



**Tactical Combat Casualty Care
&
En Route Combat Casualty Care**

2020 Journal Watch

Journal Article Abstracts

April - June 2020

A quarterly literature review of topics related to Tactical Combat Casualty Care (TCCC) and En Route Combat Casualty Care (ERCCC) from the months of April 2020 through June 2020.

Posting of articles does not imply agreement or disagreement with the contents nor constitute a change in TCCC or ERCCC guidelines, practices, or training. Links are provided to respective publications for further reading and research. Additional log-in requirements may be required at various websites. The Joint Trauma System and Deployed Medicine do not provide downloadable articles or free access to journal sites. Access may be acquired through service medical departments/commands or medical agencies/organizations.

The CoTCCC is the branch of the JTS focused on the standard of care for prehospital battlefield medicine. The CoERCCC is the branch of the JTS focused on the standard of care for en route care medicine through the evacuation echelons of care. The JTS is the Department of Defense Center of Excellence for Trauma and division of the Defense Health Agency (DHA) providing clinical practice guidelines and performance improvement for all levels of military trauma care.

[Effect of tranexamic acid by baseline risk of death in acute bleeding patients: a meta-analysis of individual patient-level data from 28 333 patients](#)

Francois-Xavier Ageron, Angele Gayet-Ageron, Katharine Ker, Timothy J Coats, Haleema Shakur-Still, Ian Roberts, Antifibrinolytics Trials Collaboration

Br J Anaest. 2020 Jun;124(6):676-683

Background: Early administration of the antifibrinolytic drug tranexamic acid reduces death from bleeding in trauma and postpartum haemorrhage. We examined how the effectiveness and safety of antifibrinolytic drugs varies by the baseline risk of death as a result of bleeding.

Methods: We performed an individual patient-level data meta-analysis of randomised trials including more than 1000 patients that assessed antifibrinolytics in acute severe bleeding. We identified trials performed between January 1, 1946 and July 5, 2018 (PROSPERO, number 42016052155).

Results: Two randomised trials were selected where 28 333 patients received tranexamic acid treatment within 3 h after the onset of acute bleeding. Baseline characteristics to estimate the risk of death as a result of bleeding were divided into four categories: Low (0-5%), intermediate (6-10%), high (11-20%), and very high (>20%). Most patients had a low baseline risk of death as a result of bleeding (23 008 [81%]). Deaths as a result of bleeding occurred in all baseline risk categories with 240 (1%), 202 (8%), 232 (14%), and 357 (30%) deaths in the low-, intermediate-, high-, and very high-risk categories, respectively. The effectiveness of tranexamic acid did not vary by baseline risk when given within 3 h after bleeding onset ($P=0.51$ for interaction term). There was no increased risk of vascular occlusive events with tranexamic acid and it did not vary by baseline risk categories ($P=0.25$).

Conclusions: Tranexamic acid appears to be safe and effective regardless of baseline risk of death. Because many deaths are in patients at low and intermediate risk, tranexamic acid use should not be restricted to the most severely injured or bleeding patients.

[U.S. Army Combat Medic eFAST Performance with a Novel Versus Conventional Transducers: A Randomized, Crossover Trial](#)

Brian J Ahern, Jonathan D Monti, Jason F Naylor, Aaron J Cronin, Michael D Perreault

Mil Med 2020 Jan 7;185(Suppl 1):19-24

Background: Point-of-injury extended focused assessment with sonography in trauma (eFAST) may identify life-threatening torso hemorrhage and expedite casualty evacuation. The purpose of this study was to compare combat medic eFAST performance between the novel and conventional ultrasound (US) transducers.

Methods: We conducted a randomized crossover trial. Medic participants, previously naïve to US, were randomized to the type of transducer first utilized. The primary outcome was eFAST completion time in seconds. Secondary outcomes included diagnostic accuracy, technical adequacy, and transducer ease-of-use rating.

Results: Forty medics performed 160 eFASTs. We found a statistically significant difference in eFAST completion times in favor of conventional transducers (304 vs. 358 s; $P = 0.03$). There was no statistically significant difference between the conventional and novel transducers in terms of diagnostic accuracy (97.7% vs. 96.0%; $P = 0.25$) and technical adequacy (65% vs. 72.5%; $P = 0.11$). Median transducer ease-of-use rating (Likert 1-5 scale) was statistically significant in favor of the conventional transducers (5 vs. 4; $P < 0.001$).

Conclusions: Extended focused assessment with sonography in trauma exam times was faster with the conventional transducers. Combat medics performed diagnostically accurate eFASTs with both transducer types in a simulated aid station setting after a brief training intervention. Conventional transducers were rated higher for ease-of-use.

[Hemorrhage Control: Lessons Learned From the Battlefield Use of Hemostatic Agents That Can Be Applied in a Hospital Setting](#)

Herman A Allison

Crit Care Nurs Q Apr/Jun 2019;42(2):165-172

Uncontrolled blood loss is a major cause of preventable death worldwide. A severe injury can occur anywhere at any time. Controlling blood loss is an important issue for patient care in the hospital setting. Through the casualties of war, the lifesaving value of quick interventions was developed. Since 2001, new hemostatic agents have advanced the benefits of controlling blood loss. There are unforgettable lessons learned in the preventable deaths of many soldiers and should be passed on to the next generation of health care providers, to include all hospitals up to level I trauma hospitals. This article covers the current hemostatic agents that have been used for more than 17 years on the battlefield and are slowly making their way into the hospital settings. The hemostatic agents covered include QuikClot Combat Gauze, QuikClot Control+, WoundClot Hemostatic Gauze, HemCon Nasal Plug, and RevMedx's XSTAT hemostatic device. The standard of care should not be affected by the location of a patient, whether that patient is in a remote village overseas, on the battlefield, a rural farm, or at a major metropolitan hospital here in the United States.

Prehospital Trauma Scene and Transport Times for Pediatric and Adult Patients

Nicklaus P Ashburn, Nella W Hendley, Ryan M Angi, Andrew B Starnes, R Darrell Nelson, Henderson D McGinnis, James E Winslow, David M Cline, Brian C Hiestand, Jason P Stopyra

West J Emerg Med 2020 Feb 21;21(2):455-462

Introduction: Increased out-of-hospital time is associated with worse outcomes in trauma. Sparse literature exists comparing prehospital scene and transport time management intervals between adult and pediatric trauma patients. National Emergency Medical Services guidelines recommend that trauma scene time be less than 10 minutes. The objective of this study was to examine prehospital time intervals in adult and pediatric trauma patients.

Methods: We performed a retrospective cohort study of blunt and penetrating trauma patients in a five-county region in North Carolina using prehospital records. We included patients who were transported emergency traffic directly from the scene by ground ambulance to a Level I or Level II trauma center between 2013-2018. We defined pediatric patients as those less than 16 years old. Urbanicity was controlled for using the Centers for Medicare and Medicaid's Ambulance Fee Schedule. We performed descriptive statistics and linear mixed-effects regression modeling.

Results: A total of 2179 records met the study criteria, of which 2077 were used in the analysis. Mean scene time was 14.2 minutes (95% confidence interval [CI], 13.9-14.5) and 35.3% (n = 733) of encounters had a scene time of 10 minutes or less. Mean transport time was 17.5 minutes (95% CI, 17.0-17.9). Linear mixed-effects regression revealed that scene times were shorter for pediatric patients ($p < 0.0001$), males ($p = 0.0016$), penetrating injury ($p < 0.0001$), and patients with blunt trauma in rural settings ($p = 0.005$), and that transport times were shorter for males ($p = 0.02$), non-White patients ($p < 0.0001$), and patients in urban areas ($p < 0.0001$).

Conclusion: This study population largely missed the 10-minute scene time goal. Demographic and patient factors were associated with scene and transport times. Shorter scene times occurred with pediatric patients, males, and among those with penetrating trauma. Additionally, suffering blunt trauma while in a rural environment was associated with shorter scene time. Males, non-White patients, and patients in urban environments tended to have shorter transport times. Future studies with outcomes data are needed to identify factors that prolong out-of-hospital time and to assess the impact of out-of-hospital time on patient outcomes.

[Whole blood transfusion versus component therapy in adult trauma patients with acute major haemorrhage](#)

Pascale Avery, Sarah Morton Harriet Tucker, Laura Green, Anne Weaver, Ross Davenport

Emerg Med J 2020 Jun;37(6):370-378

Objective: In the era of damage control resuscitation of trauma patients with acute major haemorrhage, transfusion practice has evolved to blood component (component therapy) administered in a ratio that closely approximates whole blood (WB). However, there is a paucity of evidence supporting the optimal transfusion strategy in these patients. The primary objective was therefore to establish if there is an improvement in survival at 30 days with the use of WB transfusion compared with blood component therapy in adult trauma patients with acute major haemorrhage.

Methodology: A systematic literature search was performed on 15 December 2019 to identify studies comparing WB transfusion with component therapy in adult trauma patients and mortality at 30 days. Studies which did not report mortality were excluded. Methodological quality of included studies was interpreted using the Cochrane risk of bias tool, and rated using the Grading of Recommendations Assessment, Development and Evaluation approach.

Results: Search of the databases identified 1885 records, and six studies met the inclusion criteria involving 3255 patients. Of the three studies reporting 30-day mortality (one randomised controlled trial (moderate evidence) and two retrospective (low and very low evidence, respectively)), only one study demonstrated a statistically significant difference between WB and component therapy, and two found no statistical difference. Two retrospective studies reporting in-hospital mortality found no statistical difference in unadjusted mortality, but both reported statistically significant logistic regression analyses demonstrating that those with a WB transfusion strategy were less likely to die.

Conclusion: Recognising the limitations of this systematic review relating to the poor-quality evidence and limited number of included trials, it does not provide evidence to support or reject use of WB transfusion compared with component therapy for adult trauma patients with acute major haemorrhage.

[Practical Considerations for a Military Whole Blood Program](#)

Marshall Bahr, Andrew P Cap, Devin Dishong Mark H Yazer

Mil Med 2020 Aug 14;185(7-8):e1032-e1038

Introduction: Prehospital care in the combat environment has always been of great importance to the U.S. military, and trauma resuscitation has remained a cornerstone. More evidence continues to demonstrate the advantages of intervention with early transfusion of blood products at the point of injury. The military has recognized these benefits; as such, the Department of Defense Joint Trauma System and the Committee on Tactical Combat Casualty Care have developed new advanced resuscitation guidelines, which now encourage the use of whole blood (WB) in the prehospital setting.

Materials and methods: This general review of peer-reviewed journal articles was performed through an extensive electronic search from the databases of PubMed Central (MEDLINE) and the Cochrane Library.

Results: Based on this literature search, the current evidence suggests that transfusion with WB is safe and efficacious. Additionally, soldier function is preserved after donating fresh WB in the field. Currently, the collection and implementation of WB is accomplished through several different protocol-driven techniques.

Conclusion: WB has become the favored transfusion product as it provides all of the components of blood in a convenient package that is easy to store and transport. Specifically, group O WB containing low titers of anti-A and -B antibodies has become the transfusion product of choice, offering the ability to universally fluid resuscitate patients despite not knowing their blood group. This new ability to obtain low titer group O WB has transformed the approach to the management of hemorrhagic shock in the prehospital combat environment.

[Ketamine as a Prehospital Analgesic: A Systematic Review](#)

Akhil Bansal, Matthew Miller, Ian Ferguson, Brian Burns

Prehosp Disaster Med 2020 Jun;35(3):314-321

Objective: Analgesia in the prehospital setting is an extremely important, yet controversial topic. Ketamine, a N-methyl D-aspartate (NMDA) receptor antagonist, has been commonly used in the prehospital setting, including recommendations by the US Department of Defense and by the Royal Australian College of Pain Medicine, despite the paucity of high-level evidence.

Methods: Accordingly, a review of the literature was conducted using several electronic medical literature databases from the earliest available records to the time at which the search was conducted (October 2018).

Results: The search strategy yielded a total of 707 unique papers, of which 43 were short-listed for full review, and ultimately, ten papers were identified as meeting all the relevant inclusion criteria. The included studies varied significantly in the prehospital context and in the means of administering ketamine. There was only low-grade evidence that ketamine offered a safe and effective analgesia when used as the only analgesic, and only low-grade evidence that it was as effective as alternative opioid options. However, there was moderate evidence that co-administration of ketamine with morphine may improve analgesic efficacy and reduce morphine requirement.

Conclusions: Overall, ketamine as a prehospital analgesic may be best used in combination with opioids to reduce opioid requirement. It is suggested that future studies should use a standardized approach to measuring pain reduction. Future studies should also investigate short-term side effects and long-term complications or benefits of prehospital ketamine.

Combat Application Tourniquet fares well in a chemical, biological, radiological or nuclear dress state

Alastair Beaven, E Sellon, M Ballard, P Parker

BMJ Mil Health 2020 Feb 20;Online ahead of print

Introduction: There is a need for a military tourniquet to control catastrophic haemorrhage in a chemical, biological, radiological or nuclear (CBRN) threat environment. No published data exist as to the efficacy of tourniquets while wearing British military CBRN individual protective equipment (IPE).

Methods: 12 volunteers from the counter CBRN instructors' course allowed testing on 24 legs. A Combat Application Tourniquet (C-A-T) was applied to all volunteers at the level of the midthigh. 12 legs were tested while wearing CBRN IPE (both operator and simulated casualty), and the control group of 12 legs was tested while wearing conventional combat dress state (both operator and simulated casualty). The order of leg laterality and dress state were sequenced according to a prerandomised system. Efficacy was measured via use of an ultrasound probe at the popliteal artery. Tourniquets were considered effective if arterial flow was completely occluded on ultrasound imaging. Data were collected on time to successful application, failure of tourniquets and pain scores as rated by the visual analogue scale (1-10).

Results: There were no failures of tourniquet application in the CBRN group, and two failures (17%) in the control group. Failures were pain threshold exceeded (n=1) and tourniquet internal strap failure (n=1). The mean application time for the CBRN group was 28.5 s (SD 11.7) and 23.7 s (SD 9.8) for the conventional combat group. There was no statistically significant difference (p=0.27). The median CBRN pain score was 2.0 (IQR 2.0-3.5). The median control pain score was 4.0 (IQR 3-6). This was a statistically significant difference (p=0.002).

Conclusion: C-A-Ts applied to simulated casualties in CBRN IPE at the midthigh are at least as efficacious as those applied to the midthigh in a conventional combat dress state. The pain experienced was less in CBRN IPE than when in a conventional combat dress state.

[Cold-stored whole blood in a Norwegian emergency helicopter service: an observational study on storage conditions and product quality](#)

Christopher Bjerkvig, Joar Sivertsen, Hanne Braathen, Turid Helen Felli Lunde, Geir Strandenes, Jörg Assmus, Tor Hervig, Andrew Cap, Einar K Kristoffersen, Theodor Fosse, Torunn Oveland Apelseeth

Transfusion 2020 Jul;60(7):1544-1551

Background: Increasing numbers of emergency medical service agencies and hospitals are developing the capability to administer blood products to patients with hemorrhagic shock. Cold-stored whole blood (WB) is the only single product available to prehospital providers who aim to deliver a balanced resuscitation strategy. However, there are no data on the safety and in vitro characteristics of prehospital stored WB. This study aimed to describe the effects on in vitro quality of storing WB at remote helicopter bases in thermal insulating containers.

Study design and methods: We conducted a two-armed single-center study. Twenty units (test) were stored in airtight thermal insulating containers, and 20 units (controls) were stored according to routine procedures in the Haukeland University Hospital Blood Bank. Storage conditions were continuously monitored during emergency medical services missions and throughout remote and blood bank storage. Hematologic and metabolic variables, viscoelastic properties, and platelet (PLT) aggregation were measured on Days 1, 8, 14, and 21.

Results: Storage conditions complied with the EU guidelines throughout remote and in-hospital storage for 21 days. There were no significant differences in PLT aggregation, viscoelastic properties, and hematology variables between the two groups. Minor significantly lower pH, glucose, and base excess and higher lactate were observed after storage in airtight containers.

Conclusion: Forward cold storage of WB is safe and complies with EU standards. No difference is observed in hemostatic properties. Minor differences in metabolic variables may be related to the anaerobic conditions within the thermal box.

[Tranexamic acid in emergency care](#)

Benjamin Bloom

Eur J Emerg Med 2020 Apr;27(2):81-82

No abstract available

Early management of severe abdominal trauma

Pierre Bouzat, Guillaume Valdenaire, Tobias Gauss, Jonhatan Charbit, Catherine Arvieux, Paul Balandraud, Xavier Bobbia, Jean-Stéphane David, Julien Frandon, Delphine Garrigue, Jean-Alexandre Long, Julien Pottecher, Bertrand Prunet, Bruno Simonnet, Karim Tazarourte, Christophe Trésallet, Julien Vaux, Damien Viglino, Barbara Villoing, Laurent Zieleskiewicz, Cédric Gil-Jardiné, Emmanuel Weiss

Anaesth Crit Care Pain Med 2020 Apr;39(2):269-277

Objective: To develop French guidelines on the management of patients with severe abdominal trauma.

Design: A consensus committee of 20 experts from the French Society of Anaesthesiology and Critical Care Medicine (Société française d'anesthésie et de réanimation, SFAR), the French Society of Emergency Medicine (Société française de médecine d'urgence, SFMU), the French Society of Urology (Société française d'urologie, SFU) and from the French Association of Surgery (Association française de chirurgie, AFC), the Val-de-Grâce School (École du Val-De-Grâce, EVG) and the Federation for Interventional Radiology (Fédération de radiologie interventionnelle, FRI-SFR) was convened. Declaration of all conflicts of interest (COI) policy by all participants was mandatory throughout the development of the guidelines. The entire guideline process was conducted independently of any industry funding. The authors were advised to follow the principles of the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system for assessment of the available level of evidence with particular emphasis to avoid formulating strong recommendations in the absence of high level. Some recommendations were left ungraded.

Methods: The guidelines are divided in diagnostic and, therapeutic strategy and early surveillance. All questions were formulated according to Population, Intervention, Comparison, and Outcomes (PICO) format. The panel focused on three questions for diagnostic strategy: (1) What is the diagnostic performance of clinical signs to suggest abdominal injury in trauma patients? (2) Suspecting abdominal trauma, what is the diagnostic performance of prehospital FAST (Focused Abdominal Sonography for Trauma) to rule in abdominal injury and guide the prehospital triage of the patient? and (3) When suspecting abdominal trauma, does carrying out a contrast enhanced thoraco-abdominal CT scan allow identification of abdominal injuries and reduction of mortality? Four questions dealt with therapeutic strategy: (1) After severe abdominal trauma, does immediate laparotomy reduce morbidity and mortality? (2) Does a "damage control surgery" strategy decrease morbidity and mortality in patients with a severe abdominal trauma? (3) Does a laparoscopic approach in patients with abdominal trauma decrease mortality or morbidity? and (4) Does non-operative management of patients with abdominal trauma without bleeding reduce mortality and morbidity? Finally, one question was formulated regarding the early monitoring of these patients: In case of severe abdominal trauma, which kind of initial monitoring does allow to reduce the morbi-mortality? The analysis of the literature and the recommendations were conducted following the GRADE® methodology.

Results: The SFAR/SFMU Guideline panel provided 15 statements on early management of severe abdominal trauma. After three rounds of discussion and various amendments, a strong agreement was reached for 100% of recommendations. Of these recommendations, five have a high level of evidence (Grade 1±), six have a low level of evidence (Grade 2±) and four are expert judgments. Finally, no recommendation was provided for one question.

Conclusions: Substantial agreement exists among experts regarding many strong recommendations for the best early management of severe abdominal trauma.

[From battlefield to homefront: creation of a civilian walking blood bank](#)

Maxwell A Braverman, Alison Smith, Charles Patrick Shahan, Benjamin Axtman, Eric Epley, Scott Hitchman, Elizabeth Waltman, Christopher Winckler, Susannah E Nicholson, Brian J Eastridge, Ronald M Stewart, Donald H Jenkins

Transfusion. 2020 Jun;60 Suppl 3:S167-S172

Hemorrhagic shock remains the leading cause of preventable death on the battlefield, despite major advances in trauma care. Early initiation of balanced resuscitation has been shown to decrease mortality in the hemorrhaging patient. To address transfusion limitations in austere environments or in the event of multiple casualties, walking blood banks have been used in the combat setting with great success. Leveraging the success of the region-wide whole blood program in San Antonio, Texas, we report a novel plan that represents a model response to mass casualty incidents.

Resuscitative Endovascular Balloon Occlusion of the Aorta Process Improvement: Examining a Novel Case Evaluation Tool and Standardized Simulations

David J Burkard, Jessica Thompson, Matthew Dull, Jennifer Haverkamp, Amy Koestner, Alan Davis, Cathryn Chadwick, Charles J Gibson, Gaby Iskander, Alistair J Chapman

Trauma Nurs Mar/Apr 2020;27(2):82-87

A quality improvement project was undertaken. The objectives of this study were to describe an original case evaluation tool, discuss barriers encountered, present a standardized simulation course, and evaluate the efficacy of this course. Resuscitative endovascular balloon occlusion of the aorta (REBOA) is an emerging adjunct in the trauma bay for patients with noncompressible subdiaphragmatic hemorrhage. Compared with the alternative (emergency department thoracotomy), it is less invasive and allows for continuation of chest compressions, and early studies suggest a positive effect on mortality. Infrequent utilization of REBOA limits provider and support staff exposure to its indications and technical skills required to deploy the device. Furthermore, there is no standardized evaluation tool for collecting and reporting REBOA-related data. The REBOA Review Tool was designed to easily evaluate all the steps involved in deploying the REBOA tool and was implemented at our institution without difficulty. This tool provided meaningful feedback for areas that required improvement including ease of information retrieval and documentation of sheath removal. Standardized simulation courses were performed to further improve provider and support staff confidence in using the REBOA tool. Analysis of pre- and postsimulation surveys showed significant improvement in participants' confidence in their understanding and utilization of the REBOA tool and its indications. REBOA placement is a low-volume but high-impact procedure. Therefore, simulations to prepare and a standardized tool to learn from prior experience are vital to improving patient care.

[Effectiveness of different supralottic airways during resuscitation manoeuvres. A systematic review](#)

J Calheiros, P Charco-Mora

Rev Esp Anesthesiol Reanim Jun-Jul 2020;67(6):316-324

Introduction: Supraglottic airways, which are easily inserted and minimize interruptions in cardiopulmonary resuscitation manoeuvres, are now widely used in pre- and in-hospital emergencies. However, most studies in these devices do not specify whether they ensure good ventilation during CPR. This systematic review aims to determine whether there is evidence that supraglottic airways enable effective ventilation during resuscitation.

Methods: The MEDLINE and COCHRANE databases were searched for studies published in English up to 30 November 2018. Eligible studies were all those that objectively evaluated tidal volume during resuscitation maneuvers in patients over 18 years of age using various supraglottic airways.

Results: A total of 3734 articles were identified, of which 252 were duplicates. Only 1 objectively evaluated ventilation during resuscitation maneuvers and presented data relevant to this review. The study included 470 patients, 51 of which underwent spirometry. Only 4.48% of patients survived to hospital discharge; however, the correlation with ventilation effectiveness was not assessed.

Conclusion: There is no scientific evidence that supraglottic airways provide effective ventilation during resuscitation maneuvers. Evaluation by spirometry, chest impedance and ultrasound may help to determine the ventilatory efficacy of supraglottic airways during CPR, and clarify whether this factor contributes to the difficulties experienced in reversing cardiorespiratory arrest.

Comprehensive analysis of combat casualty outcomes in U.S. servicemembers from the beginning of World War II to the end of Operation Enduring Freedom

Jeremy W Cannon, Daniel N Holena, Zhi Geng, Ian J Stewart, Yanlan Huang, Wei Yang, Emily R Mayhew, Shawn C Nessen, Kirby R Gross, C William Schwab

J Trauma Acute Care Surg 2020 May 19; Online ahead of print.

Advances in combat casualty care have improved combat survivability over the past two decades. However, these outcomes remain incompletely framed in the broader context of combat casualty outcomes over the past eighty years. We hypothesized that starting with World War II, combat survival worsened at the beginning of each new conflict but then improved over time. To evaluate long-term trends in combat casualty outcomes, monthly combat injuries and deaths during World War II, the Korean conflict, the Vietnam conflict, Operation Iraqi Freedom (OIF), and Operation Enduring Freedom (OEF) were collated. From these numbers, we calculated the monthly case fatality rate (CFR), the killed in action rate (%KIA), and the died of wounds rate (%DOW). We analyzed these metrics for significant trends during and between each conflict using linear and Loess regression. We then simulated alternate outcome scenarios by eliminating outcome variability. In this comprehensive analysis, CFR decreased over the study period in parallel with a decrease in %KIA. When examining individual conflicts, however, several unfavorable trends emerged including a spike in all fatality measures at the end of Vietnam and a rise in %DOW over the course of Korea and OIF. In comparing CFR at the beginning of each conflict to the best CFR from the prior conflict, high mortality outliers occurred in every conflict after a period of relative peace, and a clear "peacetime effect" occurred in both World War II and Vietnam. Eliminating these negative trends and the attendant preventable deaths would have reduced combat fatalities over the course of eighty years by 107,256 (39.7%). In summary, although combat mortality rates have generally improved since World War II, closer examination indicates several unfavorable trends both during and between conflicts. Identifying factors behind these trends will reveal further opportunities to improve combat casualty outcomes in the future. LEVEL OF EVIDENCE: III, Epidemiological.

[An analysis of US Africa command area of operations military medical transportations, 2008-2018](#)

Brandon Carius, William T Davis, Carlissa D Linscomb, Mireya A Escandon, Dylan Rodriguez, Nguvan Uhaa, Joseph K Maddry, Kevin K Chung, Steve Schauer

Afr J Emerg Med 2020 Mar;10(1):13-16

Introduction: With personnel scattered throughout a continent 3 times larger than the United States, a lack of mature medical facilities necessitates a significant transportation network for medical evacuation in US Africa Command (AFRICOM). We describe medical evacuations analyzed from the US Air Force Transportation Command Regulating and Command & Control Evacuation System (TRAC2ES).

Methods: We performed a retrospective review of all TRAC2ES medical records for medical evacuations from the AFRICOM theater of operations conducted between January 1, 2008 and December 31, 2018. We abstracted free text data entry in TRAC2ES for diagnostic and therapeutic interventions performed prior to the patient movement request.

Results: During this time, there were 963 cases recorded in TRAC2ES originating within AFRICOM. 961 records were complete for analysis. Most patients were male (82%) and military personnel (92%). Most transports originated in Djibouti (72%), and Germany (93%) was the most common destination. Medical evacuations were largely routine (66%), and routine evacuations were proportionally highest amongst US military personnel compared to all other groups. A small portion of patients were evacuated for battle injuries (4%), compared to non-battle injury (33%) and disease (63%). Within disease, the largest proportion of patient complaints centered on gastrointestinal symptoms (13%), behavioral health (11%) and chest pain (8%). Prior to evacuation, only 55% of patients were document as receiving any medication. Pain control was documented in 21% of cases, most commonly being NSAIDs (7%).

Discussion: Extremely low numbers of battle injuries highlight the unique nature of AFRICOM operations compared to areas with more intense combat operations. Limitations of the dataset highlight the need for a data collection mandate within AFRICOM as within other areas for optimization and performance improvement.

[In response to Early and prehospital trauma deaths: emergency physicians should not be alone to win the game](#)

Shannon L Carroll, John B Holcomb, Jan O Jansen

J Trauma Acute Care Surg 2020 May 26; Online ahead of print.

No abstract available

[Early and prehospital trauma deaths: emergency physicians should not be alone to win the game](#)

Nicolas Cazes, Aurélien Renard, Daniel Meyran

Trauma Acute Care Surg 2020 May 26;Online ahead of print

No abstract available

Telehealth Impact on Primary Care Related Ambulance Transports

Tiffany Champagne-Langabeer, James R Langabeer, Kirk E Roberts, Joshua S Gross, Guy R Gleisberg, Michael G Gonzalez, David Persse

Prehosp Emerg Care Sep-Oct 2019;23(5):712-717

Introduction: Telehealth has been used nominally for trauma, neurological, and cardiovascular incidents in prehospital emergency medical services (EMS). Yet, much less is known about the use of telehealth for low-acuity primary care. We examine the development of one telehealth program and its impact on unnecessary ambulance transports.

Objective: The objective of this study is to describe the development and impact of a large-scale telehealth program on ambulance transports.

