of Pre-Hospital REBOA are discussed together with the training and governance required for a safe system.

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**KEYWORDS:** Aortic occlusion; Catastrophic Haemorrhage; Endovascular Haemorrhage Control; Exsanguination; Hypovolaemia; NCTH; Non-compressible torso haemorrhage; Pelvic Fracture; Pre-Hospital Care; REBOA; Resuscitative Endovascular Balloon Occlusion of the Aorta; Shock; Trauma; Uncontrolled Haemorrhage; junctional vascular injuries

PMID: 27377669 DOI: [10.1016/j.resuscitation.2016.06.029](https://doi.org/10.1016/j.resuscitation.2016.06.029)

## Initial safety and feasibility of cold-stored uncrossmatched whole blood transfusion in civilian trauma patients.

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### Abstract

**BACKGROUND:** The transfusion of cold-stored uncrossmatched whole blood (WB) has not been extensively used in civilian trauma resuscitation. This report details the initial experience with the safety and feasibility of using WB in this setting after a change of practice at a Level 1 trauma center was instituted.

**METHODS:** Up to two units of uncrossmatched group O positive WB that was leukoreduced using a platelet-sparing filter from male donors were transfused to male trauma patients with hypotension secondary to bleeding. Hemolytic marker haptoglobin and reports of transfusion reactions in these patients were followed. Additionally, transfusion volumes and outcomes were compared to a historical cohort of male trauma patients who received at least one red blood cell (RBC) unit, but not WB, during the first 24 hours of admission.

**RESULTS:** There were 47 WB patients who were transfused with a mean (SD) of 1.74 (0.61) WB units. The median haptoglobin concentration on post-WB transfusion Day 1 was 25.1 (9.3) mg/dL in 7 of 30 non-group O recipients. No adverse reactions in temporal relation to the WB transfusions were reported. There were 145 male historical control patients identified who were resuscitated with component therapy; the median volume of incompatible plasma transfused to the WB versus component therapy group was not significantly different (1,000 vs. 800 mL, respectively;  $p = 0.38$ ); the mean plasma:RBC (0.99 [0.47] vs. 0.77 [0.73], respectively;  $p = 0.006$ ) and platelet:RBC (0.72 [0.40] vs. 0.51 [0.734], respectively;  $p < 0.0001$ ) ratios were significantly higher in the WB group.

**CONCLUSION:** Transfusion of two units of cold-stored uncrossmatched WB is feasible and seems to be safe in civilian trauma resuscitation. Determining the efficacy of WB with regard to reducing the number of blood products transfused in the first 24 hours or improving recipient survival will require a larger randomized trial.

**LEVEL OF EVIDENCE:** Therapeutic study, level IV.

PMID: 27120323 DOI: [10.1097/TA.0000000000001100](#)

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## Analysis of injury patterns and roles of care in US and Israel militaries during recent conflicts: Two are better than one.

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### Abstract

**BACKGROUND:** As new conflicts emerge and enemies evolve, military medical organizations worldwide must adopt the "lessons learned." In this study, we describe roles of care (ROCs) deployed and injuries sustained by both US and Israeli militaries during recent conflicts. The purpose of this collaborative work is facilitate exchange of medical data among allied forces in order to advance military medicine and facilitate strategic readiness for future military engagements that may involve less predictable situations of evacuation and care, such as prolonged field care.

**METHODS:** This retrospective study was conducted for the periods of 2003 to 2014 from data retrieved from the Department of Defense Trauma Registry and the Israel Defense Force (IDF) Trauma Registry. Comparative analyses included ROC capabilities, casualties who died of wounds, as well as mechanism of injury, anatomical wound distribution, and Injury Severity Score of US and IDF casualties during recent conflicts.

**RESULTS:** Although concept of ROCs was similar among militaries, the IDF supports increased capabilities at point of injury and Role 1 including the presence of physicians, but with limited deployment of other ROCs; conversely, the US maintains fewer capabilities at Role 1 but utilized the entire spectrum of care, including extensive deployment of Roles 2/2+, during recent conflicts. Casualties from US forces (n = 19,005) and IDF (n = 2,637) exhibited significant differences in patterns of injury with higher proportions of casualties who died of wounds in the US forces (4%) compared with the IDF (0.6%).

**CONCLUSIONS:** As these data suggest deployed ROCs and injury patterns of US and Israeli militaries were both conflict and system specific. We envision that identification of discordant factors and common medical strategies of the two militaries will enable strategic readiness for future conflicts as well as foster further collaboration among allied forces with the overarching universal goal of eliminating preventable death on the battlefield.

PMID:27602905 DOI:[10.1097/TA.0000000000001252](https://doi.org/10.1097/TA.0000000000001252)

## **Cryopreserved packed red blood cells in surgical patients: past, present, and future.**

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### **Abstract**

Since the advent of anticoagulation and component storage of human blood products, allogeneic red blood cell transfusion has been one of the most common practices in modern medicine. Efforts to reduce the biochemical effects of storage, collectively known as the red blood cell storage lesion, and prolong the storage duration have led to numerous advancements in erythrocyte storage solutions. Cryopreservation and frozen storage of red blood cells in glycerol have been successfully utilised by many civilian and military institutions worldwide. Through progressive improvements in liquid storage of erythrocytes in novel storage solutions, the logistical need for cryopreserved red blood cells in the civilian setting has diminished. A growing body of current literature is focused on the clinical consequences of packed red blood cell age. Modern cryopreservation techniques show promise as a cost-effective method to ameliorate the negative effect of the red blood cell storage lesion, while meeting the technical and logistical needs of both civilian and military medicine. This review outlines the history of red blood cell cryopreservation, the clinical impact of red cell storage, and highlights the current literature on frozen blood and its impact on modern transfusion.

PMID:27643751 DOI:[10.2450/2016.0083-16](#)

## The AAST prospective Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery (AORTA) registry: Data on contemporary utilization and outcomes of aortic occlusion and resuscitative balloon occlusion of the aorta (REBOA).

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### Abstract

**INTRODUCTION:** Aortic occlusion (AO) for resuscitation in traumatic shock remains controversial. Resuscitative endovascular balloon occlusion of the aorta (REBOA) offers an emerging alternative.

