# Committee on Surgical Combat Casualty Care (CoSCCC)


# Journal Watch

# 3rd Quarter

# FY 2021

## Journal Watch Key Terminology Searched:

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

Mil Med
2021 May 3;186 (5-6):e474-e479.
doi: 10.1093/milmed/usaa370.

# An Analysis of Airway Interventions in the Setting of Smoke Inhalation Injury on the Battlefield

Steven G Schauer[1,2,3,4], Jason F Naylor[5], Gregory Dion[1,2,3,4], Michael D April[6,7], Kevin K Chung[4], Victor A Convertino[1]

## Abstract

**Introduction:** The Committee on Tactical Combat Casualty Care and Capabilities Development and Integration Directorate cite airway burn injuries as an indication for prehospital cricothyrotomy. We sought to build on previously published data by describing for the first time the incidence of prehospital airway interventions in combat casualties who received airway management in the setting of inhalational injuries.15,26 We hypothesized that (1) airway interventions in combat casualties who suffered inhalational injury would have a higher mortality rate than those without airway intervention and (2) prehospital cricothyrotomy was used with greater incidence than endotracheal intubation.

**Materials and methods:** Using a previously described Department of Defense Trauma Registry dataset from January 2007 to August 2016, unique casualties with documented inhalational injury were identified.

**Results:** Our predefined search codes captured 28,222 (72.8% of all encounters in the registry) of those subjects. A total of 347 (1.2%) casualties had a documented inhalational injury, 27 (7.8%) of those with at least 1 prehospital airway intervention inhalational injuries (0.09% of our dataset [n = 28,222]). Within the subset of patients with an inhalation injury, 23 underwent intubation, 2 underwent cricothyrotomy, 3 had placement of an airway adjunct not otherwise specifically listed, and 1 casualty had both a cricothyrotomy and intubation documented. No casualties had a supraglottic, nasopharyngeal, or oropharyngeal airway listed. Contrary to our hypotheses, of those with an airway intervention, 74.0% survived to hospital discharge. In multivariable regression models, when adjusting for confounders, there was no difference in survival to discharge in those with an airway intervention compared to those without.

**Conclusions:** Casualties undergoing airway intervention for inhalation injuries had similar survival adjusting for injury severity, supporting its role when indicated. Without case-specific data on airway status and interventions, it is challenging to determine if the low rate of cricothyrotomy in this population was a result of rapid transport to a more advanced provider capable of performing intubation or cricothyrotomy may not be meeting the needs of the medics.

Mil Med
2021 Apr 7;usab117.
doi: 10.1093/milmed/usab117. Online ahead of print.

# Ketamine Use in Operation Enduring Freedom

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## Abstract

**Introduction:** Ketamine is a dissociative anesthetic increasingly used in the prehospital and battlefield environment. As an analgesic, it has been shown to have comparable effects to opioids. In 2012, the Defense Health Board advised the Joint Trauma System to update the Tactical Combat Casualty Care Guidelines to include ketamine as an acceptable first line agent for pain control on the battlefield. The goal of this study was to investigate trends in the use of ketamine during Operation Enduring Freedom (OEF) and Operation Freedom's Sentinel (OFS) during the years 2011-2016.

**Materials and methods:** A retrospective review of Department of Defense Trauma Registry (DoDTR) data was performed for all patients receiving ketamine during OEF/OFS in 2011-2016. Prevalence of ketamine use, absolute use, mechanism of injury, demographics, injury severity score, provider type, and co-administration rates of various medications and blood products were evaluated.

**Results:** Total number of administrations during the study period was 866. Ketamine administration during OEF/OFS increased during the years 2011-2013 (28 patient administrations in 2011, 264 administrations in 2012, and 389 administrations in 2013). A decline in absolute use was noted from 2014 to 2016 (98 administrations in 2014, 41 administrations in 2015, and 46 administrations in 2016). The frequency of battlefield ketamine use increased from 0.4% to 11.3% for combat injuries sustained in OEF/OFS from 2011 to 2016. Explosives (51%) and penetrating trauma (39%) were the most common pattern of injury in which ketamine was administered. Ketamine was co-administered with fentanyl (34.4%), morphine (26.2%), midazolam (23.1%), tranexamic acid (12.3%), plasma (10.3%), and packed red blood cells (18.5%).