Methods: We describe the patient characteristics and results from a cohort of patients in Houston, Texas who received a prehospital telehealth consultation from an emergency medicine physician. Inclusion criteria were adults and pediatric patients with complaints considered to be non-urgent, primary care related. Data were analyzed for 36 months, from January 2015 through December 2017. Our primary dependent variable was the percentage of patients transported by ambulance. We used descriptive statistics to describe patient demographics, chi-square to examine differences between groups, and logistic regression to explore the effects with multivariate controls including age, gender, race, and chief complaint.

Results: A total of 15,067 patients were enrolled (53% female; average age 44 years \pm 19 years) over the three-year period. The 3 primary chief complaints were based on abdominal pains (13% of cases), nausea/vomiting/diarrhea (NVD) (9.4%), and back pain (9.3%). Ambulance transports represented 11.2% of all transports in the program, while alternative taxi transportation was used in 75.6%, and the remainder were self- or no-transports. Taxi transportation to an alternate, affiliated clinic (versus ED) was utilized in 5% of incidents. After multivariate controls, older age patients presenting with low-risk, non-acute chest pain, shortness of breath, and dizziness were much more likely to use ambulance transport. Race and gender were not significant predictors of ambulance transport.

Conclusions: We found telehealth offers a technology strategy to address potentially unnecessary ambulance transports. Based on prior cost-effectiveness analyses, the reduction of unnecessary ambulance transports translates to an overall reduction in EMS agency costs. Telehealth programs offer a viable solution to support alternate destination and alternate transport programs.

Prehospital Blood Transfusion During Aeromedical Evacuation of Trauma Patients in Israel: The IDF CSAR Experience

Jacob Chen, Avi Benov, Roy Nadler, Daniel N Darlington, Andrew P Cap, Ari M Lipsky, Elon Glassberg

Mil Med 2017 Mar;182(S1):47-52

Background: Data regarding the effect of prehospital blood administration to trauma patients during short-to-moderate time evacuations is scarce. The Israel Air Force Airborne Combat Search and Rescue is the only organization that deals with aeromedical evacuation for both military and civilian casualties in Israel and the only one with the ability to give blood in the prehospital setting.

Methods: Data on packed red blood cells (PRBCs) administration in the evacuation missions from January 2003 to June 2010 were analyzed and actual transfusion practice was compared to clinical practice guidelines (CPGs).

Results: Over the studied 101 months, a total of 1,721 patients were evacuated by Combat Search and Rescue. Of these, 87 (5.1%) trauma patients were transfused with PRBC. Demographics included 83% male and 17% female with a median age of 23 years. Main mechanisms of injury included gunshot wounds (36%), motor vehicle accidents (28%), and blast injuries (24%) with an average of 2.6 injured regions per casualty. The most commonly injured body regions included lower extremities (52%), chest (45%), and abdomen (38%). Overall, 10 (11%) casualties died. Lifesaving intervention included tourniquets (27%), endotracheal intubation (24%), tube thoracostomy (24%), and needle thoracostomy (21%) times. For 98% of the patients, clinical judgment led to administration of red blood cells before indicated by the CPG. The heart rate tended to decrease during the evacuation, whereas there was no clear trend in systolic or diastolic blood pressure or shock index.

Conclusions: In our aeromedical experience, transfusion of PRBCs for trauma patients was safe, feasible, and most likely beneficial. PRBCs were administered according to the flight surgeons' clinical judgment and not in complete adherence to CPGs in most cases. Data collected from this and similar studies worldwide have led to change in CPGs with the shift from hypertensive resuscitation to hypotensive-hemostatic Remote Damage Control Resuscitation.

[Fresh frozen plasma attenuates lung injury in a novel model of prolonged hypotensive resuscitation](#)

Amanda M Chipman, Feng Wu, Shibani Pati, Alexander J Burdette, Jacob J Glaser, Rosemary A Kozar

J Trauma Acute Care Surg. 2020 Aug;89(2S Suppl 2):S118-S125

Background: Hemorrhagic shock remains a leading cause of early death among severely injured in both civilian and military settings. As future military operations will require strategies allowing prolonged field care of the injured, we sought to develop an in vivo model of prolonged hypotensive resuscitation (PHR) and to evaluate the role of plasma-based resuscitation in this model. We hypothesized that resuscitation with fresh frozen plasma (FFP) would mitigate lung injury when compared with Hextend in a rodent model of PHR.

Methods: Mice underwent laparotomy and hemorrhagic shock (mean arterial blood pressure, 35 ± 5 mm Hg \times 90 minutes) followed by PHR with either FFP or Hextend to maintain a mean arterial blood pressure of 55 mm Hg to 60 mm Hg for 6 hours. Sham animals underwent cannulation only. At the end of 6 hours, animals were euthanized, and lung tissue harvested for measurement of histopathologic injury, inflammation and permeability using hematoxylin and eosin staining, myeloperoxidase immunofluorescence staining and Evans Blue dye. Pulmonary syndecan-1 immunostaining was assessed as an indicator of endothelial cell integrity.

Results: All animals in the FFP, Hextend, and sham groups survived to the end of resuscitation. Resuscitation with FFP mitigated lung histopathologic injury compared with Hextend (histologic injury score of 4.38 ± 2.07 vs. 7.5 ± 0.93 , scale of 0-9, $p = 0.002$) and was comparable to shams (histologic injury score of 4.0 ± 1.93 , scale of 0-9, $p = 0.99$). Fresh frozen plasma also reduced lung inflammation (0.116 ± 0.044 vs. 0.308 ± 0.054 relative fluorescence of myeloperoxidase, $p = 0.002$) and restored pulmonary syndecan-1 (0.514 ± 0.061 vs. 0.059 ± 0.021 , relative syndecan-1 fluorescence, $p < 0.001$) when compared with Hextend. Consistently, FFP mitigated lung hyperpermeability compared with Hextend (7.30 ± 1.34 μ g vs. 14.91 ± 5.55 μ g Evans blue/100 mg lung tissue, $p = 0.005$).

Conclusion: We have presented a novel model of PHR of military relevance to the prolonged field care environment. In this model, FFP maintains its pulmonary protective effects using a PHR strategy compared with Hextend, which supports the need for further development and implementation of plasma-based resuscitation in the forward environment.

[Fresh frozen plasma attenuates lung injury in a novel model of prolonged hypotensive resuscitation](#)

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Level of evidence: Basic science.

[Aortic balloon occlusion \(REBOA\) in pelvic ring injuries: preliminary results of the ABO Trauma Registry](#)

Federico Coccolini, Marco Ceresoli, David T McGreevy, Mitra Sadeghi, Artai Pirouzram, Asko Toivola, Per Skoog, Koji Idoguchi, Yuri Kon, Tokiya Ishida, Yosuke Matsumura, Junichi Matsumoto, Viktor Reva, Mariusz Maszkowski, Paola Fugazzola, Matteo Tomasoni, Enrico Cicuttin, Luca Ansaloni, Claudia Zaghi, Maria Grazia Sibilla, Camilla Cremonini, Adam Bersztel, Eva-Corina Caragounis, Mårten Falkenberg, Lauri Handolin, George Oosthuizen, Endre Szarka, Vassil Manchev, Tongporn Wannatoop, Sung Wook Chang, Boris Kessel, Dan Hebron, Gad Shaked, Miklosh Bala, Carlos A Ordoñez, Peter Hibert-Carius, Massimo Chiarugi, Kristofer F Nilsson, Thomas Larzon, Emiliano Gamberini, Vanni Agnoletti, Fausto Catena, Tal M Hörer

Updates Surg 2020 Jun;72(2):527-536

EndoVascular and Hybrid Trauma Management (EVTM) has been recently introduced in the treatment of severe pelvic ring injuries. This multimodal method of hemorrhage management counts on several strategies such as the REBOA (resuscitative endovascular balloon occlusion of the aorta). Few data exist on the use of REBOA in patients with a severely injured pelvic ring. The ABO (aortic balloon occlusion) Trauma Registry is designed to capture data for all trauma patients in hemorrhagic shock where management includes REBOA placement. Among all patients included in the ABO registry, 72 patients presented with severe pelvic injuries and were the population under exam. 66.7% were male. Mean and median ISS were respectively 43 and 41 (SD \pm 13). Isolated pelvic injuries were observed in 12 patients (16.7%). Blunt trauma occurred in 68 patients (94.4%), penetrating in 2 (2.8%) and combined in 2 (2.8%). Type of injury: fall from height in 15 patients (23.1%), traffic accident in 49 patients (75.4%), and unspecified impact in 1 patient (1.5%). Femoral access was gained pre-hospital in 1 patient, in emergency room in 43, in operating room in 12 and in angio-suite in 16. REBOA was positioned in zone 1 in 59 patients (81.9%), in zone 2 in 1 (1.4%) and in zone 3 in 12 (16.7%). Aortic occlusion was partial/periodical in 35 patients (48.6%) and total occlusion in 37 patients (51.4%). REBOA associated morbidity rate: 11.1%. Overall mortality rate was 54.2% and early mortality rate (\leq 24 h) was 44.4%. In the univariate analysis, factors related to early mortality (\leq 24 h) are lower pH values ($p = 0.03$), higher base deficit ($p = 0.021$), longer INR ($p = 0.012$), minor increase in systolic blood pressure after the REBOA inflation ($p = 0.03$) and total aortic occlusion ($p = 0.008$). None of these values resulted significant in the multivariate analysis. In severe hemodynamically unstable pelvic trauma management, REBOA is a viable option when utilized in experienced centers as a bridge to other treatments; its use might be, however, accompanied with severe-to-lethal complications.

[The compensatory reserve: potential for accurate individualized goal-directed whole blood resuscitation](#)

Victor A Convertino, Natalie J Koons

Transfusion. 2020 Jun;60 Suppl 3:S150-S157

Hemorrhagic shock can be mitigated by timely and accurate resuscitation designed to restore adequate delivery of oxygen (DO_2). Current doctrine of using systolic blood pressure (SBP) as a guide for resuscitation can be associated with increased morbidity. The compensatory reserve measurement (CRM) is a novel vital sign based on the recognition that the sum of all mechanisms that contribute to the compensatory response to hemorrhage reside in features of the arterial pulse waveform. CRM can be assessed continuously and non-invasively in real time. Compared to standard vital signs, CRM provides an early, as well as more sensitive and specific, indicator of patient hemorrhagic status since the activation of compensatory mechanisms occurs immediately at the onset of blood loss. Recent data obtained from our laboratory experiments on non-human primates have demonstrated that CRM is linearly related to DO_2 during controlled progressive hemorrhage and subsequent whole blood resuscitation. We used this relationship to determine that the time of hemodynamic decompensation (i.e., CRM = 0%) is defined by a critical DO_2 at approximately $5.3 \text{ mL O}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$. We also demonstrated that a target CRM of 35% during whole blood resuscitation only required replacement of 40% of the total blood volume loss to adequately sustain a DO_2 more than 50% (i.e., $8.1 \text{ mL O}_2 \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$) above critical DO_2 (i.e., threshold for decompensated shock) while maintaining hypotensive resuscitation (i.e., SBP at ~ 90 mmHg). Consistent with our hypothesis, specific values of CRM can be used to accurately maintain DO_2 thresholds above critical DO_2 , avoiding the onset of hemorrhagic shock with whole blood resuscitation.

The ticking clock: does actively making an enhanced care team aware of the passage of time improve pre-hospital scene time following traumatic incidents?

L Curtis, E Ter Avest, J Griggs, J Williams, R M Lyon

Scand J Trauma Resusc Emerg Med 2020 Apr 29;28(1):31

Introduction: Pre-hospital enhanced care teams like Helicopter Emergency Medical Services (HEMS) are often dispatched to major trauma patients, including patients with traumatic brain injuries and those with major haemorrhage. For these patients, minimizing the time to definitive care is vital. The aim of this study was to determine whether increased awareness of elapsed on scene time produces a relevant time performance improvement for major trauma patients attended by HEMS, and whether introducing such a timer was feasible and acceptable to clinicians.

Methods: We performed a prospective cohort study of all single casualty traumatic incidents attended by Air Ambulance Kent Surrey Sussex (AAKSS) between 15 October 2016 and 23 May 2017 to test if introduction of a prompting scene timer within the service resulted in a reduction in pre-hospital scene times.

Results: The majority of the patients attended were male (74%) and sustained blunt trauma (92%). Overall, median scene time was 25.5 [IQR16.3] minutes before introduction of the scene timer and 23.0 [11.0] minutes after introduction, $p = 0.13$). Scene times for patients with a GCS < 8 and for patients requiring prehospital anaesthesia were significantly lower after introduction of the timer (28 [IQR 14] vs 25 [1], $p = 0.017$ and 34 [IQR 13] vs 28 [IQR11] minutes, $p = 0.007$ respectively). The majority of clinicians felt the timer made them more aware of passing time (91%) but that this had not made a difference to scene time (62%) or their practice (57%).

Conclusion: Audible scene timers may have the potential to reduce pre-hospital scene time for certain single casualty trauma patients treated by a HEMS team, particularly for those patients needing pre-hospital anaesthesia. Regular use of on-scene timers may improve outcomes by reducing time to definitive care for certain subgroups of trauma patients.

[It's In The Bag: Tidal Volumes in Adult and Pediatric Bag Valve Masks](#)

Benjamin Dafilou, Daniel Schwester, Nathan Ruhl, Andreia Marques-Baptista

West J Emerg Med 2020 Apr 27;21(3):722-726

Introduction: A bag valve mask (BVM) is a life saving device used by all levels of health care professionals during resuscitative care. We focus most of our time optimizing the patient's position, firmly securing the mask, and frequency of ventilations. However, despite our best efforts to control these factors, we may still be precipitating harm to the patient. Multiple studies have shown the tidal volumes typically delivered by the adult BVM are often higher than recommended for lung-protective ventilation protocols. In this study we measure and compare the ventilation parameters delivered by the adult and pediatric BVM ventilators.

Methods: A RespiTrainer Advance® adult mannequin was used to simulate a patient. Healthcare providers were directed to manually ventilate an intubated mannequin for two minutes using adult and pediatric sized BVMs. Tidal volume, minute ventilation, peak pressure, and respiration rate was recorded.

Results: The adult BVM provided a mean tidal volume of 807.7mL versus the pediatric BVM providing 630.7mL, both of which exceeded the upper threshold of 560mL of tidal volume necessary for lung protective ventilation of an adult male with an ideal body weight of 70kg. The adult BVM exceeded this threshold by 44.2% versus the pediatric BVM's 12.6% with 93% of participants exceeding the maximum threshold with the adult BVM and 82.3% exceeding it with the pediatric BVM.

Conclusion: The pediatric BVM in our study provided far more consistent and appropriate ventilation parameters for adult patients compared to an adult BVM, but still exceeded the upper limits of lung protective ventilation parameters. The results of this study highlight the potential dangers in using an adult BVM due to increased risk of pulmonary barotrauma. These higher tidal volumes can contribute to lung injury. This study confirms that smaller BVMs may provide safer ventilatory parameters. Future studies should focus on patient-centered outcomes with BVM.

Prehospital emergency thoracotomy performed by helicopter emergency medical service team: A case report

Tomasz Darocha, Sylweryusz Kosinski, Wojciech Serednicki, Tomasz Derkowski, Pawel Podsiadlo, Jan Szpor, Tomasz Sanak, Robert Galazkowski

Ulus Travma Acil Cerrahi Derg 2019 May;25(3):303-306

Emergency thoracotomy can be a life-saving procedure in critically injured patients who present with chest injuries. Currently, the indications for an on-the-scene thoracotomy are penetrating trauma of the chest or upper abdomen with cardiac arrest that has occurred in the presence of an emergency team or within 10 minutes prior to their arrival. The indications for an emergency thoracotomy in blunt chest trauma are less clearly defined. In the present case, a helicopter emergency medical service (HEMS) team performed an emergency thoracotomy at the scene. To the best of our knowledge, it is the first description of such a procedure in Poland. A 41-year-old male was crushed in a tractor accident. Though all available measures were taken, a sudden cardiac arrest occurred. The HEMS team performed an emergency thoracotomy at the scene as an integral part of prehospital cardiopulmonary arrest management. The patient survived, and was later discharged from the hospital in good physical condition. No neurological deficit was identified (cerebral performance category 1). The patient returned to his previous activities with no complications or deficits. The presence of a fully trained crew allows for the performance of a potentially critical on-the-scene emergency thoracotomy. In a well-selected group of patients with blunt thoracic injury, a prehospital emergency thoracotomy may be a significant and life-saving procedure.

[Use of ketamine for prehospital pain control on the battlefield: A systematic review](#)

Gaël de Rocquigny, Christophe Dubecq, Thibault Martinez, John Pepper, Amandine Cauet, Stéphane Travers, Pierre Pasquier

J Trauma Acute Care Surg 2020 Jan;88(1):180-185

Background: Intravenous ketamine is commonly used for pain management in the civilian prehospital setting. Several studies have evaluated its effectiveness in the military setting. To date, there has been no report reviewing the published data on the use of ketamine in this context. The objective of this systematic review was to analyze the content and quality of published data on the use of ketamine for prehospital pain management in military trauma.

Methods: The MEDLINE database was searched for studies on ketamine use in combat prehospital settings, at point of injury or during evacuation, published between 2000 and 2019. The systematic review was conducted following PRISMA guidelines, and the protocol was registered on PROSPERO (CRD42019115728). Civilian reports and case series lacking systematic data collection were excluded.

Results: Eight studies were included with 2029 casualties receiving ketamine. All but one were American reports from Afghanistan and Iraq conflicts. Studies implied retrospective cohorts or prospective observational analysis. Ketamine use rose from 3.9% during the period preceding its addition to the Tactical Combat Casualty Care guidelines in 2012 to 19.8% thereafter. It was the most common analgesic administered (up to 52% of casualties) in one of the studies. Ketamine was more likely given during tactical medical evacuation when no analgesic was provided at the point of injury. The median total intravenous dose was 50 mg. Pain intensity decreased from moderate or severe to mild or none, sometimes after only one dose. In one study, ketamine administration during tactical evacuation was associated with increased systolic blood pressure as opposed to morphine. Incoherent speech, extremity movements, and hallucinations were the main adverse events reported.

Conclusion: Published data on ketamine use in military trauma are rare and heterogeneous. Though, all studies tend to strengthen the belief in the efficacy and safety of ketamine when given at 50-mg to 100-mg intravenous for prehospital analgesia in combat casualties.

Impact of Early Tranexamic Acid Administration on Overall Blood Product Utilization at 24 Hours

Alisha Douglas, Donna Faviere, Amber Gallo, Ashley VanderSchaaf, Ward Wall, Kayla Wilson, Ashley Young

J Trauma Nurs Mar/Apr 2020;27(2):66-70

Antifibrinolytics have demonstrated a mortality benefit in trauma patients when utilized early after injury. In line with recent literature, the authors hypothesize that early tranexamic acid (TXA) administration will decrease overall blood product administration at 24 hr. This is a retrospective cohort evaluation of 65 trauma patients admitted and discharged between May 1, 2015, and December 31, 2017, who received packed red blood cells (PRBCs) and TXA within 3 hr following injury. The primary outcome was overall PRBC utilization at 24 hr when TXA was administered less than 1 hr of injury compared with 1-3 hr of injury. A subgroup analysis compared PRBC usage at 24 hr when PRBC to TXA administration time was less than 30 min compared with 30 min or more. During the study time, 15 patients received TXA early, less than 1 hr from injury, and 50 patients received TXA within 1-3 hr of injury. Patients received a median of 7 units of PRBCs in the early group and 8 units in the standard group ($p = .64$) at 24 hr. Patients who received TXA less than 30 min after first PRBC received a median of 6 units at 24 hr compared with 9 units when PRBC to TXA time was 30 min or more ($p = .014$). There was no difference in PRBCs at 24 hr in patients who received TXA early compared with 1-3 hr from injury. There was a significant increase in PRBC requirement at 24 hr when patients received TXA 30 min or more from first PRBC. Further inquiry into the optimal timing of TXA administered is needed.

[Prehospital Mortality Due to Hemorrhagic Shock Remains High and Unchanged: A Summary of Current Civilian EMS Practices and New Military Changes](#)

Juan Duchesne, Sharven Taghavi, August Houghton, Mansoor Khan, Bruno Perreira, Bryan Cotton, Danielle Tatum, Megan Brenner, Paula Ferrada, Tal Horer, David Kauvar, Andrew Kirkpatrick, Carlos Ordonez, Artai Priouzram, Derek Roberts, Damage Control Resuscitation Committee

Shock 2020 Feb 19; Online ahead of print.

Mortality secondary to trauma related hemorrhagic shock has not improved for several decades. Underlying the stall in progress is the conundrum of effective pre-hospital interventions for hemorrhage control. As we know, neither pressing hard on the gas nor "Stay and play" have changed mortality over the last 20 years. For this reason, when dealing with effective changes that will improve severe hemorrhage mortality outcomes, there is a need for the creation of a hybrid pre-hospital model. Improvements in mortality outcomes for patients with severe hemorrhage based on evidence for common civilian prehospital procedures such as in-field intubation and immediate fluid resuscitation with crystalloid solution is weak at best. The use of tourniquets, once considered too risky to use, however, has risen dramatically in large part due success seen during their use in the military. Their use in the civilian setting shows promising results. Recently updated military Advanced Resuscitative Care (ARC) guidelines propose the use of prehospital whole blood transfusion as well as in-field use of Zone 1 Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA). Several case studies from Europe suggest these strategies are feasible for use in the civilian population, but could they be implemented in the U.S.?

[Point-of-care ultrasound at Role 1: is it time for a rethink?](#)

Patrick G A Duncan, J Mackey

BMJ Mil Health 2020 May 20;Online ahead of print

Introduction: The past 20 years have seen a rapid increase in point-of-care ultrasound (POCUS) use in the prehospital sphere. However, in the British Army there is no POCUS capability in the Defence Primary Healthcare (DPHC) or deployed Role 1 setting. POCUS can improve diagnostic capability, influence management decisions and transfer destination, and is a useful triage tool in mass casualty management.

Method: A survey on POCUS use was sent to 279 clinicians working in the Role 1, civilian prehospital and Defence Primary Healthcare environments. Questions explored current levels of experience and training, indications for use and attitudes towards roll out. Results were analysed using a mixed methods approach.

Results: There were 124 respondents (279 recipients; 44.4% response rate). 74.2% (92 respondents) had no experience of using POCUS while 9.7% (12 respondents) were classed as frequent users. The four most common indications for prehospital POCUS were abdominal, cardiac and lung imaging and vascular access. The majority of respondents felt that POCUS would add value in the deployed Role 1 environment; this was even more evident in the frequent user group. Common concerns were difficulty maintaining currency, governance burden and uncertainty over impact on management.

Conclusion: The majority of doctors surveyed feel that POCUS would add value at Role 1 and is a capability that should be developed. The authors will watch with interest the progress of Project MORPHO.

Traumatic injury results in prolonged circulation of ultralarge von Willebrand factor and a reduction in ADAMTS13 activity

Mitchell R Dyer, William E Plautz, Margaret V Ragni, Wyeth Alexander, Shannon Haldeman, Jason L Sperry, Francis X Guyette, Brian S Zuckerbraun, Marian A Rollins-Raval, Jay S Raval, Matthew D Neal, A TACTIC Publication

Transfusion 2020 Jun;60(6):1308-1318

Background: Increases in plasma von Willebrand Factor (VWF) levels, accompanied by decreases in the metalloprotease ADAMTS13, have been demonstrated soon after traumatic injury while downstream effects remain unclear.

Study design and methods: A cohort of 37 injured trauma patients from a randomized control trial investigating the use of prehospital plasma transfusion were analyzed for activity and antigen levels of ADAMTS13 and VWF at 0 and 24 hours after admission. Relevant clinical data were abstracted from the medical records. Trauma patient plasma was analyzed via agarose gel electrophoresis to evaluate the effects of injury on VWF multimer composition compared to healthy controls.

Results: von Willebrand factor levels were elevated at presentation (189% [110%-263%] vs. 95% [74%-120%]), persisting through 24 hours (213% [146%-257%] vs. 132% [57%-160%]), compared to healthy controls. Ultralarge VWF (UL-VWF) forms were elevated in trauma patients at both 0 and 24 hours, when compared to pooled normal plasma (10.0% [8.9%-14.3%] and 11.3% [9.1%-21.2%], respectively, vs. 0.6%). Circulating plasma ADAMTS13 activity was decreased at 0 hours (66% [47%-86%] vs. 100% [98%-100%]) and at 24 hours (72.5% [56%-87.3%] vs. 103% [103%-103%]) in trauma patients. ADAMTS13 activity independently predicted the development of coagulopathy and correlated with international normalized ratio, thromboelastography values, injury severity, and blood product transfusion.

Conclusion: Traumatic injury is associated with acute coagulopathy that is characterized by increased UL-VWF multimers and reduction in ADAMTS13, which correlates with blood loss, transfusion requirement, and injury severity. These findings suggest the potential for future trials targeting ADAMTS13 repletion to enhance clearance of VWF multimers.

[Canine Tactical Combat Casualty Care \(K9TCCC\) Guidelines](#)

Thomas H Edwards, Lee E Palmer, Rebecca L Baxter, Thomas C Sager, James G Coisman, Jamie C Brown, Clinton George, Andrew C McGraw

J Spec Oper Med Spring 2020;20(1):101-111.

First introduced in 1996, Tactical Combat Casualty Care (TCCC) redefined prehospital, point-of-injury (POI), battlefield trauma care for the human combat casualty. Today, many consider TCCC as one of the most influential interventions for reducing combat-related case fatality rates from preventable deaths in human combat casualties. Throughout history, Military Working Dogs (MWDs) have proved and continue to prove themselves as force multipliers in the success of many military operations. Since the start of the Global War on Terror in 2001, these elite canine operators have experienced an upsurge in combat-related deployments, placing them at a higher risk for combat-related injuries. Until recently, consensus-based Canine-TCCC (K9TCCC) guidelines for POI battlefield trauma care did not exist for the MWD, leaving a critical knowledge gap significantly jeopardizing MWD survival. In 2019, the Canine Combat Casualty Care Committee was formed as an affiliate of the Committee on Tactical Combat Casualty Care with the intent of developing evidence-based, best practice K9TCCC guidelines. Modeled after the same principles of the human TCCC, K9TCCC focuses on simple, evidence-based, field-proven medical interventions to eliminate preventable deaths and to improve MWD survival. Customized for the battlefield, K9TCCC uniquely adapts the techniques of TCCC to compensate for canine-specific anatomic and physiological differences.

[Superficial Stab Wound to Zone I of the Neck Resulting in Thyrocervical Trunk Pseudoaneurysm Presented as Recurrent Hemothorax and Successfully Managed by Coil Embolization](#)

Adel Elkbuli, Saamia Shaikh, John D Ehrhardt Jr, Mark McKenney, Dessy Boneva.

Am J Case Rep 2020 Mar 8;21:e920196

BACKGROUND Thyrocervical trunk pseudoaneurysms are rare complications that have been documented after internal jugular or subclavian venous cannulation. Even less common, these pseudoaneurysms can arise after blunt or penetrating trauma. Clinical hallmarks include an expanding supraclavicular mass with local compressive symptoms such as paresthesias, arterial steal syndrome, and Horner's syndrome. Patients may be asymptomatic, however, or present with overlying ecchymosis or the presence of a new bruit or thrill. With the risk of rupture, thyrocervical trunk pseudoaneurysm is associated with significant morbidity and mortality. **CASE REPORT** We report the case of a 27-year-old man who presented after sustaining a self-inflicted stab wound to zone I of his neck. Initial examination revealed only a superficial small laceration, but a chest x-ray revealed a pneumothorax, and tube thoracostomy returned 300 mL of bloody output. After resolution of the hemothorax and removal of the thoracostomy tube, the patient reaccumulated blood, requiring a repeat tube thoracostomy. Angiography at that time revealed a pseudoaneurysm of the thyrocervical trunk, and coil embolization was performed to obliterate the pseudoaneurysm. **CONCLUSIONS** Thyrocervical trunk pseudoaneurysms can be asymptomatic, often have a delayed presentation, and can be life-threatening due to the risk of rupture and subsequent hemodynamic decline or airway compromise. While these pseudoaneurysms are well-known complications of deep penetrating injuries, they can also present following superficial penetrating injury to zone I of the neck. Selective angiography is the imaging modality of choice. Open surgical repair was traditionally the criterion standard for treatment; however, endovascular approaches are minimally invasive, feasible, and safer alternatives with reduced complications and are becoming more common.