**METHODS:** The American Association for the Surgery of Trauma Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery registry prospectively identified trauma patients requiring AO from eight ACS Level 1 centers. Presentation, intervention, and outcome variables were collected and analyzed to compare REBOA and open AO.

**RESULTS:** From November 2013 to February 2015, 114 AO patients were captured (REBOA, 46; open AO, 68); 80.7% were male, and 62.3% were blunt injured. Aortic occlusion occurred in the emergency department (73.7%) or the operating room (26.3%). Hemodynamic improvement after AO was observed in 62.3% [REBOA, 67.4%; open OA, 61.8%]; 36.0% achieving stability (systolic blood pressure consistently >90 mm Hg, >5 minutes); REBOA, 22 of 46 (47.8%); open OA, 19 of 68 (27.9%);  $p = 0.014$ . Resuscitative endovascular balloon occlusion of the aorta (REBOA) access was femoral cut-down (50%); US guided (10.9%) and percutaneous without imaging (28.3%). Deployment was achieved in Zones I (78.6%), II (2.4%), and III (19.0%). A second AO attempt was required in 9.6% [REBOA, 2 of 46 (4.3%); open OA, 9 of 68 (13.2%)]. Complications of REBOA were uncommon (pseudoaneurysm, 2.1%; embolism, 4.3%; limb ischemia, 0%). There was no difference in time to successful AO between REBOA and open procedures (REBOA,  $6.6 \pm 5.6$  minutes; open OA,  $7.2 \pm 15.1$ ;  $p = 0.842$ ). Overall survival was 21.1% (24 of 114), with no significant difference between REBOA and open AO with regard to mortality [REBOA, 28.2% (13 of 46); open OA, 16.1% (11 of 68);  $p = 0.120$ ].

**CONCLUSION:** Resuscitative endovascular balloon occlusion of the aorta has emerged as a viable alternative to open AO in centers that have developed this capability. Further maturation of the American Association for the Surgery of Trauma Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery database is required to better elucidate optimal indications and outcomes.

**LEVEL OF EVIDENCE:** Therapeutic/care management study, level IV.

PMID:27050883 DOI:[10.1097/TA.0000000000001079](https://doi.org/10.1097/TA.0000000000001079)

## Stratification of risk to the surgical team in removal of small arms ammunition implanted in the craniofacial region: case report.

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**Abstract**In cases of penetrating injury with implantation of small arms ammunition, it can often be difficult to tell the difference between simple ballistics and ballistics associated with unexploded ordnances (UXOs). In the operative environment, where highly flammable substances are often close to the surgical site, detonation of UXOs could have catastrophic consequences for both the patient and surgical team. There is a paucity of information in the literature regarding how to evaluate whether an implanted munition contains explosive material. This report describes a patient who presented during Operation Enduring Freedom with an implanted munition suspicious for a UXO and the subsequent workup organized by Explosive Ordnance Disposal (EOD) Company prior to surgical removal. Clinical risk factors for UXOs include assassination attempts and/or wartime settings. Specific radiological features suggestive of a UXO include projectile size greater than 7.62-mm caliber, alterations in density of the tip, as well as radiological evidence of a hollowed-out core. If an implanted UXO is suspected, risks to the surgical and anesthesia teams can be minimized by notifying the nearest military installation with EOD capabilities and following clinical practice guidelines set forth by the Joint Theater Trauma System.

**KEYWORDS:** ACH = advanced combat helmet; CJTH = Craig Joint Theater Hospital; EOD = Explosive Ordnance Disposal; IOTV = improved outer tactical vest; UXO; UXO = unexploded ordnance; implanted projectile; small arms ammunition; traumatic brain injury; unexploded ordnance

PMID: 26832604 DOI:[10.3171/2015.6.JNS15779](#)

## Decompressive craniectomy for severe traumatic brain injury: clinical study, literature review and meta-analysis.

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### **Abstract**

**OBJECTIVE:** To examine the clinical and neurological outcome of patients who sustained a severe non-penetrating traumatic brain injury (TBI) and underwent unilateral decompressive craniectomy (DC) for refractory intracranial hypertension.

**DESIGN:** Single center, retrospective, observational.

**SETTING:** Level I Trauma Center in Portland, Maine.

**PATIENTS:** 31 patients aged 16-72 of either sex who sustained a severe, non-penetrating TBI and underwent a unilateral DC for evacuation of parenchymal or extra-axial hematoma or for failure of medical therapy to control intracranial pressure (ICP).

**INTERVENTIONS:** Review of the electronic medical record of patients undergoing DC for severe TBI and assessment of extended Glasgow Outcome Score (e-GOS) at 6-months following DC.

**MEASUREMENTS AND MAIN RESULTS:** The mean age was  $39.3y \pm 14.5$ . The initial GCS was  $5.8 \pm 3.2$ , and the ISS was  $29.7 \pm 6.3$ . Twenty-two patients underwent DC within the first 24 h, two within the next 24 h and seven between the 3rd and 7th day post injury. The pre-DC ICP was  $30.7 \pm 10.3$  and the ICP was  $12.1 \pm 6.2$  post-DC. Cranioplasty was performed in all surviving patients 1-4 months post-DC. Of the 29 survivors following DC, the e-GOS was 8 in seven patients, and 7 in ten patients. The e-GOS was 5-6 in 6 others. Of the 6 survivors with poor outcomes (e-GOS = 2-4), five were the initial patients in the series.

**CONCLUSIONS:** In patients with intractable cerebral hypertension following TBI, unilateral DC in concert with practice guideline directed brain resuscitation is associated with good functional outcome and acceptable-mortality.

**KEYWORDS:** Cerebral Edema; DECRAN; Decompressive craniectomy; Severe TBI; TBI

## The Operative Burden of General Surgical Disease and Non-Battle Injury in a Deployed Military Treatment Facility in Afghanistan.

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### **Abstract**

**OBJECTIVES:** Contemporary medical operations support a mobile, nonconventional force involved in nation building, counterinsurgency, and humanitarian operations. Prior reports have described surgical care for disease and nonbattle injuries (DNBI). The purpose of this report is to describe the prevalence and scope of DNBI managed by general surgeons in a contemporary, deployed medical facility.