**Conclusions:** This study demonstrates increasing use of ketamine by the U.S. Military on the battlefield and effectiveness of clinical practice guidelines in influencing practice patterns.

Mil Med
2021 May 3;usab143.
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# A Focus on Non-Amputation Combat Extremity Injury: 2001-2018

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## Abstract

**Introduction:** Extremity injuries have comprised the majority of battlefield injuries in modern U.S. conflicts since World War II. Most reports have focused on serious injuries only and, to date, no reports have described the full extent of combat extremity injuries, from mild to severe, resulting from post-9/11 conflicts. This study aims to identify and characterize the full spectrum of non-amputation combat-related extremity injury and extend the findings of previous reports.

**Methods:** The Expeditionary Medical Encounter Database was queried for all extremity injured service members (SMs) deployed in support of post-9/11 conflicts through July 2018. Only injuries incurred during combat operations were included in this report. Major amputations were excluded as well as SMs killed in action or who died of wounds. Extremity injuries were categorized by body region, nature of injury, and severity. Demographics and injury event characteristics are also presented.

**Results:** A total of 17,629 SMs sustained 42,740 extremity injuries during 18,004 separate injury events. The highest number of SMs were injured in 2004 (n = 3,553), 2007 (n = 2,244), and 2011 (n = 2,023). Injured SMs were mostly young (78% under 30 years), male (97%), junior- to mid-level enlisted (89%), in the Army (69%) or Marine Corps (28%), active duty (84%), serving as infantry and gun crew (59%), and injured in support of Operation Iraqi Freedom (60%). Blast weaponry was responsible for 75% of extremity injuries. Injuries were similarly distributed between the lower (52%) and upper (48%) extremities. The most common sites of lower extremity injury were the lower leg/ankle complex (40%) and thigh (26%). The most common upper extremities sites were the shoulder and upper arms (37%), and the hand, wrist, and fingers (33%). Nearly half (48%) of all extremity injuries were open wounds (48%), followed by fractures (20%) and contusions/superficial injuries (16%). SMs sustained an average of 2.4 extremity injuries per event and 56% of injuries were considered mild, with a median Injury Severity Score (ISS) of 3.

**Conclusion:** This study is the first publication to capture, review, and characterize the full range, from mild to severe, of non-amputation combat-related extremity injuries resulting from post-9/11 conflicts. The high prevalence of extremity injury, particularly in such a young population, and associated short- and long-term health outcomes, will impact military health care systems for decades to come.

Prehosp Emerg Care
2021 Apr 16;1-15.
doi: 10.1080/10903127.2021.1907491. Online ahead of print.

# An Analysis of 13 Years of Prehospital Combat Casualty Care: Implications for Maintaining a Ready Medical Force

Steven G Schauer[1], Jason F Naylor[1], Andrew D Fisher[1], Michael D April[1], Ronnie Hill[1], Kennedy Mdaki[1], Tyson E Becker[1], Vikhyat S Bebarta[1], James Bynum[1]

## Abstract

**Background:** Most potentially preventable deaths occur in the prehospital setting before reaching a military treatment facility with surgical capabilities. Thus, optimizing the care we deliver in the prehospital combat setting represents a ripe target for reducing mortality. We sought to analyze prehospital data within the Department of Defense Trauma Registry (DODTR). **Materials and methods:** We requested all encounters with any prehospital activity (e.g., interventions, transportation, vital signs) documented within the DODTR from January 2007 to March 2020 along with all hospital-based data that was available. We excluded from our search casualties that had no prehospital activity documented. **Results:** There were 28,950 encounters that met inclusion criteria. Of these, 25,897 (89.5%) were adults and 3053 were children (10.5%). There was a steady decline in the number of casualties encountered with the most notable decline occurring in 2014. U.S. military casualties comprised the largest proportion (n = 10,182) of subjects followed by host nation civilians (n = 9637). The median age was 24 years (interquartile range/IQR 21-29). Most were battle injuries (78.6%) and part of Operation ENDURING FREEDOM (61.8%) and Operation IRAQI FREEDOM (24.4%). Most sustained injuries from explosives (52.1%) followed by firearms (28.1%), with serious injury to the extremities (24.9%) occurring most frequently. The median injury severity score was 9 (IQR 4-16) with most surviving to discharge (95.0%). A minority had a documented medic or combat lifesaver (27.9%) in their chain of care, nor did they pass through an aid station (3.0%). Air evacuation predominated (77.9%). **Conclusions:** Within our dataset, the deployed U.S. military medical system provided prehospital medical care to at least 28,950 combat casualties consisting mostly of U.S. military personnel and host nation civilian care. There was a rapid decline in combat casualty volumes since 2014, however, on a per-encounter basis there was no apparent drop in procedural volume.