The Efficacy of Novel Commercial Tourniquet Designs for Extremity Hemorrhage Control: Implications for Spontaneous Responder Every Day Carry

Joshua Ellis, Melissa M Morrow, Alec Belau, Luke S Sztajnkrycer, Jeffrey N Wood, Tobias Kummer, Matthew D Sztajnkrycer

Prehosp Disaster Med 2020 Jun;35(3):276-280

Introduction: Tourniquets (TQs) save lives. Although military-approved TQs appear more effective than improvised TQs in controlling exsanguinating extremity hemorrhage, their bulk may preclude every day carry (EDC) by civilian lay-providers, limiting availability during emergencies.

Study objective: The purpose of the current study was to compare the efficacy of three novel commercial TQ designs to a military-approved TQ.

Methods: Nine Emergency Medicine residents evaluated four different TQ designs: Gen 7 Combat Application Tourniquet (CAT7; control), Stretch Wrap and Tuck Tourniquet (SWAT-T), Gen 2 Rapid Application Tourniquet System (RATS), and Tourni-Key (TK). Popliteal artery flow cessation was determined using a ZONARE ZS3 ultrasound. Steady state maximal generated force was measured for 30 seconds with a thin-film force sensor.

Results: Success rates for distal arterial flow cessation were 89% CAT7; 67% SWAT-T; 89% RATS; and 78% TK (H 0.89; P = .83). Mean (SD) application times were 10.4 (SD = 1.7) seconds CAT7; 23.1 (SD = 9.0) seconds SWAT-T; 11.1 (SD = 3.8) seconds RATS; and 20.0 (SD = 7.1) seconds TK (F 9.71; P <.001). Steady state maximal forces were 29.9 (SD = 1.2) N CAT7; 23.4 (SD = 0.8) N SWAT-T; 33.0 (SD = 1.3) N RATS; and 41.9 (SD = 1.3) N TK.

Conclusion: All novel TQ systems were non-inferior to the military-approved CAT7. Mean application times were less than 30 seconds for all four designs. The size of these novel TQs may make them more conducive to lay-provider EDC, thereby increasing community resiliency and improving the response to high-threat events.

Endotracheal tube fixation time: a comparison of three fixation methods in a military field scenario

Danny Epstein, R Strashewsky, A Furer, A M Tsur, J Chen, A Lehavi

BMJ Mil Health 2020 Mar 23;bmjilitary-2020-001402.

Introduction: Endotracheal intubation is required in many emergency, trauma and prehospital scenarios. Endotracheal tube (ETT) fixation must be stable and quick to apply to enable rapid evacuation and patient transport. This study compares performance times of three common ETT securement techniques which are practical for out-of-hospital and combat scenarios.

Methods: We compared the time required by military medics to complete ETT fixation in three techniques—fixation of a wide gauze roll wrapped twice around the head and tied twice around the ETT (GR), using a Thomas Tube Holder (TH) and using a pre-tied non-adhesive tape (PT). 300 military medics were randomised to apply one technique each on a manikin, and time to completion was recorded.

Results: 300 ETTs were successfully fixated by 300 military medics. Median times to complete ETT fixation by PT and TH techniques were 24 s (IQR (19 to 31) and (IQR 20 to 33), respectively). Both were significantly shorter to apply than the GR technique, with a median time of 57 s (IQR 47 to 81), $p < 0.001$.

Conclusions: In time critical situations such as combat, severe trauma, mass casualties and whenever rapid evacuation might improve the clinical outcome, using a faster fixation technique such as Thomas Tube Holder or a pre-tied non-adhesive tape might enable faster evacuation than the use of traditional endotracheal tube fixation techniques.

[Aeromedical evacuation: experiences from the UK military level 2 hospital in Bentiu, South Sudan, during Op TRENTON](#)

Leanne Jane Eveson, W Nevin, N Cordingley, M Almond

BMJ Mil Health 2020 Apr 27;bmjmilitary-2020-001448

Introduction: Aeromedical Evacuation (AE) is a vital role of the Defence Medical Services (DMS). With a far-reaching defence global footprint, an AE capability is crucial to enable movement of patients in the fastest, safest and least stressful way that meets or exceeds the level of care an injured or ill person may expect to receive in the UK. Operation (Op) TRENTON is a UK military humanitarian operation in support of the United Nations (UN) Mission in South Sudan.

Methods: A retrospective analysis was carried out of all patients who underwent AE from the UK level 2 hospital at Bentiu during Op TRENTON over a 17-month period from June 2017 to October 2018.

Results: 14 patients underwent AE. The median age was 36 (22-64) years and all patients were male. 21% of AEs were for UK personnel and 79% were for UN personnel. 29% of AEs were due to non-battle injury with the remainder due to disease. Musculoskeletal was the largest diagnostic group (n=4) followed by respiratory (n=3), cardiovascular (n=2), undifferentiated febrile illness (n=2), neurology (n=1), renal medicine (n=1) and psychiatry (n=1).

Conclusions: Patients requiring AE from the level 2 hospital at Bentiu mostly had musculoskeletal and medical pathology, a stark contrast to the trauma patient cohort from operations in the past. The majority of patients had definitive care under the medical team highlighting the requirement for DMS physicians and the AE team, to be trained in acute, general and aviation medicine. The majority of AE moves were for UN personnel and on UN airframes, highlighting the importance of a sound understanding of the nations we are working with.

[Freeze-dried plasma in major haemorrhage: a systematic review](#)

Solveig Johanna Feuerstein, Kamilla Skovmand, Ann Merete Møller, Kim Wildgaard

Vox Sang 2020 May;115(4):263-274

Background and objectives: Freeze-dried plasma (FDP) has logistical advantages in terms of storage and reconstitution time compared to fresh-frozen plasma. In vitro studies show FDP to be equivalent to fresh-frozen plasma regarding coagulation and clotting capacities. FDP is used in an increasing number of countries. We wanted to evaluate the clinical effects of FDP in major haemorrhage compared to standard care.

Methods: MEDLINE, Embase, Central, Biosis Previews, WHO ICTRP, Clinical Trials and Open Grey were systematically searched from inception until September 2018, without language restriction. Studies were eligible if they examined haemorrhagic adult patients transfused with FDP. Our primary outcome was mortality. Two reviewers independently assessed studies for eligibility, extracted data and assessed bias.

Results: Nine studies were eligible for inclusion. Three studies had a comparison group: one was a randomized controlled trial and two were before and after comparisons. Six studies were uncontrolled. A total of 606 patients received FDP, while 72 patients received non-FDP transfusion. In total, five minor adverse effects were documented. Two studies compared FDP to fresh-frozen plasma and found no difference in 30-day mortality between the groups. The included studies were heterogenous and had several methodological weaknesses, such as no control group, missing data or no protocol.

Conclusions: The available research does not document the clinical effects of FDP. We cannot recommend or discourage use of FDP in major haemorrhage on base of available research.

The Role of Tranexamic Acid (TXA) in Military Trauma: Current Practices and Implications for the Future

Hugh W Finlayson

Traumatology (Tallahass Fla) 2018;0:2018.

Objectives: To review current literature on the use of Tranexamic acid in battlefield trauma to assess its effects on mortality and determine whether or not it should become more widely used in both civilian and military trauma. A subsection was to look at the feasibility of administering Tranexamic acid in a pre-hospital setting to minimise the time between injury and drug administration.

Methods: A search of the literature was performed on a variety of databases using the terms described in table 1. The papers were then reviewed and analysed regarding the effects of the drug in trauma.

Patients: The papers selected reviewed 21,160 patients as detailed in Table 2. These patients were across both military and civilian trauma units.

Outcomes: The main outcomes being examined were the effects on short term mortality at 24 and 48 hours and whether there was any increase in the thromboembolic risk associated with the administration of Tranexamic acid.

Results: The review of the literature showed that Tranexamic acid had a significant effect on improving mortality across the board (17.4% vs 23.9% mortality ($p = 0.03$)). This was most marked in the more severely injured who had received over 10 units of transfused blood (14.4% vs 28.4% mortality ($p = 0.004$)). In terms of side effects Tranexamic acid was shown to be safe in large doses, which is key for battlefield administration where there is a tendency to err on the side of overtreating. Interestingly, the risk of thromboembolic events was similar to those not receiving Tranexamic acid.

Conclusions: Tranexamic acid is a very safe and effective means of improving survival when used in combination with current practices involving the use of blood products and surgical interventions. Tranexamic acid can safely be administered in the pre-hospital setting to minimise the delay between injury and treatment. The use of Tranexamic acid should be incorporated into trauma management across the board in the both military and civilian cases particularly in the most severe cases.

[Implementation of a low titer group O whole blood program for a law enforcement tactical team](#)

Andrew D Fisher, John Dunn, Jason R Pickett, Justine Garza, Ethan A Miles, Vivian Diep, Mark Escott

Transfusion 2020 Jun;60 Suppl 3:S36-S44

The Texas Ranger Special Operations Group (SOG) performs high-risk warrant service and responds to callouts for evolving kinetic situations and special missions as required. These operations may occur many hours from a trauma center. Fresh whole blood (FWB) transfusions may offer a stopgap for those who are critically injured. To make FWB transfusions a viable option, several steps must be implemented. The following lays out how the Texas Ranger SOG will implement and conduct FWB transfusions using low titer group O whole blood. The techniques outlined may be useful for communities that may face critical blood shortage in disasters.

VALIDATION OF A NOVEL PARTIAL REBOA DEVICE IN A SWINE HEMORRHAGIC SHOCK MODEL: FINE TUNING FLOW TO OPTIMIZE BLEEDING CONTROL AND REPERFUSION INJURY

Dominic Forte, Woo S Do, Jessica B Weiss, Rowan R Sheldon, John P Kuckelman, Benjamin A Cook, Tiffany C Levine, Matthew J Eckert, Matthew J Martin

J Trauma Acute Care Surg 2020 Apr 8; Online ahead of print

Objectives: Partial restoration of aortic flow during REBOA is advocated by some to mitigate distal ischemia. Our lab has validated the mechanics and optimal partial REBOA flow rates using a prototype device (pREBOA). We hypothesize that pREBOA will increase survival when compared to full REBOA (fREBOA) in prolonged non-operative management of hemorrhagic shock.

Methods: 20 swine underwent placement of aortic flow probes, zone 1 REBOA placement, and 20% blood volume hemorrhage. They were randomized to either solid organ (SOI) or abdominal vascular (AVI) injury. The pREBOA arm (10 swine) underwent full inflation for 10min, then deflation to a flow rate of 0.5L/min for 2hr. The fREBOA arm (10 swine) underwent full inflation for 60min, followed by deflation/resuscitation. The primary outcome is survival, secondary outcomes are serologic/pathologic signs of ischemia-reperfusion injury and quantity of hemorrhage.

Results: 2/10 swine survived in the fREBOA group (2/5 SOI, 0/5 AVI) v. 7/10 surviving in the pREBOA group (3/5 SOI, 4/5 AVI). Survival was increased ($p=.03$) and hemorrhage was higher in the pREBOA group (SOI $1.36\pm.25\text{kg}$ v. $0.70\pm.33\text{kg}$, $p = 0.007$; $0.86\pm.22\text{kg}$ v. $0.71\pm.28\text{kg}$, not significant). Serum evidence of ischemia was greater with fREBOA, but this was not significant (e.g. Lactate 16.91 ± 3.87 mg/dL v. 12.96 ± 2.48 mg/dL at 120min, not significant). Swine treated with pREBOA that survived demonstrated trends towards lower ALT, lower potassium, and higher calcium. The potassium was significantly lower in survivors at 60min and 90min time points (5.97 ± 0.60 v. 7.53 ± 0.90 , $p=.011$; 6.67 ± 0.66 v. 8.15 ± 0.78 , $p=.029$). Calcium was significantly higher at 30min, 60min, 90min (8.56 ± 0.66 v. 7.50 ± 0.40 , $p=.034$; 8.63 ± 0.62 v. 7.15 ± 0.49 , $p=.019$; 8.96 ± 0.64 v. 7.00 , $p=.028$).

Conclusion: Prolonged pREBOA at a moderate distal flow rate provided adequate hemorrhage control, improved survival, and had evidence of decreased ischemic injury versus fREBOA. Prophylactic aggressive calcium supplementation may have utility prior to and during the reperfusion phase.

Study type: Basic Science (Original Article) LEVEL OF EVIDENCE: III.

Prehospital Point of Care Testing for the Early Detection of Shock and Prediction of Lifesaving Interventions

Samuel M Galvagno Jr, Robert A Sikorski, Douglas J Floccare, Peter Rock, Michael A Mazzeffi, Joseph J DuBose, Thomas M Scalea, Catriona Miller, Justin E Richards, James V O'Connor, Colin F Mackenzie, Peter Hu

Shock 2020 May 21; Online ahead of print

Introduction: Early diagnosis and treatment are essential for enhancing outcomes for the traumatically injured. In this prospective prehospital observational study, we hypothesized that a variety of laboratory results measured in the prehospital environment would predict both the presence of early shock and the need for LSIs for adult patients with traumatic injuries.

Methods: Adult trauma patients flown by a helicopter emergency medical service were prospectively enrolled. Using an i-STAT® portable analyzer, data from sixteen laboratory tests were collected. Vital signs data were also collected. Outcomes of interest included detection of shock, mortality, and requirement for lifesaving interventions (LSIs). Logistic regression, including a Bayesian analysis, was performed.

Results: Among 300 patients screened for enrollment, 261 had complete laboratory data for analysis. The majority of patients were male (75%) with blunt trauma (91.2%). The median injury severity score was 29 (IQR, 25-75) and overall mortality was 4.6%. A total of 170 LSIs were performed. The median lactate for patients who required a LSI was 4.1 (IQR, 3-5.4). The odds of requiring a LSI within the first hour of admission to the trauma center was highly associated with increases in lactate and glucose. A lactate level > 4 mmol/L was statistically associated with greater sensitivity and specificity for predicting the need for a LSI compared to shock index.

Conclusions: In this prospective observational trial, lactate outperformed static vital signs, including shock index, for detecting shock and predicting the need for LSIs. A lactate level > 4 mmol/L was found to be highly associated with the need for LSIs.

[Association of resuscitative endovascular balloon occlusion of the aorta \(REBOA\) and mortality in penetrating trauma patients](#)

Alberto F García, Ramiro Manzano-Nunez, Claudia P Orlas, Juan Ruiz-Yucuma, Alejandra Londoño, Camilo Salazar, Juan Melendez, Álvaro I Sánchez, Juan Carlos Puyana, Carlos A Ordoñez

Eur J Trauma Emerg Surg 2020 Apr 16. doi: 10.1007/s00068-020-01370-9

Purpose: The purpose of this study was to examine the association of REBOA and mortality in a group of patients with penetrating trauma to the torso, treated in a level-I trauma center from Colombia.

Methods: In a retrospective cohort study, patients with penetrating trauma, requiring emergency surgery, and treated between 2014 and 2018, were included. The decision to use or not use REBOA during emergent surgery was based on individual surgeon's opinion. A propensity score (PS) was calculated after adjusting for age, clinical signs on admission (systolic blood pressure, cardiac rate, Glasgow coma scale), severe trauma in thorax and abdomen, and the presence of non-compressive torso hemorrhage. Subsequently, logistic regression for mortality was adjusted for the number of red blood cells (RBC) transfused within the first six hours after admission, injury severity score (ISS), and quintiles of PS.

Results: We included 345 patients; 28 of them (8.1%) were treated with REBOA. Crude mortality rates were 17.9% (5 patients) in REBOA group and 15.3% (48 patients) in control group ($p = 0.7$). After controlling for RBC transfused, ISS, and the PS, the odds of death in REBOA group was 78% lower than that in the control group (odds ratio [OR] 0.20, 95% confidence interval [95%CI] 0.05-0.77, $p = 0.01$).

Conclusion: We found that, when compared to no REBOA use, patients treated with REBOA had lower risk-adjusted odds of mortality. These findings should be interpreted with caution and confirmed in future comparative studies, if possible.

[Tranexamic Acid; A Glittering Player in the Field of Trauma](#)

Fariborz Ghaffarpasand, Hamid Reza Abbasi, Shahram Bolandparvaz, Shahram Paydar,
Maryam Dehghankhalili

Bull Emerg Trauma 2020 Apr;8(2):53-55

No abstract available

Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) for Thoracic Trauma: A Translational Swine Study

Jacob J Glaser, Leslie E Neidert, Clifford G Morgan, Megan Brenner, Kyle S Stigall, Sylvain Cardin

J Trauma Acute Care Surg 2020 Apr 16; Online ahead of print.

Non-compressible torso hemorrhage in trauma is particularly lethal. Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) has the potential to stabilize these patients, but currently is contraindicated for major thoracic bleeding. The goal of this study was to evaluate the effect of REBOA on the hemodynamic and metabolic profile as well as its effect on early survival in a porcine model of thoracic hemorrhage and shock.

Methods: Forty-eight (48) male Yorkshire swine (60-80kg) underwent 30% hemorrhage and were randomized to three thoracic injuries, with and without Zone 1 REBOA occlusion: pulmonary parenchymal injury (PI), thoracic venous injury (VI), or subclavian artery injury (AI). Following hemorrhage, thoracic injuries were induced (T0) and allowed to bleed freely. REBOA groups had Zone 1 occlusion after the thoracic injury, with deflation at T30. All groups had whole blood resuscitation at T30 and were euthanized at T90. Survival, total blood loss, mean arterial pressure (MAP), end tidal CO₂ (EtCO₂), and arterial blood gas parameters were analyzed. Statistical significance was determined by t-tests and two-way repeated measures ANOVA.

Results: The use of REBOA improved the hemodynamics in all three injury patterns, with no differences observed in the outcomes of short-term survival and thoracic blood loss between the REBOA and non-REBOA groups. All groups showed equivalent changes in markers of shock (pH, HCO₃, and Base Excess) prior to resuscitation.

Conclusion: In this animal study of hemorrhage and major thoracic bleeding, the addition of Zone 1 REBOA did not significantly affect short-term survival or blood loss, while providing hemodynamic stabilization. Therefore in non-compressible thoracic bleeding, without immediate surgical capability, long-term outcomes may be improved with REBOA, and thoracic hemorrhage should not be considered contraindications to REBOA use.

Level of evidence: Level I Therapeutic/Care Management Study.

Successful endotracheal intubation following a failed first attempt during aeromedical retrieval

John Glasheen, Jeff Hooper, Andrew Donohue, Emmeline Finn, Bronwyn Murray-Smith, Renée Bolot, Mark Edwards

Emerg Med J 2020 May;37(5):314-318

Introduction: First attempt intubation success is used by many prehospital services as a marker of quality and safety. An increasing complication rate is associated with repeated intubation attempts. The aim of this study was to identify changes to intubation technique following a failed intubation attempt.

Methods: LifeFlight Retrieval Medicine provides aeromedical retrieval services in Queensland, Australia. This retrospective study identified cases of failed intubation attempts from an electronic database registry over a 41-month period from March 2015 to July 2018. These data were analysed using descriptive statistics.

Results: Of the 762 patients who required intubation 758 (99.5%) were successfully intubated, with 684 intubated at the first attempt (89.8%; 95% CI: 0.87 to 0.92). There was no difference in first attempt success between direct and video laryngoscopy (511/563 (90.8%) vs 172/194 (88.6%) $p=0.38$), trauma or medical (374/419 (89.3%) vs 310/343 (90.4%), $p=0.61$), primary or interhospital missions (329/370 (88.7%) vs 355/392 (90.8%), $p=0.33$). 78 cases of failed first attempt intubations were identified. In 65 of these cases, intubation was successful at the second attempt. A single change was made to the intubation procedure prior to a second successful attempt in 28/78 cases (35.9%), and more than one change was made in 41/78 (52.6%). The changes included the operator, intubation device, patient position, intubating aid and external laryngeal manipulation. No change between attempts was recorded in 9/78 (11.5%). 9 cases were successfully intubated at the third attempt, and changes prior to the third attempt included operator, device and intubating aid.

Conclusion: Although a high overall intubation success was found, one in ten patients who were intubated had a failed first attempt. The majority of successful subsequent attempts were preceded by at least one change to intubating technique. Intubating clinicians need the ability to identify and correct issues leading to a failed first attempt.

[Brief report on combat trauma surgical training using a perfused cadaver model](#)

Daniel Grabo, Travis Polk, Michael Minneti, Kenji Inaba, Demetrios Demetriades

J Trauma Acute Care Surg 2020 Aug;89(2S Suppl 2):S175-S179

Background: Surgical combat casualty care presents difficult training challenges. Although several high-fidelity simulation (SIM) techniques have emerged, none are able to fully integrate the many intricacies involved in the care of a complex trauma patient. Herein, we report the use of perfused fresh human cadaver model for training and assessment of forward surgical teams (FSTs).

Methods: Forward surgical teams attend a 4-day combat trauma surgical skills course including focused on trauma exposures. A half-day SIM involves the entire surgical team in four sequential surgical scenarios that involve the neck, chest, abdomen, and extremities, as well as airway management and resuscitation. Teams undergo immediate debriefing and videotape review of team dynamics and technical skills, as well as times to completion of critical interventions.

Results: The data evaluated include five initial demonstration courses in which training metrics were available. Each team included both a junior and experienced surgeon, anesthesiologists, and surgical scrub technicians. As FSTs progressed through SIMs, they demonstrated improvements in team dynamics and technical skills evaluations. There was considerable variability in the times to completion of critical intervention, particularly for control of cardiac and vascular injuries.

Conclusion: Initial evaluations support the use of this novel perfused cadaver model for the training and evaluation of military FSTs. Preliminary data highlight the utility for open vascular, thoracic, and other high-acuity/low-volume procedures critical to combat casualty care. Larger studies are needed for model optimization and further validation of an objective structured technical assessment tool.

Level of evidence: Care management, level V.

Ketamine as an Anesthetic for Patients with Acute Brain Injury: A Systematic Review

Mads Christian Tofte Gregers, Søren Mikkelsen, Katrine Prier Lindvig, Anne Craveiro Brøchner

Neurocrit Care 2020 Aug;33(1):273-282

For years, the use of ketamine as an anesthetic to patients suffering from acute brain injury has been debated because of its possible deleterious effects on the cerebral circulation and thus on the cerebral perfusion. Early studies suggested that ketamine could increase the intracranial pressure thus lowering the cerebral perfusion and hence reduce the oxygen supply to the injured brain. However, more recent studies are less conclusive and might even indicate that patients with acute brain injury could benefit from ketamine sedation. This systematic review summarizes the evidence regarding the use of ketamine in patients suffering from traumatic brain injury. Databases were searched for studies using ketamine in acute brain injury. Outcomes of interest were mortality, intracranial pressure, cerebral perfusion pressure, blood pressure, heart rate, spreading depolarizations, and neurological function. In total 11 studies were included. The overall level of evidence concerning the use of ketamine in brain injury is low. Only two studies found a small increase in intracranial pressure, while two small studies found decreased levels of intracranial pressure following ketamine administration. We found no evidence of harm during ketamine use in patients suffering from acute brain injury.

CHARACTERIZATION OF UNEXPECTED SURVIVORS FOLLOWING A PREHOSPITAL PLASMA RANDOMIZED TRIAL

Danielle S Gruen, Frank X Guyette, Joshua B Brown, Brian J Daley, Richard S Miller, Brian G Harbrecht, Jeffrey A Claridge, Herb A Phelan, Mark H Yazer, Matthew D Neal, Brian S Zuckerbraun, Jason L Sperry

J Trauma Acute Care Surg 2020 May 27; Online ahead of print.

Background: Prehospital plasma improves survival for severely injured trauma patients transported by air ambulance. We sought to characterize the unexpected survivors, patients who survived despite having high predicted mortality following traumatic injury.

Methods: The Prehospital Air Medical Plasma (PAMPer) trial randomized severely injured patients (n=501) to receive either standard care (crystalloid) or two units of prehospital plasma followed by standard care fluid resuscitation. We built a generalized linear model to estimate patient mortality. Area under the receiver operating characteristic curve (AUC) was used to evaluate model performance. We defined unexpected survivors as patients who had a predicted mortality >50% and survived to 30 days. We characterized patient demographics, clinical features, and outcomes of the unexpected survivors. Observed to expected (O/E) ratios and Z-statistics were calculated using model-estimated mortality for each cohort.

Results: Our model predicted mortality better than ISS or RTS parameters and identified 36 unexpected survivors. Compared to expected survivors, unexpected survivors were younger (33 [24, 52] vs. 47 [32, 59] years, $P=0.013$), were more severely injured (ISS 34 [22, 50] vs. 18 [10, 27], $P<0.001$), had worse organ dysfunction and hospital resource outcomes (MOF, ICU and hospital length of stay, and ventilator days), and were more likely to receive prehospital plasma (67 vs. 46%, $P=0.031$). Nonsurvivors with high predicted mortality were more likely to receive standard care resuscitation ($P<0.001$). Unexpected survivors who received prehospital plasma had a lower observed to expected mortality than those that received standard care resuscitation (O/E 0.56 [0.33-0.84] vs. 1.0 [0.73-1.32]). The number of prehospital plasma survivors (24) exceeded the number of predicted survivors (n=10) estimated by our model ($P<0.001$).

Conclusions: Prehospital plasma is associated with an increase in the number of unexpected survivors following severe traumatic injury. Prehospital interventions may improve the probability of survival for injured patients with high predicted mortality based on early injury characteristics, vital signs, and resuscitation measures. Secondary Analysis LEVEL OF EVIDENCE: II.

[Emergency Care Provided by the Israeli Military Airborne Combat Evacuation Unit during Helicopter Winch Rescue Operations](#)

Ariel Guinzburg, Danny Epstein, Jonathan Cohen, Shai Kiso, Eliad Aviram, Shachar Shapira, Itai Shavit 1, Asaf Miller

Prehosp Emerg Care. 2020 May 1; Online ahead of print

Objectives: The objective of this study was to evaluate the emergency care provided by the Israeli Military Airborne Combat Evacuation Unit (MACEU) during helicopter winching operations.

Methods: A retrospective cohort study was performed of all patients rescued by winching by the MACEU between December 2011 and October 2018. Data were extracted from the electronic medical records of the unit registry. The data collected included helicopter type, scene times, demographics, mechanism of injury, interventions, medications, and survival.

Results: During the study period, 208 civilians with a mean age of 36.8 ± 19.2 years were evacuated from inaccessible areas, 192 were from difficult terrain, 10 from sea vessels, and 5 from floods. All patients were winched up with a crewmember. No patient or crewmember was injured during winching. Overall, 156/208 (75%) had a traumatic injury, and 52/208 (25%) had a medical emergency. Sikorsky UH-60 "BlackHawk" helicopters and Sikorsky CH-53 "Sea Stallion" helicopters were used in 179 and 28 operations, respectively. Eighteen different procedures were performed by the medical personnel of the unit on scene and en route. The most performed procedures were peripheral vascular access establishment (60.6%), fluids administration (57.7%), oxygen supplementation (42.8%), analgesia (39.9%) and spine immobilization (37.5%). On scene, none of the patients was treated with a physician-only intervention. Thirty/208 (14.5%) patients were winched-up in darkness conditions. Eleven/208 (5.3%) apneic breathing patients were winched up ventilated by a crewmember. All the six patients who had oxygen saturation $\geq 89\%$ after entrance into the cabin, survived.

Conclusions: The reported MACEU experience provides useful information on the clinical characteristics, medical interventions, and outcomes of patients rescued using a winching operation. Study findings emphasize the importance of airway management and ventilation during winching.

[Prehospital plasma is associated with distinct biomarker expression following injury](#)

Danielle S Gruen, Joshua B Brown, Francis X Guyette 3, Yoram Vodovotz, Pär I Johansson, Jakob Stensballe, Derek A Barclay, Jinling Yin, Brian J Daley, Richard S Miller, Brian G Harbrecht, Jeffrey A Claridge, Herb A Phelan, Matthew D Neal, Brian S Zuckerbraun, Timothy R Billiar, Jason L Sperry, PAMPer study group

JCI Insight 2020 Apr 23;5(8):e135350

BACKGROUND: Prehospital plasma improves survival in severely injured patients transported by air ambulance. We hypothesized that prehospital plasma would be associated with a reduction in immune imbalance and endothelial damage.

METHODS: We sampled blood from 405 trauma patients enrolled in the Prehospital Air Medical Plasma (PAMPer) trial upon hospital admission (0 hours) and 24 hours post admission across 6 U.S. sites. We assayed samples for 21 inflammatory mediators and 7 markers associated with endothelial function and damage. We performed hierarchical clustering analysis (HCA) of these biomarkers of the immune response and endothelial injury. Regression analysis was used to control for differences across study and to assess any association with prehospital plasma resuscitation.