**METHODS:** A 2-year retrospective review of the operative logbook from the U.K. Role 3 Multinational Hospital, Camp Bastion, Afghanistan, was performed to determine the prevalence and makeup of procedures performed for DNBI by general surgeons.

**RESULTS:** Nontrauma general surgical procedures accounted for 7.7% (n = 279 of 3,607 cases) of cases; appendectomy (n = 146) was the most common, followed by drainage of soft tissue (n = 55) and oral abscesses (n = 5), scrotal exploration (n = 12), and hernia repair (n = 7). A total of 7.2% (n = 20 of 279) of cases fell outside the standard scope of practice of an urban, civilian general surgeon.

**CONCLUSION:** Although the prevalence of operative procedures for DNBI was low, the spectrum of cases included those not typically managed in the civilian setting of the United Kingdom. With an evolving decline in case volume performed in multiple anatomic locations due to subspecialization during surgical training, this gap in expertise is likely to increase.

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PMID: 27612354 DOI:[10.7205/MILMED-D-15-00450](#)

## Challenges in war-related thoracic injury faced by French military surgeons in Afghanistan (2009-2013).

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### Abstract

**BACKGROUND:** This study reports the challenges faced by French military surgeons in the management of thoracic injury during the latest Afghanistan war.

**METHODS:** From January 2009 to April 2013, all of the civilian, French and Coalition casualties admitted to French NATO Combat Support Hospital situated on Kabul were prospectively recorded in the French Military Health Service Registry (OPEX(®)). Only penetrating and blunt thoracic trauma patients were retrospectively included.

**RESULTS:** Eighty-nine casualties were included who were mainly civilian (61%) and men (94%) with a mean age of 27.9 years old. Surgeons dealt with polytraumas (78%), severe injuries (mean Injury Severity Score=39.2) and penetrating wounds (96%) due to explosion in 37%, gunshot in 53% and stabbing in 9%. Most of casualties were first observed or drained (n=56). In this non-operative group more than 40% of casualties needed further actions. In the operative group, Damage Control Thoracotomy (n=22) was performed to stop ongoing bleeding and air leakage and Emergency Department Thoracotomy (n=11) for agonal patient. Casualties suffered from hemothorax (60%), pneumothorax (39%), diaphragmatic (37%), lung (35%), heart or great vessels (20%) injuries. The main actions were diaphragmatic sutures (n=25), lung resections (wedge n=6, lobectomy n=4) and haemostasis (intercostal artery ligation n=3, heart injury repairs n=5, great vessels injury repairs n=5). Overall mortality was 11%. The rate of subsequent surgery was 34%.

**CONCLUSIONS:** The analysis of the OPEX(®) registry reflects the thoracic surgical challenges of general (visceral) surgeons serving in combat environment during the latest Afghanistan War. Copyright © 2016 Elsevier Ltd. All rights reserved.

**KEYWORDS:** Database; General surgery; Thoracic injury; Trauma

## Reducing Surgical Site Infection with Negative-Pressure Wound Therapy After Open Abdominal Surgery: A Prospective Randomized Controlled Study.

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### Abstract

**BACKGROUND AND AIMS:** Surgical site infection, in particular superficial incision infection, is a common type of complication following abdominal surgery. Negative-pressure wound therapy has been confirmed to reduce the incidence of surgical site infection in various surgeries, but there are few prospective randomized studies into its application to abdominal surgery.

**MATERIAL AND METHODS:** A prospective randomized controlled study was conducted in which patients with abdominal surgery and open surgery were randomly divided into a negative-pressure wound therapy experimental group and a gauze-covering control group. Information about demographic data, type of surgery, surgical sites, incision treatment outcomes, surgical site infection factors, and follow-up was recorded.

**RESULTS:** From May 2015 to December 2015, 71 patients were enrolled in this study, including 33 in the experimental group and 38 in the control group. There were 10 cases of incision complications, all superficial infections, with an incidence of 14.1%. The surgical site infection incidence was statistically different between the experimental and control groups (3.0% vs 23.7%,  $p = 0.031$ ). Multivariate logistic regression analysis showed that incision length  $\geq 20$  cm increased the surgical site infection incidence (odds ratio value of 15.576,  $p = 0.004$ ) and that the application of negative-pressure wound therapy reduced the surgical site infection incidence (odds ratio value of 0.073,  $p = 0.029$ ).

**CONCLUSION:** Negative-pressure wound therapy can reduce the incidence of surgical site infection in open abdominal surgery. © The Finnish Surgical Society 2016.

### KEYWORDS:

Negative-pressure wound therapy; abdominal wound closure techniques; risk factors; surgical procedures; surgical wound infection; wound healing

## "Limb Salvage With Intrepid Dynamic Exoskeleton Orthosis Versus Transtibial Amputation: A Comparison of Functional Gait Outcomes".

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### Abstract

#### OBJECTIVES:

To determine if there is a difference in functional gait outcomes between patients with limb injuries treated with either transtibial amputation or limb preservation with Intrepid Dynamic Exoskeletal Orthosis (IDEO).

**DESIGN:** Retrospective prognostic study.

**SETTING:** Tertiary referral military hospital.

**PATIENTS:** This study included 10 transtibial amputees and ten limb preservation patients using the IDEO who were matched by body mass index after excluding for non-traumatic, proximal ipsilateral, contralateral, spine or traumatic brain injuries. Transtibial amputation patients were also excluded if they did not have a gait study between 6 and 12 months after independent ambulation and limb preservation were excluded if they did not complete the "Return to Run" program.

**INTERVENTIONS:** An observational study of functional outcomes utilizing instrumented gait analysis.

**OUTCOME MEASURES:** Spatiotemporal, kinetic (vertical ground reaction force), unified deformable (UD) power, work, and efficiency.

**RESULTS:** Limb preservation patients walked with a significantly slower cadence ( $p=0.036$ ) and spent less time on their affected limb in stance ( $p=0.045$ ), and longer in swing ( $p=0.019$ ). Amputees had significantly increased maximum positive power in both limbs ( $p=0.004$  and  $p=0.029$ ) and increased maximum negative power on the unaffected limb ( $p=0.035$ ). Amputees had significantly increased positive and negative work in the affected limb ( $p=0.0009$  and  $p=0.014$ ) and positive work in the unaffected limb ( $p=0.042$ ). There was no significant difference in the kinetic data or efficiency.

