Tactical Combat Casualty Care

Journal Article Abstracts

Committee on Tactical Combat Casualty Care
November 2015

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J Trauma Acute Care Surg. 2015 Nov;79(5):790-796

The safety of early fresh whole blood transfusion among severely battle injured at US Marine Corps forward surgical care facilities in Afghanistan.

Auten JD, Lunceford NL, Horton JL, Galarneau MR, Galindo RM, Shepps CD, Zieber TJ, Dewing CB

BACKGROUND: In Afghanistan, care of the acutely injured trauma patient commonly occurred in facilities with limited blood banking capabilities. Apheresis platelets were often not available. Component therapy consisted of 1:1 packed red blood cells and fresh frozen plasma. Fresh, whole blood transfusion often augmented therapy in the severely injured patient. This study analyzed the safety of fresh, whole blood use in a resource-limited setting.

METHODS: A retrospective analysis was performed on a prospectively collected data set of US battle injuries presenting to three US Marine Corps (USMC) expeditionary surgical care facilities in Helmand Province, Afghanistan, between January 2010 and July 2012. Included in the review were patients with Injury Severity Scores (ISSs) of 15 or higher receiving blood transfusions. Univariate analyses were performed, followed by multivariable logistic regression to describe the relationship between the treatment group and post-treatment complications such as trauma-induced coagulopathy, infection, mortality, venous thromboembolism, and transfusion reaction. Propensity scores were calculated and included in multivariable models to adjust for potential bias in treatment selection.

RESULTS: A total of 61 patients were identified; all were male Marines with a mean (SD) age of 23.5 (3.6) years. The group receiving fresh, whole blood was noted to have higher ISSs and lower blood pressure, pH, and base deficits on arrival. Traumatic coagulopathy was significantly less common in the group receiving fresh, whole blood (odds ratio, 0.01; 95% confidence interval, 0.00-0.18). Multivariable models found no other significant differences between the treatment groups.

CONCLUSION: The early use of fresh, whole blood in a resource-limited setting seems to confer a benefit in reducing traumatic coagulopathy. This study's small sample size precludes further statement on the overall safety of fresh, whole blood use.

LEVEL OF EVIDENCE: Therapy study, level IV.

J R Army Med Corps. 2015 Sep 23. pii: jramc-2015-000489. doi: 10.1136/jramc-2015-000489. [Epub ahead of print]

Transfusion support by a UK Role 1 medical team: a 2-year experience from Afghanistan.

Aye Maung N, Doughty H, MacDonald S, Parker P

INTRODUCTION: This paper describes the clinical governance, training, equipment and infrastructure developed to enable a UK Role 1 medical team to deliver forward transfusion in Southern Afghanistan. The aim was to explore the utility and feasibility of forward blood transfusion by a Role 1 medical team in an austere military environment.

METHODS: An audit of prospectively collected transfusion regulatory and cold chain data using standard-issue equipment and governance systems. TempIT tags were read before and after each mission to record blood storage temperature. Two years' data were analysed to review the use of blood products, cold chain compliance and equipment issues.

RESULTS: Over 24 months, blood products were carried on over 1000 mission hours. Two clinical cases required transfusion and were successfully resuscitated. The team was able to correctly transport, store and deploy red cells and plasma on missions using standard Ministry of Defence (MOD) issue equipment. There were seven cold chain failures, all of which were addressed locally. Current cold chain and diagnostic equipment would require further optimisation for use at Role 1.

CONCLUSIONS: An isolated Role 1 medical team can safely deliver blood transfusion on vehicle, helicopter or foot patrols. The transport and storage of blood created a large logistical burden for a relatively small clinical output. However, with further developments, this capability may have utility in contingency operations especially for isolated teams.

Acad Emerg Med. 2015 Aug;22(8):908-14. doi: 10.1111/acem.12732

The inaccuracy of using landmark techniques for cricothyroid membrane identification: a comparison of three techniques.

Bair AE, Chima R

OBJECTIVES: Successful cricothyrotomy is predicated on accurate identification of the cricothyroid membrane (CTM) by palpation of superficial anatomy. However, recent research has indicated that accuracy of the identification of the CTM can be as low as 30%, even in the hands of skilled providers. To date, there are very little data to suggest how to best identify this critical landmark. The objective was to compare three different methods of identifying the CTM.

METHODS: A convenience sample of patients and physician volunteers who met inclusion criteria was consented. The patients were assessed by physician volunteers who were randomized to one of three methods for identifying the CTM (general palpation of landmarks vs. an approximation based on four finger widths vs. an estimation based on overlying skin creases of the neck). Volunteers would then mark the skin with an invisible but florescent pen. A single expert evaluator used ultrasound to identify the superior and inferior borders of the CTM. The variably colored florescent marks were then visualized with ultraviolet light and the accuracy of the various methods was recorded as the primary outcome. Additionally, the time it took to perform each technique was measured. Descriptive statistics and report 95% confidence intervals (CIs) are reported.

RESULTS: Fifty adult patients were enrolled, 52% were female, and mean body mass index was 28 kg/m(2) (95% CI = 26 to 29 kg/m(2)). The general palpation method was successful 62% of the time (95% CI = 48% to 76%) and took an average of 14 seconds to perform (range = 5 to 45 seconds). In contrast, the four-finger technique was successful 46% of the time (95% CI = 32% to 60%) and took an average of 12 seconds to perform (range = 6 to 40 seconds). Finally, the neck crease method was successful 50% of the time (95% CI = 36% to 64%) and took an average of 11 seconds to perform (range = 5 to 15 seconds).

CONCLUSIONS: All three methods performed poorly overall. All three techniques might potentially be even less accurate in instances where the superficial anatomy is not palpable due to body habitus. These findings should alert clinicians to the significant risk of a misplaced cricothyrotomy and highlight the critical need for future research.

Can J Anaesth. 2015 Nov;62(11):1179-1187.

Universal tranexamic acid therapy to minimize transfusion for major joint arthroplasty: a retrospective analysis of protocol implementation.

Baker J, Pavenski K, Pirani R, White A, Kataoka M, Waddell J, Ho A, Schemitsch E, Lo N, Bogoch E, Pronovost A, Luke K, Howell A, Nassis A, Tsui A, Tanzini R, Pulendrarajah R, Mazer C, Freedman J, Hare G.

PURPOSE: Tranexamic acid (TXA) therapy can reduce red blood cell (RBC) transfusion; however, this therapy remains underutilized in many surgical patient populations. We assessed whether implementation of a protocol to facilitate universal administration of TXA in patients undergoing total hip or knee arthroplasty would reduce the incidence of RBC transfusion without increasing adverse clinical outcomes.

METHODS: We implemented a quality of care policy to provide universal administration of intravenous TXA at a dose of 20 mg·kg(-1) iv to all eligible patients undergoing total hip or knee arthroplasty from October 21, 2013 to April 30, 2014. We compared data from an equal number of patients before and after protocol implementation (n = 422 per group). The primary outcome was RBC transfusion with secondary outcomes including postoperative hemoglobin concentration (Hb) and length of hospital stay. Adverse events were identified from the electronic medical records. Data were analyzed by a Chi square test and adjusted logistic and linear regression analysis.

RESULTS: Implementation of the protocol resulted in an increase in TXA utilization from 45.8% to 95.3% [change 49.5%; 95% confidence interval (CI), 44.1 to 54.5; P < 0.001]. This change was associated with a reduction in the rate of RBC transfusion from 8.8% to 5.2%, (change -3.6%; 95% CI, -0.1 to -7.0; P = 0.043). Pre- and post-protocol mean [standard deviation (SD)] Hb values were similar, including the nadir Hb prior to RBC transfusion [72 (8) g·L(-1) vs 70 (8) g·L(-1), respectively; mean difference -1 g·L(-1); 95% CI, -3 to 5; P = 0.569]. Length of stay was not altered, and no increase in adverse events was observed.

CONCLUSIONS: Implementation of a perioperative TXA protocol was associated with both an increase in TXA use and a reduction in RBC transfusion following hip or knee arthroplasty. Adverse events and length of hospital stay were not influenced by the protocol.

J Perioper Pract. 2015 Jul-Aug;25(7-8):140-3.

Intraosseous access to the circulatory system: An under-appreciated option for rapid access.

Benson G.

Abstract: In many emergency situations rapid vascular access is a priority, particularly in cases involving haemodynamic compromise. Traditional vascular access through the use of an intravenous cannula, although the preferred first line method, can in certain circumstances have a high rate of failure. A study by Minville et al (2006) showed that the success rate of first attempt venous cannulation can be as low as 76%. Repeated attempts at venous cannulation in patients with difficult vascular access wastes valuable time which in some situations could prove fatal.

J Blood Transfus. 2015;2015:874920. doi: 10.1155/2015/874920. Epub 2015 Sep 7.

CRASH-2 Study of Tranexamic Acid to Treat Bleeding in Trauma Patients: A Controversy Fueled by Science and Social Media.

Binz S, McCollester J, Thomas S, Miller J, Pohlman T, Waxman D, Shariff F, Tracy R, Walsh M

Abstract: This paper reviews the application of tranexamic acid, an antifibrinolytic, to trauma. CRASH-2, a large randomized controlled trial, was the first to show a reduction in mortality and recommend tranexamic acid use in bleeding trauma patients. However, this paper was not without controversy. Its patient recruitment, methodology, and conductance in moderate-to-low income countries cast doubt on its ability to be applied to trauma protocols in countries with mature trauma networks. In addition to traditional vetting in scientific, peer-reviewed journals, CRASH-2 came about at a time when advances in communication technology allowed debate and influence to be leveraged in new forms, specifically through the use of multimedia campaigns, social media, and Internet blogs. This paper presents a comprehensive view of tranexamic acid utilization in trauma from peer-reviewed evidence to novel multimedia influences.

Br J Pain. 2015 May;9(2):115-21. doi: 10.1177/2049463714535563.

Is intramuscular morphine satisfying frontline medical personnels' requirement for battlefield analgesia in Helmand Province, Afghanistan? A questionnaire study.

Blankenstein T, Gibson L, Claydon M

BACKGROUND: All deployed British Army personnel carry intramuscular (IM) morphine auto-injectors to treat battlefield casualties. No other nation supplies parenteral opiate analgesia on individual issue. Studies highlight this agent's inefficacy and safety issues, but are limited by a relative lack of inclusion of frontline personnel. We aimed to determine the opinions of frontline medical personnel on current battlefield analgesia.