RESULTS: HCA distinguished two patient clusters with different injury patterns and outcomes. Patients in cluster A had greater injury severity and incidence of blunt trauma, traumatic brain injury, and mortality. Cluster A patients that received prehospital plasma showed improved 30-day survival. Prehospital plasma did not improve survival in cluster B patients. In an adjusted analysis of the most seriously injured patients, prehospital plasma was associated with an increase in adiponectin, IL-1 β , IL-17A, IL-23, and IL-17E upon admission, and a reduction in syndecan-1, TM, VEGF, IL-6, IP-10, MCP-1, and TNF- α , and an increase in IL-33, IL-21, IL-23, and IL-17E 24 hours later.

CONCLUSION: Prehospital plasma may ameliorate immune dysfunction and the endotheliopathy of trauma. These effects of plasma may contribute to improved survival in injured patients.

TRIAL REGISTRATION: NCT01818427.

FUNDING: Department of Defense; National Institutes of Health, U.S. Army.

[Improved survival in critically injured combat casualties treated with fresh whole blood by forward surgical teams in Afghanistan](#)

Jennifer Gurney, Amanda Staudt, Andrew Cap, Stacy Shackelford, Elizabeth Mann-Salinas, Tuan Le, Shawn Nessen, Philip Spinella

Transfusion 2020 Jun;60 Suppl 3:S180-S188

Background: The objective of this study was to assess transfusion strategies and outcomes, stratified by the combat mortality index, of casualties treated by small surgical teams in Afghanistan. Resuscitation that included warm fresh whole blood (FWB) was compared to blood component resuscitation.

Study design and methods: Casualties treated by a Role 2 surgical team in Afghanistan from 2008 to 2014 who received 1 or more units of red blood cells (RBCs) or FWB were included. Patients were excluded if they had incomplete data or length of stay less than 30 minutes. Patients were separated into two groups: 1) received FWB and 2) did not receive FWB; moreover, both groups potentially received plasma, RBCs, and platelets. The analysis was stratified by critically versus noncritically injured patients using the prehospital combat mortality index. Kaplan-Meier plot, log-rank test, and multivariable Cox regression were performed to compare survival.

Results: In FWB patients, median units of FWB and total blood product were 4.0 (interquartile range [IQR], 2.0-7.0) and 16.0 (IQR, 10.0-28.0), respectively. The Kaplan-Meier plot demonstrated that survival was similar between FWB (79.1%) and no-FWB (74.5%) groups ($p = 0.46$); after stratifying patients by the combat mortality index, the risk of mortality was increased in the no-FWB group (hazard ratio, 2.8; 95% confidence interval, 1.2-6.4) compared to the FWB cohort.

Conclusion: In forward-deployed environments, where component products are limited, FWB has logistical advantages and was associated with reduced mortality in casualties with a critical combat mortality index. Additional analysis is needed to determine if these effects of FWB are appreciable in all trauma patients or just in those with severe physiologic derangement.

[Initial blood pressure is important for long-term outcome after traumatic spinal cord injury](#)

Mette Haldrup, Stig Dyrskog, Mathias Møller Thygesen, Hans Kirkegaard, Helge Kasch, Mikkel Mylius Rasmussen

J Neurosurg Spine 2020 Mar 20;1-5;Online ahead of print.

Objective: Patients with traumatic spinal cord injury (TSCI) are at risk of developing neurogenic shock that causes hypotension and thereby secondary injury to the spinal cord due to ischemia. Hemodynamic treatment of patients with acute TSCI remains inadequately elucidated. Guidelines for management are divergent and based on limited evidence. To this end, the authors evaluated whether mean arterial blood pressure (MABP) during the prehospital and initial hospital phases of TSCI treatment is correlated with long-term neurological outcome.

Methods: The authors performed a retrospective cohort study based on a chart review of MABP data collected during the prehospital transport, in the operating room (OR), and in the neurointensive care unit (NICU) during the first 7 days after trauma. Data from the NICU were divided into two periods: days 1-2 and days 3-7. Data were analyzed using Spearman's rank correlation to evaluate for any correlation between MABP and changes in the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) score 1 year postinjury. In the analysis, the MABP target value was 80 mm Hg. Hypotension was treated with metaoxedrin or norepinephrine. Statistically significant differences were evaluated using Spearman's rank correlation coefficient.

Results: The chart review yielded 129 patients treated for TSCI. The inclusion period was 2010-2017. For the prehospital transport measurements of MABP, the Spearman's rank correlation coefficient was a rho of 0.5662 ($p < 0.001$), for OR measurements it was a rho of 0.6818 ($p < 0.001$), and for the NICU measurements it was a rho of 0.4611 ($p < 0.001$); for NICU unit days 1-2 and days 3-7, the Spearman's rank correlation coefficient was a rho of 0.2209 ($p = 0.0681$).

Conclusions: Continuous MABP levels exceeding 80 mm Hg have a significant impact on neurological outcome—from earliest possible stabilization in the prehospital care, through hospital admission, the surgical phase, and into the first 2 days in the NICU.

[Role of the pre-hospital treatment team on the UK military exercise SAIF SAREEA 3](#)

Peter Nicholas Harper, N Taylor, P Royal, M B Smith

BMJ Mil Health 2020 Apr 28;Online ahead of print.

The prehospital treatment team (PHTT) involves a small team working under the clinical supervision of a clinical lead. The clinical lead can be a general duties medical officer (Post Foundation Years Doctor), military nurse practitioner or more senior clinician. The team is mounted in vehicles appropriate to the environment they expect to operate in. A PHTT is closely located to the front line reducing transportation timelines from the point of wounding to more definitive care. The PHTT can provide medical support on the move or when time is available; a more permanent fully erected treatment facility can be established. Either configuration can provide both trauma and primary care. The size of the team allows for multiple trauma subteams enabling care to casualties that arrive simultaneously. The PHTT can move independently which could leave the team vulnerable as there is no integral force protection within the current structure. In such a small team, the right balance of medical and soldiering skills among team members is essential to success. Exercise SAIF SAREEA 3 represented a large-scale battlegroup exercise to the Middle East in the austere desert of Oman. This provided an ideal environment for employing the PHTT concept in a large deployed force undertaking dynamic activity.

[An explorative, biomechanical analysis of spine motion during out-of-hospital extrication procedures](#)

David Häske, Lars Schier, Jeronimo O N Weerts, Berthold Groß, Adrian Rittmann, Paul A Grützner, Matthias Münzberg, Michael Kreinest

Injury 2020 Feb;51(2):185-192

Objectives: The extrication of patients following a road traffic collision is among the basic procedures in emergency medicine. Thus, extrication is a frequently performed procedure by most of the emergency medical services worldwide. The appropriate extrication procedure depends on the patient's current condition and accompanying injuries. A rapid extrication should be performed within a few minutes, and the cervical spine (at least) should be immobilized. To our knowledge, the scientific literature and current guidelines do not offer detailed recommendations on the extrication of injured patients. Thus, the aim of the current study is to compare the effectiveness of spinal stabilization during various out-of-hospital extrication procedures.

Methods: This is an explorative, biomechanical analysis of spine motion during different extrication procedures on an example patient. Movement of the cervical spine was measured using a wireless human motion tracker. Movement of the thoracic and lumbar spine was quantified with 12 strain gauge sensors, which were positioned paravertebrally on both sites along the thoracic and lumbar spine. To interpret angular movement, a motionscore was developed based on newly defined axioms on the biomechanics of the injured spine.

Results: Self-extrication showed the least spinal movement (overall motionscore sum = 667). Movement in the cervical spine could further be reduced by applying a cervical collar. The extrication by a rescue boa showed comparable results in overall spinal movement compared to the traditional extrication via spineboard (overall motionscore sum = 1862 vs. 1743). Especially in the cervical spine, the spinal movement was reduced (motionscore sum = 339 vs. 595). However, the thoracic spine movement was increased (motionscore sum = 812 vs. 432).

Conclusion: In case of a suspected cervical spine injury, guided self-extrication seems to be the best option. If the patient is not able to perform self-extrication, using a rescue boa might reduce cervical spinal movement compared to the traditional extrication procedure. Since promising results are shown in the case of extrication using a patient transfer sheet that has already been placed below the driver, future developments should focus on novel vehicle seats that already include an extrication device.

[A Comparison of Improvised and Commercially Available Point-of-Wounding Tourniquets in Simulated Traumatic Amputation with Catastrophic Hemorrhage](#)

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Mil Med 2020 May 19; Online ahead of print.

Introduction: Catastrophic hemorrhage is the leading cause of preventable trauma deaths in the military and civilian populations. The use of tourniquets by first responders (medical and nonmedically trained) is supported and has the potential to save lives if applied correctly.

Aims: We sought to examine the use of 5 tourniquets: 1 improvised and 4 commercially available tourniquets to investigate the time taken to stop simulated bleeding and to secure the device; evidence of rebleeding when the "blood pressure" was restored and to gain qualitative feedback on their application.

Materials and methods: Four commercially available tourniquets (Combat Application Tourniquet [C-A-T], Special Operations Forces Tactical Tourniquet - Wide (SOFTT-W), stretch, wrap, and tuck tourniquet [SWAT-T], and the Tourni-key) and an improvised tourniquet (tie & wooden spoon) were tested on a complex silicone simulation model used to replicate catastrophic hemorrhage from a blast injury with above traumatic knee amputation (SAM 4.1 Trauma Simulation Ltd, UK). To limit the user variability, the same investigator applied each tourniquet and each was tested 3 times. No ethical approval was required to conduct this study.

Results: None of the devices took longer than 1 minute to secure. The C-A-T and SOFTT-W were quickest to occlude and secure. Although the Tourni-key took longer statistically, this was unlikely to be a clinically important difference. Compared to the others, the SOFTT-W rebled on 2 out of 3 applications. The improvised tourniquet had an obvious ligature effect because of its narrowness, followed by the Tourni-key. This effect was least evident with the SWAT-T; however, particular care was needed to ensure it was safely secured as it was slippery when wet.

Conclusions: All tourniquets tested were effective and swift to apply. The Tourni-key's antipinch card seems helpful in reducing local pain under the windlass. Reinspection for rebleeding is important and should be routinely performed irrespective of the device. The width of the SWAT-T may be beneficial, thereby, reducing the risk of crush injury.

Reliability of prehospital patient classification in helicopter emergency medical service missions

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BMC Emerg Med 2020 May 25;20(1):42

Background: Several scores and codes are used in prehospital clinical quality registries but little is known of their reliability. The aim of this study is to evaluate the inter-rater reliability of the American Society of Anesthesiologists physical status (ASA-PS) classification system, HEMS benefit score (HBS), International Classification of Primary Care, second edition (ICPC-2) and Eastern Cooperative Oncology Group (ECOG) performance status in a helicopter emergency medical service (HEMS) clinical quality registry (CQR).

Methods: All physicians and paramedics working in HEMS in Finland and responsible for patient registration were asked to participate in this study. The participants entered data of six written fictional missions in the national CQR. The inter-rater reliability of the ASA-PS, HBS, ICPC-2 and ECOG were evaluated using an overall agreement and free-marginal multi-rater kappa (K_{free}).

Results: All 59 Finnish HEMS physicians and paramedics were invited to participate in this study, of which 43 responded and 16 did not answer. One participant was excluded due to unfinished data entering. ASA-PS had an overall agreement of 40.2% and K_{free} of 0.28 in this study. HBS had an overall agreement of 44.7% and K_{free} of 0.39. ICPC-2 coding had an overall agreement of 51.5% and K_{free} of 0.47. ECOG had an overall agreement of 49.6% and K_{free} of 0.40.

Conclusion: This study suggests a marked inter-rater unreliability in prehospital patient scoring and coding even in a relatively uniform group of practitioners working in a highly focused environment. This indicates that the scores and codes should be specifically designed or adapted for prehospital use, and the users should be provided with clear and thorough instructions on how to use them.

Who Would Have Benefited from the Prehospital Use of Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA)? An Autopsy Study

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J Am Coll Surg 2019 Oct;229(4):383-388

Background: Resuscitative endovascular balloon occlusion of the aorta (REBOA) has been increasingly used as part of damage control resuscitation for patients with non-compressible truncal hemorrhage. We hypothesized that there might be a select group of patients that could have benefited from prehospital placement of the REBOA.

Study design: This was a retrospective cohort study including patients who presented to a Level I trauma center with cardiac arrest between January 2014 and March 2018. The findings of a full autopsy were reviewed for the details of internal injuries. A patient was determined to be a REBOA candidate if the patient sustained abdominal organ injuries or pelvic fractures and no associated severe head injuries. The candidate group was compared with the non-candidate group based on prehospital vital signs and other patient characteristics. A multiple logistic regression analysis was performed to identify certain prehospital factors associated with candidacy for prehospital REBOA.

Results: A total of 198 patients met our inclusion criteria. Of those, 27 (13.6%) patients were deemed REBOA candidates. Median Injury Severity Score was 22 (interquartile range 17 to 29). Patients in the candidate group were more likely to have a Glasgow Coma Scale score ≥ 9 (48% vs 15%; $p = 0.012$), oxygen saturation $>90\%$ (56% vs 35%; $p = 0.03$), and systolic blood pressure <90 mmHg (48% vs 26%; $p = 0.04$) in the field. Logistic regression showed that these 3 clinical parameters of prehospital vital signs were significantly associated with REBOA candidacy.

Conclusions: Our data suggest that $>10\%$ of trauma patients who presented with cardiac arrest could have benefited from prehospital REBOA. Additional prospective studies are warranted to validate the use of field vital signs in selecting candidates.

[Pre-hospital CPR and early REBOA in trauma patients - results from the ABOTrauma Registry](#)

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World J Emerg Surg 2020 Mar 30;15(1):23

Background: Severely injured trauma patients suffering from traumatic cardiac arrest (TCA) and requiring cardiopulmonary resuscitation (CPR) rarely survive. The role of resuscitative endovascular balloon occlusion of the aorta (REBOA) performed early after hospital admission in patients with TCA is not well-defined. As the use of REBOA increases, there is great interest in knowing if there is a survival benefit related to the early use of REBOA after TCA. Using data from the ABOTrauma Registry, we aimed to study the role of REBOA used early after hospital admission in trauma patients who required pre-hospital CPR.

Methods: Retrospective and prospective data on the use of REBOA were collected from the ABOTrauma Registry from 11 centers in seven countries globally between 2014 and 2019. In all patients with pre-hospital TCA, the predicted probability of survival, calculated with the Revised Injury Severity Classification II (RISC II), was compared with the observed survival rate.

Results: Of 213 patients in the ABOTrauma Registry, 26 patients (12.2%) who had received pre-hospital CPR were identified. The median (range) Injury Severity Score (ISS) was 45.5 (25-75). Fourteen patients (54%) had been admitted to the hospital with ongoing CPR. Nine patients (35%) died within the first 24 h, while seventeen patients (65%) survived post 24 h. The survival rate to hospital discharge was 27% (n = 7). The predicted mortality using the RISC II was 0.977 (25 out of 26). The observed mortality (19 out of 26) was significantly lower than the predicted mortality (p = 0.049). Patients not responding to REBOA were more likely to die. Only one (10%) out of 10 non-responders survived. The survival rate in the 16 patients responding to REBOA was 37.5% (n = 6). REBOA with a median (range) duration of 45 (8-70) minutes significantly increases blood pressure from the median (range) 56.5 (0-147) to 90 (0-200) mmHg.

Conclusions: Mortality in patients suffering from TCA and receiving REBOA early after hospital admission is significantly lower than predicted by the RISC II. REBOA may improve survival after TCA. The use of REBOA in these patients should be further investigated.

[Enhanced prehospital volume therapy does not lead to improved outcomes in severely injured patients with severe traumatic brain injury](#)

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BMC Emerg Med 2019 Jan 23;19(1):13

Background: Whether enhanced prehospital volume therapy leads to outcome improvements in severely injured patients with severe traumatic brain injury (TBI) remains controversial. The aim of this study was to investigate the influence of prehospital volume therapy on the clinical course of severely injured patients with severe TBI.

Methods: Data for 122,672 patients from TraumaRegister DGU® (TR-DGU) was analyzed. Inclusion criteria were defined as follows: Injury Severity Score (ISS) ≥ 16 , primary admission, age ≥ 16 years, Abbreviated Injury Scale (AIS) head ≥ 3 , administration of at least one unit of packed red blood cells (pRBCs), and available volume and blood pressure data. Stratification based on the following matched-pair criteria was performed: group 1: prehospital volumes of 0-1000 ml; group 2: prehospital volumes of ≥ 1501 ml; AIS head (3, 4, 5 + 6 and higher than for other body regions); age (16-54, 55-69, ≥ 70 years); gender; prehospital intubation (yes/no); emergency treatment time +/- 30 min.; rescue resources (rescue helicopter, emergency ambulance); blood pressure (20-60, 61-90, ≥ 91 mmHg); year of accident (2002-2005, 2006-2009, 2010-2012); AIS thorax, abdomen, and extremities plus pelvis.

Results: A total of 169 patients per group fulfilled the inclusion criteria. Increasing volume administration was associated with reduced coagulation capability and reduced hemoglobin (Hb) levels (prothrombin ratio: group 1: 68%, group 2: 63.7%; $p \leq 0.04$; Hb: group 1: 11.2 mg/dl, group 2: 10.2 mg/dl; $p \leq 0.001$). It was not possible to show a significant reduction in the mortality rate with increasing volumes (group 1: 45.6, group 2: 45.6; $p = 1$).

Conclusions: The data presented in this study demonstrates that prehospital volume administration of more than 1500 ml does not improve severely injured patients with severe traumatic brain injury (TBI).

Early management of severe pelvic injury (first 24 hours)

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Anaesth Crit Care Pain Med 2019 Apr;38(2):199-207

Objective: Pelvic fractures represent 5% of all traumatic fractures and 30% are isolated pelvic fractures. Pelvic fractures are found in 10 to 20% of severe trauma patients and their presence is highly correlated to increasing trauma severity scores. The high mortality of pelvic trauma, about 8 to 15%, is related to actively bleeding pelvic injuries and/or associated injuries to the head, abdomen or chest. Regardless of the severity of pelvic trauma, diagnosis and treatment must proceed according to a strategy that does not delay the management of the most severely injured patients. To date, in France, there are no guidelines issued by healthcare authorities or professional societies that address this subject.

Design: A consensus committee of 22 experts from the French Society of Anaesthesia and Intensive Care Medicine (Société Française d'Anesthésie et de Réanimation; SFAR) and the French Society of Emergency Medicine (Société Française de Médecine d'Urgence; SFMU) in collaboration with the French Society of Radiology (Société Française de Radiologie; SFR), French Defence Health Service (Service de Santé des Armées; SSA), French Society of Urology (Association Française d'Urologie; AFU), the French Society of Orthopaedic and Trauma Surgery (Société Française de Chirurgie Orthopédique et Traumatologique; SOFCOT), and the French Society of Digestive Surgery (Société Française de Chirurgie digestive; SFCD) was convened. A formal conflict-of-interest (COI) policy was developed at the onset of the process and enforced throughout. The entire guidelines process was conducted independently from any industry funding. The authors were advised to follow the principles of the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system to guide assessment of quality of evidence. The potential drawbacks of making strong recommendations in the presence of low-quality evidence were emphasised.

Methods: Population, intervention, comparison, and outcomes (PICO) questions were reviewed and updated as needed, and evidence profiles were generated. The analysis of the literature and the recommendations were then conducted according to the GRADE® methodology.

Results: The SFAR Guideline panel provided 22 statements on prehospital and hospital management of the unstable patient with pelvic fracture. After three rounds of discussion and various amendments, a strong agreement was reached for 100% of recommendations. Of these recommendations, 11 have a high level of evidence (Grade 1 ±), 11 have a low level of evidence (Grade 2 ±).

Conclusions: Substantial agreement exists among experts regarding many strong recommendations for management of the unstable patient with pelvic fracture.

Current state of whole blood transfusion for civilian trauma resuscitation

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Transfusion 2020 Jun;60 Suppl 3:S45-S52

Background: Whole blood (WB) is rapidly emerging as the treatment modality of choice for the initial resuscitation of civilian trauma patients across the United States. The reemergence of WB has been rapid and driven in part by recognition of the importance of early plasma transfusion in the resuscitation process.

Study design and methods: The study was designed as a critical analysis of the available literature on WB transfusion in civilian trauma patients. Studies were included if they reported on transfusion of cold-stored WB used in a civilian setting and measured safety, feasibility, or a direct clinical outcome.

Results: Examination of the available literature supports the feasibility and safety of WB used in treatment of civilian trauma patients. The evidence regarding clinical outcomes, particularly with direct comparison to equivalent doses of component therapy, is more limited. The literature is predominantly descriptive and retrospective in nature and limited by the heterogeneity of clinical WB protocols being used. Based on this limited data set, there are limited conclusions that can be used to definitely support or refute the clinical superiority of WB to component therapy.

Conclusion: Current literature supports the safety and feasibility of WB, but prospective randomized trials comparing WB to component therapy are needed to provide the definitive evidence on this topic.

Demographics and Mortality Rates of Surgical Emergencies Treated at the Casualty Operation Theater: A Six-month Retrospective Analysis

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Cureus. 2020 Apr 13;12(4):e7658

Introduction: Emergencies such as appendicitis, peritonitis, road traffic accidents and gunshots require immediate surgical intervention. Patients are first resuscitated at the emergency department and then shifted to the casualty operation theater (COT). COT is a state-of-the-art operation theater that is open 24/7 and ready to deal with any surgical crisis. Once surgery is performed, the patients are admitted to the surgical ward for post-operative care. Jinnah Postgraduate Medical Centre (JPMC) is the largest tertiary care hospital in Karachi. There is very limited data on the cases that are dealt with on regular basis at the COT in JPMC. Here we break the mold and analyze the various aspects of surgical emergencies treated at the COT over the course of last six months. Objectives To evaluate the demographics and mortality rates of emergencies treated at the COT in the last six months. Methods This was a retrospective study, held for six months (July 1st 2019 to December 31st 2019). Data was obtained from the Records and Administration section, Surgical Unit IV (ward 21), Jinnah Postgraduate Medical Centre. Results Three hundred and fifty-five patients were inducted into the study, predominantly male. Majority (71.54%) of the referrals were made from within the city. The mean age of the patients was 48.57 ± 14.92 years. Appendicitis was the most common emergency treated at the COT. The overall mortality rate was 23.94%. Peritonitis and road traffic accidents contributed significantly to the mortality rate. Conclusion Surgical emergencies treated at the COT have a high mortality rate at one week. Prompt recognition, early referrals and intervention can help reduce mortality in the future.

Impact of Prehospital Antibiotic Therapy on Septic Shock Mortality

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Prehosp Emerg Care 2020 May 15;1-8

Background: Septic shock (SS) is associated with high morbidity and mortality rate. Early antibiotic therapy administration in septic patients was shown to reduce mortality but its impact on mortality in a prehospital setting is still under debate. To clarify this point, we performed a retrospective analysis on patients with septic shock who received antibiotics in a prehospital setting.

Methods: From April 15th, 2017 to March 1st, 2020, patients with septic shock requiring Mobile Intensive Care Unit (MICU) intervention were retrospectively analyzed to assess the impact of prehospital antibiotic therapy administration on a 30-day mortality.

Results: Three-hundred-eight patients with septic shock requiring MICU intervention in the prehospital setting were analyzed. The mean age of the study population was 70 ± 15 years. Presumed origin of SS was mainly pulmonary (44%), digestive (21%) or urinary (19%) infection. Overall 30-day mortality was 29%. Ninety-eight (32%) patients received antibiotic therapy. Using Cox regression analysis, we showed that prehospital antibiotic therapy significantly reduces 30-day mortality for patients with septic shock (hazard ratio = 0.56, 95%CI [0.35-0.89], $p = 0.016$).

Conclusion: In this retrospective study, prehospital antibiotic therapy reduces 30-day mortality of septic shock patients cared for by MICU. Further studies will be needed to confirm the beneficial effect of prehospital antibiotic therapy in association or not with prehospital hemodynamic optimization to improve the survival of septic shock patients.

Bomb Explosion: Ocular Effects of Primary, Secondary and Tertiary Mechanisms

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Clin Ophthalmol 2020 Apr 28;14:1145-1151

Purpose: To report the type and severity of ocular injuries sustained by the survivors of a bomb-loaded explosion that occurred in Mogadishu, Somalia on December 28, 2019.

Patients and methods: The recorded data included age, gender, wounded eye, initial examination of ocular injuries and associated systemic injuries, initial visual acuity, anterior and posterior segment examinations. The type of injury (open vs closed globe), the injured zone of the globe, and the presence of a relative afferent pupil defect were evaluated in all cases where possible.

Results: After the explosion, ocular injuries were detected in 28 of 114 patients in our hospital. Thirty-two eyes of 28 patients were included in the study. The mean age was 32.4 ± 6.7 years. The number of open-globe injuries was more than that of closed-globe injuries (26 vs 6; 81.25% vs 18.75%, respectively). Zone 1 was the most affected zone in open-globe injuries (18/26 eyes, 61.6%), followed by Zone 3 in six (23%) patients and Zone 2 in four (15.4%) patients. Sixteen open-globe injuries were laceration type (61.5%) and 10 (38.5%) were rupture type. An intraocular foreign body was detected in eight (30.8%) eyes with open-globe injuries. A total of 28 patients had 11 (39.3%) isolated eye injuries, whereas 17 (60.7%) had concomitant systemic injuries.

Conclusion: The frequency of blast-related ocular injuries is increasing. Today, the increase in the use of vehicle-borne improvised explosives in terrorist-related explosions leads to more frequent and serious ocular injuries.

[Cricothyroidotomy needle length is associated with posterior tracheal wall injury: A randomized crossover simulation study \(CONSORT\)](#)

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Medicine (Baltimore) 2020 Feb;99(9):e19331

Background: Cricothyroidotomy is the final strategy in the "cannot intubate, cannot oxygenate" scenario, but half of needle cricothyroidotomy attempts result in failure. The most frequent complication in needle cricothyroidotomy is posterior tracheal wall injury. We hypothesized that needle length is related to posterior wall injury and compared needle cricothyroidotomy with a commercial kit to a modified shorter needle to evaluate success and posterior wall injury rates.

Methods: The commercial kit has a needle stopper to prevent posterior wall injury, with a penetrating length of 25 mm. We made long stopper to shorten the length by 5 mm (net 20 mm penetrating length). Residents were recruited, received a lecture about cricothyroidotomy and practiced needle cricothyroidotomy using the commercial kit on a simulator. They then performed cricothyroidotomy using the commercial kit or the shorter needle on an ex-vivo porcine larynx covered with artificial skin. An intra-tracheal endoscope recorded the procedure. The video was evaluated for success/failure or posterior wall injury by independent evaluators. Larynxes with a distance from the outer surface to the inner lumen exceeding 13 mm were excluded. The distance in each larynx was measured by dissection after the study. Success and posterior wall injury rates were analyzed using Fisher exact test ($P < .05$ was statistically significant).

Results: Forty-seven residents participated in the study. Data for two residents were excluded. There was no statistically significant difference in success rate between the commercial kit (100%, 45/45) and the shorter needle (91%, 41/45, $P = .12$). Failure was defined if the needle tip did not reach the lumen in four trials. Cannulated but complicated by posterior wall injury occurred in 33% (15/45) with the commercial kit and 5% (2/43) with the shorter needle ($P < .01$).

Conclusion: During needle cricothyroidotomy, force is needed for the needle to penetrate the cricothyroid ligament. The advancing needle sometimes cannot be stopped after penetrating the cricothyroid ligament. These data suggest that needle length is associated with posterior wall injury.

Should Albumin be Considered for Prehospital Resuscitation in Austere Environments? A Prospective Randomized Survival Study in Rabbits

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Shock 2020 Sep;54(3):358-367

Background: The new guidelines for prehospital care of combat casualties in shock recommend administration of whole blood or blood components to increase blood pressure to a permissible hypotensive level (i.e., hypotensive resuscitation [HR]). We investigated if 2 h of HR using limited volumes of whole blood, plasma, or albumin would lead to full recovery and long-term survival of rabbits subjected to severe hemorrhagic shock (HS).