Am J Emerg Med
2021 Jun;44:423-427.
doi: 10.1016/j.ajem.2020.05.012. Epub 2020 May 11.

# Vital sign thresholds predictive of death in the combat setting

Michael D April[1], Tyson E Becker[2], Andrew D Fisher[3], Jason F Naylor[4], Steven G Schauer[5]

## Abstract

**Introduction:** Identifying patients at imminent risk of death is a paramount priority in combat casualty care. This study measures the vital sign values predictive of mortality among combat casualties in Iraq and Afghanistan.

**Methods:** We used data from the Department of Defense Trauma Registry from January 2007 to August 2016. We used the highest documented heart rate and the lowest documented systolic pressure in the emergency department for each casualty. We constructed receiver operator curves (ROCs) to assess the accuracy of these variables for predicting survival to hospital discharge.

**Results:** There were 38,769 encounters of which our dataset included 15,540 (40.1%). The median age of these patients was 25 years and 97.5% were male. The most common mechanisms of injury were explosives (n = 9481, 61.0%) followed by gunshot wounds (n = 2393, 15.3%). The survival rate to hospital discharge was 97.5%. The median heart rate was 94 beats per minute (bpm) with area under the ROC of 0.631 with an optimal threshold to predict mortality of 110 bpm (sensitivity 52.2%, specificity 79.2%). The median systolic blood pressure was 128 mmHg with area under the ROC of 0.790 with an optimal threshold to predict mortality of 112 mmHg (sensitivity 68.5%, specificity 81.5%).

**Conclusions:** Casualties with a systolic blood pressure <112 mmHg, are at high risk of mortality, a value significantly higher than the traditional 90 mmHg threshold. Our dataset highlights the need for better methods to guide resuscitation as vital sign measurements have limited accuracy in predicting mortality.

J Trauma Acute Care Surg
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# Trends in combat casualty care following the publication of clinical practice guidelines

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## Abstract

**Background:** The current study explores the trends in the application of combat casualty care following the publication of clinical practice guidelines in five domains over thirteen years.

**Methods:** The Israel Defense Forces Trauma Registry was used to assess practice and adherence to guidelines in five domains: (a) crystalloid transfusions, (b) Tranexamic acid use, (c) freeze-dried plasma use, (d) chest decompression, and (e) airway management. All patients injured between January 2006 and December 2018 were included in the analysis. Trends were analyzed and presented monthly using linear regression and were compared using the Chow test.

**Results:** Mean crystalloid volume transfused decreased from 1179 ± 653 ml in 2006 to 466 ± 202 ml in 2018 (B = 0.016, 0.006-0.044). The proportion of patients with an indication treated with tranexamic acid dropped from 8% (238/2979) to 2.5% (60/2356) following the stricter guideline's publication. Freeze-dried plasma administration in indicated casualties rose from 12.5% in 2013 to 48% in 2018 (B = 1.63, 1.3-2.05). The overall proportion of casualties undergoing chest decompression rose from 1% (61/6036) to 1.5% (155/10493) following the release of a new CPG in 2012 (p = 0.013). There were no significant trends in intubation ratios before (B = 0.987, 0.953-1.02) or after 2012 (B = 10.2, 0.996-1.05).

**Conclusions:** Some aspects demonstrate the desired trends in response to new CPGs; in others, initial improvement is achieved but followed by stagnation. In some medical care aspects, completely unexpected and undesirable trends are observed. Every change and update in clinical practice guidelines should be based on reliable data. The effect of every change must be monitored carefully to ensure adequate adherence to life-saving guidelines.

**Level of evidence:** Level IV, epidemiological study.

BMJ Mil Health
2021 Apr;167(2):84-88.
doi: 10.1136/bmjmilitary-2020-001490. Epub 2020 Jun 2.

# Killed in action (KIA): an analysis of military personnel who died of their injuries before reaching a definitive medical treatment facility in Afghanistan (2004-2014)

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## Abstract

**Introduction:** The majority of combat deaths occur before arrival at a medical treatment facility but no previous studies have comprehensively examined this phase of care.