METHODS: We surveyed 88 British Army frontline medical personnel (medical officers (n = 12), nurses (n = 7), combat medical technicians (CMTs) (n = 67), paramedics (n = 1) and health-care assistants (n = 1)) upon completion of a six-month deployment (September 2011 to April 2012) to Helmand Province, Afghanistan, using Likert scale questions on the efficacy of battlefield analgesia, complications of IM morphine, safety of morphine auto-injectors and its suitability for treating child casualties.

RESULTS: A total of 88/88 questionnaires were returned. Of these, 61/88 had treated casualties on the battlefield, 26/86 agreed that current battlefield analgesia is effective, 80/87 agreed that a more potent analgesic with a faster onset than IM morphine is desirable in the first hour following injury, 47/65 CMTs agreed that they can manage complications of current battlefield analgesia and 53/86 respondents correctly disagreed that current battlefield analgesia is suitable for child casualties. The potential for accidental self-injection was reported.

CONCLUSIONS: A more potent, faster onset analgesic than IM morphine is desirable in the first hour following injury. Pre-deployment training should emphasise management of complications of opiate analgesics and treatment of child casualties. Oral transmucosal fentanyl citrate is now being issued to all frontline medical personnel. IM morphine will remain on individual issue to all deployed soldiers for environments where an oral agent is not suitable, for example, chemical, biological, radiological and nuclear warfare.

SUMMARY POINTS: Frontline medical personnel agree that a more potent, faster onset analgesic than IM morphine is desirable in the first hour following injury. The two most desirable features of the ideal analgesic were ranked as rapid onset of action, and when fully onset produces a high degree of pain relief. Oral transmucosal fentanyl citrate (OTFC) has now been issued to all frontline medical personnel as an adjunct to IM morphine.IM morphine will remain on individual issue for situations where parenteral analgesia is required. Consideration should be given to individual issue of OTFC to all deployed personnel in the future. Pre-deployment training should emphasise management of complications of opiate analgesics and treatment of child casualties.

J Spec Oper Med. 2015 Fall;15(3):60-5.

What Is the Optimal Device Length and Insertion Site for Needle Thoracostomy in UK Military Casualties? A Computed Tomography Study.

Blenkinsop G, Mossadegh S, Ballard M, Parker P

Abstract: Significant lessons to inform best practice in trauma care should be learned from the last decade of conflict in Afghanistan and Iraq. This study used radiological data collated in the UK Military Hospital in Camp Bastion, Afghanistan, to investigate the most appropriate device length for needle chest decompression of tension pneumothorax (TP). We reviewed the optimal length of device and site needed for needle decompression of a tension pneumothorax in a UK military population and found no significant difference between sites for needle chest decompression (NCD). As a result, we do not recommend use of devices longer than 60mm for UK service personnel.

J Emerg Med. 2015 Dec;49(6):920-7. doi: 10.1016/j.jemermed.2015.06.078.

Intubation of the Neurologically Injured Patient.

Bucher J, Koyfman A

BACKGROUND: Intubation of the neurologically injured patient is a critical procedure that must be done in a manner to prevent further neurologic injury. Although many different medications and techniques have been used to meet specific needs, there is little to no evidence to support many claims.

OBJECTIVE: To review the literature regarding important topics relating to intubating patients with neurologic injury.

DISCUSSION: Airway management requires ideal pre-oxygenation and airway maneuvers to minimize manipulation of the larynx and to maximize first-pass success. There is no evidence that lidocaine pretreatment decreases intracerebral pressure (ICP). Fentanyl can be used to help blunt the hemodynamic response to intubation. Esmolol is another medication that can blunt the hemodynamic response. Ketamine can be used and is possibly the ideal agent, having a neutral hemodynamic profile. A prefasciculation dose for neuromuscular blockade has not been shown to have any effect on ICP.

CONCLUSIONS: Ideal intubation conditions should be obtained through the use of airway manipulation techniques and appropriate medication choice for rapid sequence intubation in patients who are neurologically injured.

Eur J Trauma Emerg Surg. 2015 Sep 11. [Epub ahead of print]

The impact of increased plasma ratios in massively transfused trauma patients: a prospective analysis.

Bui E, Inaba K, Ebadat A, Karamanos E, Byerly S, Okoye O, Shulman I, Rhee P, Demetriades D

PURPOSE: Transfusion ratios approaching 1:1 FFP:PRBC for trauma resuscitation have become the de facto standard of care. The aim of this study was to prospectively evaluate the effect of increasing ratios of FFP:PRBC transfusion on survival for massively transfused civilian trauma patients as well as determine if time to reach the target ratio had any effect on outcomes.

METHODS: This is a prospective, observational study of all trauma patients requiring a massive transfusion (≥10 PRBC in ≤24 h) at a level 1 trauma center over a 2.5-year period. The ratio of FFP:PRBC was tracked hourly up to 24 h post-initiation of massive transfusion. A logistic regression model was utilized to identify the ideal ratio associated with mortality prediction. A stepwise logistic regression was performed to identify independent predictors of mortality.

RESULTS: The study population was predominantly male (89 %) with a mean age of 34.8 ± 16. On admission, 22 % had a systolic blood pressure ≤90 mmHg, 47 % had a heart rate ≥120, and 25 % had a GCS ≤8. The overall mortality was 33 %. The ratio of FFP:PRBC ≥ 1:1.5 was the second most important independent predictor of mortality for this population (R (2) = 0.59). Survivors had a higher FFP:PRBC ratio at all times during the first 24 h of resuscitation.

CONCLUSIONS: Achieving a ratio of FFP:PRBC ≥ 1:1.5 after the initial 24 h of resuscitation significantly improves survival in massively transfused trauma patients compared to patients that achieved a ratio <1:1.5.

The Hartford Consensus: A major step forward in translating battlefield trauma care advances to the civilian sector.

Butler, F;

J Spec Oper Med 2015;133-163

Quote:

As noted in the article that discusses the military experience with tourniquets and hemostatic dressings, the Hartford Consensus Working Group has endorsed these two TCCC recommendations for external hemorrhage control for use by first responders in the civilian sector.

The article by Holcomb et al. on how to most effectively employ these devices is based on the experience gained by the US Military during 14 years of conflict. This experience has been well documented by retired Army COL John F. Kragh Jr and other military authors and shaped into best-practice battlefield trauma care guidelines by the Committee on TCCC. While some civilian communities have implemented these guidelines into their police, fire, and EMS sectors very successfully, many have not and much remains to be done. There are now a number of courses sponsored by the National Association of Emergency Medical Technicians that teach the current US military recommendations regarding tourniquet and hemostatic dressing use, to include Bleeding Control, Law Enforcement First Responder, Tactical Emergency Casualty Care, and Tactical Combat Casualty Care.

The imperative to translate military advances in trauma care to the civilian sector, especially for victims of gunshot wounds and explosions, was described by Elster and his co-authors. This is especially true in the prehospital phase of care, where most preventable deaths in trauma victims occur.

The nation owes Dr Jacobs, the Harford Consensus Working Group, and the ACS a great debt for their leadership in this area. Their work was highlighted at a ceremony held at the White House on 6 October 2015, as part of a ceremony announcing the start of a national “Stop the Bleed” campaign that includes the prehospital measures recommended by the JTS and TCCC to control external hemorrhage. If widely implemented, these recommendations will undoubtedly improve prehospital care and survival for trauma victims in the United States—both those injured in active shooter or mass casualty events and those who are injured in the motor vehicle accidents and acts of violence that occur throughout our country every day.

J Spec Oper Med 2015;15:7-19

The Combat Medic Aid Bag: 2025. CoTCCC Top 10 recommended battlefield trauma care research, development, and evaluation priorities 2015.

Butler, F, Blackbourne L, Gross K

Quote:

In April 2015, voting members of the CoTCCC were provided with the compiled list of 116 proposed RDT&E projects and asked to identify the 10 research projects that each member believed to be most important. Members were asked to consider the following in selecting their Top 10 projects:

- Will the project help to identify the causes of preventable death on the battlefield?
- Will the project help reduce preventable deaths on the battlefield?
- Will the project help reduce long-term disability?
- Is the intervention in the project feasible for prehospital care providers?
- What other methods to accomplish the desired effect for the casualty are currently available?
- How long would the project take to complete?
- How much will the project cost?
- How much will the new equipment or medication cost to field?
- What is the likelihood of successful completion of the project?

The following list contains the Top 10 priorities for battlefield trauma care RDT&E as established by the votes of the CoTCCC.

Summary: While the list presented here is by no means a comprehensive list of all of the research areas of interest in battlefield trauma care, much less a list of research needs across the entire continuum of combat casualty care, it does provide the collective judgment of the CoTCCC about the highest priorities for RDT&E that relate to battlefield trauma care.

Two additional observations should be made regarding that point: (1) As the landmark Eastridge et al.2 2012 study convincingly documented, most combat fatalities occur in the prehospital phase of care, so research efforts that enable Combat medics, corpsmen, and PJs to care for their casualties more effectively will convey the highest probability of further reducing the case fatality rate and preventable deaths among US Combat casualties; and (2) inasmuch as the mission of the CoTCCC is to update the TCCC Guidelines as needed, this group has excellent visibility of the most important current research questions in battlefield trauma care.

J Trauma Acute Care Surg. 2015 Oct;79(4 Suppl 2):S221-6.

The vital civilian-military link in combat casualty care research: Impact of attendance at scientific conferences.

Cancio L, Rasmussen T, Cannon J, Dubick M

BACKGROUND: Attendance by military medical personnel (MMP) at scientific meetings (SMs) of civilian associations has been centrally managed since 2012. We aimed to document the importance of civilian-military interaction to and the impact of this change on combat casualty care (CCC) research.

METHODS: (1) We identified 25 clinically significant CCC articles published by MMP between 2005 and 2014; we determined whether these articles were preceded by presentation by MMP at an SM. (2) We examined the changing civilian-military mix of publications on "damage control resuscitation" (DCR). (3) We analyzed the number of presentations by MMP each year at the American Association for the Surgery of Trauma. (4) We reviewed whether past presidents of the AAST (for 1992-2014) had military experience.