Methods: Following instrumentation, laparotomy was performed on IV-anesthetized spontaneously breathing New Zealand white rabbits (3.0 kg -3.5 kg). Next, ~40% of rabbits' blood volume was removed producing HS (mean arterial pressure [MAP]~20 mm Hg). Fifteen minutes later, rabbits were resuscitated with a limited volume (12.5 mL/kg) of rabbit whole blood (fresh whole blood [FWB]), rabbit fresh frozen plasma (FFP), or 5% human albumin (ALB) to a target pressure (MAP) of 60 mm Hg (n=8/grp) and monitored for 2 h. Liver bleeding time was measured at baseline and 10 min after HR. Subsequently, animals were fully resuscitated (blood + lactated Ringer [LR]), surgically repaired, and recovered for 8 days. An untreated group (n = 6) was also included.

Results: Following HS, lactate and base deficit levels were increased to 8.2 ± 1.6 and 12.9 ± 3.1 mM respectively with no difference among groups. A lower volume of FWB volume was required to reach the target MAP ($P < 0.05$ vs. ALB) but MAP declined during the HR period ($P < 0.01$ vs. ALB). FWB provided higher hematocrit and platelets but it did not reduce lactate level faster than other fluids. Beside higher fibrinogen, no differences were found in hemostatic or resuscitative effects of FFP versus ALB. Bleeding time was prolonged with ALB and FFP fluids but unchanged with FWB. Untreated rabbits died during shock or shortly after. All treated rabbits except one recovered and lived for 8 days with normal blood tests and similar tissue histology.

Conclusions: Two hours of HR using a limited volume of FWB, FFP, or ALB led to full recovery and long-term survival of rabbits subjected to HS. Apart from bleeding time, no clinically significant differences were found among the three fluids. Five percent human albumin solutions are isotonic, iso-oncotic, ready-to-use, stable, and compatible with all blood types and should be considered for prehospital resuscitation where blood products are not available or not accepted.

Colloid osmotic pressure of contemporary and novel transfusion products

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Vox Sang 2020 May 6; Online ahead of print

Background and objectives: Colloid osmotic pressure (COP) is a principal determinant of intravascular fluid homeostasis and a pillar of fluid therapy and transfusion. Transfusion-associated circulatory overload (TACO) is a leading complication of transfusion, and COP could be responsible for recruiting additional fluid. Study objective was to measure COP of blood products as well as investigate the effects of product concentration and storage lesion on COP.

Materials and methods: Three units of each product were sampled longitudinally. COP was measured directly as well as the determinants thereof albumin and total protein. Conventional blood products, that is red blood cell (RBC), fresh-frozen plasma (FFP) and platelet concentrates (PLTs), were compared with their concentrated counterparts: volume-reduced RBCs, hyperconcentrated PLTs, and fully and partially reconstituted lyophilized plasma (prLP). Fresh and maximally stored products were measured to determine changes in protein and COP. We calculated potential volume load (PVL) to estimate volume recruited using albumin's water binding per product.

Results: Colloid osmotic pressure varies widely between conventional products (RBCs, 1·9; PLTs, 7·5; and FFP, 20·1 mmHg); however, all are hyponcotic compared with human plasma COP (25·4 mmHg). Storage lesion did not increase COP. Concentrating RBCs and PLTs did not increase COP; only prLP showed a supraphysiological COP of 47·3 mm Hg. The PVL of concentrated products was lower than conventional products.

Conclusion: Colloid osmotic pressure of conventional products was low. Therefore, third-space fluid recruitment is an unlikely mechanism in TACO. Concentrated products had a lower calculated fluid load and may prevent TACO. Finally, storage did not significantly increase oncotic pressure of blood products.

Wound patterns in survivors of modern firearm related civilian Mass Casualty Incidents

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Am J Disaster Med 2019 Summer;14(3):175-180

Background: Civilian mass shooting events (CMSE) are occurring with increased frequency. Unfortunately, our knowledge of how to respond to these events is largely based on military experience and medical examiner data. While this translational knowledge has improved our basic response to such events, it is critical that we have a better understanding of the wound patterns observed and the resources utilized in civilian mass shootings. This will allow us to better prepare our systems for future events.

Methods: Patients from two consecutive CMSEs presented to the same level 1 trauma center in Fort Lauderdale, Florida. The patients received by this center were studied for their wound patterns as well as the care they received while in the hospital. This included wound patterns and severity, subspecialty interventions, and hospitalization requirements.

Results: Both events produced a total of 19 victims who were brought to the center as trauma activations. The events had a combined fatality rate of 55 percent. Fifty-five percent of patients also had at least one wound to an extremity, two with major vascular injuries who had field tourniquets applied. Sixty-three percent required an orthopedic intervention and 32 percent required intensive care unit (ICU) admission, half of these with prolonged ventilator support.

Conclusions: Given the number of extremity wounds in these events, we should continue the efforts championed by the stop the bleed campaign. The variety and quantity of specialties involved in the care of these patients also highlights the importance of a multidisciplinary approach to preparation and implementation of care in mass shooting events.

Potential survivability of prehospital injury deaths in New Zealand: a cross-sectional study

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Inj Prev 2020 May 23;injuryprev-2019-043408

Introduction: Acknowledging a notable gap in available evidence, this study aimed to assess the survivability of prehospital injury deaths in New Zealand.

Methods: A cross-sectional review of prehospital injury death postmortems (PM) undertaken during 2009-2012. Deaths without physical injuries (eg, drownings, suffocations, poisonings), where there was an incomplete body, or insufficient information in the PM, were excluded. Documented injuries were scored using the AIS and an ISS derived. Cases were classified as survivable (ISS <25), potentially survivable (ISS 25-49) and non-survivable (ISS >49).

Results: Of the 1796 cases able to be ISS scored, 11% (n=193) had injuries classified as survivable, 28% (n=501) potentially survivable and 61% (n=1102) non-survivable. There were significant differences in survivability by age (p=0.017) and intent (p<0.0001). No difference in survivability was observed by sex, ethnicity, day of week, seasonality or distance to advanced-level hospital care. 'Non-survivable' injuries occurred more commonly among those with multiple injuries, transport-related injuries and aged 15-29 year. The majority of 'survivable' cases were deceased when found. Among those alive when found, around half had received either emergency medical services (EMS) or bystander care. One in five survivable cases were classified as having delays in receiving care.

Discussion: In New Zealand, the majority of injured people who die before reaching hospital do so from non-survivable injuries. More than one third have either survivable or potentially survivable injuries, suggesting an increased need for appropriate bystander first aid, timeliness of EMS care and access to advanced-level hospital care.

Determining optimal needle size for decompression of tension pneumothorax in children - a CT-based study

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Scand J Trauma Resusc Emerg Med 2019 Oct 11;27(1):90

Background: For neonates and children requiring decompression of tension pneumothorax, specific recommendations for the choice of needle type and size are missing. The aim of this retrospective study was to determine optimal length and diameter of needles for decompression of tension pneumothorax in paediatric patients.

Methods: Utilizing computed tomography, we determined optimal length and diameter of needles to enable successful decompression and at the same time minimize risk of injury to intrathoracic structures and the intercostal vessels and nerve. Preexisting computed tomography scans of the chest were reviewed in children aged 0, 5 and 10 years. Chest wall thickness and width of the intercostal space were measured at the 4th intercostal space at the anterior axillary line (AAL) on both sides of the thorax. In each age group, three needles different in bore and length were evaluated regarding sufficient length for decompression and risk of injury to intrathoracic organs and the intercostal vessels and nerve.

Results: 197 CT-scans were reviewed, of which 58 were excluded, resulting in a study population of 139 children and 278 measurements. Width of the intercostal space was small at 4th ICS AAL (0 years: 0.44 ± 0.13 cm; 5 years: 0.78 ± 0.22 cm; 10 years: 1.12 ± 0.36 cm). The ratio of decompression failure to risk of injury at 4th ICS AAL was most favourable for a 22G/2.5 cm catheter in infants (Decompression failure: right: 2%, left: 4%, Risk of injury: right: 14%, left: 24%), a 22G/2.5 cm or a 20G/3.2 cm catheter in 5-year-old children (20G/3.2 cm: Decompression failure: right: 2.1%, left: 0%, Risk of injury: right: 2.1%, left: 17%) and a 18G/4.5 cm needle in 10-year-old children (Decompression failure: right: 9.5%, left: 9.5%, Risk of injury: right: 7.1%, left: 11.9%).

Conclusions: In children aged 0, 5 and 10 years presenting with a tension pneumothorax, we recommend 22G/2.5 cm, 20G/3.2 cm and 18G/4.5 cm needles, respectively, for acute decompression.

Characteristics and treatments of ocular blast injury in Tianjin explosion in China

Yuanyuan Liu, Kang Feng, Hao Jiang, Fuhua Hu, Jun Gao, Wanhong Zhang, Wenjing Zhang, Bo Huang, Rodrigo Brant, Cheng Zhang, Hua Yan

BMC Ophthalmol 2020 May 6;20(1):185

Background: To document characteristics and treatments of ocular blast injury from a fire and explosion.

Method: Authors retrospectively evaluated 116 patients with 166 eye injuries from six hospitals. Terminology of ocular injury referred to Birmingham Eye Trauma Terminology, and best-corrected visual acuity (BCVA) was categorized with the ocular trauma score (OTS) grading system. Incidence, preoperational and follow-up BCVA, treatment of severe ocular blast injuries were surveyed.

Results: Oculoplastic injuries accounted for the majority of eye injuries, while globe injuries were presented in 52 eyes with median baseline OTS 70 ranging from 26 to 100. No endophthalmitis occurred. The mean timing of the first-stage operations was 9.4 ± 6.4 h after blast, while second-stage operations were performed on average 14.7 ± 0.9 days post blast. Final BCVA of 68.8% of eyes achieved 20/200 or better as followed, 7 open globe injuries had a BCVA of no light perception. Additionally, eyes presenting rupture, retinal detachment, vitreous hemorrhage, choroidal injury and initial BCVA less than 20/200 had worse final visual outcomes, while globe penetration was not associated with poor visual acuity.

Conclusion: Various ocular injuries were commonly in the casualties of blast, in which open-globe injuries have worst visual prognosis. OTS is a valid approach for evaluation of prognosis and optimizing the therapeutic strategies subsequently in the massive casualty. Intense rescue and careful examination, proper surgery should be performed correctly to rescue patients.

[Improved Hemodynamic Recovery and 72-Hour Survival Following Low-Volume Resuscitation with a PEGylated Carboxyhemoglobin in a Rat Model of Severe Hemorrhagic Shock](#)

Antoni Macko, Forest R Sheppard, William H Nugent, Abe Abuchowski, Bjorn K Song

Mil Med 2020 Aug 14;185(7-8):e1065-e1072

Introduction: Hemorrhage is a leading cause of death from potentially survivable civilian and military trauma. As projected conflicts move from settings of tactical and logistical supremacy to hyper-dynamic tactical zones against peer and near-peer adversaries, protracted medical evacuation times are expected. Treatment at the point-of-injury is critical. Although crystalloids like Lactated Ringer's (LR) are ubiquitous, whole blood (WB) is the preferred resuscitation fluid following hemorrhage; however, logistical constraints limit the availability of WB in prehospital settings. Hemoglobin-based oxygen carriers (HBOCs) offer both hemodynamic support and oxygen-carrying capacity while avoiding logistical constraints of WB. We hypothesized that low-volume resuscitation of severe hemorrhagic shock with an HBOC (PEGylated carboxyhemoglobin, [PC]) would improve hemodynamic recovery and 72-hour survival; comparable to WB and superior to LR.

Materials and methods: A total of 21 anesthetized male Sprague-Dawley rats underwent severe hemorrhagic shock followed by randomly assigned low-volume resuscitation with LR, WB, or PC, and then recovered from anesthesia for up to 72-hour observation. Mean arterial pressure (MAP) was recorded continuously under anesthesia, and arterial blood gases were measured at baseline (BL), 60 minutes post-hemorrhage (HS1h), and 24 hours post-resuscitation (PR24h). Survival was presented on a Kaplan-Meier plot and significance determined with a log-rank test. Cardiovascular and blood gas data were assessed with one-way analysis of variance and post hoc analysis where appropriate.

Results: All measured cardiovascular and blood chemistry parameters were equivalent between groups at BL and HS1h. BL MAP values were 90 ± 3 , 86 ± 1 , and 89 ± 2 mmHg for LR, PC, and WB, respectively. Immediately following resuscitation, MAP values were 57 ± 4 , 74 ± 5 , and 62 ± 3 mmHg, with PC equivalent to WB and higher than LR ($P < 0.05$). WB and LR were both lower than BL ($P < 0.0001$), whereas PC was not ($P = 0.13$). The PC group's survival to 72 hours was 57%, which was not different from WB (43%) and higher than LR (14%; $P < 0.05$).

Conclusions: A single bolus infusion of PC produced superior survival and MAP response compared to LR, which is the standard fluid resuscitant carried by combat medics. PC was not different from WB in terms of survival and MAP, which is encouraging because its reduced logistical constraints make it viable for field deployment. These promising findings warrant further development and investigation of PC as a low-volume, early treatment for hemorrhagic shock in scenarios where blood products may not be available.

[Prehospital critical care is associated with increased survival in adult trauma patients in Scotland](#)

Alistair Maddock, Alasdair R Corfield, Michael J Donald, Richard M Lyon, Neil Sinclair, David Fitzpatrick, David Carr, Stephen Hearn

Emerg Med J. 2020 Mar;37(3):141-145

Background: Scotland has three prehospital critical care teams (PHCCTs) providing enhanced care support to a usually paramedic-delivered ambulance service. The effect of the PHCCTs on patient survival following trauma in Scotland is not currently known nationally.

Methods: National registry-based retrospective cohort study using 2011-2016 data from the Scottish Trauma Audit Group. 30-day mortality was compared between groups after multivariate analysis to account for confounding variables.

Results: Our data set comprised 17 157 patients, with a mean age of 54.7 years and 8206 (57.5%) of male gender. 2877 patients in the registry were excluded due to incomplete data on their level of prehospital care, leaving an eligible group of 14 280. 13 504 injured adults who received care from ambulance clinicians (paramedics or technicians) were compared with 776 whose care included input from a PHCCT. The median Injury Severity Score (ISS) across all eligible patients was 9; 3076 patients (21.5%) met the ISS>15 criterion for major trauma. Patients in the PHCCT cohort were statistically significantly (all $p<0.01$) more likely to be male; be transported to a prospective Major Trauma Centre; have suffered major trauma; have suffered a severe head injury; be transported by air and be intubated prior to arrival in hospital. Following multivariate analysis, the OR for 30-day mortality for patients seen by a PHCCT was 0.56 (95% CI 0.36 to 0.86, $p=0.01$).

Conclusion: Prehospital care provided by a physician-led critical care team was associated with an increased chance of survival at 30 days when compared with care provided by ambulance clinicians.

[Influence of Time to Transport to a Higher Level Facility on the Clinical Outcomes of US Combat Casualties with TBI: A Multicenter 7-Year Study](#)

Joseph K Maddry, Allyson A Arana, Crystal A Perez, Kimberly L Medellin, Joni A Paciocco, Alejandra G Mora, William G Holder, William T Davis, Paco S Herson, Vikhyat S Bebartha

Mil Med 2020 Feb 13;185(1-2):e138-e145

Introduction: Traumatic brain injury (TBI) is a leading cause of death and disability worldwide and is associated with mortality rates as high as 30%. Patients with TBI are at high risk for secondary injury and need to be transported to definitive care expeditiously. However, the physiologic effects of aeromedical evacuation are not well understood and may compound these risks. Combat TBI patients may benefit from delayed aeromedical evacuation. The goal of this study was to evaluate the impact of transport timing out of theater via Critical Care Air Transport Teams (CCATT) to a higher level facility on the clinical outcomes of combat casualties with TBI.

Materials and methods: We performed a retrospective review of patients with TBI who were evacuated out of theater by CCATT from January 2007 to May 2014. Data abstractors collected flight information, vital signs, procedures, in-flight assessments, and outcomes. Time to transport was defined as the time from injury to CCATT evacuation out of combat theater. We calculated descriptive statistics and constructed regression models to determine the association between time to transport and clinical outcomes. This study was approved by the U.S. Air Force 59th Medical Wing Institutional Review Board.

Results: We analyzed the records of 438 patients evacuated out of theater via CCATT and categorized them into three groups: patients who were transported in one day or less (n = 165), two days (n = 163), and three or more days (n = 110). We used logistic regression models to compare outcomes among patients who were evacuated in two days or three or more days to those who were transported within one day while adjusting for demographics, injury severity, and injury type. Patients who were evacuated in two days or three or more days had 50% lower odds of being discharged on a ventilator and were twice as likely to return to duty or be discharged home than those who were evacuated within one day. Additionally, patients transported in three or more days were 70% less likely to be ventilated at discharge with a GCS of 8 or lower and had 30% lower odds of mortality than those transported within one day.

Conclusions: In patients with moderate to severe TBI, a delay in aeromedical evacuation out of the combat theater was associated with improved mortality rates and a higher likelihood of discharge to home and return to duty dispositions. This study is correlational in nature and focused on CCATT transports from Role III to Role IV facilities; as such, care must be taken in interpreting our findings and future studies are needed to establish a causal link between delayed evacuation and improved discharge disposition. Our study suggests that delaying aeromedical evacuation of TBI patients when feasible may confer benefit.

[Emerging hemorrhage control and resuscitation strategies in trauma: Endovascular to extracorporeal](#)

James E Manning, Todd E Rasmussen, Samuel A Tisherman, Jeremy W Cannon

J Trauma Acute Care Surg 2020 Aug;89(2S Suppl 2):S50-S58

This article reviews four emerging endovascular hemorrhage control and extracorporeal perfusion techniques for management of trauma patients with profound hemorrhagic shock including hemorrhage-induced traumatic cardiac arrest: resuscitative endovascular balloon occlusion of the aorta, selective aortic arch perfusion, extracorporeal life support, and emergency preservation and resuscitation. The preclinical and clinical studies underpinning each of these techniques are summarized. We also present an integrated conceptual framework for how these emerging technologies may be used in the future care of trauma patients in both resource-rich and austere environments.

[Prehospital blunt traumatic arrest resuscitation augmented by whole blood: a case report](#)

Julian G Mapp, Craig A Manifold, Alberto M Garcia, Jason L Aguilar, Michael L Stringfellow, Christopher J Winckler

Transfusion 2020 May;60(5):1104-1107

Background: Prehospital hemorrhagic shock accounts for approximately 25,000 civilian deaths annually in the United States. A balanced, blood-based resuscitation strategy is hypothesized to be the optimal treatment for these patients. Due to logistical constraints, delivering a balanced, blood-based resuscitation is difficult in the prehospital setting. A low titer O+ whole blood (LTO+ WB) ground ambulance initiative, may help alleviate this capability gap.

Case report: A 37-year-old female was involved in a motor vehicle collision at approximately 16:30. While she was trapped inside the vehicle, her mental status deteriorated. The patient was successfully extricated at 17:04 and found to be in cardiac arrest. The paramedics and firefighters quickly secured her airway and applied a mechanical CPR device. The first responder team obtained return of spontaneous circulation, but the patient's blood pressure was 43/27 mmHg. The paramedics transfused one unit of LTO+ WB. Twenty-one minutes after the initial LTO+ WB transfusion, the air ambulance team transfused a second unit of LTO+ WB. Upon hospital arrival, the transfusion was completed, and the patient's shock index improved to 1.0. The trauma team identified a grade 5 splenic injury with active extravasation. Interventional radiology performed an angiogram and successfully embolized the tertiary branches of the inferior splenic pole. She was extubated on postinjury Day one and discharged to her home neurologically intact on postinjury Day 12.

Conclusion: The prehospital availability of LTO+ WB may enhance the resuscitation of critically ill trauma patients.

[Validation of Shock Index Pediatric-Adjusted \(SIPA\) for Children Injured in Warzones](#)

Christopher W Marengo, Woo S Do, Daniel T Lammers, John D Horton, Kenneth Azarow, Matthew J Eckert

J Trauma Acute Care Surg 2020 Mar 12; Online ahead of print.

Background: Shock Index Pediatric-Adjusted (SIPA) has been used to predict injury severity and outcomes after civilian pediatric trauma. We hypothesize that SIPA can predict the need for blood transfusion and emergent surgery among pediatric patients injured in warzones, where resources are limited and accurate triage is essential.

Methods: Retrospective review of the DoD Trauma Registry for all patients ≤ 17 years, from 2008-2015. SIPA was determined using vital signs recorded upon arrival to the initial level of care. Patients were classified into two groups (normal v. elevated SIPA) using age-specific threshold values. Need for blood product transfusion (BPT) within 24 hours and emergent surgical procedures (ESP) was compared between groups. ICU admission, injury severity, and mortality were also compared. Regression analysis was performed to evaluate the relationship between SIPA and primary outcomes.

Results: 2121 patients were included with mean ISS 12 ± 10 . The mechanism of injury was penetrating (63%), blunt (25%), and burns (12%). Patients with an elevated SIPA (43%) had significantly greater need for BPT (49.2% v. 25.0%) and ESP (22.9% v. 16.0%), as well as mortality (10.3% v. 4.8%) and ICU admission (49.9% v. 36.1%), all $p < 0.001$. Regression analysis confirmed an elevated SIPA as independently associated with both BPT (OR=2.36, 95% CI 1.19-2.94, $p < 0.001$) and ESP (OR=1.29, 95% CI 1.01-1.64, $p = 0.044$).

Conclusion: This is the first study of SIPA in pediatric warzone trauma. Elevated SIPA is associated with significantly increased need for blood product transfusion and emergent surgery, and may therefore serve as a valuable tool for planning and triage in austere settings.

Neurological outcome in patients after successful resuscitation in out-of-hospital settings

Martin Marinšek, Andreja Sinkovič, David Šuran

Bosn J Basic Med Sci 2020 Aug 3;20(3):389-395

Neurological outcome is an important determinant of death in admitted survivors after out-of-hospital cardiac arrest (OHCA). Studies demonstrated several significant pre-hospital predictors of ischemic brain injury (time to resuscitation, time of resuscitation, and cause of OHCA). Our aim was to evaluate the relationship between post-resuscitation clinical parameters and neurological outcome in OHCA patients, when all recommended therapeutic strategies, including hypothermia, were on board. We retrospectively included consecutive 110 patients, admitted to the medical ICU after successful resuscitation due to OHCA. Neurological outcome was defined by cerebral performance category (CPC) scale I-V. CPC categories I-II defined good neurological outcome and CPC categories III-V severe ischemic brain injury. Therapeutic measures were aimed to achieve optimal circulation and oxygenation, early percutaneous coronary interventions (PCI) in acute coronary syndromes (ACS), and therapeutic hypothermia to improve survival and neurological outcome of OHCA patients. We observed good neurological outcome in 37.2% and severe ischemic brain injury in 62.7% of patients. Severe ischemic brain injury was associated significantly with known pre-hospital data (older age, cause of OHCA, and longer resuscitations), but also with increased admission lactate, in-hospital complications (involuntary muscular contractions/seizures, heart failure, cardiogenic shock, acute kidney injury, and mortality), and inotropic and vasopressor support. Good neurological outcome was associated with early PCI, dual antiplatelet therapy, and better survival. We conclude that in OHCA patients, post-resuscitation early PCI and dual antiplatelet therapy in ACS were significantly associated with good neurological outcome, but severe ischemic brain injury was associated with several in-hospital complications and the need for vasopressor and inotropic support.

Effectiveness and Usage Trends of Hemorrhage Control Interventions in Patients with Pelvic Fracture in Shock

Shokei Matsumoto, Tomohiro Funabiki, Kei Hayashida, Motoyasu Yamazaki, Takayuki Ebihara, Takashi Moriya

World J Surg 2020 Jul;44(7):2229-2236

Background: Hemorrhage control for pelvic fractures remains challenging. There are several kinds of hemostatic interventions, including angiography/angioembolization (AG/AE), external fixation (EF), and resuscitative endovascular balloon occlusion of the aorta (REBOA). However, no large studies have been conducted for the comparative review of each intervention. In this study, we examined the usage trend of therapeutic interventions in Japan for patients with pelvic fractures in shock and the influence of these interventions on mortality.

Methods: Data of adult patients with pelvic fracture who were in shock were obtained from the Japanese Trauma Data Bank (2004-2014). The primary endpoint was the influence of each intervention (AG/AE, EF, and REBOA) on in-hospital mortality. We also investigated the frequency of each intervention.

Results: A total of 3149 patients met all our inclusion criteria. Specifically, 1131 (35.9%), 496 (15.8%), and 256 (8.1%) patients underwent AG, EF, and REBOA interventions, respectively. Therapeutic AE was performed in 690 patients who underwent AG (61.0%). The overall mortality rate was 31.4%. Multiple regression analysis identified that AG/AE (OR 0.64, 95% CI 0.52-0.80) and EF (OR 0.75, 95% CI 0.58-0.98) were significantly associated with survival, whereas REBOA (OR 4.17, 95% CI 3.00-5.82) was significantly associated with worse outcomes.

Conclusions: In Japan, patients with pelvic fracture who were in shock had high mortality rates. AG/AE and EF were associated with decreased mortality. AG may benefit from the early detection of arterial bleeding, leading to decreased mortality of patients with pelvic fracture in shock.

[Organ ischemia during partial resuscitative endovascular balloon occlusion of the aorta: Dynamic 4D Computed tomography in swine](#)

Yosuke Matsumura, Akiko Higashi, Yoshimitsu Izawa, Shuji Hishikawa, Hiroshi Kondo, Viktor Reva, Shigeto Oda, Junichi Matsumoto

Sci Rep 2020 Mar 30;10(1):5680

Resuscitative endovascular balloon occlusion of the aorta (REBOA) increases proximal pressure, and simultaneously induces distal ischemia. We aimed to evaluate organ ischemia during partial REBOA (P-REBOA) with computed tomography (CT) perfusion in a swine model. The maximum balloon volume was recorded as total REBOA when the distal pulse pressure ceased. The animals (n = 4) were scanned at each 20% of the maximum balloon volume, and time-density curve (TDC) were analysed at the aorta, portal vein (PV), liver parenchyma, and superior mesenteric vein (SMV, indicating mesenteric perfusion). The area under the TDC (AUTDC), the time to peak (TTP), and four-dimensional volume-rendering images (4D-VR) were evaluated. The TDC of the both upper and lower aorta showed an increased peak and delayed TTP. The TDC of the PV, liver, and SMV showed a decreased peak and delayed TTP. The dynamic 4D-CT analysis suggested that organ perfusion changes according to balloon volume. The AUTDC at the PV, liver, and SMV decreased linearly with balloon inflation percentage to the maximum volume. 4D-VR demonstrated the delay of the washout in the aorta and retrograde flow at the inferior vena cava in the highly occluded status.

Thoracic Injury in Patients Injured by Explosions on the Battlefield and in Terrorist Incidents

Andrew McDonald Johnston, Joseph Edward Alderman

Chest 2020 Apr;157(4):888-897

Thoracic injury is common on the battlefield and in terrorist attacks, occurring in 10% to 70% of patients depending on the type of weapons used. Typical injuries seen include bullet, blast, and fragment injuries to the thorax, which are often associated with injuries to other parts of the body. Initial treatment prehospital and in the ED is carried out according to the principles of Tactical Combat Casualty Care or other standard trauma management systems. Immediately life-threatening problems including catastrophic hemorrhage are dealt with rapidly, and early consideration is given to CT scanning or rapid surgical intervention where appropriate. All patients should be given lung-protective ventilation. Treatment of these patients in the critical care unit is complicated by the severity of associated injuries and by features specific to combat trauma including blast lung injury, a high incidence of delirium, unusual infections such as colonization with multidrug-resistant *Acinetobacter baumannii* complex, and sometimes invasive fungal infections. A minority of patients with blast lung injury in published series have been successfully treated with prolonged respiratory support with high-frequency oscillatory ventilation and extracorporeal membrane oxygenation. The role of newer treatment options such as resuscitative endovascular balloon occlusion of the aorta is not yet known. In this article we review the relatively sparse literature on this group of patients and provide practical advice based on the literature and our institution's extensive experience of managing battlefield casualties.

Field-expedient thawing of fresh-frozen plasma

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Transfusion 2020 Jun;60 Suppl 3:S87-S95

Introduction: Frozen plasma is superior to crystalloids for hemorrhage resuscitation but remains logistically challenging in austere environments because of specialized clinical equipment for on-demand thawing. This research examines some ad hoc thawing techniques that have been implemented by military medical personnel.

Methods: Fresh-frozen plasma (FFP) units were thawed accordingly: using a slow cooker (three temperature settings) with preheated or room temperature water; affixing flameless ration heaters from meals ready-to-eat (MREs) to FFP and submerging in water; exposing FFP to electric kettle-boiled water; incubating with a sous vide immersion circulator; or using a clinical thawer (control). Hemostatic function, thrombin generation, factor activities, and essential chemistry were measured after thawing.