**Methods:** The UK Joint Theatre Trauma Registry was used to identify all UK military personnel who died in Afghanistan (2004-2014). These data were linked to non-medical tactical and operational records to provide an accurate timeline of events. Cause of death was determined from records taken at postmortem review. The primary objective was to report time between injury and death in those killed in action (KIA); secondary objectives included: reporting mortality at key North Atlantic Treaty Organisation timelines (0, 10, 60, 120 min), comparison of temporal lethality for different anatomical injuries and analysing trends in the case fatality rate (CFR).

**Results:** 2413 UK personnel were injured in Afghanistan from 2004 to 2014; 448 died, with a CFR of 18.6%. 390 (87.1%) of these died prehospital (n=348 KIA, n=42 killed non-enemy action). Complete data were available for n=303 (87.1%) KIA: median Injury Severity Score 75.0 (IQR 55.5-75.0). The predominant mechanisms were improvised explosive device (n=166, 54.8%) and gunshot wound (n=96, 31.7%).In the KIA cohort, the median time to death was 0.0 (IQR 0.0-21.8) min; 173 (57.1%) died immediately (0 min). At 10, 60 and 120 min post injury, 205 (67.7%), 277 (91.4%) and 300 (99.0%) casualties were dead, respectively. Whole body primary injury had the fastest mortality. Overall prehospital CFR improved throughout the period while in-hospital CFR remained constant.

**Conclusion:** Over two-thirds of KIA deaths occurred within 10 min of injury. Improvement in the CFR in Afghanistan was predominantly in the prehospital phase.

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# Combat-related ocular injuries in the IDF during the years 2013-2019

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## Abstract

**Background:** Ocular injuries account for up to 13% of battle injuries, despite the implementation of advanced protective eyewear (PE). This study aims to describe the extent of ocular injuries over the last years among Israel Defense Force (IDF) soldiers, and to examine the change in PE policy introduced in 2013 and the effect of a high-intensity conflict on ocular injury characteristics.

**Methods:** This retrospective registry-based analysis derived data from the IDF Trauma Registry (IDF-TR) and included soldiers who sustained combat-related ocular injuries between the years 2013 and 2019. Demographic data and injury characteristics of casualties, as well as information regarding the use of PE, were collected and analyzed.

**Results:** A total of 2,312 military casualties were available for this study; the incidence of combat-related ocular injuries was 8.9% (n=113). Ocular injuries occurred among male soldiers (98.2%) with a mean age of 22.7 years (±4.6); mechanism of injury was penetrating in 59.3% of the casualties and blunt in 22.1% of the casualties; ocular injury was isolated in 51.3% of the casualties, others sustained concomitant injuries including head (32.7%), upper extremity injury (17.7%), lower extremity (15.9%), torso (8.0%), neck (6.2%) and other (5.9%) injuries. Ocular injuries rate was similar among casualties who used PE (11.2%) and those who did not use PE (13.0%) while injured (P=0.596). Rate of open globe injuries was 9.1% in casualties who used PE and 39.5% (P=0.002) in casualties who did not.

**Conclusions:** Eye protection may significantly reduce ocular injuries severity. Education of the combatants on the use of PE, and guidance of medical teams on proper assessment, initial treatment, and rapid evacuation of casualties, is needed in order to improve visual outcomes of the casualties further.

**Level of evidence:** Level IV epidemiological study.

J Trauma Acute Care Surg
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# Military Deployment's Impact on the Surgeon's Practice

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## Abstract

**Background:** As the United States withdraws from overseas conflicts, general surgeons remain deployed in support of global operations. Surgeons and surgical teams are foundational to combat casualty care; however, currently there are few casualty producing events. Low surgical volume and acuity can have detrimental effects on surgical readiness for those frequently deployed. The surgical team cycle of deployment involves pre deployment training, draw-down of clinical practice, deployment, post deployment reintegration and rebuilding of a patient panel. This study aims to assess these effects on typical general surgeon practices. Quantifying the overall impact of deployment may help refine and implement measures to mitigate the effects on skill retention and patient care.

**Methods:** Surgeon case logs of eligible surgeons deploying between January 1, 2017 and January 1, 2020 were included from participating military treatment facilities (MTF). Eligible surgeons were surgeons whose case logs were primarily at a single MTF(s) 26 weeks prior and after deployment and whose deployment duration, location, and number of deployed cases were obtainable.