RESULTS: (1) Ninety-two percent of the CCC articles were previously presented at an SM; 66% were presented at civilian association venues such as AAST. (2) DCR was first described in 2006; the civilian-military mix of publications rose steadily from 0 in 2006 to 80% in 2014. (3) The number of MMP oral presentations at AAST peaked during 2005 to 2007 and has declined to one to two per year since 2012. (4) Thirty-three percent of recent AAST presidents had military experience, versus 100% for the previous era.

CONCLUSION: Recent conflicts led to intense civilian-military collaboration in CCC research and to the spread of ideas such as DCR from military to civilian care. However, long-term trends (e.g., declining rates of military service nationally) place such collaboration at risk. Vigorous efforts to foster the vital civilian-military link in CCC are needed.

Mil Med. 2015 Sep;180(9):932-3.

ResQFoam for the Treatment of Non-Compressible Hemorrhage on the Front Line.

Chang J, Holloway B, Zamisch M, Hepburn M, Ling G

Abstract: Noncompressible torso hemorrhage is the leading cause of potentially survivable death on the battlefield. While medical advances have decreased the rate of "died of wounds" to less than 5%, significant treatment limitations in pre-hospital care remain. To address this persistent capability gap, the Defense Advanced Research Projects Agency launched the Wound Stasis System program in 2010. Under that program, Arsenal Medical, in collaboration with Massachusetts General Hospital and Harvard Medical School, developed a novel, self-expanding polyurethane foam that rapidly treats major abdominal bleeding due to trauma, for use at the point of care. This foam treatment is envisioned as an emergency "bridge to surgery" for warfighters who would otherwise die in the field. This commentary presents this emerging technology with the objective to bring to the community's attention a potentially promising device for the treatment of noncompressible abdominal hemorrhage.

J Trauma Acute Care Surg. 2015 Oct 21. [Epub ahead of print]

Field intubation in civilian patients with hemorrhagic shock is associated with higher mortality.

Chou D, Harada MY, Barmparas G, Ko A, Ley EJ, Margulies DR, Alban RF

BACKGROUND: Field intubation (FI) by Emergency Medical Services personnel on severely injured trauma patients remains a contentious practice. Clinical studies suggest an association between FI and adverse outcomes in patients with traumatic brain injury. Military tactical emergency casualty care recommends deferring intubation and providing supplemental oxygenation until reaching a more equipped destination. Additionally, animal models with penetrating hemorrhagic shock demonstrate increased acidosis with intubation prior to resuscitation. The purpose of this study was to evaluate the impact of FI on outcomes in trauma patients with hemorrhagic shock requiring massive transfusion.

METHODS: The Los Angeles County Trauma System Database was retrospectively queried for all trauma patients ≥ 16 years of age with hemorrhagic shock requiring massive transfusion (≥6 units PRBCs in the first 24 hours) between January 1, 2012 and June 30, 2014. Demographics, clinical and transfusion data and outcomes were compared between patients who received FI and those who did not (NO-FI). Multivariate regression analysis was utilized to adjust for confounders.

RESULTS: Of 552 trauma patients meeting inclusion criteria, 63 (11%) received FI and the remaining 489 (89%) were NO-FI. Age, gender, and incidence of blunt injury were similar between FI and NO-FI. The FI cohort presented with a lower GCS median (3 v. 14, $p<0.001$), a lower SBP median (86 v. 104 mmHg, $p<0.001$), and a higher ISS median (41 v. 29, $p<0.001$). Mortality was significantly higher in FI patients (83% v. 43%, $p<0.001$). Transfusion patterns and total field times were similar in both groups. After adjusting for confounders, FI patients had increased odds of mortality (AOR 2.89; 95% CI 1.08-7.78, $p=0.035$). Additionally, FI was identified as an independent predictor of mortality (AOR 3.41; 95% CI 1.35-8.59, $p=0.009$).

CONCLUSION: Field intubation may be associated with higher mortality in trauma patients with hemorrhagic shock requiring massive transfusion. Less invasive airway interventions and rapid transport might improve outcome for these patients.

LEVEL OF EVIDENCE: Prognostic Study, Level III.

J Emerg Med. 2015 Nov;49(5):675-8

The Concealment of Significant Pelvic Injuries on Computed Tomography Evaluation by Pelvic Compression Devices.

Clements J, Jeavons R, White C, McMurtry I

BACKGROUND: Fractures of the pelvis and acetabulum are relatively rare, with a reported incidence of 3% to 8% of all adult fractures, but occur in approximately 20% of all polytrauma cases. They have high associated morbidity (40% to 50%) and mortality (5% to 30%). It is recommended that an external compression splint be applied in the presence of a suspected pelvic fracture before transfer and definitive investigation and management.

CASE REPORT: Two cases are presented in which these recommendations were met and the patients underwent computed tomography (CT) scanning upon arrival to the emergency department at a major trauma center with the pelvic binder in situ. In both these cases, CT scanning failed to identify a significant pelvic injury, which was concealed by the pelvic external compression belt. WHY SHOULD AN EMERGENCY PHYSICIAN BE AWARE OF THIS?: When there is high clinical indication of pelvic injury, whether related to mechanism of injury or clinical findings, despite a CT scan where no bony injury is identified, obtaining plain pelvic x-ray studies out of the pelvic compression device to avoid overlooking or neglecting a significant pelvic injury would be prudent.

Mil Med. 2015 Nov;180(11):1189-95

Control of Junctional Hemorrhage in a Consensus Swine Model With Hemostatic Gauze Products Following Minimal Training.

Conley SP, Littlejohn LF, Henao J, DeVito SS, Zarow GJ

OBJECTIVE: Uncontrolled hemorrhage from junctional wounds that cannot be controlled by traditional tourniquets accounts for one in five preventable battlefield exsanguination deaths. Products for treating these wounds are costly and require special training. However, chemically treated gauze products are inexpensive, potentially effective, and require only minimal training. This study was designed to assess the efficacy of three hemostatic gauze products following brief training, using a consensus swine groin injury model.

METHODS: After viewing a 15-minute PowerPoint presentation, without demonstration or practice, 24 U.S. Navy Corpsmen, most with little to no live tissue or hemostatic agent experience, applied one of three hemostatic agents: QuikClot Combat Gauze, Celox Trauma Gauze, or Hemcon ChitoGauze. Animals were resuscitated and monitored for 150 minutes to assess initial hemostasis, blood loss, rebleeding, and survival. Participants completed a survey before training and following testing.

RESULTS: Products were similar in initial hemostasis, blood loss, and rebleeding. Twenty-three swine survived (96%). Ease of use and perceived efficacy of training ratings were high. Comfort level with application improved following training.

CONCLUSIONS: Hemostatic gauze can potentially be effective for treating junctional wounds following minimal training, which has important implications for corpsmen, self-aid/buddy-aid, civilian providers, and Tactical Combat Casualty Care guidelines.

Injury. 2015 Nov;46(11):2239-42. doi: 10.1016/j.injury.2015.08.029.

Double-barrelled resuscitation: A feasibility and simulation study of dual-intraosseous needles into a single humerus.

Douma MJ, Bara GS, O'Dochartaigh D, Brindley PG

INTRODUCTION: Resuscitation can be delayed, or impaired, by insufficient vascular access. This study examines whether dual-intraosseous needles, inserted into a single porcine humerus, can facilitate rapid and concomitant fluid and medication delivery.

METHODS: After inserting one- and then two-intraosseous needles into the same porcine humerus, we determined the rate of fluid administration using (i) an infusion pump set to 999mL/h, and (ii) a standard pressure-bag set to 300mmHg. Next, we concomitantly infused blood, crystalloid and medications into the same medullary canal, using the two-needle set-up. Humeri were inspected for fluid-leakage, needle-displacement, and bone damage.

RESULTS: Using an infusion pump, the mean normal-saline infusion-rate was significantly higher with dual-intraosseous needles compared to a single-intraosseous needle: the infusion-rate was 16mL/min using dual-needles versus 8mL/min for a single needle set-up ($p<0.001$). In contrast, using the pneumatic pressure-bag, the infusion rate was not statistically different when comparing dual-intraosseous needles versus single-intraosseous: the infusion-rate was 22mL/min versus 21ml/min ($p=0.4$) for 500mL, and 22ml/min versus 21ml/min ($p=0.64$) for one-litre, respectively. Blood product could be infused at a mean rate of 20mL/min through one needle while tranexamic acid was simultaneously infused through a second. There were no complications with a dual-intraosseous set-up (no fluid leakage; no needle-displacement; no high-pressure alarms, and no external bone-fractures or internal macrohistological damage) during any of our simulated resuscitation scenarios.

CONCLUSIONS: This is the first published study evaluating dual-intraosseous needles in a single bone. Despite limitations, this preliminary study (using a porcine humerus) suggests that dual-intraosseous needles are feasible. For critically-ill patients with limited insertion sites, dual-intraosseous (a.k.a. 'double-barrelled resuscitation') may facilitate rapid and concurrent resuscitation.

J Spec Oper Med. 2015 Fall;15(3):81-5.

Tourniquet Conversion: A Recommended Approach in the Prolonged Field Care Setting.

Drew B, Bird D, Matteucci M, Keenan S

Abstract: Life-saving interventions take precedence over diagnostic maneuvers in the Care Under Fire stage of Tactical Combat Casualty Care. The immediate threat to life with an actively hemorrhaging extremity injury is addressed with the liberal and proper use of tourniquets. The emphasis on hemorrhage control has and will continue to result in the application of tourniquets that may not be needed past the Care Under Fire stage. As soon as tactically allowable, all tourniquets must be reassessed for conversion. Reassessment of all tourniquets should occur as soon as the tactical situation permits, but no more than 2 hours after initial placement. This article describes a procedure for qualified and trained medical personnel to safely convert extremity tourniquets to local wound dressings, using a systematic process in the field setting.

J Spec Oper Med. 2015 Fall;15(3):46-53.

The Ranger First Responder Program and Tactical Emergency Casualty Care Implementation: A Whole-Community Approach to Reducing Mortality from Active Violent Incidents.