**CONCLUSIONS:** Limb preservation patients spend less time on their affected limb as a percentage of the gait cycle. The UD power demonstrated more dynamic gait in amputees, with peak values closer to normative data.

**LEVEL OF EVIDENCE:** Therapeutic Level III. See Instructions for Authors for a complete description of levels of evidence.

PMID:27580318 DOI:[10.1097/BOT.0000000000000688](https://doi.org/10.1097/BOT.0000000000000688)

## Systematic review of the anaesthetic management of non-iatrogenic acute adult airway trauma.

[Mercer SJ](#)<sup>1</sup>, [Jones CP](#)<sup>2</sup>, [Bridge M](#)<sup>2</sup>, [Clitheroe E](#)<sup>2</sup>, [Morton B](#)<sup>3</sup>, [Groom P](#)<sup>2</sup>.

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### Abstract

**INTRODUCTION:** Non-iatrogenic trauma to the airway is rare and presents a significant challenge to the anaesthetist. Although guidelines for the management of the unanticipated difficult airway have been published, these do not make provision for the 'anticipated' difficult airway. This systematic review aims to inform best practice and suggest management options for different injury patterns.

**METHODS:** A literature search was conducted using Embase, Medline, and Google Scholar for papers after the year 2000 reporting on the acute airway management of adult patients who suffered airway trauma. Our protocol and search strategy are registered with and published by PROSPERO (<http://www.crd.york.ac.uk/PROSPERO>, ID: CRD42016032763).

**RESULTS:** A systematic literature search yielded 578 articles, of which a total of 148 full-text papers were reviewed. We present our results categorized by mechanism of injury: blunt, penetrating, blast, and burns.

**CONCLUSIONS:** The hallmark of airway management with trauma to the airway is the maintenance of spontaneous ventilation, intubation under direct vision to avoid the creation of a false passage, and the avoidance of both intermittent positive pressure ventilation and cricoid pressure (the latter for laryngotracheal trauma only) during a rapid sequence induction. Management depends on available resources and time to perform airway assessment, investigations, and intervention (patients will be classified into one of three categories: no time, some time, or adequate time). Human factors, particularly the development of a shared mental model amongst the trauma team, are vital to mitigate risk and improve patient safety. © Crown copyright 2016.

**KEYWORDS:** airway management; blast injuries; blunt injuries; burns; wounds, penetrating

## Dismounted Blast Injuries in Patients Treated at a Role 3 Military Hospital in Afghanistan: Patterns of Injury and Mortality.

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### Abstract

**BACKGROUND:** The purposes of this study are to define the pattern of injuries sustained by dismounted troops exposed to improvised explosive devices blasts treated at a Role 3 combat support hospital and to assess injury patterns and mortality associated with the mechanism. Our hypothesis was that mortality is associated with pelvic fracture, massive transfusion, high Injury Severity Score (ISS), multiple limb amputations, and transfer from a Role 2 facility.

**STUDY DESIGN:** Retrospective study of 457 patients. Analysis performed on trauma registry data and systematic review of radiographs.

**RESULTS:** 99.9% were men with a median age of 23 years and median ISS 10. 141 patients (30.9%) required massive blood transfusion. Limb amputations were frequently observed injuries, 109 of 172 amputees (63.4%) had a double amputation. 34 subjects (7.4%) had pelvic fractures; majority of pelvic fractures (88%) were unstable (Tile B or C). Risk factors associated with the overall mortality rate of 1.8% were an ISS greater than 15 (odds ratio: 11.5; 95% confidence interval: 1.38, 533;  $p = 0.009$ ), need for massive transfusion ( $p < 0.0001$ ), and the presence of a pelvic fracture (odds ratio: 7.63; 95% confidence interval: 1.13, 41.3;  $p = 0.018$ ).

**CONCLUSIONS:** Dismounted improvised explosive devices blast injuries result in devastating multiple limb amputations and unstable pelvic fractures, which are associated with mortality after initial trauma resuscitation at a Role 3 hospital.

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PMID: 27612355 DOI: [10.7205/MILMED-D-15-00264](#)

## Comparison of Penetrating Neck Injury Management in Combat Versus Civilian Trauma: A Review of 55 Cases.

[de Régloix SB](#)<sup>1</sup>, [Baumont L](#)<sup>1</sup>, [Daniel Y](#)<sup>2</sup>, [Maurin O](#)<sup>3</sup>, [Crambert A](#)<sup>1</sup>, [Pons Y](#)<sup>1</sup>.

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**Abstract** The objective was to describe a case series of penetrating neck injuries (PNIs) and compare their management in combat versus civilian trauma.

**METHODS:** From 2012 to 2014, all soldiers and civilians referred to Percy Military Training Hospital for PNI were analyzed. The mechanism of injury, type and site of the lesion, and initial emergency management were noted.

**RESULTS:** Among the 55 patients, 26 were wounded in action, and 29 were civilians. PNIs were commonly stab wounds resulting from an assault. Anatomical zone II, as well as the central neck compartment, was the most affected area. The most affected organ was the larynx. 74% of patients underwent computed tomography angiography (CTA), surgical exploration was performed for 42% of patients, and 33% of patients required intensive care unit monitoring. The differences between the two groups in terms of management were not statistically significant.

**CONCLUSIONS:** The current management is based on clinical examination and CTA and is similar between soldiers and civilians. Surgical exploration is less commonly used than CTA, which is a fast and accurate method to evaluate PNI for stable patients. The classification by compartment seems more relevant than the classification by anatomical zone, particularly in absence of medical imaging.

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PMID:27483537 DOI:[10.7205/MILMED-D-15-00434](#)

## **Burnout in U.S. Military Orthopaedic Residents and Staff Physicians.**

[Simons BS](#)<sup>1</sup>, [Foltz PA](#)<sup>1</sup>, [Chalupa RL](#)<sup>1</sup>, [Hylden CM](#)<sup>1</sup>, [Dowd TC](#)<sup>1</sup>, [Johnson AE](#)<sup>1</sup>.

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### **Abstract**

**OBJECTIVE:** The purpose of this study was to measure the prevalence of burnout among military orthopaedic residents and staff surgeons at the U.S. Army Medical Center.