**Results:** Starting 26 weeks prior to deployment, analyzing in one-week intervals towards deployment time, case count decreased by 4.8% ($p < .0001$). With each one-week interval post deployment up to the 26-week mark, case count increased by 6% ($p < .0001$). Cases volumes most prominently drop 3 weeks prior to deployment and do not reach normal levels until approximately 7 weeks post deployment. Case volumes were similar across service branches.

**Conclusions:** There is a significant decrease in the number of cases performed before deployment and increase after return regardless of military branch. The peri-deployment surgical volume decline should be understood and mitigated appropriately; pre-deployment training, surgical skill retention and measures to safely reintegrate surgeons back into their practice should be further developed and implemented.

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

Am Surg
2021 Apr;87(4):543-548.
doi: 10.1177/0003134820949997. Epub 2020 Oct 28.

# The Use of a Urinary Balloon Catheter to Control Hemorrhage From Penetrating Torso Trauma: A Single-Center Experience at a Major Inner-City Hospital Trauma Center

Amber Himmler[1,2], Ignacio Luis Maria Calzetta[3], Andrea Potes[3], Juan Carlos Puyana[4], Guillermo Fabián Barillaro[3]

## Abstract

**Introduction:** Use of a urinary catheter balloon tamponade (UCBT) in controlling traumatic hemorrhage is a frequently employed but infrequently described technique. We aim to discuss the experience of balloon tamponade as a bridge to definitive hemorrhage control in the operating room.

**Methods:** This is retrospective review at a single institution from January 2008 to December 2018. We identified patients with active bleeding from penetrating torso trauma in whom UCBT was used to tamponade bleeding. We used revised trauma score (RTS), injury severity score (ISS), and new trauma and injury severity score (TRISS) to quantify injury severity. All surviving patients required definitively hemorrhage control in the operating room. Primary endpoint was mortality at 24 hours and 30 days.

**Results:** Twenty-nine patients were managed with UCBT. Nine had hemorrhage controlled in the trauma bay, including 4 with neck trauma and 5 with cardiac trauma. Twenty patients had hemorrhage controlled in the operating room, including 15 with cardiac trauma and 5 with intra-abdominal hemorrhage. Mean RTS, ISS, and TRISS in this population were: 5.93, 19.31, and 83.78, respectively. Of the 9 patients treated in the trauma bay, 1 (11.1%) died in the first 24 hours and 2 died in the first 30 days (22.2%). Of the 20 patients treated in the operating room, 0 (0%) patients died in the first 24 hours and 3 died in the first 30 days (15.0%).

**Conclusion:** UCBT is an effective tool that can be used to stabilize and bridge an actively bleeding patient to definitive hemorrhage control in the operating room.

J Trauma Acute Care Surg
2021 Apr 1;90(4):659-665.
doi: 10.1097/TA.0000000000003053.

# Patterns and outcomes of zone 3 REBOA use in the management of severe pelvic fractures: Results from the AAST Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery database

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## Abstract

**Background:** Knowledge on practice patterns for aortic occlusion (AO) in the setting of severe pelvic fractures is limited. This study aimed to describe clinical outcomes based on number and types of interventions after zone 3 resuscitative endovascular balloon occlusion of the aorta (REBOA) deployment.

**Methods:** A retrospective review of the American Association for the Surgery of Trauma Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery multicenter registry was performed for patients who underwent zone 3 AO from 2013 to 2020. Patients with a blunt mechanism who survived beyond the emergency department were included. Interventions evaluated were preperitoneal pelvic packing (PP), angioembolization (AE), and external fixation (EF) of the pelvis. Management approaches were compared against the primary outcome of mortality. Secondary outcomes included transfusion requirements, overall complications and acute kidney injury (AKI).

**Results:** Of 207 patients who underwent zone 3 AO, 160 (77.3%) fit the inclusion criteria. Sixty (37.5%) underwent AO alone, 50 (31.3%) underwent a second hemostatic intervention, and 49 (30.6%) underwent a third hemostatic intervention. Overall mortality was 37.7% (n = 60). There were no differences in mortality based on any number or combination of interventions. On multivariable regression, only EF was associated with a mortality reduction (odds ratio, 0.22; p = 0.011). Increasing number of interventions were associated with higher transfusion and complication rates. Pelvic packing + AE was associated with increased AKI than PP or AE alone (73.3% vs. 29.5% and 28.6%, p = 0.005), and AE was associated with increased AKI resulting in dialysis than PP alone (17.9% vs. 6.8%, p = 0.036).