Fisher AD, Callaway DW, Robertson JN, Hardwick SA, Bobko JP, Kotwal RS

Abstract: Active violent incidents are dynamic and challenging situations that can produce a significant amount of preventable deaths. Lessons learned from the military's experience in Afghanistan and Iraq through the Committee on Tactical Combat Casualty Care and the 75th Ranger Regiment's Ranger First Responder Program have helped create the Committee for Tactical Emergency Casualty Care (C-TECC) to address the uniqueness of similar wounding patterns and to end preventable deaths. We propose a whole-community approach to active violent incidents, using the C-TECC Trauma Chain of Survival and a tiered approach for training and responsibilities: the first care provider, nonmedical professional first responders, medical first responders, and physicians and trauma surgeons. The different tiers are critical early links in the Chain of Survival and this approach will have a significant impact on active violent incidents.

J Am Coll Surg. 2015 May;220(5):809-19.

Early resuscitation with fresh frozen plasma for traumatic brain injury combined with hemorrhagic shock improves neurologic recovery.

Halaweish I, Bambakidis T, He W, Linzel D, Chang Z, Srinivasan A, Dekker SE, Liu B, Li Y, Alam HB

BACKGROUND: We have shown that early administration of fresh frozen plasma (FFP) reduces the size of brain lesions 6 hours after injury in a large animal model of traumatic brain injury (TBI) and hemorrhagic shock (HS). To examine long-term outcomes, we hypothesized that early treatment with FFP would result in faster neurologic recovery and better long-term outcomes in a combined TBI and HS model.

STUDY DESIGN: Anesthetized Yorkshire swine underwent combined TBI and volume-controlled hemorrhage (40% blood volume). After 2 hours of shock, animals were randomized (n = 5/group) to normal saline (3× shed blood) or FFP (1× shed blood) treatment. A neurologic severity score was assessed for 30 days. Magnetic resonance imaging of the brain was performed at days 3, 10, and 24. Cognitive function was tested by training animals to retrieve food from color-coded boxes.

RESULTS: Neurologic impairment was lower and speed of recovery was considerably faster in the FFP-treated animals. There was a trend toward a smaller lesion size in FFP-treated animal at days 3 and 10, but this did not reach statistical significance. Both groups reached baseline performance on the cognitive testing; however, FFP-treated animals were able to participate, on average, 8 days earlier due to quicker recovery.

CONCLUSIONS: This is the first study to demonstrate the beneficial effects of FFP treatment in a long-term survival model of combined TBI and HS. Our data show that early treatment with FFP substantially attenuates the degree of neurologic impairment, improves the rate of recovery, and preserves the cognitive functions.

Biomed Res Int. 2015;2015:201898. doi: 10.1155/2015/201898. Epub 2015 Oct 1.

Comparison of Five 2nd-Generation Supraglottic Airway Devices for Airway Management Performed by Novice Military Operators.

Henlin T, Sotak M, Kovaricek P, Tyll T, Balcarek L, Michalek P.

Objectives. Five different second-generation supraglottic airway devices, ProSeal LMA, Supreme LMA, i-gel, SLIPA, and Laryngeal Tube Suction-D, were studied. Operators were inexperienced users with a military background, combat lifesavers, nurses, and physicians.

Methods. This was a prospective, randomized single-blinded study. Devices were inserted in the operating room in low light conditions after induction of general anesthesia. Primary outcome was successful insertion on the first attempt while secondary aims were insertion time, number of attempts, oropharyngeal seal pressure, ease of insertion, fibre optic position of device, efficacy of ventilation, and intraoperative trauma or regurgitation of gastric contents.

Results. In total, 505 patients were studied. First-attempt insertion success rate was higher in the Supreme LMA (96%), i-gel (87.9%), and ProSeal LMA (85.9%) groups than in the Laryngeal Tube Suction-D (80.6%) and SLIP (69.4%) groups. Insertion time was shortest in the Supreme LMA (70.4 ± 32.5 s) and i-gel (74.4 ± 41.1 s) groups ($p < 0.001$). Oropharyngeal seal pressures were higher in the Laryngeal Tube Suction-D and ProSeal LMA groups than in other three devices.

Conclusions. Most study parameters for the Supreme LMA and i-gel were found to be superior to the other three tested supraglottic airway devices when inserted by novice military operators.

Lancet 2015;Epub ahead of print

The medical response to multisite terrorist attacks in Paris.

Hirsch M, Carli P, Nizard R, et al:

Quote:
“Since the wounds were principally bullet related, the strategy applied was prehospital damage control to allow the fastest possible haemostatic surgery. This is the civil application of war medicine. Indeed, four out of five people shot in the head or the thorax will die. Among those without lethal wounds, damage control consists of maintaining the blood pressure at the lowest level ensuring consciousness (mean arterial pressure 60 mm Hg) using tourniquets, vasoconstrictors, antifibrinolytic agents (tranexamic acid), and prevention of temperature lowering instead of fluid filling (the demand for tourniquets was so high that the mobile teams came back without their belts).”

Prehosp Emerg Care. 2015 January-March;19(1):1-9.

Prehospital Transfusion of Plasma and Red Blood Cells in Trauma Patients.

Holcomb JB, Donathan DP, Cotton BA, Del Junco DJ, Brown G, Wenckstern TV Podbielski JM, Camp EA, Hobbs R, Bai Y, Brito M, Hartwell E, Duke JR, Wade CE.

Abstract Objective. Earlier use of plasma and red blood cells (RBCs) has been associated with improved survival in trauma patients with substantial hemorrhage. We hypothesized that prehospital transfusion (PHT) of thawed plasma and/or RBCs would result in improved patient coagulation status on admission and survival.

Methods. Adult trauma patient records were reviewed for patient demographics, shock, coagulopathy, outcomes, and blood product utilization from September 2011 to April 2013. Patients arrived by either ground or two different helicopter companies. All patients transfused with blood products (either pre- or in-hospital) were included in the study. One helicopter system (LifeFlight, LF) had thawed plasma and RBCs while the other air (OA) and ground transport systems used only crystalloid resuscitation. Patients receiving PHT were compared with all other patients meeting entry criteria to the study cohort. All comparisons were adjusted in multilevel regression models. Results. A total of 8,536 adult trauma patients were admitted during the 20-month study period, of which 1,677 met inclusion criteria. They represented the most severely injured patients (ISS = 24 and mortality = 26%). There were 792 patients transported by ground, 716 by LF, and 169 on OA. Of the LF patients, 137 (19%) received prehospital transfusion. There were 942 units (244 RBCs and 698 plasma) placed on LF helicopters, with 1.9% wastage. PHT was associated with improved acid-base status on hospital admission, decreased use of blood products over 24 hours, a reduction in the risk of death in the sickest patients over the first 6 hours after admission, and negligible blood products wastage. In this small single-center pilot study, there were no differences in 24-hour (odds ratio 0.57, $p = 0.117$) or 30-day mortality (odds ratio 0.71, $p = 0.441$) between LF and OA.

Conclusions. Prehospital plasma and RBC transfusion was associated with improved early outcomes, negligible blood products wastage, but not an overall survival advantage. Similar to the data published from the ongoing war, improved early outcomes are associated with placing blood products prehospital, allowing earlier infusion of life-saving products to critically injured patients.

J R Army Med Corps. 2015 Oct 14. pii: jramc-2015-000490. doi: 10.1136/jramc-2015-000490. [Epub ahead of print]

Died of wounds: a mortality review.

Keene D, Penn-Barwell J, Wood P, Hunt N, Delaney R, ClasperJ, Russell R, Mahoney F

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

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

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

CONCLUSIONS: Severe head injury was the most common cause of death. Irrespective of available medical treatment, none of this group had salvageable injuries. Future emphasis should be placed in preventative strategies to protect the head against battlefield trauma.

J Blood Med. 2015 Aug 25;6:239-44.

Tranexamic acid for the prevention and management of orthopedic surgical hemorrhage: current evidence.

Kim C, Park SS, Davey JR

Abstract: Total joint arthroplasty can be associated with major blood loss and require subsequent blood transfusions for postoperative anemia. Measures to effectively and safely decrease blood loss and reduce the need for blood transfusions would help improve patient safety and lower health care costs. A possible pharmacological option to reduce surgical blood loss in total joint arthroplasty is the use of tranexamic acid. Abundant literature has shown that intravenous and/or topical administration of tranexamic acid is effective in reducing blood loss and blood transfusions, with no increased risk of venous thromboembolic events or other complications.

JAMA Surg. 2015 Sep 30:1-10. doi: 10.1001/jamasurg.2015.3104. [Epub ahead of print]

The Effect of a Golden Hour Policy on the Morbidity and Mortality of Combat Casualties.

Kotwal RS, Howard JT, Orman JA, Tarpey BW, Bailey JA, Champion HR, Mabry RL, Holcomb JB, Gross KR

Importance: The term golden hour was coined to encourage urgency of trauma care. In 2009, Secretary of Defense Robert M. Gates mandated prehospital helicopter transport of critically injured combat casualties in 60 minutes or less.

Objectives: To compare morbidity and mortality outcomes for casualties before vs after the mandate and for those who underwent prehospital helicopter transport in 60 minutes or less vs more than 60 minutes.

Design, Setting, and Participants: A retrospective descriptive analysis of battlefield data examined 21 089 US military casualties that occurred during the Afghanistan conflict from September 11, 2001, to March 31, 2014. Analysis was conducted from September 1, 2014, to January 21, 2015.

Main Outcomes and Measures: Data for all casualties were analyzed according to whether they occurred before or after the mandate. Detailed data for those who underwent prehospital helicopter transport were analyzed according to whether they occurred before or after the mandate and whether they occurred in 60 minutes or less vs more than 60 minutes. Casualties with minor wounds were excluded. Mortality and morbidity outcomes and treatment capability-related variables were compared.