Results: Even at the highest temperatures, without preheated water the slow cooker doubled thawing time (62.5 min vs. control, 32.5 min; $p < 0.0001$), and the final temperature was 13.5°C versus 28.8°C in control ($p < 0.01$). When preheated, the slow cooker thawed in 31.3 minutes ($p < 0.05$), with a final temperature of 22.4°C. Kettle-boiled water thawed in 23.0 minutes with a final temperature of 25.1°C. The sous vide thawed in 28.1 minutes, with a final temperature of 20.2°C. MRE heaters were insufficient. Functional measures were similar in all conditions.

Discussion: In emergencies, protracted plasma thawing is unacceptable, and slower thawing methods also produced cryoprecipitate. Although no functional changes were observed with boiled water thawing, potential negative physiological impacts must be examined. Safe, controlled thawing can be obtained with the sous vide, although optimization requires further testing.

Mass Casualty Shootings and Emergency Preparedness: A Multidisciplinary Approach for an Unpredictable Event

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J Multidiscip Healthc 2019 Dec 10;12:1013-1021

Mass casualty events (MCE) are an infrequent occurrence to most daily healthcare systems however these incidents are the causation for new hospital preparedness and the development of coordinated emergency services. The broad support and operational plans outside the hospital include emergency medical services, local law enforcement, government agencies, and city officials. Modern-day hospital disaster preparedness goals include scheduled training for healthcare personnel to ensure effective and accurate triage for a high-volume of injured patients. This MDT collaboration strengthens the emergency response to optimize the delivery of life-saving care during MCEs. This review identifies the clinical importance of the interdisciplinary team interactions and the lessons learned from past MCE experiences, strengthening healthcare system readiness for such critical incidents.

[Effect of tranexamic acid in traumatic brain injury: a case report](#)

Toru Miike, Yuichiro Sakamoto, Satoshi Inoue

J Nippon Med Sch 2020 Apr 30;Online ahead of print.

Traumatic brain injury (TBI) often results in coagulopathy, which increases mortality risk. The clinical randomization of an antifibrinolytic in significant head injury (CRASH) -2 and CRASH-3 trials confirmed that tranexamic acid (TXA) was effective after trauma. Herein, we report a unique coagulation change in a patient with TBI given TXA after point-of-care assessment. Coagulation functions were impaired on admission. At 1 hour after TXA administration, clotting time was further prolonged in the extrinsic coagulation pathway but shortened in the intrinsic coagulation system. The results of a total thrombus-formation analysis system test showed improved blood clot formation ability. Intrinsic coagulation and clot formation improved after TXA administration in a TBI patient with coagulopathy.

[The Light Role CCP: A Blueprint for Far Forward Medical Support to Contemporary Operations](#)

John Miles, C Jones

BMJ Mil Health 2020 May 17;bmjmilitary-2020-001435

November 2018 saw the deployment of a medical team with a remit to provide far forward medical support to UK, Coalition and indigenous forces. The delivery of this capability demanded a solution unique within the UK Defence Medical Services. The 'light role' casualty collection points provided emergency medical care to 475 casualties over a 4-month period. The success of the deployment was dependant on the ability to remain light and agile which brought with it logistical considerations. The clinical caseload was predominantly secondary blast injury and gunshot wound (GSW). The positioning of a Role 1 facility close to the front line of troops enabled early Damage Control Resuscitation including the delivery of blood products. MEDEVAC to Role 2 was enabled by indigenous forces. The unique situation demanded bespoke solutions for documentation and blood warming. The lessons learnt during the deployment may form a blueprint for future contingency operations.

[Prehospital time and mortality in patients requiring a highest priority emergency medical response: a Danish registry-based cohort study](#)

Elisabeth Helen Anna Mills, Kristian Aasbjerg MD, PhD, Steen Moeller Hansen, Kristian Bundgaard Ringgren MB, Michael Dahl MD, PhD, Bodil Steen Rasmussen, Christian Torp-Pedersen, Peter Søgaard, Kristian Kragholm

BMJ Open 2019 Nov 21;9(11):e023049

Objective: To examine the association between time from emergency medical service vehicle dispatch to hospital arrival and 1-day and 30-day mortality.

Design: Register-based cohort study.

Setting: North Denmark Region (≈ 8000 km², catchment population ≈ 600 000).

Participants: We included all highest priority dispatched ambulance transports in North Denmark Region in 2006-2012.

Interventions: Using logistic regression and the g-formula approach, we examined the association between time from emergency dispatch to hospital arrival and mortality for presumed heart, respiratory, cerebrovascular and other presumed medical conditions, as well as traffic or other accidents, as classified by emergency dispatch personnel.

Main outcome measures: 1-day and 30-day mortality.

Results: Among 93 167 individuals with highest priority ambulances dispatched, 1948 (2.1%) were dead before the ambulance arrived and 19 968 (21.4%) were transported to the hospital under highest priority (median total prehospital time from dispatch to hospital arrival 47 min (25%-75%: 35-60 min); 95th percentile 84 min). Among 18 709 with population data, 1-day mortality was 10.9% (n=2038), and was highest for patients with dyspnoea (20.4%) and lowest for patients with traffic accidents (2.8%). Thirty-day mortality was 18.3% and varied between 36.6% (patients with dyspnoea) and 3.7% (traffic accidents). One-day mortality was not associated with total prehospital time, except for presumed heart conditions, where longer prehospital time was associated with decreased mortality: adjusted OR for >60 min vs 0-30 min was 0.61 (95% CI 0.40 to 0.91). For patients with dyspnoea, OR for >60 min vs 0-30 min was 0.90 (95% CI 0.56 to 1.45), for presumed cerebrovascular conditions OR 1.41 (95% CI 0.53 to 3.78), for other presumed medical conditions OR 0.84 (95% CI 0.70 to 1.02), for traffic accidents OR 0.65 (95% CI 0.29 to 1.48) and for other accidents OR 0.84 (95% CI 0.47 to 1.51). Similar findings were found for 30-day mortality.

Conclusions: In this study, where time from emergency dispatch to hospital arrival mainly was <80 min, there was no overall relation between this prehospital time measure and mortality.

Early experience with transfusing low titer group O whole blood in the pre-hospital setting in Israel

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Transfusion 2020 Jun;60 Suppl 3:S10-S16

Background: The Israeli Defense Force Medical Corps (IDF-MC) recently implemented the use of low titer group O whole blood (LTOWB) in the airborne combat search and rescue unit (CSAR) for both military and civilian patients during transport to definitive care. LTOWB is preferentially used by the CSAR instead of red blood cell units and freeze-dried plasma (FDP) for patients with signs of hemorrhagic shock. Ten percent of group O donors were eligible to donate LTOWB as they had anti-A and -B IgM titers of <50.

Methods: All patients treated by CSAR providers with LTOWB between July 2018 and June 2019 were included.

Results: Between July 2018 and June 2019, eight patients have received 10 units of LTOWB. All patients suffered blunt injuries, 6 out of 8 (75%) of whom were due to motor vehicle accidents. Four patients (4 out of 8, 50%) received a single LTOWB unit, two patients (2 out of 8, 25%) received two units. Two pediatric patients received fewer than one unit of LTOWB. Median (range) heart rate was 130 (30-150) bpm, median systolic blood pressure was 107 (80-124) mmHg, and median Glasgow coma scale was 8 (on a scale of 3-15). For four (4 out of 8, 50%) patients, LTOWB was the only blood product used for volume resuscitation. All six adult patients were treated with 1 g of tranexamic acid at the point of injury.

Conclusions: The CSAR has successfully implemented a LTOWB program for the pre-hospital treatment of bleeding patients, and as its experience grows this product will be made available to other units and in civilian hospitals.

[Comparison of 10- versus 14-gauge angiocatheter for treatment of tension pneumothorax and tension-induced pulseless electrical activity with hemorrhagic shock: Bigger is still better](#)

Emily A Norris, Christian S McEvoy, Matthew L Leatherman, Michael R Boboc, Jamie L Fitch, Shane D Jensen, Travis M Polk

J Trauma Acute Care Surg 2020 Aug;89(2S Suppl 2):S132-S136

Background: Little is known regarding the effect of hemorrhagic shock on the diagnosis and treatment of tension pneumothorax (tPTX). Recently, the Tactical Combat Casualty Care guidelines included the 10-gauge angiocatheter (10-g AC) as an acceptable alternative to the 14-g AC. This study sought to compare these two devices for decompression of tPTX and rescue from tension-induced pulseless electric activity (tPEA) in the setting of a concomitant 30% estimated blood volume hemorrhage.

Methods: Following a controlled hemorrhage, carbon dioxide was insufflated into the chest to induce either tPTX or tPEA. Tension pneumothorax was defined as a reduction in cardiac output by 50%, and tPEA was defined as a loss of arterial waveform with mean arterial pressure less than 20 mm Hg. The affected hemithorax was decompressed using a randomized 14-g AC or 10-g AC while a persistent air leak was maintained after decompression. Successful rescue from tPTX was defined as 80% recovery of baseline systolic blood pressure, while successful return of spontaneous circulation following tPEA was defined as a mean arterial pressure greater than 20 mm Hg. Primary outcome was success of device.

Results: Eighty tPTX and 50 tPEA events were conducted in 38 adult Yorkshire swine. There were no significant differences in the baseline characteristics between animals or devices. In the tPTX model, the 10-g AC successfully rescued 90% of events, while 14-g AC rescued 80% of events ($p = 0.350$). In the tPEA model, the 10-g AC rescued 87% of events while the 14 AC rescued only 48% of events ($p = 0.006$).

Conclusion: The 10-g AC was vastly superior to the 14-g AC for return of spontaneous circulation following tPEA in the setting of 30% hemorrhage. These findings further support the importance of larger caliber devices that facilitate rapid recovery from tPTX, particularly in the setting of polytrauma.

[Diagnostic performance of prehospital ultrasound diagnosis for traumatic pneumothorax by a UK Helicopter Emergency Medical Service](#)

Prudence Oliver, Peter Bannister, Duncan Bootland, Richard M Lyon

Eur J Emerg Med 2020 Jun;27(3):202-206

Objective: Up to 20% of major trauma patients may sustain a pneumothorax. Traumatic pneumothoraces can be difficult to diagnose on scene. Although the use of handheld ultrasound (HHUS) is becoming increasingly widespread, there remains uncertainty about its efficacy as a diagnostic tool in the prehospital setting. The aim of this study was to determine the diagnostic performance of prehospital chest HHUS in trauma patients.

Method: Retrospective review of trauma patients who received a prehospital chest HHUS and subsequently conveyed to the Royal Sussex County Hospital (RSCH) between 1 July 2013 and 24 September 2018. Data including patient age, sex, mechanism of injury and clinical interventions were obtained. Prehospital ultrasound findings were compared with the computer tomography (CT) scan performed on arrival at the hospital.

Results: Four hundred eleven patients were conveyed to RSCH, the single largest group being following road traffic collisions. The majority of HHUS (66%) were performed by doctors. Three hundred sixty-one patients (88%) subsequently had a CT scan. Of these, 98 patients (27%) were found to have pneumothoraces. For pneumothorax diagnosis, prehospital HHUS had a sensitivity of 28% [95% confidence interval (CI): 19-37%] and specificity of 98% [95% CI: 97-99%].

Conclusion: In this retrospective study, sensitivity of prehospital HHUS for diagnosing a pneumothorax was lower than is often reported in in-hospital studies. This suggests that caution should be exercised in using HHUS for the exclusion of pneumothorax in the prehospital setting.

[Prehospital care of burn injuries in Africa: A review, 1990-2018](#)

Anne H Outwater, Tanya Van Braekel

Burns 2019 Nov 27;S0305-4179(19)30173-1

Purpose: Administration of appropriate first aid immediately after a burn injury is crucial to averting further harm to the victim, physically and psychologically. The aim of this review is to enable the design of better interventions by describing what is known about prehospital care of burn victims in Africa.

Results: This review is based on 17 articles from 5 countries. For the purposes of the review, first responders are defined as those nearest the victim when a burn occurs. First responders include nonclinicians, most typically the mother of a young burn victim. Forty-five different substances, sometimes used in combination, are reported to have been applied to burn injuries: water, 15 food items (especially oils and egg), 14 pharmaceutical products, 9 traditional treatments, 5 minerals (petroleum products being the most common), and charcoal. Appropriate treatment, defined as the application of cool water for 10 min, was achieved about 0.5% of the time, most frequently in Cape Town, South Africa. Most victims do not have their wounds covered while they are transported to a health-care facility. Treatment delays are common. Pain management is hardly addressed.

Conclusions: Appropriate prehospital care for burn injury generally is not practiced in Africa. Yet best practices for prehospital care are affordable, available, and easily understood. The greatest risk factor for poor care is first responders' lack of knowledge. Awareness and education campaigns focusing on the lay public, as well as educational institutions for health workers, are urgently needed throughout the continent.

[Hemostatic agents for prehospital hemorrhage control: a narrative review](#)

Henry T Peng

Mil Med Res 2020 Mar 25;7(1):13

Hemorrhage is the leading cause of preventable death in combat trauma and the secondary cause of death in civilian trauma. A significant number of deaths due to hemorrhage occur before and in the first hour after hospital arrival. A literature search was performed through PubMed, Scopus, and Institute of Scientific Information databases for English language articles using terms relating to hemostatic agents, prehospital, battlefield or combat dressings, and prehospital hemostatic resuscitation, followed by cross-reference searching. Abstracts were screened to determine relevance and whether appropriate further review of the original articles was warranted. Based on these findings, this paper provides a review of a variety of hemostatic agents ranging from clinically approved products for human use to newly developed concepts with great potential for use in prehospital settings. These hemostatic agents can be administered either systemically or locally to stop bleeding through different mechanisms of action. Comparisons of current hemostatic products and further directions for prehospital hemorrhage control are also discussed.

[An up-to-date overview of sublingual sufentanil for the treatment of moderate to severe pain](#)

Expert Opin Pharmacother. 2020 Aug;21(12):1407-1418

Susanna Porela-Tiihonen, Hannu Kokki, Merja Kokki

Introduction: Sufentanil is a selective μ -opioid agonist, used intravenously and intrathecally for moderate to severe acute pain. Sublingual sufentanil nanotablets have been developed; 15 mcg tablet for a patient-controlled analgesia device and 30-mcg tablet for a single-dose device administered by a healthcare professional. Dosing interval is a minimum of 20 min for a 15 mcg tablet and a treatment duration of up to 72 hours. The single 30-mcg nanotablet dosing interval is 1 hour. Mean plasma elimination half-life is 13 hours and bioavailability 47-57% after the first sublingual sufentanil tablet.

Areas covered: This review focuses on the effectiveness, safety, and feasibility of sublingual sufentanil 30-mcg single dose suspended by a healthcare professional for the management of moderate to severe acute pain. A few Phase 4 studies concerning the sublingual sufentanil tablet system containing 15-mcg nanotablets are also reviewed.

Expert opinion: Sufentanil sublingual 30-mcg nanotablets provide effective pain relief in various acute moderate to severe pain states. The safety profile of sublingual sufentanil 30 mcg is typical to opioids nausea, vomiting, and sedation being the most common ones. Sublingual sufentanil 30-mcg nanotablet has the potential for efficient moderate to severe pain management in supervised healthcare facilities.

[Developing clinical performance indicators for pre-hospital blood transfusion: The Thames Valley Air Ambulance approach.](#)

James Raitt, Nicola Curry, Pip Lewis, James Dearman, Kurtis Poole, Dhushy Surendra Kumar

Transfus Med 2020 Apr;30(2):134-140

Objective: In this article, we describe how we developed and validated key performance indicators (KPIs) for pre-hospital blood transfusion and offer suggestions for other organisations wishing to develop performance metrics.

Background: KPIs are metrics that compare actual care against an ideal structure, process or outcome standard. An increasing number of UK-based pre-hospital critical care services now carry blood components to enable pre-hospital blood transfusion.

Methods: A working group of pre-hospital physicians and paramedics was formed to create and validate performance indicators that reflected a high-quality pre-hospital transfusion. This was performed by literature searching and reviewing consensus documents that guide the best practice and then adjusting the indicators as the process evolved.

Results: Throughout the year, the performance against the domains was monitored monthly and outputs communicated within the clinical staff of the organisation; at the end of the year, the domains were amended. The final list of performance indicators was as follows: (a) rationale for transfusion documented in the notes; (b) rationale for transfusion in line with Thames Valley Air Ambulance blood transfusion guideline; (c) aggressive management of hypothermia; (d) tranexamic acid administered within an hour of injury; (e) evidence of bleeding in hospital; (f) monitoring of adverse effects of blood transfusion; (g) overall-was the use of blood justified; and (h) no units wasted this month.

Conclusions: This study has shown that it is feasible to devise and implement clinical performance indicators for pre-hospital blood transfusion and that their use has increased the focus on this important area.

[Bleeding control in combat fields with extreme transfer time](#)

Amila Sanjiva Ratnayake, T J Worlton

BMJ Mil Health. 2020 Jun;166(3):203

No abstract available

Prehospital Life-Saving Interventions Performed on Pediatric Patients in a Combat Zone: A Multicenter Prospective Study

Lauren K Reeves, Shelia C Savell, Joseph K Maddry, Kathleen M Samsey, Alejandra G Mora, Julio R Lairet

Pediatr Crit Care Med 2020 Jul;21(7):e407-e413

Objectives: We aimed to describe and evaluate prehospital life-saving interventions performed in a pediatric population in the Afghanistan theater of operations.

Design: Our study was a post hoc, subanalysis of a larger multicenter, prospective, observational study.

Setting: We evaluated casualties enrolled upon admission to one of the nine military medical facilities in Afghanistan between January 2009 and March 2014.

Patients: Adult and pediatric (<17 yr old) patients.

Measurements: We conducted initial descriptive analyses followed by comparative tests. For comparative analysis, we stratified the study population (adult vs pediatric), and subsequently, we compared injury descriptions and the interventions performed. Following tests for normality, we used the t test or Wilcoxon rank-sum test (nonparametric) for continuous variables and chi-square or Fisher exact for categorical variables. We reported percentages and 95% CIs.

Main results: We enrolled 2,106 patients, of which 5.6% (n = 118) were pediatric. Eighty-two percent of the pediatric patients were male, and 435 had blast related injuries. A total of 295 prehospital life-saving interventions were performed on 118 pediatric patients, for an average of 2.5 life-saving interventions per patient. Vascular access (IV 96%, intraosseous 91%) and hypothermia prevention-related interventions (69%) were the most common. Incorrectly performed life-saving interventions in pediatric patients were rare (98% of life-saving interventions performed correctly) and n equals to 24 life-saving interventions over the 6-year period were missed. The most common incorrectly performed and missed life-saving interventions were related to vascular access. When compared with adult life-saving interventions received in the prehospital environment, pediatric patients were more likely to receive intraosseous access (p < 0.0001), whereas adult patients were more likely to have a tourniquet placed (p = 0.0019), receive wound packing with a hemostatic agent (p = 0.0091), and receive chest interventions (p = 0.0003).

Conclusions: In our study, the most common intervention was vascular access followed by hypothermia prevention and hemorrhage control. The occurrence of missed or incorrectly performed life-saving interventions were rare.

[Meta-Analysis of Failure of Prehospital Endotracheal Intubation in Pediatric Patients](#)

Jhon Jairo Rodríguez, Luis Felipe Higuera-Gutiérrez, Edwar Arturo Carrillo Garcia, Esneider Castaño Betancur, Mauricio Luna Londoño, Sara Restrepo Vargas

Emerg Med Int 2020 May 2;2020:7012508

Prehospital care is essential for airway preservation in pediatric patients who require early endotracheal intubation to improve oxygenation and prevent aspiration. However, high frequencies of failure of endotracheal intubation have been reported for this age group. We aimed to analyze the frequency of failure of endotracheal intubation in pediatric patients within a prehospital context and compare it with adult patients. Thus, a systematic revision of literature with a meta-analysis was performed using a study search and selection strategy ensuring extensiveness, sensitivity, and reproducibility. Meta-analyses were performed for odds ratio, DerSimonian and Laird's Q test was used to assess heterogeneity, and Egger and Begg's test was used to assess publication bias. Overall, 17 papers and 8772 patients were included, and the main cause of prehospital care was assessed to be trauma. Failed endotracheal intubation frequency was 0.4%-52.6% in pediatric patients. The most frequent complication was with esophageal intubation. Forest plot suggests that risk of failure during intubation of pediatric patients is 3.54 fold higher than that observed for adults. It was concluded that airway management in pediatric patients within a prehospital context is a challenge for prehospital care providers because it entails clear physiological and anatomical differences and a low frequency of exposure to this kind of events as opposed to adults. These differences support a widely higher risk of failure of intubation, suggesting the necessity of consistently trained prehospital care providers to ensure proficiency in technique as well as availability of the required equipment.

[Life on the battlefield: Valproic acid for combat applications](#)

Rachel Russo, Michael Kemp, Umar F Bhatti, Manjunath Pai, Glenn Wakam, Ben Biesterveld, Hasan B Alam

J Trauma Acute Care Surg. 2020 Aug;89(2S Suppl 2):S69-S76

The leading causes of death in military conflicts continue to be hemorrhagic shock (HS) and traumatic brain injury (TBI). Most of the mortality is a result of patients not surviving long enough to obtain surgical care. As a result, there is a significant unmet need for a therapy that stimulates a "prosurvival phenotype" that counteracts the cellular pathophysiology of HS and TBI to prolong survival. Valproic acid (VPA), a well-established antiepileptic therapy for more than 50 years, has shown potential as one such prosurvival therapy. This review details how VPA's role as a nonselective histone deacetylase inhibitor induces cellular changes that promote survival and decrease cellular pathways that lead to cell death. The review comprehensively covers more than two decades worth of studies ranging from preclinical (mice, swine) to recent human clinical trials of the use of VPA in HS and TBI. Furthermore, it details the different mechanisms in which VPA alters gene expression, induces cytoprotective changes, attenuates platelet dysfunction, provides neuroprotection, and enhances survival in HS and TBI. Valproic acid shows real promise as a therapy that can induce the prosurvival phenotype in those injured during military conflict.

Outcomes of Casualties Without Airway Trauma Undergoing Prehospital Airway Interventions: A Department of Defense Trauma Registry Study

Steven G Schauer, Jason F Naylor, Joseph K Maddry, Fred C Kobylarz, Michael D April

Mil Med 2020 Mar 2;185(3-4):e352-e357

Introduction: Airway obstruction is the second leading cause of preventable death on the battlefield. Most airway obstruction occurs secondary to traumatic disruptions of the airway anatomical structures. However, casualties may require airway interventions for other indications (e.g., depressed mental status). We describe casualties undergoing airway intervention in the prehospital, combat setting without apparent upper airway trauma.

Materials and methods: We used a series of emergency department procedure codes to identify patients within the Department of Defense Trauma Registry (DODTR) from January 2007 to August 2016. This is a subgroup analysis of those patients with a documented prehospital airway intervention and no apparent airway trauma as defined by abbreviated injury scale of 0 for body regions 1 (head/neck) and 2 (face).

Results: Our predefined search codes captured 28222 DODTR subjects of whom 409 (1.4%) met criteria for study inclusion. Subjects included members of host nation forces (34%) and civilians (30%). Most subjects sustained injuries in Afghanistan (82%). Explosive (57%) and gunshot wounds (36%) were the most frequent mechanisms of injury. Median injury severity scores were 17. The most common anatomical locations of injuries for included subjects included extremities (53%) and thorax (29%). A majority of subjects underwent intubation (89%); comparatively few casualties underwent placement of a nasopharyngeal airway (2%) or supraglottic airway (2%). The proportion of subjects surviving to hospital discharge was 80% and was highest among subjects undergoing intubation (82%).

Conclusions: In this subgroup analysis of casualties without apparent upper airway trauma, survival rates were lower when compared to our previous report. Higher quality data are necessary to better understand the resuscitation needs of this critically ill subset of combat casualties.

[How effective are different models of pelvic binders: results of a study using a Pelvic Emergency Simulator](#)

Uwe Schweigkofler, Dennis Wincheringer, Jörg Holstein, Tobias Fritz, Reinhard Hoffmann, Tim Pohlemann, Steven C Herath

Eur J Trauma Emerg Surg 2020 May 26; Online ahead of print

Background: The application of pelvic binders in the preclinical and early clinical phase is advisable to avoid or treat C-problems in unstable and potential bleeding pelvic ring fractures, even if the clinical effectivity is not completely proved. The use for pathologies in the posterior pelvic ring is still debatable.

Questions/purposes: We determined if there is a difference in achievable compression in the dorsal pelvic ring depending on position and pelvic binder model. Can this effect be tested with a simplified artificial model?

Methods: We simulated a Tile type C fracture within the established pelvic emergency trainer and measured in a test series the effectivity of reduction with a non-invasive stabilization technique using 3 different pelvic binders.

Results: Any therapeutic effect of a pelvic binder with compression to the posterior pelvic ring requires at first a reduction maneuver. While the compression effect in the symphysis depends only on positioning of the binder, in the posterior pelvic ring, the result varies with the used model. The achievable pressure in the SI joint with a pelvic binder is only 20-25% (33.5-47 N) compared to the C-Clamp values (156 N).

Conclusions: The use of pelvic binders for non-invasive pelvic ring stabilization, even with a posterior pathology, could be proven in a simplified fracture model. A proper fracture reduction and an adequate device positioning influence the effectiveness.

Clinical relevance: The use of an emergency pelvic trainer even for a non-invasive maneuver is advisable.

Implementation and Evaluation of Tactical Combat Casualty Care for Army Aviators

Stephen M Scott, Margaret J Carman, Michael E Zychowicz, Mark L Shapiro, Nicholas A True

Mil Med 2020 Aug 14;185(7-8):e1271-e1276

Introduction: The importance of developing military strategies to decrease preventable death by mitigating hemorrhage and reducing time between the point of injury and surgical intervention on the battlefield is highlighted in previous studies. Successful implementation of Tactical Combat Casualty Care (TCCC) throughout elements of the USA and allied militaries begins to address this need. However, TCCC implementation is neither even nor complete in the larger, conventional force. Army Aviators are at risk for preventable death as they do not receive prehospital care training and are challenged to render prehospital care in the austere environment of helicopter operations. Army aviators are at risk for preventable death due to the challenges to render prehospital care in the austere environment of helicopter operations. Helicopters often fly at low altitudes, engage in direct action in support of ground troops, operate at a great distance from medical facilities, typically do not have medical personnel onboard, and can have long wait times for medical evacuation services due to the far forward nature of helicopter operations.

Materials and methods: This is a quality improvement pre-post-intervention design study evaluating the implementation of a combat casualty care training program for Army aviators using well-established evidence-based guidelines for providing care to casualties on the battlefield. The evaluation consisted of participants' self-perceived confidence in providing care to a casualty and change in knowledge level in combat casualty care in a pre/post-intervention design. Clinical skills of tourniquet application, nasopharyngeal airway placement, and needle chest decompression were assessed on a pass/fail grading standard.

Results: A total of 18 participants completed the pre- and post-education surveys. A paired t-test showed a statistically significant increase in total composite scores from pre (M = 24.67, SD = 5.06) to post-education self-efficacy (M = 37.94, SD = 2.10), $t(17) = -11.29$, $p < 0.001$. A paired t-test revealed a significant increase in exam scores from pre (M = 70.22, SD = 9.43) to post (M = 87.78, SD = 7.19), $t(17) = -7.31$, $p < 0.001$. There was no pre-intervention skills assessment, however, all participants (n = 18, 100%) passed the tourniquet application, needle chest compression, and insertion of nasopharyngeal airway.

Conclusion: TCCC for Army Aviators is easily implemented, demonstrates an increase in knowledge and confidence in providing prehospital care, and provides effective scenario-based training of necessary psychomotor skills needed to reduce preventable death on the battlefield. TCCC for Army Aviators effectively takes the TCCC for All Combatants curriculum and modifies it to address the unique considerations in treating wounded aviators and passengers, both in flight and after crashes. This project demonstrates on a small scale how TCCC can be tailored to specific military jobs in order to successfully meet the intent of the upcoming All Service Member TCCC course mandated in DoD 1322.24. Beyond Army aviation, this program is easily modifiable for aviators throughout the military and civilian sector.

Cut to Air

Mary Scott-Herring, Ionela Morosanu, Jason Bates, Bonjo Batoon

AANA J 2020 Apr;88(2):116-120.