**Conclusion:** Zone 3 REBOA can be used as a standalone hemorrhage control technique and as an adjunct in the management of severe pelvic fractures. The only additional intervention associated with a mortality reduction was EF. The benefit of increasing number of interventions must be weighed against more harm. Heterogeneity in practice patterns for REBOA use in pelvic fracture management underscores the need for an evidence base to standardize care.

**Level of evidence:** Therapeutic, Level IV.

J Vasc Surg
2021 Apr;73(4):1304-1313.
doi: 10.1016/j.jvs.2020.08.137. Epub 2020 Sep 25.

# Temporary intravascular shunt use improves early limb salvage after extremity vascular injury

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## Abstract

**Objective:** The use of temporary intravascular shunts (TIVSs) allow for restoration of distal perfusion and reduce ischemic time in the setting of arterial injury. As a damage control method, adjunct shunts restore perfusion during treatment of life-threatening injuries, or when patients require evacuation to a higher level of care. Single-center reports and case series have demonstrate that TIVS use can extend the opportunity for limb salvage. However, few multi-institutional studies on the topic have been reported. The objective of the present study was to characterize TIVS use through a multi-institutional registry and define its effects on early limb salvage.

**Methods:** Data from the Prospective Observation Vascular Injury Treatment registry was analyzed. Civilian patients aged ≥18 years who had sustained an extremity vascular injury from September 2012 to November 2018 were included. Patients who had a TIVS used in the management of vascular injury were included in the TIVS group and those who had received treatment without a TIVS served as the control group. An unadjusted comparison of the groups was conducted to evaluate the differences in the baseline and outcome characteristics. Double robust estimation combining logistic regression with propensity score matching was used to evaluate the effect of TIVS usage on the primary end point of limb salvage.

**Results:** TIVS use was identified in 78 patients from 24 trauma centers. The control group included 613 patients. Unmatched analysis demonstrated that the TIVS group was more severely injured (mean ± standard deviation injury severity score, 18.83 ± 11.76 for TIVS vs 14.93 ± 10.46 for control; P = .002) and had more severely mangled extremities (mean ± standard deviation abbreviated injury scale, extremity, score 3.23 ± 0.80 for TIVS vs 2.95 ± 0.87 for control; P = .008). Logistic regression demonstrated that propensity-matched control patients had a three times greater likelihood of amputation compared with the TIVS patients (odds ratio, 3.6; 95% confidence interval, 1.2-11.1; P = .026). Concomitant nerve injury and orthopedic fracture were associated with a greater risk of amputation. The median follow-up for the TIVS group was 12 days (interquartile range, 4-25 days) compared with 9 days (interquartile range, 4-18 days) for the control group.

**Conclusions:** To the best of our knowledge, the present study is the first multicenter, matched-cohort study to characterize early limb salvage as a function of TIVS use in the setting of extremity vascular injury. Shunts expedite limb perfusion and resulted in lower rates of amputation during the early phase of care. The use of TIVS should be one part of a more aggressive approach to restore perfusion in the most injured patients and ischemic limbs.

Transfusion
2021 Jun 4.
doi: 10.1111/trf.16515. Online ahead of print.

# Whole truths but half the blood: Addressing the gap between the evidence and practice of pre-hospital and in-hospital blood product use for trauma resuscitation

Zain G Hashmi[1,2], Mohamad Chehab[3], Avery B Nathens[4], Bellal Joseph[3], Eric A Bank[5], Jan O Jansen[1,2], John B Holcomb[1,2]

## Abstract

**Background:** In recent years, several studies have demonstrated the efficacy of using pre-hospital blood product and in-hospital whole blood for trauma resuscitation. While some observations suggest an encouraging uptake of this evidence by emergency medical service (EMS) agencies and trauma centers, a nationwide characterization of blood product utilization for bleeding trauma patients remains unknown. The objective of this study is to determine nationwide estimates of pre-hospital blood product and in-hospital whole blood utilization for trauma resuscitation.