Results: For the total casualty population, the percentage killed in action (16.0% [386 of 2411] vs 9.9% [964 of 9755]; P < .001) and the case fatality rate ([CFR] 13.7 [469 of 3429] vs 7.6 [1344 of 17 660]; P < .001) were higher before vs after the mandate, while the percentage died of wounds (4.1% [83 of 2025] vs 4.3% [380 of 8791]; P = .71) remained unchanged. Decline in CFR after the mandate was associated with an increasing percentage of casualties transported in 60 minutes or less (regression coefficient, -0.141; P < .001), with projected vs actual CFR equating to 359 lives saved. Among 4542 casualties (mean injury severity score, 17.3; mortality, 10.1% [457 of 4542]) with detailed data, there was a decrease in median transport time after the mandate (90 min vs 43 min; P < .001) and an increase in missions achieving prehospital helicopter transport in 60 minutes or less (24.8% [181 of 731] vs 75.2% [2867 of 3811]; P < .001). When adjusted for injury severity score and time period, the percentage killed in action was lower for those critically injured who received a blood transfusion (6.8% [40 of 589] vs 51.0% [249 of 488]; P < .001) and were transported in 60 minutes or less (25.7% [205 of 799] vs 30.2% [84 of 278]; P < .01), while the percentage died of wounds was lower among those critically injured initially treated by combat support hospitals (9.1% [48 of 530] vs 15.7% [86 of

547]; P < .01). Acute morbidity was higher among those critically injured who were transported in 60 minutes or less (36.9% [295 of 799] vs 27.3% [76 of 278]; P < .01), those severely and critically injured initially treated at combat support hospitals (severely injured, 51.1% [161 of 315] vs 33.1% [104 of 314]; P < .001; and critically injured, 39.8% [211 of 530] vs 29.3% [160 of 547]; P < .001), and casualties who received a blood transfusion (50.2% [618 of 1231] vs 3.7% [121 of 3311]; P < .001), emphasizing the need for timely advanced treatment.

Conclusions and Relevance: A mandate made in 2009 by Secretary of Defense Gates reduced the time between combat injury and receiving definitive care. Prehospital transport time and treatment capability are important factors for casualty survival on the battlefield.

Prehosp Emerg Care. 2015 Apr-Jun;19(2):184-90.

U.S. Military use of tourniquets from 2001 to 2010.

Kragh JF Jr, Dubick MA, Aden JK, McKeague AL, Rasmussen TE, Baer DG, Blackbourne LH

OBJECTIVE: This study was conducted to associate tourniquet use and survival in casualty care over a decade of war in order to provide evidence to emergency medical personnel for the implementation and efficacy of tourniquet use in a large trauma system.

METHODS: This survey is a retrospective review of data extracted from a trauma registry. The decade (2001-2010) outcome trend analysis of tourniquet use in the current wars was made in order to associate tourniquet use and survival in an observational cohort design.

RESULTS: Of 4,297 casualties with extremity trauma in the total study, 30% (1,272/4,297) had tourniquet use and 70% (3,025/4,297) did not. For all 4,297 casualties, the proportion of casualties with severe or critical extremity Abbreviated Injury Scales (AIS) increased during the years surveyed ($p < 0.0001$); the mean annual Injury Severity Score (ISS) rose from 13 to 21. Tourniquet use increased during the decade by almost tenfold from 4 to nearly 40% ($p < 0.0001$). Survival for casualties with isolated extremity injury varied by injury severity; the survival rate for AIS 3 (serious) was 98%, the rate for AIS 4 (severe) was 76%, and the rate for AIS 5 (critical) was 0%. Survival rates increased for casualties with injuries amenable to tourniquets but decreased for extremity injuries too proximal for tourniquets.

CONCLUSIONS: Average injury severity increased during the decade of war for casualties with extremity injury. Both tourniquet use rates and casualty survival rates rose when injuries were amenable to tourniquets.

J Spec Oper Med. 2015 Fall;15(3):20-30.

Junctional Tourniquet Training Experience.

Kragh JF, Geracci JJ, Parsons DL, Robinson JB, Biever KA, Rein EB, Glassberg E, Strandenes G, Chen J, Benov A, Marcozzi D, Shackelford S, Cox KM, Mann-Salinas EA

Abstract: Since 2009, out-of-hospital care of junctional hemorrhage bleeding from thetrunk-appendage junctions has changed, in part, due to the newly available junctional tourniquets (JTs) that have been cleared by the US Food and Drug Administration. Given four new models of JT available in 2014, several military services have begun to acquire, train, or even use such JTs in care. The ability of users to be trained in JT use has been observed by multiple instructors. The experience of such instructors has been broad as a group, but their experience as individuals has been neither long nor deep. A gathering into one source of the collective experience of trainers of JT users could permit a collation of useful information to include lessons learned, tips in skill performance, identification of pitfalls of use to avoid, and strategies to optimize user learning. The purpose of the present review is to record the experiences of several medical personnel in their JT training of users to provide a guide for future trainers.

Clin Drug Investig. 2015 Oct;35(10):653-7. doi: 10.1007/s40261-015-0326-2.

Association of Meloxicam Use with the Risk of Acute Pancreatitis: A Case-Control Study.

Lai SW, Lin CL, Liao KF

BACKGROUND AND OBJECTIVE: No sufficient research has focused on the relationship between meloxicam use and acute pancreatitis. This study aimed to explore this issue in Taiwan.

METHODS: This case-control study was conducted using the database of the Taiwan National Health Insurance Program. In all, there were 6780 cases aged 20-84 years who were newly diagnosed with acute pancreatitis during the period 1998-2011, and 21,393 control subjects without acute pancreatitis. Cases and controls were matched for sex, age and comorbidities. Odds ratios (ORs) and 95 % confidence intervals (CIs) were measured to explore the associations between acute pancreatitis, meloxicam use and comorbidities, using a multivariable unconditional logistic regression model.

RESULTS: After controlling for potential confounding factors, the adjusted OR for acute pancreatitis was 1.76 (95 % CI 1.30-2.40) for subjects with current use of meloxicam, in comparison with subjects who had never used meloxicam. The adjusted OR decreased to 1.29 (95 % CI 0.82-2.03) for subjects with late use of meloxicam, but without statistical significance.

CONCLUSIONS: Current use of meloxicam is associated with increased odds of acute pancreatitis. Clinicians should consider the potential risk of acute pancreatitis when prescribing meloxicam.

J Spec Oper Med. 2015 Fall;15(3):126-8.

Public Access Hemorrhage Control and the Stop the Bleeding Coalition.

Levy MJ

Quote: Beyond theory, the tenets behind THREAT have been proven both on the battlefield and in the wake of some of the worse recent domestic attacks in the U.S. This concept aligns naturally with recommendations and guidelines of other allied groups, including the U.S. military's Committee on Tactical Combat Casualty Care and the civilian Committee for Tactical Emergency Casualty Care. Both groups emphasize the importance of early hemorrhage control, in addition
to the ability to address immediately correctible causes of death, including tension pneumothorax and airway obstruction. The work of these groups has helped shape national-level policy and guidance documents, most recently including the U.S. Department of Homeland Security's June 2015 First Responder Guide for Improving Survivability in Improvised Explosive Device and/or Active Shooter Incidents.3 This evidence-based document calls for a realignment of traditional emergency services practices to improve victim survivability and responder safety. It focuses on three specific areas: hemorrhage control, protective equipment, and response/incident
management.

J Spec Oper Med. 2015 Fall;15(3):11-9.

Emergency Cricothyroidotomy in Tactical Combat Casualty Care.

Mabry R, Frankfurt A, Kharod C, Butler F

Conclusions: Of the techniques and cannula types reviewed in this report, we recommend an open technique via a vertical, midline incision. This approach will maximize anatomic exposure, minimize bleeding, and allow for extension of the incision at either end if the initial incision is not optimally placed. Once the incision through the skin and CTM is accomplished, the most effective airway instrument type, in our review, is the CK, which eliminates multiple sources of difficulty. In contrast, the techniques below pose additional risks for procedural difficulty and potential failure
to cannulate the airway.

• The standard surgical approach (horizontal skin incision) is challenging for nonsurgeons who are less familiar with external landmarks and anatomy.

• The rapid four-step technique poses an additional bleeding risk and opportunity for misplacement, as well as the potential for injury to the airway and adjacent structures.

• The wire-guided approach has too many steps, requires very fine motor control, and is predisposed to wire kinking

• The tube-over-needle approach can lead to perforation of the posterior tracheal wall and subsequent cannulation of the esophagus and increased risk for aspiration.

The preferred airway cannula type, based on our review, is the Melker or similar airway cannula, which has an appropriate external diameter to internal diameter ratio and has external wings allowing the airway to be secured without compressing the patient's neck. Dire circumstances may require innovative use of existing supplies, but improvised use of other airway cannulas in the setting of an acutely injured and compromised airway can lead to additional complications. Traditional tracheostomy tubes are too rigid and do not mold well to the patient's anatomy, while the excess length of ETTs, even when "cut to size," can lead to main-stem
bronchial intubation and external entanglement, especially in tactical settings.

At this time, the CK has the best supporting evidence for enabling successful performance of surgical airways by Combat medical personnel and is recommended as the device of choice for TCCC. Whatever surgical airway procedure is used, training for this procedure should include a minimum of five repetitions of the procedure and the student should demonstrate his or her mastery of the precise location for the skin incision by marking the proposed incision site on a
fellow TCCC student as part of the training evolution.

J Trauma Acute Care Surg. 2015 Oct;79(4):523-32.

Implementation of resuscitative endovascular balloon occlusion of the aorta as an alternative to resuscitative thoracotomy for noncompressible truncal hemorrhage.

Moore LJ, Brenner M, Kozar RA, Pasley J, Wade CE, Baraniuk MS, Scalea T, Holcomb JB

BACKGROUND: Hemorrhage remains the leading cause of death in trauma patients. Proximal aortic occlusion, usually performed by direct aortic cross-clamping via thoracotomy, can provide temporary hemodynamic stability, permitting definitive injury repair. Resuscitative endovascular balloon occlusion of the aorta (REBOA) uses a minimally invasive, transfemoral balloon catheter, which is rapidly inserted retrograde and inflated for aortic occlusion, and may control inflow and allow time for hemostasis. We compared resuscitative thoracotomy with aortic cross-clamping (RT) with REBOA in trauma patients in profound hemorrhagic shock.

METHODS: Trauma registry data was used to compare all patients undergoing RT or REBOA during an 18-month period from two Level 1 trauma centers.