A "cannot ventilate, cannot intubate" scenario is a rare, high-risk anesthesia event. Cricothyrotomy is the final step, but anesthesia training and maintenance of surgical airway skills is variable. The ability to "cut to air" when one performs a cricothyrotomy may be all that prevents a patient from experiencing anoxic brain injury or death. Forty-three Certified Registered Nurse Anesthetists (CRNAs) performed emergency cricothyrotomies on a simulation manikin. Three techniques were available: (1) cricothyrotomy kit, (2) scalpel and tracheostomy, and (3) scalpel/bougie/endotracheal tube. Technique selection and performance were recorded until successful confirmation of placement was achieved in less than 2 minutes. Confidence levels performing cricothyrotomy were also measured before and after simulation. Most CRNAs (53.5%) selected the cricothyrotomy kit, and all but 1 completed the cricothyrotomy in under 2 minutes. The scalpel/bougie/endotracheal tube combination was the fastest, with an average completion time of 86.6 seconds. The confidence of CRNAs in performing a successful cricothyrotomy in less than 2 minutes was significantly increased ($P \leq .001$). Simulating airway skills improved performance, speed, and confidence. Because not all CRNAs have had extensive education in performing surgical airways and practicing these skills, simulation may have additional value in developing and maintaining skills and confidence.

Cognitive skills of emergency medical services crew members: a literature review

Martin Sedlár

BMC Emerg Med 2020 May 29;20(1):44

Background: Situation awareness and decision making, listed in non-technical skills taxonomies, are critical for effective and safe performance in high-risk professions. These cognitive skills and their behavioral markers have been studied less in emergency medical services (EMS) crew members. This paper aims to review the existing literature and identify important aspects and behavioral markers of situation awareness and decision making in EMS crew members - those who work in the role of prehospital emergency care providers - and to synthesize findings as a basis for developing a rating and training tool.

Method: The search for relevant articles was conducted using electronic databases, reference lists of relevant reviews and included articles and personal collection of articles. The selection process based on the PRISMA statement yielded a total of 30 articles that met the eligibility criteria. Their findings were qualitatively synthesized using the structured approach, informed by the already known structure: situation awareness and its elements (gathering information, interpreting information, anticipating future states), decision making and its elements (generating and considering options, selecting and implementing an option, reviewing outcome/decision). Moreover, the element of maintaining standards also emerged as highly relevant for cognitive skills.

Results: This review found an increased research interest in the non-technical cognitive skills of EMS crew members. The majority of included articles' research designs were qualitative, then mixed, Delphi, and quantitative. It revealed several specifics of cognitive skills, such as EMS crew members need to holistically assess a wide range of cues and information, to make various health- and safety-related decisions and take EMS standards into account. However, there was only a limited number of observable markers of cognitive skills, such as acts and verbalizations, that could be considered as examples of good behavior. In addition, findings indicate a lack of articles focused on mass-casualty incidents and the interconnection of cognitive skills with other non-technical and medical skills.

Conclusion: Further research is needed to get a more comprehensive view of behavioral markers of cognitive skills and to develop a rating and training tool to improve EMS crew members' cognitive performance.

[Prehospital Blood Transfusion in New South Wales, Australia: A retrospective cohort study](#)

Sophie Shand, Kate Curtis, Michael Dinh, Brian Burns

Prehosp Emerg Care 2020 May 15;1-11

Introduction: Catastrophic hemorrhage remains the leading cause of preventable death. Not all New South Wales (NSW) hospitals stock blood products and, as such, blood products carried by NSW Ambulance retrieval teams are often the first available to critically unwell patients.

Objective: To describe the trends, characteristics and predictors of mortality prior to hospital treatment in patients receiving prehospital blood transfusion by NSW Ambulance retrieval teams attending primary missions from 2009-2018.

Methods: Retrospective review of all patients who received blood products with NSW Ambulance retrieval teams between 13/8/2009 and 31/12/2018.

Results: A total of 12,468 primary taskings were reviewed, identifying 1,043 (8.4%) cases of prehospital transfusion. The proportion of missions administering blood transfusions doubled between 2009 and 2018. Road traffic incidents were the predominant etiology. Eighty per cent of patients (n = 842) reached hospital alive following transfusion. Retrieval missions had a median time of 117 minutes (IQR 74-168). An initial blood pressure <100mmHg and reduced GCS were strongly associated with prehospital mortality. The median shock index of patients prior to transfusion was 1.2, which reduced to 1.0 after transfusion.

Conclusion: The use of prehospital blood transfusion for suspected bleeding in NSW Australia has more than doubled since 2010. Patients who received prehospital transfusion arrived at hospital with improved hemodynamic observations.

[The Military Medical System and Wartime Injuries to the Spine](#)

Kartik Shenoy, Yong H Kim

Bull Hosp Jt Dis (2013) 2020;78(1):42-45.

War has historically been a major catalyst for advancement in military medical care and medicine in general. In our current conflicts, advances in battlefield medicine, evacuation techniques, and personal protective equipment have improved survival rates among members of the armed services. With increased survival, there has been increased prevalence of serious but nonfatal injuries, particularly from blunt and penetrating trauma. Blast injuries are the major cause of trauma and have both blunt and penetrating components. With respect to the spine, blasts have led to open, contaminated wounds that are complex and difficult to treat. Additionally, blasts have led to an increased incidence of lower lumbar burst fractures and lumbosacral dissociation. As these and other injuries are being seen more commonly during war, we must ensure that our military medical system is adapting to ensure we are taking care of our military personnel at the highest level.

[Massive transfusion and the response to prehospital plasma: It is all in how you define it](#)

Edward S Sim, Frank X Guyette, Joshua B Brown, Brian J Daley, Richard S Miller, Brian G Harbrecht, Jeffrey A Claridge, Herb A Phelan, Matthew D Neal, Raquel Forsythe, Brian S Zuckerbraun, Jason L Sperry, PAMPer study group

J Trauma Acute Care Surg 2020 Jul;89(1):43-50

Background: A recent analysis derived from the Prehospital Air Medical Plasma trial data set demonstrated no significant independent plasma survival benefit in those who required massive transfusion (≥ 10 units of red cells in 24 hours). The definition of massive transfusion has evolved over time to minimize bias and predict those at highest risk of death. We sought to characterize the definition of massive transfusion, their associated mortality risks and the survival benefit associated with prehospital plasma.

Methods: A secondary analysis was performed using data from a recent prehospital plasma trial. Patients transferred directly from the scene were characterized. We defined historic massive transfusion using ≥ 10 units red cells in 24 hours and critical administration threshold (CAT) as ≥ 3 units per hour in the first hour (CAT1hr) or in any of the first 4 hours (CAT4hr) from arrival. The primary outcome was 30-day mortality. Kaplan-Meier analysis and Cox hazard regression were used to characterize the survival benefit of prehospital plasma.

Results: There were a total of 390 enrolled patients who were transferred from the scene and represent the study cohort. Overall, 126 patients were positive for the CAT1hr metric, 183 patients were positive for the CAT4hr metric and 84 patients were positive for historic massive transfusion metric. The overall study mortality rate for those patients who met each transfusion definition was 13.1%, 17.4% and 10.0%, respectively. The CAT4hr metric had the lowest potential for survival bias. Kaplan-Meier survival analysis demonstrated a prehospital plasma survival benefit in the patients who were CAT4hr positive.

Conclusion: The current analysis demonstrates the superior utility of the CAT4hr definition with optimization of survival bias while conserving mortality risk prediction. This transfusion definition was associated with a prehospital plasma survival benefit and may be the most appropriate definition of massive transfusion for pragmatic studies which focus on hemorrhagic shock.

[Martial arts technique for control of severe external bleeding](#)

John P Slevin, Cierra Harrison, Eric Da Silva, Nathan J White

Objectives: Haemorrhage control is a critical component of preventing traumatic death. Other than the battlefield, haemostatic devices, such as tourniquets or bandages, may not be available, allowing for significant avoidable blood loss. We hypothesised that compression of vascular pressure points using a position adapted from the martial art of Brazilian Jiu-Jitsu could be adapted to decrease blood flow velocity in major extremity arteries.

Methods: Knee mount compression was applied to the shoulder, groin and abdomen of healthy adult volunteer research subjects from Seattle, Washington, USA, from March through May 2018. Mean arterial blood flow velocity (MAV) was measured using ultrasound in the brachial and femoral arteries before and after compression. A MAV decrease greater than 20% with compression was deemed clinically relevant.

Results: For 11 subjects, median (IQR) MAV combining all anatomical locations tested was 29.2 (34.1, 24.1) cm/s at baseline and decreased to 3.3 (0, 19.1) cm/s during compression (Wilcoxon $p < 0.001$). MAV was significantly decreased during compression for each individual anatomical position tested (Wilcoxon $p \leq 0.004$). Per cent (95% CI) MAV reduction was significantly greater than 20% for shoulder compression at 97.5% (94% to 100%) and groin compression at 78% (56% to 100%), but was not statistically greater for abdominal compression at 35% (12% to 57%). Complete vessel occlusion was most common with compression at the shoulder (73%), followed by groin (55%) and abdomen (9%) (χ^2 LR, $p = 0.018$).

Conclusion: The Brazilian Jiu-Jitsu knee mount position can significantly decrease blood flow in major arteries of the extremities. This technique may be useful for bleeding control after injury.

Managing junctional haemorrhage in the combat environment

Shane A Smith, V C McAlister, L Dubois, A Beckett, R Hilsden

[BMJ Mil Health 2020 Mar 2;bmjmilitary-2019-001336](#)

Tactical combat casualty care and the application of extremity tourniquets have saved lives in combat. In the modern combat environment junctional injuries are common and difficult to treat. Recently, junctional tourniquets have emerged as a potential solution to this problem. Junctional tourniquets can be used as an adjunct to persistent haemorrhage despite application of conventional tourniquets or in the persistently hypotensive casualty. Surgeons must have an approach to receiving patients with junctional tourniquets in place in the operating room. The algorithms presented allow for an evidence-based and command-driven implantation of junctional tourniquets as part of tactical combat casualty care.

[Systematic approach to delivering prolonged field care in a prehospital care environment](#)

Michael Smith, K Johnston, R Withnall

BMJ Mil Health 2020 Feb 27;jramc-2019-001224

Background: This article describes a novel patient care algorithm which provides a Role 1 (R1) medic with a structured approach to delivering prolonged field care (PFC) in a resource-limited environment. PFC is a vital component of the operational patient care pathway providing the continuum of care from completion of a primary survey to the delivery to hospital care. Future operational environments are likely to have more fragile or extended lines of communication, potentially delaying evacuation to hospital care. This delay may lead to increases in patient morbidity and mortality. Effective PFC offers an opportunity to improve patient outcomes and help mitigate against this risk.

Methods: An initial prototype model of a PFC care process was developed using existing hospital-based guidance. A series of medical and trauma vignettes and best available evidence were used to refine the algorithm.

Results: The algorithm has been designed to be used in conjunction with patient specific clinical guidance making the approach generalisable for all patient groups. For UK military, clinical guidance is provided by clinical guidelines for operations. The algorithm can be downloaded into a convenient format to be used on mobile devices or printed as an aide memoire.

Combat thoracic surgery in Iraq and Afghanistan: 2002-2016

Caryn A Stern , Zsolt T Stockinger, Jennifer M Gurney

J Trauma Acute Care Surg 2020 Sep;89(3):551-557

Background: Thoracic surgery constitutes 2.5% of surgical procedures performed in theater, but the skills required are increasingly foreign to military surgeons. This study examines thoracic surgical workload in Iraq and Afghanistan to help define surgical training gaps.

Methods: Retrospective analysis of Department of Defense Trauma Registry for all role 2 (R2) (forward surgical) and role 3 (R3) (theater) military facilities, from January 2002 to May 2016. The 95 thoracic surgical International Classification of Diseases-9th Rev.-Clinical Modification procedure codes were grouped into 10 categories based on anatomy or endoscopy. Select groups were further stratified by type of definitive procedure. Procedure groupings were determined and adjudicated by surgeon subject matter experts. Data analysis used Stata Version 15 (College Station, TX).

Results: Of the total procedures, 5,301 were classified as thoracic surgical procedures and were included in the present study. The majority of thoracic surgical procedures (4,645 [87.6%]) were recorded as being performed at R3 medical treatment facilities (MTFs). The thoracic surgical procedures groups with the largest proportions were: bronchoscopy (39.1%), thoracotomy (16.9%), diaphragm (15.6%), and lung (11.4%). The most common lung procedure subgroup, aside from not otherwise specified, was segmentectomy (28.8%). The R3 MTFs recorded nearly five times the number of lung procedures compared with R2 MTFs; with R3 MTFs recording more than eight times the number of lobectomies compared with R2 MTFs. Thoracic workload was variable over the 15-year study period.

Conclusion: Thoracic surgical skills are necessary in the deployed environment to manage combat-related injuries. Given the current trends in training and specialization, development and sustainment of thoracic surgical skills is challenging in the deployed US trauma system and likely for other nations, and humanitarian surgical care as well. Current training and practice paradigms pose both training and sustainment challenges for surgeons who deploy to a combat zone.

Level of evidence: Therapeutic/Care Management IV.

[Pilot Study of a Novel Swine Model for Controlling Junctional Hemorrhage Using the iTClamp in Conjunction With Hemostatic Agents](#)

Sean M Stuart, Gregory Zarow, Alexandra Walchak, Julie McLean, Paul Roszko

Mil Med 2019 Mar 1;184(Suppl 1):367-373

Exsanguinating hemorrhage is a primary cause of battlefield death. The iTClamp is a relatively new device (FDA approval in 2013) that takes a different approach to hemorrhage control by applying mechanism wound closure. However, no previous studies have explored the feasibility of utilizing the iTClamp in conjunction with hemostatic packing. To fill this important gap in the literature, a novel swine model was developed, and a total of 12 trials were performed using QuikClot Combat Gauze or XSTAT sponges in conjunction with the iTClamp to treat arterial injuries through 5 cm or 10 cm skin incisions in the groin, axilla, or neck. First-attempt application success rate, application time, and blood loss were recorded. Hemostasis was achieved on all wounds, though reapplication was required in one Combat Gauze and three XSTAT applications. Application averaged ~50% slower for Combat Gauze (M = 41 seconds, 95%CI: 22-32 seconds) than for XSTAT (M = 27 seconds, 95%CI: 35-47 seconds). XSTAT application was faster than Combat Gauze for each wound location and size. The 10 cm wounds took ~10 seconds (36%) longer to close (M = 27 seconds, 95%CI: 35-47 seconds) than the 5 cm wounds (M = 27 seconds, 95%CI: 35-47 seconds). Blood loss was similar for Combat Gauze (M = 51 mL, 95%CI: 25-76 mL) and XSTAT (M = 60 mL, 95%CI: 30-90 mL). Blood loss was roughly twice as great for 10 cm wounds (M = 73 mL, 95%CI: 47-100 mL) than for 5 cm wounds (M = 38 mL, 95%CI: 18-57 mL). This pilot study supports the feasibility of a novel model for testing the iTClamp in conjunction with hemostatic packing towards controlling junctional hemorrhage.

[Anatomic injury patterns in combat casualties treated by forward surgical teams](#)

Mithun R Suresh 1, Krystal K Valdez-Delgado, Christopher A VanFosson, Jennifer D Trevino, Elizabeth A Mann-Salinas, Stacy A Shackelford, Amanda M Staudt

J Trauma Acute Care Surg 2020 Aug;89(2S Suppl 2):S231-S236

Background: Role 2 forward surgical teams provide damage-control resuscitation and surgery for life- and limb-threatening injuries. These teams have limited resources and personnel, so understanding the anatomic injury patterns seen by these teams is vital for providing adequate training and preparation prior to deployment. The objective of this study was to describe the spectrum of injuries treated at Role 2 facilities in Afghanistan.

Methods: Using Department of Defense Trauma Registry data, a retrospective, secondary data analysis was conducted. Eligible patients were all battle or non-battle-injured casualties treated by Role 2 forward surgical teams in Afghanistan from October 2005 to June 2018. Abbreviated Injury Scale (AIS) 2005 codes were used to classify each injury and Injury Severity Score (ISS) was calculated for each patient. Patients with multiple trauma were defined as patients with an AIS severity code >2 in at least two ISS body regions.

Results: The data set included 10,383 eligible patients with 45,225 diagnosis entries (range, 1-27 diagnoses per patient). The largest number of injuries occurred in the lower extremity/pelvis/buttocks (23.9%). Most injuries were categorized as minor (39.4%) or moderate (38.8%) in AIS severity, while the largest number of injuries categorized as severe or worse occurred in the head (13.5%). Among head injuries, 1,872 injuries were associated with a cerebral concussion or diffuse axonal injury, including 50.6% of those injuries being associated with a loss of consciousness. There were 1,224 patients with multiple trauma, and the majority had an injury to the extremities/pelvic girdle (58.2%). Additionally, 3.7% of all eligible patients and 10.5% of all patients with multiple trauma did not survive to Role 2 discharge.

Conclusion: The injury patterns seen in recent conflicts and demonstrated by this study may assist military medical leaders and planners to optimize forward surgical care in future environments, on a larger scale, and utilizing less resources.

[Time to Hemorrhage Control in a Hybrid ER System: Is it Time to Change?](#)

Danielle Tatum, Juan Duchesne, Bruno Pereira, Bryan Cotton, Mansoor Khan, Megan Brenner, Paula Ferrada, Tal Hörer, David Kauvar, Andrew Kirkpatrick, Carlos Ordonez, Artai Pirouzram, Derek Roberts

Shock 2020 Mar 19; Online ahead of print.

Time to hemorrhage control is critical, as mortality in patients with severe hemorrhage that arrive to trauma centers with sign of life remains over 40%. Prompt identification and management of severe hemorrhage is paramount to reducing mortality. In traditional US trauma systems, the early hospital course of a severely hemorrhaging patient typically proceeds from the trauma resuscitation bay to the operating room or angiography suite with a potential stop for radiological imaging. This protracted journey can prove fatal as it consumes valuable minutes. In contrast to the current US system is a newly developed and increasingly adopted system in Japan called the hybrid emergency room system (HERS). The hybrid ER is equipped to allow resuscitation, imaging, and damage control intervention to occur in the ER without the need to transport the patient to a subsequent destination. The HERS is relatively new and remains restricted to a small number of institutions, limiting the ability to robustly examine impact(s) on patient outcomes. Even if proven to yield superior outcomes, there are significant obstacles to adopting the HERS in the US. Challenges such as the high cost of building and implementing a HER system, return on investment, and the significant differences between the US and Japan in terms of physician training, trauma center, and reimbursement schemes may render the hybrid ER system to be unfeasible in most current trauma centers. Barriers aside, the Japanese hybrid ER system remains the most novel recent advancement in the quest to reduce potentially preventable mortality from hemorrhage.

[How emergency physicians choose chest tube size for traumatic pneumothorax or hemothorax: a comparison between 28Fr and smaller tube](#)

Takafumi Terada, Tetsuro Nishimura, Kenichiro Uchida, Naohiro Hagawa, Maiko Esaki, Yasumitsu Mizobata

Nagoya J Med Sci 2020 Feb;82(1):59-68

Most traumatic pneumothoraxes and hemothoraxes can be managed non-operatively by means of chest tube thoracostomy. This study aimed to investigate how emergency physicians choose chest tube size and whether chest tube size affects patient outcome. We reviewed medical charts of patients who underwent chest tube insertion for chest trauma within 24 hours of admission in this retrospective, single-institution study. Patient characteristics, inserted tube size, risk of additional tube, and complications were evaluated. Eighty-six chest tubes were placed in 64 patients. Sixty-seven tubes were placed initially, and 19 additionally, which was significantly smaller than the initial tube. Initial tube size was 28 Fr in 38 and <28 Fr in 28 patients. Indications were pneumothorax (n=24), hemothorax (n=7), and hemopneumothorax (n=36). Initial tube size was not related to sex, BMI, BSA, indication, ISS, RTS, chest AIS, or respiratory status. An additional tube was placed in the same thoracic cavity for residual pneumothorax (n=13), hemothorax (n=1), hemopneumothorax (n=1), and inappropriate extrapleural placement (n=3). Risk of additional tube placement was not significantly different depending on tube size. No additional tube was placed for tube occlusion or surgical intervention for residual clotted hemothorax. Emergency physicians did not choose tube size depending on patient sex, body size, or situation. Even with a <28 Fr tube placed in chest trauma patients, the risk of residual hemo/pneumothorax and tube occlusion did not increase, and drainage was effective.

Complications from Needle Thoracostomy: Penetration of the Myocardium

Arielle Thomas, K Hope Wilkinson, Kevin Young, Timothy Lenz, Jillian Theobald

Prehosp Emerg Care 2020 Jun 10;1-3

We report a rare but serious complication of needle thoracostomy, penetration of the myocardium. Needle thoracostomy is typically performed in the prehospital setting or upon arrival in the emergency department for suspected tension pneumothorax. Needle decompression is generally taught and done anteriorly, in the 2nd intercostal space on the midclavicular line (MCL). An alternative approach is laterally, along the anterior axillary line (AAL) in the 4th intercostal space. Our case supports prior literature that the anterior MCL location has a low rate of efficacy to decompress the chest, as well as a high rate of complications. We recommend performing needle decompression laterally at the AAL whether in the field or in the emergency department.

[Experience in an Urban Level 1 Trauma Center With Tranexamic Acid in Pediatric Trauma: A Retrospective Chart Review](#)

Julie M Thomson, Hanh H Huynh, Holly M Drone, Jessica L Jantzer, Albert K Tsai, Jon T Jancik

J Intensive Care Med 2020 Feb 24;Online ahead of print.

Background: Evidence for tranexamic acid (TXA) in the pharmacologic management of trauma is largely derived from data in adults. Guidance on the use of TXA in pediatric patients comes from studies evaluating its use in cardiac and orthopedic surgery. There is minimal data describing TXA safety and efficacy in pediatric trauma. The purpose of this study is to describe the use of TXA in the management of pediatric trauma and to evaluate its efficacy and safety end points.

Methods: This retrospective, observational analysis of pediatric trauma admissions at Hennepin County Medical Center from August 2011 to March 2019 compares patients who did and did not receive TXA. The primary end point is survival to hospital discharge. Secondary end points include surgical intervention, transfusion requirements, length of stay, thrombosis, and TXA dose administered.

Results: There were 48 patients aged ≤ 16 years identified for inclusion using a massive transfusion protocol order. Twenty-nine (60%) patients received TXA. Baseline characteristics and results are presented as median (interquartile range) unless otherwise specified, with statistical significance defined as $P < .05$. Patients receiving TXA were more likely to be older, but there was no difference in injury type or Injury Severity Score at baseline. There was no difference in survival to discharge or thrombosis. Patients who did not receive TXA had numerically more frequent surgical intervention and longer length of stay, but these did not reach significance.

Conclusions: TXA was utilized in 60% of pediatric trauma admissions at a single level 1 trauma center, more commonly in older patients. Although limited by observational design, we found patients receiving TXA had no difference in mortality or thrombosis.

[Early Identification of Acute Traumatic Coagulopathy Using Clinical Prediction Tools: A Systematic Review](#)

Sophie Thorn, Helge Güting, Marc Maegele, Russell L Gruen, Biswadev Mitra

Medicina (Kaunas) 2019 Sep 28;55(10):653

Background and objectives: Prompt identification of patients with acute traumatic coagulopathy (ATC) is necessary to expedite appropriate treatment. An early clinical prediction tool that does not require laboratory testing is a convenient way to estimate risk. Prediction models have been developed, but none are in widespread use. This systematic review aimed to identify and assess accuracy of prediction tools for ATC.

Materials and Methods: A search of OVID Medline and Embase was performed for articles published between January 1998 and February 2018. We searched for prognostic and predictive studies of coagulopathy in adult trauma patients. Studies that described stand-alone predictive or associated factors were excluded. Studies describing prediction of laboratory-diagnosed ATC were extracted. Performance of these tools was described.

Results: Six studies were identified describing four different ATC prediction tools. The COAST score uses five prehospital variables (blood pressure, temperature, chest decompression, vehicular entrapment and abdominal injury) and performed with 60% sensitivity and 96% specificity to identify an International Normalised Ratio (INR) of >1.5 on an Australian single centre cohort. TICCS predicted an INR of >1.3 in a small Belgian cohort with 100% sensitivity and 96% specificity based on admissions to resuscitation rooms, blood pressure and injury distribution but performed with an Area under the Receiver Operating Characteristic (AUROC) curve of 0.700 on a German trauma registry validation. Prediction of Acute Coagulopathy of Trauma (PACT) was developed in USA using six weighted variables (shock index, age, mechanism of injury, Glasgow Coma Scale, cardiopulmonary resuscitation, intubation) and predicted an INR of >1.5 with 73.1% sensitivity and 73.8% specificity. The Bayesian network model is an artificial intelligence system that predicted a prothrombin time ratio of >1.2 based on 14 clinical variables with 90% sensitivity and 92% specificity.

Conclusions: The search for ATC prediction models yielded four scoring systems. While there is some potential to be implemented effectively in clinical practice, none have been sufficiently externally validated to demonstrate associations with patient outcomes. These tools remain useful for research purposes to identify populations at risk of ATC.

[A comprehensive review of topical hemostatic agents: The good, the bad, and the novel](#)

Allison J Tompeck, Aniq Ur Reham Gajdhar, Matthew Dowling, Steven B Johnson, Philip S Barie, Robert J Winchell, David King, Thomas M Scalea, L D Britt, Mayur Narayan

J Trauma Acute Care Surg. 2020 Jan;88(1):e1-e21

Uncontrolled exsanguination remains the leading cause of death for trauma patients, many of whom die in the pre-hospital setting. Without expedient intervention, trauma-associated hemorrhage induces a host of systemic responses and acute coagulopathy of trauma. For this reason, health care providers and prehospital personnel face the challenge of swift and effective hemorrhage control. The utilization of adjuncts to facilitate hemostasis was first recorded in 1886. Commercially available products have since expanded to include topical hemostats, surgical sealants, and adhesives. The ideal product balances efficacy, with safety practicality and cost-effectiveness. This review of hemostasis provides a guide for successful implementation and simultaneously highlights future opportunities.

[Use of a Digital Cognitive Aid in the Early Management of Simulated War Wounds in a Combat Environment, a Randomized Trial](#)

Michael Truchot, Baptiste Balança, Pierre François Wey, Karim Tazarourte, François Lecomte, Arnaud Le Goff, Simon Leigh-Smith, Jean Jacques Lehot, Thomas Rimmele, Jean Christophe Cejka

Mil Med 2020 Aug 14;185(7-8):e1077-e1082

Introduction: The French army has implemented an algorithm based on the acronym "MARCHE RYAN," each letter standing for a key action to complete in order to help first care providers during emergency casualty care. On the battlefield, the risk of error is increased, and the use of cognitive aids (CAs) might be helpful to avoid distraction. We investigated the effect of using a digital CA (MAX, for Medical Assistance eXpert) by combat casualty care providers on their technical and nontechnical performances during the early management of simulated war wounds, compared to their memory and training alone.

Materials and methods: We conducted a randomized, controlled, unblinded study between July 2016 and February 2017. This study was approved by the Ethics Committee of the Ethical Board of Desgenettes Army Training Hospital (14.06.2017 n°385) and was registered on clinicaltrials.gov (NCT03483727). It took place during medicalization training in hostile environment ("MEDICHOS") in Chamonix Mont-Blanc and in the first aid training center in La Valbonne military base (France). Each participant had to deal with two different scenarios, one with MAX (MAX+) and the other without (MAX-). Scenarios were held using either high-fidelity patient simulators or actors as wounded patients. The primary outcome was participants' technical performance rated as their adherence to the MARCHE RYAN procedure (maximum 100%). The secondary outcome was the nontechnical performance according to the Ottawa crisis resource management Global Rating Scale (maximum 42).

Results: Technical performance was significantly higher in the MAX+ scenarios (70.60 IQR [63.70-73.56]) than in the MAX- scenarios (56.25 IQR [52.88-62.09], $p = 0.002$). The Ottawa scores were significantly higher in the MAX+ scenarios (31.50 IQR [29.50-33.75]) than in the MAX- scenarios (29.50 IQR [24.50-32.00], $p = 0.031$).

Conclusions: The use of a digital CA by combat casualty care providers improved technical and nontechnical performances during field training of simulated crises. Following recommendations on the design and use of CA, regular team training would improve fluidity in the use and acceptance of an aid, by a highly drilled professional corporation with a strong culture of leadership. Digital CA should be tested at a larger scale in order to validate their contribution to real combat casualty care.