**Study design and methods:** All adult trauma patients reported to the National Emergency Medical Services Information System (NEMSIS) dataset 2019 were included. Proportions of patients who received any pre-hospital blood product were calculated. The American College of Surgeons (ACS) Trauma Quality Programs (TQP) databases 2015-2017 and first quarter of 2020 were used to calculate the proportion of ACS-verified trauma centers that transfused whole blood.

**Results:** Among a total of 3,058,804 pre-hospital trauma patients, only 313 (0.01%) received any blood transfusion; 208 (0.21%) patients with systolic blood pressure (SBP) ≤90 mmHg and 121 (0.67%) patients with SBP ≤90 mmHg and heart rate ≥120 beats per minute received any blood product. The proportion of ACS-verified trauma centers transfusing whole blood increased from 16.7% (45/269) in 2015 to 24.5% (123/502) in first quarter of 2020.

**Discussion:** Despite strong evidence and recommendations, pre-hospital utilization of blood products for trauma resuscitation remains low. Additionally, while the overall in-hospital whole blood use also remains low, its use has increased at ACS-verified trauma centers over the past 5 years.

J Trauma Acute Care Surg
2021 Jun 4.
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# Point-of-care ultrasound for treatment and triage in austere military environments

Christophe Dubecq[1], Olivier Dubourg, Gabriel Morand, Romain Montagnon, Stéphane Travers, Pierre Mahe

## Abstract

**Background:** Assessment and triage in an austere environment represent a major challenge in casualty care. Modern conflicts involve a significant proportion of multiple wounds, either superficial or penetrating, which complicate clinical evaluation. Furthermore, there is often poor accessibility to computed tomography (CT) scans and a limited number of surgical teams. Therefore, ultrasound (US) represents a potentially valuable tool for distinguishing superficial fragments or shrapnels from penetrating trauma requiring immediate damage control surgery.

**Methods:** This retrospective observational multicenter study assessed casualties treated over 8 months by five medical teams deployed in Africa and Middle East. Two experts, who were experienced in military emergency medicine but did not take part in the missions, carried out an independent analysis for each case, evaluating the contribution of US to the following five items: triage categorization, diagnosis, clinical severity, prehospital therapeutic choices, and priority to operation room. Consensus was obtained using the Delphi method with three rounds.

**Results:** Out of 325 casualties, 189 underwent US examination. The mean injury severity scale score was 25.6, and 76% were wounded by an improvised explosive device. US was useful for confirming (23%) or excluding (63%) the suspected diagnosis made in the clinical assessment. It also helped obtain a diagnosis that had not been considered for 3% of casualties and was responsible for a major change in procedure or therapy in 4%. US altered the surgical priority in 43% of cases. For 30% of cases, US permitted surgery to be temporarily delayed to prioritize another more urgent casualty.

**Conclusion:** Ultrasound is a valuable tool for the management of mass casualties by improving treatment and triage, especially when surgical resources are limited. In some situations, US can also correct a diagnosis or improve prehospital therapeutic choices. Field medical teams should be trained to integrate US into their prehospital protocols.

**Level of evidence:** Level V (no Gold standard).

Ann Surg
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# A Decade of Damage Control Resuscitation: New Transfusion Practice, New Survivors, New Directions

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## Abstract

**Objective:** The aim of this study was to identify the effects of recent innovations in trauma major hemorrhage management on outcome and transfusion practice, and to determine the contemporary timings and patterns of death.

**Background:** The last 10 years have seen a research-led change in hemorrhage management to damage control resuscitation (DCR), focused on the prevention and treatment of trauma-induced coagulopathy.

**Methods:** A 10-year retrospective analysis of prospectively collected data of trauma patients who activated the Major Trauma Centre's major hemorrhage protocol (MHP) and received at least 1 unit of red blood cell transfusions (RBC).

**Results:** A total of 1169 trauma patients activated the MHP and received at least 1 unit of RBC, with similar injury and admission physiology characteristics over the decade. Overall mortality declined from 45% in 2008 to 27% in 2017, whereas median RBC transfusion rates dropped from 12 to 4 units (massive transfusion rates from 68% to 24%). The proportion of deaths within 24 hours halved (33%-16%), principally with a fall in mortality between 3 and 24 hours (30%-6%). Survivors are now more likely to be discharged to their own home (57%-73%). Exsanguination is still the principal cause of early deaths, and the mortality associated with massive transfusion remains high (48%). Late deaths are now split between those due to traumatic brain injury (52%) and multiple organ dysfunction (45%).