RESULTS: There was no difference between RT (n = 72) and REBOA groups (n = 24) in terms of demographics, mechanism of injury, or Injury Severity Scores (ISSs). There was no difference in chest and abdominal Abbreviated Injury Scale (AIS) scores between the groups. However, the RT patients had lower extremity AIS score as compared with REBOA patients (1.5 [0-3] vs. 4 [3-4], $p < 0.001$). Of the 72 RT patients, 45 (62.5%) died in the emergency department, 6 (8.3%) died in the operating room, and 14 (19.4%) died in the intensive care unit. Of the 24 REBOA patients, 4 (16.6%) died in the emergency department, 3 (12.5%) died in the operating room, and 8 (33.3%) died in the intensive care unit. In comparing location of death between the RT and REBOA groups, there were a significantly higher number of deaths in the emergency department among the RT patients as compared with the REBOA patients (62.5% vs. 16.7%, $p < 0.001$). REBOA had fewer early deaths and improved overall survival as compared with RT (37.5% vs. 9.7%, $p = 0.003$).

CONCLUSION: REBOA is feasible and controls noncompressible truncal hemorrhage in trauma patients in profound shock. Patients undergoing REBOA have improved overall survival and fewer early deaths as compared with patients undergoing RT.

LEVEL OF EVIDENCE: Therapeutic study, level IV.

Ann Emerg Med. 2015 Sep;66(3):222-229.e1.

Intravenous Subdissociative-Dose Ketamine Versus Morphine for Analgesia in the Emergency Department: A Randomized Controlled Trial.

Motov S, Rockoff B, Cohen V, Pushkar I, Likourezos A, McKay C, Soleyman-Zomalan E, Homel P, Terentiev V, Fromm C

STUDY OBJECTIVE: We assess and compare the analgesic efficacy and safety of subdissociative intravenous-dose ketamine with morphine in emergency department (ED) patients.

METHODS: This was a prospective, randomized, double-blind trial evaluating ED patients aged 18 to 55 years and experiencing moderate to severe acute abdominal, flank, or musculoskeletal pain, defined as a numeric rating scale score greater than or equal to 5. Patients were randomized to receive ketamine at 0.3 mg/kg or morphine at 0.1 mg/kg by intravenous push during 3 to 5 minutes. Evaluations occurred at 15, 30, 60, 90, and 120 minutes. Primary outcome was reduction in pain at 30 minutes. Secondary outcome was the incidence of rescue analgesia at 30 and 60 minutes.

RESULTS: Forty-five patients per group were enrolled in the study. The primary change in mean pain scores was not significantly different in the ketamine and morphine groups: 8.6 versus 8.5 at baseline (mean difference 0.1; 95% confidence interval -0.46 to 0.77) and 4.1 versus 3.9 at 30 minutes (mean difference 0.2; 95% confidence interval -1.19 to 1.46; P=.97). There was no difference in the incidence of rescue fentanyl analgesia at 30 or 60 minutes. No statistically significant or clinically concerning changes in vital signs were observed. No serious adverse events occurred in either group. Patients in the ketamine group reported increased minor adverse effects at 15 minutes post-drug administration.

CONCLUSION: Subdissociative intravenous ketamine administered at 0.3 mg/kg provides analgesic effectiveness and apparent safety comparable to that of intravenous morphine for short-term treatment of acute pain in the ED.

Curr Opin Hematol. 2015 Nov;22(6):533-9.

Massive transfusion: red blood cell to plasma and platelet unit ratios for resuscitation of massive hemorrhage.

Murphy CH, Hess JR

PURPOSE OF REVIEW: The aim of this short study is to review recently published data bearing on how to resuscitate massive uncontrolled hemorrhage.

RECENT FINDINGS: New data inform our understanding of the mechanisms of the acute coagulopathy of trauma, the median time to death of trauma patients with uncontrolled hemorrhage, the effects of blood product composition on the coagulation capacity of infused resuscitation mixtures, the outcomes of patients resuscitated according to common massive transfusion protocols in clinical situations associated with massive hemorrhage, and who might benefit from balanced, blood-product-based resuscitation. Importantly, the trial methods, blood bank methods, and primary outcomes of the Pragmatic Randomized Optimal Plasma and Platelet Ratios (PROPPR) trial were recently published. Resuscitation with a 1:1:1 ratio of units of plasma and platelets to red blood cells was well tolerated and reduced hemorrhagic mortality during resuscitation in the PROPPR trial.

SUMMARY: The bulk of currently available data support the use of a 1:1:1 ratio for the resuscitation of patients with severe injury, shock, and uncontrolled hemorrhage. The application of this formulaic approach to massive blood product-based resuscitation in other clinical situations is less well supported in the literature.

J Trauma Acute Care Surg. 2015 Oct;79(4):586-91.

Emergency tourniquets for civilians: Can military lessons in extremity hemorrhage be translated?

Ode G, Studnek J, Seymour R, Bosse MJ, Hsu JR

BACKGROUND: Among civilians, emergency tourniquet (TKT) use is infrequent because of concern for TKT-related complications. In large part because of positive reports from the military on emergency TKT use, all ambulances serving Mecklenburg County, which includes the city of Charlotte, North Carolina, were equipped with commercial TKTs in September 2012. This study compares the outcomes of emergency TKT use with conservative hemorrhage control in an urban civilian setting and evaluates outcomes related to appropriate TKT placement.

METHODS: Emergency medical service and hospital records from September 2012 to November 2013 were reviewed. Injury characteristics, clinical interventions, outcomes, and TKT-related complications were reported, and appropriateness of TKT use was assessed. Primary analysis compared all TKT patients with non-TKT patients who received other hemorrhage control measures. Secondary analysis compared all appropriate TKT patients with those who had delayed/missed TKTs.

RESULTS: Fifty-six patients met inclusion criteria (24 TKT, 32 non-TKT). Four patients died (three TKT, one non-TKT) (7.1%). There were no reported TKT-related complications. Of all the patients, 46.4% (16 of 56) demonstrated signs of shock in the prehospital or emergency department setting. Seventy-five percent (12 of 16) of the patients in shock had a vascular injury ($p = 0.023$). Of the non-TKT patients, 9.4% (3 of 32) should have received a TKT and were classified as "missed." One "missed" patient died in the emergency department. Among TKT patients, 62.5% (15 of 24) of TKTs were appropriate, 20.8% (5 of 24) were inappropriate, and 16.7% (4 of 24) were "delayed." Overall, there was a delayed/missed TKT rate of 12.5% (7 of 56). Patients with delayed/missed TKTs had higher incidences of shock (85.7% vs. 60%), inpatient admission (100% vs. 76.9%), and blood transfusions (71.4% vs. 40%).

CONCLUSION: The majority of TKTs were appropriately applied to civilians who had vascular injuries or required operative intervention for hemorrhage control. With appropriate indications, an emergency TKT is a valuable instrument for hemorrhage control in the civilian prehospital setting and has a low rate of associated complications.

LEVEL OF EVIDENCE: Therapeutic study, level IV.

J Trauma Acute Care Surg. 2015 Oct;79(4 Suppl 2):S193-6.

Effectiveness of the combat pelvic protection system in the prevention of genital and urinary tract injuries: An observational study.

Oh JS, Do NV, Clouser M, Galarneau M, Philips J, Katschke A, Clasper J, Kuncir EJ

BACKGROUND: Historically, the incidence of genital and urinary tract (GU) injuries in major conflicts has been approximately 5%. To mitigate the risk of blast injury to the external genitalia, the United States and United Kingdom issued protective overgarments and undergarments to troops deployed in support of Operation Enduring Freedom. These two systems combined constitute the pelvic protection system (PPS). Our hypothesis was that PPS use is associated with a reduction of GU injuries in subjects exposed to dismounted improvised explosive device blast injuries.

METHODS: We identified two groups for comparison: those who were confirmed to have worn the PPS at time of injury (n = 58) and a historical control group who were confirmed as not wearing the PPS (non-PPS) (n = 61). Patients with any level of lower extremity amputation from dismounted improvised explosive device blast mechanism were included. The primary outcome measure was presence of a GU injury on admission. A univariate analysis assessing the strength of association with odds ratios and 95% confidence intervals was performed between the PPS and non-PPS groups.

RESULTS: Mean Injury Severity Score (ISS) was higher in the PPS versus the non-PPS group (26.1 vs. 19.3, p = 0.0012). Overall, 31% of the patients in the PPS group sustained at least one GU injury versus 62.3% in the non-PPS group. The odds ratio of sustaining a GU injury in the PPS group as compared with the PPS group is 0.28 (31% vs. 62.3%; 95 % confidence interval, 0.62-0.12; p < 0.001). The most frequent injures were open scrotal/testes wounds, followed by open penis, and open bladder/urethra injuries.

CONCLUSION: The use of the PPS is associated with a decreased odds ratio of GU injury. Despite a 31% absolute reduction, future work should focus on improved efficiency.

LEVEL OF EVIDENCE: Prognostic/epidemiologic study, level IV; therapeutic study, level V.

Acad Emerg Med. 2015 Oct;22(10):1200-12.

Early Secondary Neurologic Deterioration after Blunt Spinal Trauma: A Review of the Literature.

Oto B, Corey DJ 2nd, Oswald J, Sifford D, Walsh B

OBJECTIVES: The objectives were to review published reports of secondary neurologic deterioration in the early stages of care after blunt spinal trauma and describe its nature, context, and associated risk factors.

METHODS: The authors searched the MEDLINE, EMBASE, and CINAHL databases for English-language studies. Cases were included meeting the criteria age 16 years or older, nonpenetrating trauma, and experiencing neurologic deterioration during prehospital or emergency department (ED) care prior to definitive management (e.g., discharge, spinal clearance by computed tomography, admission to an inpatient service, or surgical intervention). Results were qualitatively analyzed for characteristics and themes.

RESULTS: Forty-one qualifying cases were identified from 12 papers. In 30 cases, the new deficits were apparently spontaneous and were not detected until routine reassessment. In 12 cases the authors did attribute deterioration to temporally associated precipitants, seven of which were possibly iatrogenic; these included removal of a cervical collar, placement of a halo device, patient agitation, performance of flexion/extension films, "unintentional manipulation," falling in or near the ED, and forced collar application in patients with ankylosing spondylitis. Thirteen cases occurred during prehospital care, none of them sudden and movement-provoked, and all reported by a single study.

CONCLUSIONS: Published reports of early secondary neurologic deterioration after blunt spinal trauma are exceptionally rare and generally poorly documented. High-risk features may include altered mental status and ankylosing spondylitis. It is unclear how often events are linked with spontaneous patient movement andwhether such events are preventable.