**METHODS:** 37 residents and 21 staff surgeons of a military orthopaedic residency program were asked to voluntarily complete an anonymous electronic survey. The survey consisted of two parts: first, a demographic section including questions about relationship status, work hours, deployment history, medical education debt, mentorship, and job satisfaction and second, the Maslach Burnout Inventory.

**RESULTS:** 27 residents and 11 staff completed the survey for a 67% response rate. The rate of burnout among military orthopaedic surgeons in our study was 7.7% (3.7% of residents and 16.7% of staff surgeons). In addition, 25.6% of surgeons (33% of residents and 8.3% of staff) were found to be at risk of burnout.

**CONCLUSIONS:** Future studies should focus on causal relationships among specific aspects of the work environment and possible preventive or protective measures. Expanding future studies to include multiple study sites would improve the quality and generalizability of the results. Reprint & Copyright © 2016 Association of Military Surgeons of the U.S.

PMID: 27483521 DOI:[10.7205/MILMED-D-15-00325](#)

## Immersion team training in a realistic environment improves team performance in trauma resuscitation.

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### Abstract

**BACKGROUND:** In the US military, it is common for health care teams to be formed ad hoc and expected to function cohesively as a unit. Poor team dynamics decreases the effectiveness of trauma care delivery. The US Navy Fleet Surgical Team Three has developed a simulation-based trauma initiative-the Shipboard Surgical Trauma Training (S2T2) Course-that emphasizes team dynamics to improve the delivery of trauma care to the severely injured patient.

**METHODS:** The S2T2 Course combines classroom didactics with hands-on simulation over a period of 6 days, culminating in a daylong, mass casualty scenario. Each resuscitation team was initially evaluated with a simulated trauma resuscitation scenario then retested on the same scenario after completing the course. A written exam was also administered individually both before and after the course. A survey was administered to assess the participants' perceived effectiveness of the course on overall team training.

**RESULTS:** From the evaluation of 20 resuscitation teams made up of 123 medical personnel, there was a decrease in the mean time needed to perform the simulated trauma resuscitation, from a mean of 24.4 minutes to 13.5 minutes ( $P < .01$ ), a decrease in the mean number of critical events missed, from 5.15 to 1.00 ( $P < .01$ ), and a mean improvement of 41% in written test scores. More than 90% of participants rated the course as highly effective for improving team dynamics.

**CONCLUSION:** A team-based trauma course with immersion in a realistic environment is an effective tool for improving team performance in trauma training. This approach has high potential to improve trauma care and patient outcomes. The benefits of this team-based course can be adapted to the civilian rural sector, where gaps have been identified in trauma care. Published by Elsevier Inc.

PMID: 27233635 DOI: [10.1016/j.surg.2016.03.029](#)

## Single centre experience of combat-related vascular injury in victims of Syrian conflict: Retrospective evaluation of risk factors associated with amputation.

[Şişli E](#)<sup>1</sup>, [Kavala AA](#)<sup>2</sup>, [Mavi M](#)<sup>3</sup>, [Sariosmanoğlu ON](#)<sup>4</sup>, [Oto Ö](#)<sup>4</sup>.

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### Abstract

**OBJECTIVE:** To elucidate the risk factors associated with amputation in cases with combat-related vascular injury (CRVI).

**MATERIAL AND METHODS:** This retrospective study included 90 cases with CRVI treated between May 2011 and July 2013. The patients were divided into group I (n=69), in which the limb was salvaged and group II (n=21), in which the patients received amputation.

**RESULTS:** The overall and the secondary amputation rates were 23% and 18%, respectively. There were no amputations with the MESS of nine or less, increasing proportions of amputations at 10 and 11, with a level of 12 leading to 100% amputation rate. The mortality rate was 2%. Among the 52 (58%) cases with the mangled extremity severity score (MESS)  $\geq 7$ , the limb salvage rate was 60%. The patients in group II were more likely to have a combined artery and vein injury ( $p=0.042$ ). They were also more likely to be injured as a result of an explosion ( $p=0.004$ ). Along with the MESS ( $p<0.001$ ), the duration of ischemia (DoI) ( $p<0.001$ ) were higher in group II. The rate of bony fracture ( $p<0.001$ ) and wound infection ( $p=0.011$ ) were higher in group II. For the overall amputation, the odds ratio of the bony fracture (OR: 61.39,  $p=0.011$ ), nerve injury (OR: 136.23,  $p=0.004$ ), DoI (OR: 2.03,  $p=0.003$ ), vascular ligation (OR: 8.65,  $p=0.040$ ) and explosive device injury (OR: 10.8,  $p=0.041$ ) were significant. Although the DoI ( $p<0.001$ ) and the MESS ( $p=0.004$ ) were higher in whom a temporary vascular shunt (TVS) was applied, the utilisation of a TVS did not influence the amputation rate ( $p=1.0$ ).

**CONCLUSIONS:** The DoI and the variables indicating the extent of tissue disruption were the major determinants of amputation. While statistically non-significant, the benefit of the application of a TVS is non-negligible. MESS is a valid scoring system but should not be the sole foundation for deciding on amputation. Extremities which were doomed to amputation with the MESS $>7$  seem to benefit from revascularisation with initiation of reperfusion at once. The validity of MESS merits further investigation with regard to the determination of a new cut-off value under ever developing medical management strategies. Copyright © 2016 Elsevier Ltd. All rights reserved.

**KEYWORDS:** Amputation; Military medicine; Temporary vascular shunt; Vascular surgical procedures; Vascular system injury

PMID: 27060019 DOI:[10.1016/j.injury.2016.03.030](#)

[Shock](#). 2016 Sep 19. [Epub ahead of print]

## **Tranexamic Acid Attenuates the Loss of Lung Barrier Function in a Rat Model of Polytrauma and Hemorrhage with Resuscitation.**

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### **Abstract**

**INTRODUCTION:** Severe trauma, hemorrhage and resuscitation can lead to a trauma related acute lung injury that involves rapid infiltration of immune cells and platelets. This infiltration involves exymatic degradation of matrix proteins, including plasmin, and causes loss of barrier function. Since tranexamic acid (TXA) inhibits plasminogen/ plasmin binding to target substrates, it may attenuate loss of barrier function after severe trauma, hemorrhage and resuscitation.