**Conclusions:** There have been remarkable reductions in mortality after major trauma hemorrhage in recent years. Mortality rates continue to be high and there remain important opportunities for further improvements in these patients.

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# Safety and efficacy of low-titer O whole blood resuscitation in a civilian level I trauma center

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## Abstract

**Background:** Military experience has shown low-titer O whole blood (LTOWB) to be safe and beneficial in the resuscitation of hemorrhaging trauma patients. However, few civilian centers utilize LTOWB for trauma resuscitation. We evaluated the early experience and safety of a LTOWB program at a Level 1 civilian trauma center.

**Methods:** We retrospectively reviewed our trauma registry from January 2018-June 2020 for patients admitted in shock (defined as ≥1 of the following: heart rate > 120 beats per minute, systolic blood pressure [SBP] < 90 mmHg, or shock index >0.9) who received blood products within 24 hours (h). Patients were grouped by resuscitation provided: LTOWB (Group 1), component therapy (CT; Group 2), and LTOWB+CT (Group 3). Safety, outcomes, and variables associated with LTOWB transfusion and mortality were analyzed.

**Results:** 216 patients were included: 34 in Group 1, 95 in Group 2, and 87 in Group 3. Patients receiving LTOWB were more commonly male ($p < 0.001$) and had a penetrating injury ($p = 0.005$). Groups 1 and 3 had higher median ISS scores compared to Group 2 (19 and 20 vs 17; $p = 0.01$). Group 3 received more median units of blood product in the first 4 h ($p < 0.001$) and in the first 24 h ($p < 0.001$). There was no difference between groups in 24 h mortality or transfusion-related complications (all $p > 0.05$). Arrival ED SBP was associated with LTOWB transfusion (odds ratio [OR] 0.98, 95% confidence interval [CI] 0.95-1.00, $p = 0.03$). ED lactate was independently associated with 24 h mortality. (OR 1.27, CI 1.02-1.58, $p = 0.03$). LTOWB transfusion was not associated with mortality ($p = 0.49$).

**Conclusions:** Severely injured patients received LTOWB+CT and more overall product units but had similar 24 h mortality when compared to the LTOWB or CT groups. No increase in transfusion-related complications was seen after LTOWB transfusion. LTOWB should be strongly considered in the resuscitation of trauma patients at civilian centers.

**Level of evidence:** Retrospective study having more than one negative criterion; level IV evidence; therapeutic.

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# Temporary intravascular shunts after civilian arterial injury: A prospective multicenter Eastern Association for the Surgery of Trauma study

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## Abstract

**Introduction:** We sought to determine the impact of the indication for shunt placement on shunt-related outcomes after major arterial injuries. We hypothesized that a shunt placed for damage control indications would be associated with an increase in shunt-related complications including shunt dislodgement, thrombosis, or distal ischemia.

**Patients & methods:** A prospective, multicenter study (eleven level one US trauma centers) of all adult trauma patients undergoing temporary intravascular shunts (TIVS) after arterial injury was undertaken (January 2017-May 2019). Exclusion criteria included age <15years, shunt placement distal to popliteal/brachial arteries, isolated venous shunts, and death before shunt removal. Clinical variables were compared by indication and shunt-related complications. The primary endpoint was TIVS complications (thrombosis, migration, distal ischemia).

**Results:** The 66 patients who underwent TIVS were primarily young (30years [IQR 22-36]) men (85%), severely injured (ISS 17 [10-25]) by penetrating mechanisms (59%), and had their shunts placed for damage control (41%). After a median SDT of 198min [89-622], 9% experienced shunt-related complications. Compared by shunt placement indication (damage control shunts [n=27] compared to non-damage control shunts [n=39]), there were no differences in gender, mechanism, extremity AIS, MESS score, fractures, or surgeon specialty between the two groups (all p>0.05). Patients with shunts placed for damage control indications had more severe injuries (ISS 23.5 compared to 13; SBP 100 compared to 129; GCS 11 compared to 15; lactate 11.5 compared to 3.6; all p<0.05), and had more frequent shunt complication predictors, but damage control shunts did not have significantly more TIVS complications (11.1% compared to 7.7%, p=0.658). Shunt complication patients were discharged home less often (33% vs 65%; p<0.05) but all survived.

**Conclusion:** Shunts placed for damage control indications were not associated with shunt complications in this prospective, multicenter study.