J Spec Oper Med. 2015 Fall;15(3):32-8.

The Operational Canine and K9 Tactical Emergency Casualty Care Initiative.

Palmer LE, Maricle R, Brenner JA

BACKGROUND: Approximately 20% to 25% of trauma-related, prehospital fatalities inhumans are due to preventable deaths. Data are lacking, however, on the nature and the prevalence of operational canine (OC) prehospital deaths. It is plausible that OCs engaged in high-threat operations are also at risk for suffering some type of preventable death. Tactical Combat Casualty Care has significantly reduced human fatality rates on the battlefield. Standardized guidelines specifically for prehospital trauma care have not been developed for the OC caregiver. An initiation has been approved by the Committee for Tactical Emergency Casualty Care to form a K9-Tactical Emergency Casualty Care (TECC) working group to develop such guidelines.

SIGNIFICANCE: The intent of the K9-TECC initiative is to form best practice recommendations for the civilian high-risk OC caregiver. These recommendations are to focus on interventions that (1) eliminate the major causes of canine out-of-hospital preventable deaths, (2) are easily learned and applied by any civilian first responder, and (2) minimize resource consumption.

Korean J Anesthesiol. 2015 Oct;68(5):455-61.

Comparison of i-gel® and LMA Supreme® during laparoscopic cholecystectomy.

Park SY, Rim JC, Kim H, Lee JH, Chung CJ

BACKGROUND: In laparoscopic surgical procedures, many clinicians recommend supraglottic airway devices as good alternatives to intubation. We compared the i-gel® (i-gel) and LMA Supreme® (Supreme Laryngeal Mask Airway, SLMA) airway devices during laparoscopic cholecystectomy regarding sealing pressure and respiratory parameters before, during, and after pneumoperitoneum.

METHODS: Following Institutional Review Board approval and written informed consent, 93 patients were randomly allocated into the i-gel (n = 47) or SLMA group (n = 46). Insertion time, number of insertion attempts, and fiberoptic view of glottis were recorded. Oropharyngeal leak pressure (OLP), the use of airway manipulation, peak inspiratory pressure, lung compliance, and hemodynamic parameters were measured before, during, and after pneumoperitoneum.

RESULTS: There were no significant differences between the two groups regarding demographic data, insertion time, fiberoptic view of glottis, and the use of airway manipulation. The gastric tube insertion time was longer in the i-gel group (20.4 ± 3.9 s) than in the SLMA group (16.7 ± 1.6 s) ($P < 0.001$). All devices were inserted on the first attempt, excluding one case in each group. Peak inspiratory pressure, lung compliance, and OLP changed following carbon dioxide pneumoperitoneum in each group, but there were no significant differences between the groups.

CONCLUSIONS: Both the i-gel and SLMA airway devices can be comparably used in patients who undergo laparoscopic cholecystectomy, and they offer similar performance including OLP.

Eur J Emerg Med. 2015 Aug 26.

Tranexamic acid in major trauma: implementation and evaluation across South West England.

Paudyal P, Smith J, Robinson M, South A, Higginson I, Reuben A, Shaffee J,Black S, Logan S

OBJECTIVE: To carry out a prospective evaluation of tranexamic acid (TXA) use in trauma patients.

PATIENTS AND METHODS: TXA was introduced to all emergency ambulances and emergency departments in the South West, UK, on 1 December 2011. We carried out a prospective evaluation of TXA use in trauma patients in the South West Peninsula between December 2011 and December 2012. We collected prehospital and hospital data on TXA administration using the Trauma Audit Research Network database. Data on prehospital administration of TXA were cross-checked with the South Western Ambulance Service Trust. Data were analysed using SPSS (version 20).

RESULTS: Altogether, 82 patients were administered TXA during the study period. The median age of the patients was 49 years (IQR 30, 66), and 72% were men. One-third of the patients arrived at hospital by air ambulance. During the first 3 months, administration of TXA was limited to one patient each month receiving the drug. However, an upward trend was observed after June until October 2012, with the increment being more than 10 fold in July, September and October 2012.

CONCLUSION: This is the first study to evaluate the use of TXA in civilian practice in the UK. Our study shows that ambulance service personnel and emergency departments can effectively administer TXA.

Eur J Emerg Med. 2015 Oct 14. [Epub ahead of print]

Prehospital thoracostomy in patients with traumatic circulatory arrest: results from a physician-staffed Helicopter Emergency Medical Service.

Peters J, Ketelaars R, van Wageningen B, Biert J, Hoogerwerf N

OBJECTIVE: Until recently, traumatic cardiac arrest (tCA) was believed to be associated with high mortality and low survival rates. New data suggest better outcomes. The most common error in tCA management is failing to treat a tension pneumothorax (TP). In the prehospital setting, we prefer thoracostomies for decompressing a potential TP in tCA cases; however, interventions can only be recommended with adequate information on their results. Therefore, we reviewed the results of thoracostomies performed by our Helicopter Emergency Medical Service.

METHODS: Our Helicopter Emergency Medical Service database was reviewed for all patients who underwent a single or a bilateral prehospital thoracostomy in tCA. We evaluated the incidence of TP, the return of circulation in tCA, the incidence of infections, the incidence of sharps injuries and patient survival.

RESULTS: A total of 267 thoracostomies were performed in 144 tCA patients. Thoracic decompression was performed to rule out TP. TP was identified in 14 patients; the incidence of TP in tCA was 9.7%. Two of the tCA patients survived and were discharged from the hospital; neither had clinical signs of TP. No infections or sharps injuries were observed.

CONCLUSION: The outcomes of patients with tCA who underwent prehospital thoracostomy were poor in our group. The early identification of TP and strict algorithm adherence in tCA may improve outcomes. In the future, to reduce the risk of unnecessary thoracic interventions in tCA, ultrasound examination may be useful to identify TP before thoracic decompression.

Reprod Health. 2015 Mar 31;12:28. doi: 10.1186/s12978-015-0012-0.

Non-pneumatic anti-shock garment for improving maternal survival following severe postpartum haemorrhage: a systematic review.

Pileggi-Castro C, Nogueira-Pileggi V, Tunçalp Ö, Oladapo OT, Vogel JP, Souza JP

INTRODUCTION: Women with postpartum haemorrhage (PPH) in developing countries often present in critical condition when treatment might be insufficient to save lives. Few studies have shown that application of non-pneumatic anti-shock garment (NASG) could improve maternal survival.

METHODS: A systematic review of the literature explored the effect of NASG use compared with standard care for treating PPH. Medline, EMBASE and PubMed were searched. Methodological quality was assessed following the criteria suggested by the Cochrane Effective Practice and Organization of Care Group. Guidelines on Meta-analysis of Observational Studies in Epidemiology were used for reporting the results. Mantel-Haenszel methods for meta-analysis of risk ratios were used.

RESULTS: Six out 31 studies met the inclusion criteria; only one cluster randomized controlled trial (c-RCT). Among observational studies, NASG fared better than standard care regarding maternal mortality reduction (Relative Risk (RR) 0.52 (95% Confidence interval (CI) 0.36 to 0.77)). A non-significant reduction of maternal mortality risk was observed in the c-RCT (RR: 0.43 (95% CI: 0.14 to 1.33)). No difference was observed between NASG use and standard care on use of blood products. Severe maternal outcomes were used as proxy for maternal death with similar pattern corroborating the trend towards beneficial effects associated with NASG.

CONCLUSION: NASG is a temporizing alternative measure in PPH management that shows a trend to reduce PPH-related deaths and severe morbidities. In settings where delays in PPH management are common, particularly where constraints to offer blood products and definitive treatment exist, use of NASG is an intervention that should be considered as a policy option while the standard conditions for care are being optimized.

Transfusion. 2015 Oct 28. doi: 10.1111/trf.13354. [Epub ahead of print]

Intravenous administration of tranexamic acid effectively reduces blood loss in primary total knee arthroplasty in a 610-patient consecutive case series.

Pitta M, Zawadsky M, Verstraete R, Rubinstein A

BACKGROUND: Tranexamic acid (TXA) has been reported to demonstrate efficacy in reducing blood loss during arthroplasty procedures.

STUDY DESIGN AND METHODS: This study examines the effectiveness of TXA as a central element of a patient blood management program (PBMP) by evaluating blood loss and transfusion of red blood cells in three consecutive groups of patients undergoing routine total knee arthroplasty (TKA). Approximately 200 patients were in each group as follows: Group 1 was a control without TXA, Group 2 was intra-articular administration, and Group 3 was intravenous (IV) administration.

RESULTS: The IV group demonstrated a small but significant lower blood loss compared to the two other groups measured by hemoglobin (Hb) drift and nadir Hb levels. The routine use of TXA along with the other aspects of our PBMP provided significant cost savings due to the reduction in transfusions as well as a decrease in length of stay and has been an important element of our successful implementation of a PBMP.

CONCLUSION: This study demonstrates a significant benefit from the routine use of TXA for total knee arthroplasty and is one of the first studies to demonstrate a small but significant benefit for IV administration in comparison to intraarticular administration. The routine use of TXA as a central element of a PBMP provides a cost savings and can help reduce the rate of transfusions for total knee arthroplasty.

J Emerg Med. 2015 Dec;49(6):878-85.

The Hartford Consensus on Active Shooters: Implementing the Continuum of Prehospital Trauma Response.

Pons PT, Jerome J, McMullen J, Manson J, Robinson J, Chapleau W

BACKGROUND: Active shooter incidents have led to the recognition that the traditional response paradigm of sequential response and scene entry by law enforcement, first responders, and emergency medical service (EMS) personnel produced delays in care and suboptimal victim outcomes. The Hartford Consensus Group developed recommendations to improve the response to and outcomes from active shooter events and urged that a continuum of care be implemented that incorporates not only EMS response, but also the initiation of care by law enforcement officers and potentially by lay bystanders.

OBJECTIVE: To develop and implement tiered educational programs designed to teach police officers and lay bystanders the principles of initial trauma care and bleeding control using as a foundation the U.S. military's Tactical Combat Casualty Care course and the guidelines of the Committee on Tactical Emergency Casualty Care.