Prehospital Vital Signs Accurately Predict Initial Emergency Department Vital Signs

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Prehosp Disaster Med 2020 Jun;35(3):254-259

Introduction: Prehospital vital signs are used to triage trauma patients to mobilize appropriate resources and personnel prior to patient arrival in the emergency department (ED). Due to inherent challenges in obtaining prehospital vital signs, concerns exist regarding their accuracy and ability to predict first ED vitals.

Hypothesis/problem: The objective of this study was to determine the correlation between prehospital and initial ED vitals among patients meeting criteria for highest levels of trauma team activation (TTA). The hypothesis was that in a medical system with short transport times, prehospital and first ED vital signs would correlate well.

Methods: Patients meeting criteria for highest levels of TTA at a Level I trauma center (2008-2018) were included. Those with absent or missing prehospital vital signs were excluded. Demographics, injury data, and prehospital and first ED vital signs were abstracted. Prehospital and initial ED vital signs were compared using Bland-Altman intraclass correlation coefficients (ICC) with good agreement as >0.60 ; fair as $0.40-0.60$; and poor as <0.40 .

Results: After exclusions, 15,320 patients were included. Mean age was 39 years (range 0-105) and 11,622 patients (76%) were male. Mechanism of injury was blunt in 79% ($n = 12,041$) and mortality was three percent ($n = 513$). Mean transport time was 21 minutes (range 0-1,439). Prehospital and first ED vital signs demonstrated good agreement for Glasgow Coma Scale (GCS) score (ICC 0.79; 95% CI, 0.77-0.79); fair agreement for heart rate (HR; ICC 0.59; 95% CI, 0.56-0.61) and systolic blood pressure (SBP; ICC 0.48; 95% CI, 0.46-0.49); and poor agreement for pulse pressure (PP; ICC 0.32; 95% CI, 0.30-0.33) and respiratory rate (RR; ICC 0.13; 95% CI, 0.11-0.15).

Conclusion: Despite challenges in prehospital assessments, field GCS, SBP, and HR correlate well with first ED vital signs. The data show that these prehospital measurements accurately predict initial ED vitals in an urban setting with short transport times. The generalizability of these data to settings with longer transport times is unknown.

Prehospital definitive airway is not associated with improved survival in trauma patients

Avishai M Tsur 1, Roy Nadler, Nir Tsur, Alex Sorkin, Tarif Bader, Avi Benov, Elon Glassberg, Jacob Chen

J Trauma Acute Care Surg 2020 Aug;89(2S Suppl 2):S237-S241

Background: The American College of Surgeons and the National Association of Emergency Medical Technicians advise securing a definitive airway if there is any doubt about the trauma patient's ability to maintain airway integrity. The objective of this study was to investigate the association between a success in securing a definitive airway in the prehospital setting and survival among trauma patients, in which the provider deemed a definitive airway was necessary.

Methods: The study included all trauma patients recorded in the Israel Defense Forces Trauma Registry between the years 2006 and 2018 for whom a prehospital attempt of securing a definitive airway was documented. The successful definitive airway group was defined by explicit documentation of success in either endotracheal intubation or cricothyrotomy. Logistic regression was performed to determine the association between success in securing a definitive airway and survival.

Results: A total of 566 (3.6%) trauma patients underwent attempts to secure a definitive airway (successful in 425 patients and unsuccessful in 141). Prehospital survival rates were similar (77.6% vs. 78.0%, $p = 0.928$) between the groups. Whether the definitive airway was successful did not affect the rates of prehospital survival, neither before (odds ratio, 0.98; 95% confidence interval, 0.61-1.54) nor after adjustment for the other factors (odds ratio, 0.91; 95% confidence interval, 0.55-1.46).

Conclusion: This study was unable to find an association between a successful definitive airway in the prehospital setting and survival, even after adjustment for injury characteristics and in multiple models. Furthermore, survival rates were high among trauma patients in which the provider deemed a definitive airway as necessary yet failed in securing one. These results suggest that the liberal use of these invasive airway procedures in the prehospital setting should be reconsidered.

[The Israel Defense Forces Trauma Registry: 22 years of point-of-injury data](#)

Avishai M Tsur, Roy Nadler, Ari M Lipsky, Diana Levi, Tarif Bader, Avi Benov, Elon Glassberg, Jacob Chen

J Trauma Acute Care Surg 2020 Aug;89(2S Suppl 2):S32-S38

Background: Trauma is the leading cause of death among casualties between 1 and 44 years. A large proportion of trauma deaths occurs even before arriving at a medical facility. The paucity of prehospital data is a major reason for the lagging development of prehospital trauma care research. This study aims to describe the Israel Defense Forces Prehospital Trauma Registry, the steps taken to improve data collection and quality, the resulting trends, and the registry's contribution to policymaking.

Methods: This study explores the quantity and quality of point of injury and prehospital data in the registry between the years 1997 and 2018. We assessed the number of recorded casualties per year, casualties characteristics, and documentation variables in the registry, with a specific focus on documentation of vital signs throughout the years.

Results: Overall, 17,905 casualties were recorded. Most casualties were young males (88.6%)-military personnel (52.7%), Syrian refugees (16.2%), Israeli civilians (11.5%), and Palestinians (9.0%). The median number of annual records from 2006 onward was significantly higher compared with before 2006 (1,000 [IQR, 792-1,470] vs. 142 [IQR, 129-156]). Between 2010 and 2018, documentation rate increased in all vital signs investigated including heart rate (56.3% vs. 1.0%), level of consciousness (55.1% vs. 0.3%), respiratory rate (51.8% vs. 0.3%), blood oxygen saturation (50.0% vs. 1.0%), Glasgow Coma Scale (48.2% vs. 0.4%), systolic blood pressure (45.7% vs. 0.8%), and pain (19.1% vs. 0.5%).

Conclusion: Point of injury and prehospital documentation are rare yet essential for ongoing improvement of combat casualty care. The Israel Defense Forces Trauma Registry is one of the largest and oldest prehospital computerized military trauma registries in the world. This study shows a major improvement in the quantity and then in the quality of prehospital documentation throughout the years that affected guidelines and policy. Further work will focus on improving data completeness and accuracy.

[Pre-hospital emergency anaesthesia in the United Kingdom: an observational cohort study](#)

Jake Turner, Sebastian Bourn, James Raitt, Erica Ley, Matthew O'Meara, Pre-Hospital Trainee Operated research Network study investigators

Br J Anaesth 2020 May;124(5):579-584

Background: Up to one in eight trauma patients arrive at a hospital with a partially or completely obstructed airway. The UK National Institute for health and Care Excellence (NICE) practice guidelines recommend that trauma patients requiring anaesthesia for definitive airway management receive this care within 45 min of an emergency call, preferably at the incident scene. How frequently this target is achieved remains unclear. We assessed the recorded time to pre-hospital emergency anaesthesia after trauma across UK helicopter emergency medical service (HEMS) units.

Methods: We retrospectively recorded time to pre-hospital emergency anaesthesia across all 20 eligible UK HEMS units (comprising 52 enhanced care teams) from April 1, 2017 to March 31, 2018. Times recorded for emergency notification, dispatch, arrival, and neuromuscular blocking agent administration were analysed.

Results: HEMS undertook 1755 pre-hospital emergency anaesthetics for trauma across the UK during the study period. There were 1176/1755 (67%) episodes undertaken by helicopter response teams during daylight hours. The median time to pre-hospital emergency anaesthesia was 55 min (inter-quartile range: 45-70); anaesthesia within 45 min of the initial emergency call was achieved in 25% cases. Delayed dispatch time (>9 min) was associated with fewer patients receiving pre-hospital anaesthesia within 45 min (odds ratio: 7.7 [95% confidence intervals: 5.8-10.1]; $P < 0.0001$).

Conclusions: The time to achieve pre-hospital emergency anaesthesia by UK HEMS frequently exceeds the recommended 45 min target. Reducing the time to dispatch of emergency medical teams may impact on the delivery of pre-hospital emergency anaesthesia.

Systematic review with meta-analysis: the efficacy of tranexamic acid in upper gastrointestinal bleeding

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Aliment Pharmacol Ther 2020 Jun;51(11):1004-1013

Background: Upper gastrointestinal bleeding is a common medical emergency associated with substantial mortality. Tranexamic acid may be effective for reducing mortality in upper gastrointestinal bleeding.

Aim: To examine the effects of tranexamic acid in upper gastrointestinal bleeding by systematic review and meta-analysis.

Methods: We searched PubMed, EMBASE, CINAHL, the Cochrane Central Register of Controlled Trials (CENTRAL) and other relevant websites for randomised controlled trials investigating the effect of tranexamic acid published from inception to December 10, 2019. The primary outcome of interest was mortality. Estimates of effect were pooled with a random effects model. Quality of evidence was assessed using the Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) approach.

Results: The search identified 1572 citations. Eleven trials comprising 2076 patients were eligible for inclusion. Of these, 10 trials (2013 patients) compared tranexamic acid with placebo. Risk of death was significantly reduced in patients who received tranexamic acid compared with those who received placebo (RR 0.59, 95% CI 0.43-0.82, $P = 0.001$) with no significant heterogeneity noted among studies ($I^2 = 0\%$, $P = 0.81$). The GRADE assessment rated the quality of the evidence for mortality as moderate due to risk of bias. There were no statistically significant differences between tranexamic acid and placebo for the prevention of re-bleeding, need for surgical interventions, need for blood transfusions or frequency of thromboembolic events.

Conclusions: Moderate-quality evidence shows that tranexamic acid is superior to placebo for the reduction in mortality in patients with upper gastrointestinal bleeding. While our findings lend further support to the use of tranexamic acid for treating patients with upper gastrointestinal bleeding, additional higher-quality trials are needed.

Validation of an evaluation instrument for responders in tactical casualty care simulations

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Rev Lat Am Enfermagem. 2020 Apr 17;28:e3251

Objective: to construct and validate a tool for the evaluation of responders in tactical casualty care simulations.

Method: three rubrics for the application of a tourniquet, an emergency bandage and haemostatic agents recommended by the Hartford Consensus were developed and validated. Validity and reliability were studied. Validation was performed by 4 experts in the field and 36 nursing participants who were selected through convenience sampling. Three rubrics with 8 items were evaluated (except for the application of an emergency bandage, for which 7 items were evaluated). Each simulation was evaluated by 3 experts.

Results: an excellent score was obtained for the correlation index for the 3 simulations and 2 levels that were evaluated (competent and expert). The mean score for the application of a tourniquet was 0.897, the mean score for the application of an emergency bandage was 0.982, and the mean score for the application of topical haemostats was 0.805.

Conclusion: this instrument for the evaluation of nurses in tactical casualty care simulations is considered useful, valid and reliable for training in a prehospital setting for both professionals who lack experience in tactical casualty care and those who are considered to be experts.

Management of mild traumatic brain injury

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Pract Neurol 2020 May;20(3):213-221

Mild traumatic brain injury (TBI) is common and associated with a range of diffuse, non-specific symptoms including headache, nausea, dizziness, fatigue, hypersomnolence, attentional difficulties, photosensitivity and phonosensitivity, irritability and depersonalisation. Although these symptoms usually resolve within 3 months, 5%-15% of patients are left with chronic symptoms. We argue that simply labelling such symptoms as 'postconcussional' is of little benefit to patients. Instead, we suggest that detailed assessment, including investigation, both of the severity of the 'mild' injury and of the individual symptom syndromes, should be used to tailor a rehabilitative approach to symptoms. To complement such an approach, we have developed a self-help website for patients with mild TBI, based on neurorehabilitative and cognitive behavioural therapy principles, offering information, tips and tools to guide recovery: www.headinjurysymptoms.org.

[Development and validation of a novel prediction model to identify patients in need of specialized trauma care during field triage: design and rationale of the GOAT study](#)

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Diagn Progn Res 2019 Jun 20;3:12

Background: Adequate field triage of trauma patients is crucial to transport patients to the right hospital. Mistriage and subsequent interhospital transfers should be minimized to reduce avoidable mortality, life-long disabilities, and costs. Availability of a prehospital triage tool may help to identify patients in need of specialized trauma care and to determine the optimal transportation destination.

Methods: The GOAT (Gradient Boosted Trauma Triage) study is a prospective, multi-site, cross-sectional diagnostic study. Patients transported by at least five ground Emergency Medical Services to any receiving hospital within the Netherlands are eligible for inclusion. The reference standards for the need of specialized trauma care are an Injury Severity Score ≥ 16 and early critical resource use, which will both be assessed by trauma registrars after the final diagnosis is made. Variable selection will be based on ease of use in practice and clinical expertise. A gradient boosting decision tree algorithm will be used to develop the prediction model. Model accuracy will be assessed in terms of discrimination (c-statistic) and calibration (intercept, slope, and plot) on individual participant's data from each participating cluster (i.e., Emergency Medical Service) through internal-external cross-validation. A reference model will be externally validated on each cluster as well. The resulting model statistics will be investigated, compared, and summarized through an individual participant's data meta-analysis.

Discussion: The GOAT study protocol describes the development of a new prediction model for identifying patients in need of specialized trauma care. The aim is to attain acceptable undertriage rates and to minimize mortality rates and life-long disabilities.

[Pre-hospital transfusion of red blood cells. Part 1: A scoping review of current practice and transfusion triggers](#)

Elisabeth C van Turenhout, Sebastiaan M Bossers, Stephan A Loer, Georgios F Giannakopoulos, Lothar A Schwarte, Patrick Schober

Transfus Med 2020 Apr;30(2):86-105

Objectives: The primary aim of this scoping review is to describe the current use of pre-hospital transfusion of red blood cells (PHTRBC) and to evaluate criteria used to initiate PHTRBC. The effects on patients' outcomes will be reviewed in Part 2.

Background: Haemorrhage is a preventable cause of death in trauma patients, and transfusion of red blood cells is increasingly used by Emergency Medical Services (EMS) for damage control resuscitation. However, there are no guidelines and little consensus on when to initiate PHTRBC.

Methods: PubMed and Web of Science were searched through January 2019; 71 articles were included.

Results: Transfusion triggers vary widely and involve vital signs, clinical signs of poor tissue perfusion, point of care measurements and pre-hospital ultrasound imaging. In particular, hypotension (most often defined as systolic blood pressure \leq 90 mmHg), tachycardia (most often defined as heart rate \geq 120/min), clinical signs of poor perfusion (eg, prolonged capillary refill time or changes in mental status) and injury type (ie, penetrating wounds) are common pre-hospital transfusion triggers.

Conclusions: PHTRBC is increasingly used by Emergency Medical Services, but guidelines on when to initiate transfusion are lacking. We identified the most commonly used transfusion criteria, and these findings may provide the basis for consensus-based pre-hospital transfusion protocols.

[Prehospital trauma care evolution, practice and controversies: need for a review](#)

Mathew Varghese

Int J Inj Contr Saf Promot 2020 Mar;27(1):69-82

Modern medicine and surgery is historically very recent, and most interventions that are so commonly done in a hospital now are only 60 to 70 years old. Understanding of emergency care of the injured is more recent; however, for the sake of temporal convenience trauma care has become compartmentalized into phases: first aid, bystander care, prehospital care, emergency care, definitive levels of care and rehabilitation. The injured patient's body physiology is changing continuously from the time of the impact at the injury site.. The outcome of trauma is dependent not only on what is done in the prehospital phase but also on hospital care and rehabilitation. Our understanding of the changes and the response to interventions in a trauma patient has been evolving over the years. This paper discusses the need to review recent advances in our understanding of the care process and how we need to improve it and how there is a pressing need to generate valid evidence on what we do in emergency care.

Outcomes of tranexamic acid administration in military trauma patients with intracranial hemorrhage: a cohort study

Patrick F Walker, Joseph D Bozzay, Luke R Johnston, Eric A Elster, Carlos J Rodriguez, Matthew J Bradley

BMC Emerg Med 2020 May 14;20(1):39

Background: Tranexamic acid (TXA) may be a useful adjunct for military patients with severe traumatic brain injury (TBI). These patients are often treated in austere settings without immediate access to neurosurgical intervention. The purpose of this study was to evaluate any association between TXA use and progression of intracranial hemorrhage (ICH), neurologic outcomes, and venous thromboembolism (VTE) in TBI.

Methods: This was a retrospective cohort study of military casualties from October 2010 to December 2015 who were transferred to a military treatment facility (MTF) in the United States. Data collected included: demographics, types of injuries, initial and interval head computerized tomography (CT) scans, Glasgow Coma Scores (GCS), and six-month Glasgow Outcome Scores (GOS). Results were stratified based on TXA administration, progression of ICH, and VTE.

Results: Of the 687 active duty service members reviewed, 71 patients had ICH (10.3%). Most casualties were injured in a blast (80.3%), with 36 patients (50.7%) sustaining a penetrating TBI. Mean ISS was 28.2 ± 12.3 . Nine patients (12.7%) received a massive transfusion within 24 h of injury, and TXA was administered to 14 (19.7%) casualties. Patients that received TXA had lower initial reported GCS (9.2 ± 4.4 vs. 12.5 ± 3.4 , $p = 0.003$), similar discharge GCS (13.3 ± 4.0 vs. 13.8 ± 3.2 , $p = 0.58$), and a larger improvement between initial and discharge GCS (3.7 ± 3.9 vs. 1.3 ± 3.1 , $p = 0.02$). However, there was no difference in mortality (7.1% vs. 7.0%, $p = 1.00$), progression of ICH (45.5% vs. 14.7%, $p = 0.09$), frequency of cranial decompression (50.0% vs. 42.1%, $p = 0.76$), or mean GOS (3.5 ± 0.9 vs. 3.8 ± 1.0 , $p = 0.13$). Patients administered TXA had a higher rate of VTE (35.7% vs. 7.0%, $p = 0.01$). On multivariate analysis, however, TXA was not independently associated with VTE.

Conclusions: Patients that received TXA were associated with an improvement in GCS but not in progression of ICH or GOS. TXA was not independently associated with VTE, although this may be related to a paucity of patients receiving TXA. Decisions about TXA administration in military casualties with ICH should be considered in the context of the availability of neurosurgical intervention as well as severity of extracranial injuries and need for massive transfusion.

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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BMJ Mil Health 2020 Jun 2; Online ahead of print.

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.

[Systematic review of prehospital haemostatic dressings](#)

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BMJ Mil Health 2020 Jun;166(3):194-200

Introduction: Haemorrhage is one of the leading causes of battlefield and prehospital death. Haemostatic dressings are an effective method of limiting the extent of bleeding and are used by military forces extensively. A systematic review was conducted with the aim of collating the evidence on current haemostatic products and to assess whether one product was more effective than others.

Methods: A systematic search and assessment of the literature was conducted using 13 health research databases including MEDLINE and CINAHL, and a grey literature search. Two assessors independently screened the studies for eligibility and quality. English language studies using current-generation haemostatic dressings were included. Surgical studies, studies that did not include survival, initial haemostasis or rebleeding and those investigating products without prehospital potential were excluded.

Results: 232 studies were initially found and, after applying exclusion criteria, 42 were included in the review. These studies included 31 animal studies and 11 clinical studies. The outcomes assessed were subject survival, initial haemostasis and rebleeding. A number of products were shown to be effective in stopping haemorrhage, with Celox, QuikClot Combat Gauze and HemCon being the most commonly used, and with no demonstrable difference in effectiveness.

Conclusions: There was a lack of high-quality clinical evidence with the majority of studies being conducted using a swine haemorrhage model. Iterations of three haemostatic dressings, Celox, HemCon and QuikClot, dominated the studies, probably because of their use by international military forces and all were shown to be effective in the arrest of haemorrhage.

[Evaluating tourniquet use in Swedish prehospital care for civilian extremity trauma](#)

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Eur J Trauma Emerg Surg 2020 Apr 29; Online ahead of print.

Purpose: The use of tourniquet (TQ) is today a well-documented and lifesaving adjunct to control bleeding from extremity trauma in the military setting. Since August 2015, the ambulance services in Stockholm, Sweden are equipped with TQs. The implementation and potential complications related to TQ use have so far not been evaluated. The primary aim of this study was to evaluate the prehospital use of TQ for haemorrhage control in extremity trauma. Possible complications following the use of TQ were analysed.

Methods: A retrospective, descriptive cohort study of extremity haemorrhage for all patients (n = 56) with a documented prehospital use of TQ admitted to the trauma centre at Karolinska University Hospital from 1st August 2015 to 31st December 2017 was conducted. Data regarding TQ use including indication, duration, bleeding volume, complications and definitive injury were analysed.

Results: Out of 63 placements of TQ in 56 patients, TQ stopped the bleeding effectively in 98.2% of the cases and the TQ time varied from 15 to 100 min. The overall complication rate was 30.1%; however, complications possibly related to TQ use were 3.6%. In 16 (28.6%) cases, the TQ were used for a non-life-threatening haemorrhage which may have been stopped with direct pressure only.

Conclusion: This study shows TQs to be an effective but overused tool in haemorrhage control. The use of TQ was not associated with any severe complications, implying the safety and effectiveness of the device in the civilian setting if TQ time is kept under 100 min.

Development of prehospital assessment findings associated with massive transfusion

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Transfusion 2020 Jun;60 Suppl 3:S70-S76

Background: Massive transfusion is frequently a component of the resuscitation of combat casualties. Because blood supplies may be limited, activation of a walking blood bank and mobilization of necessary resources must occur in a timely fashion. The development of a risk prediction model to guide clinicians for early transfusion in the prehospital setting was sought.

Study design and methods: This is a secondary analysis of a previously described data set from the Department of Defense Trauma Registry from January 2007 to August 2016 focusing on casualties undergoing massive transfusion. Serious injury was defined based on an Abbreviated Injury Scale score of 3 or greater by body region. The authors constructed multiple imputations of the model for risk prediction development. Efforts were made to internally validate the model.

Results: Within the data set, there were 15540 patients, of which 1238 (7.9%) underwent massive transfusion. In the body region injury scale model, explosive injuries (odds ratio [OR], 3.78), serious extremity injuries (OR, 6.59), and tachycardia >120/min (OR, 5.61) were most strongly associated with receiving a massive transfusion. In the simplified model, major amputations (OR, 17.02), tourniquet application (OR, 6.66), and tachycardia >120 beats/min (OR, 8.72) were associated with massive transfusion. Both models had area under the curve receiver operating characteristic values of greater than 0.9 for the model and bootstrap forest analysis.

Conclusion: In the body region injury scale model, explosive mechanisms, serious extremity injuries, and tachycardia were most strongly associated with massive transfusion. In the simplified model, major amputations, tourniquet application, and tachycardia were most strongly associated.

Safety profile and impact of low-titer group O whole blood for emergency use in trauma

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J Trauma Acute Care Surg 2020 Jan;88(1):87-93

Purpose: Following US military implementation of a cold-stored whole blood program, several US trauma centers have begun incorporating uncrossmatched, group O cold-stored whole blood into civilian trauma resuscitation. We set out to evaluate the safety profile, transfusion reactions events, and impact of low-titer group O whole blood (LTO-WB) at our center.

Methods: In November 2017, we added LTO-WB to each of our helicopters and to our emergency department (ED) refrigerator, alongside that of existing red blood cells and plasma. We collected information on all patients with trauma receiving prehospital or ED transfusion of uncrossed, emergency release blood products between November 2017 and June 2018. Patients were divided into those receiving any LTO-WB and those receiving only red blood cell and or plasma (COMP). Serial hemolysis panels were obtained at 3 hours, 24 hours, and 48 hours. All data were run using STATA 12.1. Statistical significance was set at $p < 0.05$.

Results: One hundred ninety-eight patients received LTO-WB and 152 patients received COMP. There were no differences in age, sex, or mechanism. The LTO-WB patients had higher chest Abbreviated Injury Scale scores (median, 3 vs. 2; $p = 0.027$), as well as worse arrival base excess (median, -7 vs. -5; $p = 0.014$) and lactate (5.1 vs. 3.5; $p < 0.001$). The LTO-WB patients received less post-ED blood products than the COMP patients (median, 0 vs. 3; $p = 0.001$). There was no difference in survival (LTO-WB, 73%; COMP, 74%; $p = 0.805$). There were only two suspected transfusion reactions, both in the COMP group ($p = 0.061$). There was no difference in hemolysis panel values. Controlling for age, severity of injury, and prehospital physiology, LTO-WB was associated with a 53% reduction in post-ED blood product transfusion (odds ratio, 0.47; 0.23-0.94 95% CI; $p = 0.033$) and two-fold increase in likelihood of survival (odds ratio, 2.19; 1.01-4.76 95% CI; $p = 0.047$).

Conclusion: Low-titer group O whole blood has similar evidence of laboratory hemolysis, similar transfusion reaction rates, and is associated with a reduction in post-ED transfusions and increase likelihood of survival.

Level of evidence: Therapeutic, Level II.

[A prospective observational study of acute traumatic coagulopathy in traumatic bleeding from the battlefield](#)

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Transfusion 2020 Jun;60 Suppl 3:S52-S61

Background: Acute trauma coagulopathy (ATC) after military trauma has not been comprehensively studied. ATC is defined as a prolonged prothrombin time ratio (PT_r) or reduced clot amplitude (A5) in viscoelastic testing. Compared to civilian trauma, military trauma has more injuries from explosions and gunshot wounds (GSWs), potentially leading to a different pathophysiology for traumatic coagulopathy. This study aimed to characterize military ATC on admission to a military hospital in Afghanistan and to explore any differences due to the mechanism of injury.

Methods: Severely injured military casualties were enrolled in the study. Blood samples were taken on admission and after routine testing, waste plasma was prepared, frozen, and transported to the United Kingdom for in-depth hemostatic analysis.

Results: Seventy-seven percent of casualties had ATC defined by a PT_r greater than 1.2 and 19% when defined by rotational thromboelastometry (ROTEM) A5 less than 36 mm. Coagulation factor depletion correlated with degree of shock, particularly factor V ($p < 0.01$), factor X ($p < 0.01$), and fibrinogen levels ($p < 0.01$). Thrombin generation was well preserved. Fibrinolytic biomarkers were raised correlating with the degree of shock ($p < 0.01$), and 8% of casualties had hyperfibrinolysis on ROTEM analysis. Plasmin-antiplasmin complexes ($p < 0.01$) and d-dimer levels ($p = 0.01$) were higher and clot firmness lower ($p = 0.02$) in those injured by explosion compared to GSW's.

Conclusions: ATC was present and correlated with shock, similar to civilian trauma. Thrombin generation remained adequate. Fibrinogen and factor V levels were disproportionately low but still sufficient to allow clot formation. Fibrinolysis is a key feature, probably due to a tissue plasminogen activator surge at the time of injury. Blast injuries are associated with a greater activation of fibrinolysis than GSWs.

Transfusion of Uncrossmatched Group O Erythrocyte-containing Products Does Not Interfere with Most ABO Typings

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Anesthesiology 2020 Mar;132(3):525-534

Background: Group O erythrocytes and/or whole blood are used for urgent transfusions in patients of unknown blood type. This study investigated the impact of transfusing increasing numbers of uncrossmatched type O products on the recipient's first in-hospital ABO type.

Methods: This was a retrospective cohort study. Results of the first ABO type obtained in adult, non-type O recipients (i.e., types A, B, AB) after receiving at least one unit of uncrossmatched type O erythrocyte-containing product(s) for any bleeding etiology were analyzed along with the number of uncrossmatched type O erythrocyte-containing products administered in the prehospital and/or in hospital setting before the first type and screen sample was drawn.

Results: There were 10 institutions that contributed a total of 695 patient records. Among patients who received up to 10 uncrossmatched type O erythrocyte-containing products, the median A antigen agglutination strength in A and AB individuals on forward typing (i.e., testing the recipient's erythrocytes for A and/or B antigens) was the maximum (4+), whereas the median B antigen agglutination strength among B and AB recipients of up to 10 units was 3 to 4+. The median agglutination strength on the reverse type (i.e., testing the recipient's plasma for corresponding anti-A and -B antibodies) was very strong, between 3 and 4+, for recipients of up to 10 units of uncrossmatched erythrocyte-containing products. Overall, the ABO type of 665 of 695 (95.7%; 95% CI, 93.9 to 97.0%) of these patients could be accurately determined on the first type and screen sample obtained after transfusion of uncrossmatched type O erythrocyte-containing products.

Conclusions: The transfusion of smaller quantities of uncrossmatched type O erythrocyte-containing products, in particular up to 10 units, does not usually interfere with determining the recipient's ABO type. The early collection of a type and screen sample is important.