**METHODS:** Sprague-Dawley rats were subjected to polytrauma (laparotomy, and trauma to intestines, liver, right leg skeletal muscle and right femur fracture), then bled 40% of their blood volume. One hour after completion of polytrauma and hemorrhage, resuscitation was begun with fresh whole blood (FWB) or FWB with prior bolus administration of TXA (10mg/kg in 0.2ml).

**RESULTS:** Polytrauma, hemorrhage and resuscitation with FWB led to an elevation in lung water content that was significantly reduced with TXA administration. Polytrauma and hemorrhage led to rise in the number of neutrophils/monocytes and platelets in the lungs, and a rise in myeloperoxidase (MPO), neutrophil elastase and complement C5a content. While resuscitation with FWB significantly reduced the cellular infiltrate and MPO, FWB/TXA further reduced the levels of neutrophil/ monocytes, neutrophil elastase, and complement C5a. Polytrauma and hemorrhage led to rise in lung plasmin activity that was significantly reduced with either FWB or FWB/TXA resuscitation.

**CONCLUSION:** Severe trauma and hemorrhage leads to increases in lung water content, and immune cell, platelets, MPO, elastase and C5a content in lung tissue, all markers of inflammation and acute lung injury. The addition of TXA to FWB resuscitation markedly attenuated the rise in these parameters suggesting its utility in treating acute lung injury.

PMID:27648695 DOI:[10.1097/SHK.0000000000000758](https://doi.org/10.1097/SHK.0000000000000758)

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[J R Army Med Corps](#). 2016 Oct;162(5):321-323. doi: 10.1136/jramc-2015-000574. Epub 2016 Jan 14.

## **Ethics surrounding the medical evacuation of catastrophically injured individuals from an operational theatre of war.**

[Bennett RA](#).

### **Abstract**

Although prolonging life is usually in the best interests of patients, the British Medical Association states that it is not appropriate to prolong life with no regard to its quality. Medical advances both on the battlefield and within the field hospitals have resulted in the unexpected survival of a number of British personnel, and in some cases, soldiers are being repatriated with injuries categorised as 'catastrophic'. This paper considers medical ethics based on the Beauchamp and Childress Four Principles framework with regard to whether catastrophically injured individuals should be repatriated without any prior advanced directive and without evaluation of future quality of life. Published by the BMJ Publishing Group Limited. For permission to use (where not already granted under a licence) please go to <http://www.bmj.com/company/products-services/rights-and-licensing/>

**KEYWORDS:** ETHICS (see Medical Ethics); MEDICAL ETHICS; TRAUMA MANAGEMENT

PMID:26767596 DOI: [10.1136/jramc-2015-000574](https://doi.org/10.1136/jramc-2015-000574)

[J Orthop Trauma](#). 2016 Oct;30 Suppl 3:S11-S15.

## **Lower Extremity Limb Salvage: Lessons Learned From 14 Years at War.**

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### **Abstract**

American survivability during the current conflicts in Iraq and Afghanistan continues to improve, though the rate of extremity injury remains quite high. The decision to proceed with amputation versus limb salvage remains controversial. Exposure to combat wound with severe high-energy lower extremity trauma during the previous 14 years at war has incited important advances in limb salvage technique and rehabilitation.

PMID:27661420 DOI:[10.1097/BOT.0000000000000669](https://doi.org/10.1097/BOT.0000000000000669)

## **Dismounted Complex Blast Injuries: A Comprehensive Review of the Modern Combat Experience.**

[Cannon JW](#)<sup>1</sup>, [Hofmann LJ](#)<sup>2</sup>, [Glasgow SC](#)<sup>3</sup>, [Potter BK](#)<sup>4</sup>, [Rodriguez CJ](#)<sup>5</sup>, [Cancio LC](#)<sup>6</sup>, [Rasmussen TE](#)<sup>7</sup>, [Fries CA](#)<sup>6</sup>, [Davis MR](#)<sup>8</sup>, [Jeziar JR](#)<sup>9</sup>, [Mullins RJ](#)<sup>10</sup>, [Elster EA](#)<sup>5</sup>.

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- PMID:27481095 DOI: [10.1016/j.jamcollsurg.2016.07.009](https://doi.org/10.1016/j.jamcollsurg.2016.07.009)

## **Debridement and Irrigation: Evolution and Current Recommendations.**

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### **Abstract**

Debridement is an integral step in the orthopaedic management of traumatic wounds, from open soft tissue injuries and routine open fracture care to the management of extensive high-energy blast injuries. While the necessity of debridement has been well established, the level of energy and degree of contamination of blast wounds encountered in recent armed conflict has offered a challenge and a new opportunity for military surgeons to revisit the most recent literature to guide our practice with the best evidence currently available. While the core tenants of removing the nonviable tissue and preserving the viable to maintain the best functional outcome have not changed, new wound care therapies and advances in prosthetics and salvage techniques and the ability to rapidly evacuate casualties have changed the approach to care provided on the front lines. This paper seeks to review the core principles of debridement and guide treatment using evidence-based methods that can be applied to contaminated open injuries on the battlefield and disaster and intentional violence injuries abroad and at home.

PMID:27661426 DOI:[10.1097/BOT.0000000000000671](https://doi.org/10.1097/BOT.0000000000000671)

## **Obstetric complications on deployed operations: a guide for the military surgeon.**

[Faulconer ER](#)<sup>1</sup>, [Irani S](#)<sup>2</sup>, [Dufty N](#)<sup>3</sup>, [Bowley D](#)<sup>3</sup>.

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### **Abstract**

Modern military general surgeons tend to train and then practice in 'conventional' surgical specialties in their home nation; however, the reality of deployed surgical practice, either in a combat zone or on a humanitarian mission, is that they are likely to have to manage patients with a broad range of ages, conditions and pathologies. Obstetric complications of war injury include injury to the uterus and fetus as well as the mother and both placental abruption and uterine rupture are complications that military surgeons may have little experience of recognising and managing. On humanitarian deployments, fetomaternal complications are a common reason for surgical intervention. We report a recent patient's story to highlight the obstetric training needs of military surgeons.

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**KEYWORDS:** OBSTETRICS; TRAUMA MANAGEMENT

PMID: 26530216 DOI:[10.1136/jramc-2015-000426](https://doi.org/10.1136/jramc-2015-000426)

## Died of wounds: a mortality review.

[Keene DD](#)<sup>1</sup>, [Penn-Barwell JG](#)<sup>2</sup>, [Wood PR](#)<sup>3</sup>, [Hunt N](#)<sup>4</sup>, [Delaney R](#)<sup>5</sup>, [Clasper J](#)<sup>6</sup>, [Russell RJ](#)<sup>7</sup>, [Mahoney PF](#)<sup>8</sup>.

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### Abstract

**OBJECTIVES:** Combat casualty care is a complex system involving multiple clinicians, medical interventions and casualty transfers. Improving the performance of this system requires examination of potential weaknesses. This study reviewed the cause and timing of death of casualties deemed to have died from their injuries after arriving at a medical treatment facility during the recent conflicts in Iraq and Afghanistan, in order to identify potential areas for improving outcomes.

**METHODS:** This was a retrospective review of all casualties who reached medical treatment facilities alive, but subsequently died from injuries sustained during combat operations in Afghanistan and Iraq. It included all deaths from start to completion of combat operations. The UK military joint theatre trauma registry was used to identify cases, and further data were collected from clinical notes, postmortem records and coroner's reports.

**RESULTS:** There were 71 combat-related fatalities who survived to a medical treatment facility; 17 (24%) in Iraq and 54 (76%) in Afghanistan. Thirty eight (54%) died within the first 24 h. Thirty-three (47%) casualties died from isolated head injuries, a further 13 (18%) had unsurvivable head injuries but not in isolation. Haemorrhage following severe lower limb trauma, often in conjunction with abdominal and pelvic injuries, was the cause of a further 15 (21%) deaths.

**CONCLUSIONS:** Severe head injury was the most common cause of death. Irrespective of available medical treatment, none of this group had salvageable injuries. Future emphasis should be placed in preventative strategies to protect the head against battlefield trauma. Published by the BMJ Publishing Group Limited. For permission to use (where not already granted under a licence) please go to <http://www.bmj.com/company/products-services/rights-and-licensing/>

**KEYWORDS:** Afghan Campaign 2001; Cause of Death; Iraq War 2003-2011; United Kingdom; military

PMID:26468431 DOI: [10.1136/jramc-2015-000490](https://doi.org/10.1136/jramc-2015-000490)

## Role of Pre-Morbid Factors and Exposure to Blast Mild Traumatic Brain Injury on Post-Traumatic Stress in United States Military Personnel.

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### **Abstract**

Mild traumatic brain injury (mTBI), the signature injury of the recent wars in Afghanistan and Iraq, is a prevalent and potentially debilitating condition that is associated with symptoms of post-traumatic stress/post-traumatic stress disorder (PTS/PTSD). Prior mTBI, severity and type of injury (blast vs. non-blast), and baseline psychiatric illness are thought to impact mTBI outcomes. It is unclear if the severity of pre-morbid PTS/PTSD is a risk factor of post-injury levels of PTS and mTBI symptoms. The objective of the study was to examine predictors of post-injury PTS/PTSD, including pre-morbid PTS symptoms, and physical and cognitive symptoms in the sub-acute phase (1 week-3 months) following an acute mTBI. A retrospective review of medical records was performed of 276 servicemen assigned to the United States Army Special Operations Command referred for mTBI evaluation between December 2009 and March 2011. Post-Concussion Symptom Scale and PTSD Checklist scores were captured pre- and post-injury. A total of 276 records were reviewed. Pre-morbid and post-injury data were available for 91% (251/276). Of the 54% (136/251) of personnel with mTBI, 29% (39/136) had positive radiology findings and 11% (15/136) met criteria for clinical PTS symptoms at baseline. Logistic regression analysis found baseline PTS symptoms predicted personnel who met clinical levels of PTSD. Receiver operating characteristic curve analysis revealed that baseline PTS ( $p = 0.001$ ), baseline mTBI symptoms ( $p = 0.001$ ), and positive radiology (magnetic resonance imaging or computed tomography) findings for complicated mTBI ( $p = 0.02$ ) accurately identified personnel with clinical levels of PTSD following mTBI. Years of military service, combat deployment status, age, and injury mechanism (blast vs. non-blast) were not associated with increased risk of PTS following mTBI. Pre-morbid PTS symptoms are associated with an increased risk for clinical levels of PTS following a subsequent mTBI. Symptom severity and positive radiologic findings may amplify this risk. At-risk personnel may benefit from early identification and intervention.

**KEYWORDS:** PTSD; blast; concussion; mTBI

PMID: 27027526 DOI:[10.1089/neu.2015.4245](https://doi.org/10.1089/neu.2015.4245)

# British Military surgical key performance indicators: time for an update?

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## **Abstract**

**BACKGROUND:** Key performance indicators (KPIs) are metrics that compare actual care against an ideal structure, process or outcome standard. KPIs designed to assess performance in deployed military surgical facilities have previously been published. This study aimed to review the overall performance of surgical trauma care for casualties treated at Role 3 Camp Bastion, Medical Treatment Facility, Afghanistan, in light of the existing Defence Medical Services (DMS) KPIs. The secondary aims were to assess the utility of the surgical KPIs and make recommendations for future surgical trauma care review.

**METHODS:** Data on 22 surgical parameters were prospectively collected for 150 injured patients who had primary surgery at Camp Bastion between 1 May 2013 and 20 August 2013. Additional information for these patients was obtained using the Joint Theatre Trauma Register. The authors assessed data recording, applicability and compliance with the KPIs.

**RESULTS:** Median data recording was 100% (IQR 98%-100%), median applicability was 56% (IQR 10%-99%) and median compliance was 78% (IQR 58%-93%). One KPI was not applicable to any patient in our population. Eleven KPIs achieved >80% compliance, five KPIs had 80%-60% compliance and five KPIs had <60% compliance. Recommendations are made for minor modifications to the current KPIs.

**CONCLUSION:** 78% compliance with the DMS KPIs provides a snapshot of the performance of the surgical aspect of military trauma care in 2013. The KPIs highlight areas for improvement in service delivery. Individual KPI development should be driven by evidence and reflect advances in practice and knowledge. A method of stakeholder consultation, and sequential refinement following evidence review, may be the right process to develop the future set of DMS KPIs.

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**KEYWORDS:** AUDIT; SURGERY; TRAUMA MANAGEMENT

PMID: 26578479 DOI: [10.1136/jramc-2015-000521](https://doi.org/10.1136/jramc-2015-000521)

# Microbiology and risk factors associated with war-related wound infections in the Middle East.

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## **Abstract**

The Middle East region is plagued with repeated armed conflicts that affect both civilians and soldiers. Injuries sustained during war are common and frequently associated with multiple life-threatening complications. Wound infections are major consequences of these war injuries. The microbiology of war-related wound infections is variable with predominance of Gram-negative bacteria in later stages. The emergence of antimicrobial resistance among isolates affecting war-related wound injuries is a serious problem with major regional and global implications. Factors responsible for the increase in multidrug-resistant pathogens include timing and type of surgical management, wide use of antimicrobial drugs, and the presence of metallic or organic fragments in the wound. Nosocomial transmission is the most important factor in the spread of multidrug-resistant pathogens. Wound management of war-related injuries merits a multidisciplinary approach. This review aims to describe the microbiology of war-related wound infections and factors affecting their incidence from conflict areas in Iraq, Syria, Israel, and Lebanon.

**KEYWORDS:** Middle East; microbiology; multidrug resistance; wound

PMID: 26931769 DOI: [10.1017/S0950268816000431](https://doi.org/10.1017/S0950268816000431)

## Management and reconstruction of blast wounds of the head and neck.

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### **Abstract**

**PURPOSE OF REVIEW:** The purpose of this review is to highlight recent literature related to the initial management and reconstruction of blast injuries to the head and neck.

**RECENT FINDINGS:** An increasing percentage of combat-related injuries are caused by blast trauma. Management of blast trauma over the last 10 years has improved understanding of the unique nature of these injuries and the importance of thoughtful management and reconstruction. Blast trauma is associated with an increased need for definitive airway management. As a result, initial triage principles of airway management and hemorrhage control are extremely important in the acute setting. Blast trauma results in high-velocity injuries that can lead to extensive soft tissue damage, which has important implications for reconstruction. Staging reconstruction is an important consideration for more extensive injuries.

**SUMMARY:** Experience on the battlefield with blast injuries over the last decade has led to efficient triage with focus on hemorrhage and airway control. The lessons learned in Iraq and Afghanistan with the unique physiology of blast trauma have improved the casualty care of service members and can be used both in future military conflicts and in civilian trauma care.

PMID:27366860 DOI:[10.1097/MOO.0000000000000285](#)

## What Is New in Trauma-Related Amputations.

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### **Abstract**

Traumatic and trauma-related amputations represent unfortunate sequelae of severe injury, but should not be viewed as a treatment failure and may represent the best reconstructive option for some patients. Lessons from recent military conflicts have guided the evolution of modern surgical techniques and rehabilitation management of this challenging patient population, and treatment at a specialty center may improve patient outcomes. Despite appropriate management, however, surgical complications remain common and revision surgery is often necessary. Bridge synostosis procedures remain controversial, and clinical equipoise remains regarding their functional benefits. Based on European experience over the last 3 decades, osseointegration has evolved into a viable clinical alternative for patients unable to achieve acceptable function using conventional sockets, and several devices are being developed or tested in the United States. Targeted muscle reinnervation and advanced pattern recognition may dramatically improve the functional potential of many upper extremity amputees, and the procedure may also relieve neuroma-related pain. Furthermore, exciting new research may eventually facilitate haptic feedback and restore useful sensation for amputees. Natural disasters and global terrorism events, in addition to conventional trauma resulting in limb loss, make a working knowledge of current amputation surgical techniques essential to the practicing orthopaedic trauma surgeon.

PMID:27661421 DOI:[10.1097/BOT.0000000000000668](https://doi.org/10.1097/BOT.0000000000000668)

## Infection After Orthopaedic Trauma: Prevention and Treatment.

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### **Abstract**

Trauma to the extremities is disproportionately represented in casualties of recent conflicts, accounting for >50% of injuries sustained during operations in Iraq and Afghanistan. Infectious complications have been reported in >25% of those evacuated for trauma, and 50% of such patients were treated in the intensive care unit (ICU). Osteomyelitis has been reported in 9% (14% of intensive care unit patients), and deep-wound infection in 27% of type III open-tibia fractures. Infections complicating extremity trauma are frequently caused by multidrug-resistant bacteria and have been demonstrated to lead to failure of limb salvage, unplanned operative take-backs, late amputations, and decreased likelihood of returning to duty. Invasive fungal infections of extremities have also presented a unique challenge in combat-injured patients, particularly in those with blast injuries with massive transfusion requirements and high injury severity scores. Infection prevention should begin at the time of injury and, although context-specific depending on the level of care, includes appropriate irrigation, surgical debridement, wound care and coverage, fracture fixation, and antibiotic prophylaxis, in addition to basic infection prevention measures. Clinical practice guidelines to address infection prevention after combat trauma (including extremity infection) were developed in 2007 and revised in 2011, with endorsement from the Surgical Infection Society and the Infectious Disease Society of America. Nevertheless, significant challenges remain, including austere environments of care, multiple transitions of care, and lack of coordinated efforts in prevention. Treatment of established infections is optimally multidisciplinary, particularly when deep wounds, bone, and joints are involved. Surgical debridement of overtly infected or necrotic tissue is necessary, with particularly aggressive margins if invasive fungal infection is suspected. Infected nonunion frequently requires the use of prosthetic materials for fixation, potentiating biofilm formation, and complicating medical therapy. Antibiotic therapy should be targeted at results of deep wound and bone cultures. However, this is complicated by frequent contamination of wounds, requiring differentiation between potential pathogens in terms of their virulence and decreased culture recovery in patient who have frequently received previous antibiotics. Lessons learned in infection prevention and treatment of orthopaedic trauma from combat can serve to inform the care of patients injured in natural disasters and noncombat trauma.

PMID:27661423 DOI:[10.1097/BOT.0000000000000667](https://doi.org/10.1097/BOT.0000000000000667)