DISCUSSION: The Tactical Casualty Care for Law Enforcement and First Responders course is a 1-day program combining didactic lecture, hands-on skills stations, and clinical scenarios designed primarily for police officers. The Bleeding Control for the Injured is a 2- to 3-h program for the potential citizen responder in the skills of hemorrhage control. In addition, we document the application of these skills by law enforcement officers and first responders in several real-life incidents involving major hemorrhage.

CONCLUSIONS: Developing and implementing tiered educational programs for hemorrhage control will improve response by police officers and the lay public. Educating law enforcement officers in these skills has been demonstrated to improve trauma victim survival.

J Trauma Acute Care Surg. 2015 Oct;79(4 Suppl 2):S78-84.

Chronic safety assessment of hemostatic self-expanding foam: 90-day survival study and intramuscular biocompatibility.

Rago AP, Duggan MJ, Hannett P, Brennecke LH, LaRochelle A, Khatri C, Zugates GT, Chang Y, Sharma U, King DR

BACKGROUND: Non-compressible hemorrhage is a significant cause of preventable death in trauma, with no effective presurgical treatments. We previously described the efficacy and 28-day safety of a self-expanding hemostatic foam in swine models. We hypothesized that the 28-day results would be confirmed at a second site and that results would be consistent over 90 days. Finally, we hypothesized that the foam material would be biocompatible following intramuscular implantation.

METHODS: Foam treatment was administered in swine following a closed-cavity splenic injury. The material was explanted after 3 hours, and the animals were monitored to 28 days (n = 6) or 90 days (n = 4). Results were compared with a control group with injury alone (n = 6 at 28 days, n = 3 at 90 days). In a separate study, foam samples were implanted in rabbit paravertebral muscle and assessed at 28 days and 90 days relative to a Food and Drug Administration-approved polyurethane mesh (n = 3 per group).

RESULTS: All animals survived the acute phase of the study, and the foam animals required enterorrhaphy. One animal developed postoperative ileus and was euthanized; all other animals survived to the 28-day or 90-day end point without clinically significant complications. Histologic evaluation demonstrated that remnant particles were associated with a fibrotic capsule and mild inflammation. The foam was considered biocompatible in 28-day and 90-day intramuscular implant studies.

CONCLUSION: Foam treatment was not associated with significant evidence of end-organ dysfunction or toxicity at 28 days or 90 days. Remnant foam particles were well tolerated. These results support the long-term safety of this intervention for severely bleeding patients.

J Spec Oper Med. 2015 Fall;15(3):39-45.

Conceptualized Use of Self-Expanding Foam to Rescue Special Operators From Abdominal Exsanguination: Percutaneous Damage Control for the Forward Deployed.

Rago AP, Sharma U, Sims K, King DR

BACKGROUND: Noncompressible hemorrhage is the leading cause of potentially survivable death on the battlefield. In Special Operations Forces (SOF), 50% of potentially survivable deaths have been related to noncompressible hemorrhage. Currently, there are no widely available presurgical interventions that can slow abdominal bleeding. Consequently, many of the preventable deaths occur en route to definitive care as a failure to rescue from exsanguination. A self-expanding polyurethane foam has been developed as a percutaneous damage control intervention to rescue casualties who would otherwise die of noncompressible hemorrhage, and allow them to survive long enough to reach surgical intervention. The purpose of this paper is to summarize the existing preclinical data, describe the role of SOF personnel in foam delivery-system development, and to integrate these together to conceptualize how foam could be incorporated into SOF medical care.

METHODS: All existing publications on self-expanding foam are reviewed. Additionally, eight SOF medical providers with combat experience provided end-user input to delivery-device design through an interactive human-factors testing process.

RESULTS: Ten preclinical publications described efficacy, safety, dose translation, and risk-benefit analysis of exsanguination rescue with percutaneous-foam damage control. SOF medical providers guided weight, cubic, operational requirements, and limits for the foam delivery device.

CONCLUSION: Presurgical exsanguination rescue with percutaneous foam damage control is safe and effective with a favorable risk-benefit profile in preclinical studies. Battlefield, presurgical use by SOF medical providers is conceptually possible. Adoption of the technology on the battlefield should proceed with SOF medical provider input.

J Trauma Acute Care Surg. 2015 Sep;79(3):343-8.

The evil of good is better: Making the case for basic life support transport for penetrating trauma victims in an urban environment.

Rappold JF, Hollenbach KA, Santora TA, Beadle D, Dauer ED, Sjoholm LO, Pathak A, Goldberg AJ

BACKGROUND: Controversy remains over the ideal way to transport penetrating trauma victims in an urban environment. Both advance life support (ALS) and basic life support (BLS) transports are used in most urban centers

METHODS: A retrospective cohort study was conducted at an urban Level I trauma center. Victims of penetrating trauma transported by ALS, BLS, or police from January 1, 2008, to November 31, 2013, were identified. Patient survival by mode of transport and by level of care received was analyzed using logistic regression.

RESULTS: During the study period, 1,490 penetrating trauma patients were transported by ALS (44.8%), BLS (15.6%), or police (39.6%) personnel. The majority of injuries were gunshot wounds (72.9% for ALS, 66.8% for BLS, 90% for police). Median transport minutes were significantly longer for ALS (16 minutes) than for BLS (14.5 minutes) transports ($p = 0.012$). After adjusting for transport time and Injury Severity Score (ISS), among victims with an ISS of 0 to 30, there was a 2.4-fold increased odds of death (95% confidence interval [CI], 1.3-4.4) if transported by ALS as compared with BLS. With an ISS of greater than 30, this relationship did not exist (odds ratio, 0.9; 95% CI, 0.3-2.7). When examined by type of care provided, patients with an ISS of 0 to 30 given ALS support were 3.7 times more likely to die than those who received BLS support (95% CI, 2.0-6.8). Among those with an ISS of greater than 30, no relationship was evident (odds ratio, 0.9; 95% CI, 0.3-2.7).

CONCLUSION: Among penetrating trauma victims with an ISS of 30 or lower, an increased odds of death was identified for those treated and/or transported by ALS personnel. For those with an ISS of greater than 30, no survival advantage was identified with ALS transport or care. Results suggest that rapid transport may be more important than increased interventions.

LEVEL OF EVIDENCE: Therapeutic study, level IV.

J Trauma Acute Care Surg. 2015 Oct;79(4 Suppl 2):S175-80. doi: 10.1097/TA.0000000000000738.

Predicting blood transfusion using automated analysis of pulse oximetry signals and laboratory values.

Shackelford S, Yang S, Hu P, Miller C, Anazodo A, Galvagno S, Wang Y, Hartsky L, Fang R, Mackenzie C; ONPOINT Study Group.

BACKGROUND: Identification of hemorrhaging trauma patients and prediction of blood transfusion needs in near real time will expedite care of the critically injured. We hypothesized that automated analysis of pulse oximetry signals in combination with laboratory values and vital signs obtained at the time of triage would predict the need for blood transfusion with accuracy greater than that of triage vital signs or pulse oximetry analysis alone.

METHODS: Continuous pulse oximetry signals were recorded for directly admitted trauma patients with abnormal prehospital shock index (heart rate [HR] / systolic blood pressure) of 0.62 or greater. Predictions of blood transfusion within 24 hours were compared using Delong's method for area under the receiver operating characteristic (AUROC) curves to determine the optimal combination of triage vital signs (prehospital HR + systolic blood pressure), pulse oximetry features (40 waveform features, O2 saturation, HR), and laboratory values (hematocrit, electrolytes, bicarbonate, prothrombin time, international normalization ratio, lactate) in multivariate logistic regression models.

RESULTS: We enrolled 1,191 patients; 339 were excluded because of incomplete data; 40 received blood within 3 hours; and 14 received massive transfusion. Triage vital signs predicted need for transfusion within 3 hours (AUROC, 0.59) and massive transfusion (AUROC, 0.70). Pulse oximetry for 15 minutes predicted transfusion more accurately than triage vital signs for both time frames (3-hour AUROC, 0.74; $p = 0.004$) (massive transfusion AUROC, 0.88; $p < 0.001$). An algorithm including triage vital signs, pulse oximetry features, and laboratory values improved accuracy of transfusion prediction (3-hour AUROC, 0.84; $p < 0.001$) (massive transfusion AUROC, 0.91; $p < 0.001$).

CONCLUSION: Automated analysis of triage vital signs, 15 minutes of pulse oximetry signals, and laboratory values predicted use of blood transfusion during trauma resuscitation more accurately than triage vital signs or pulse oximetry analysis alone. Results suggest automated calculations from a noninvasive vital sign monitor interfaced with a point-of-care laboratory device may support clinical decisions by recognizing patients with hemorrhage sufficient to need transfusion.

LEVEL OF EVIDENCE: Epidemiologic/prognostic study, level III.

J Trauma Acute Care Surg. 2015 Oct;79(4 Suppl 2):S204-9.

Prehospital use of hemostatic dressings by the Israel Defense Forces Medical Corps: A case series of 122 patients.

Shina A, Lipsky AM, Nadler R, Levi M, Benov A, Ran Y, Yitzhak A, Glassberg E

BACKGROUND: Hemostatic dressings are advanced topical dressings designed to control hemorrhage by enhancing clot formation. These dressings may be effective when used on injuries sustained in junctional zones. The Israeli Defense Forces Medical Corps (IDF-MC) chose to equip its medical personnel with the QuikClot Combat Gauze. There is a paucity of data describing clinical use and results of hemostatic dressing especially at the point of injury. The purpose of this article was to report the IDF-MC experience with prehospital use of the QuikClot Combat Gauze in junctional zones in a case series retrieved from the IDF Trauma Registry.

METHODS: All IDF Trauma Registry documented cases of prehospital use of hemostatic dressings in the IDF-MC between January 2009 and September 2014 were retrieved. Data collection included injury mechanism, wound location, reported success of hemostatic dressing, tourniquet use, lifesaving interventions, mortality, and caregiver identity.

RESULTS: A total of 122 patients on whom 133 hemostatic dressings were applied were identified. Median age was 22 years. Of the patients, 118 (96.7%) were male and 2 (1.6%) were female (missing, n = 2). Injury mechanism was penetrating in 104 (85.2%), blunt in 4 (3.3%), and combined in 14 (11.5%) patients. Seven patients (5.9%) died. Thirty-seven dressings (27.8%) were used for junctional hemorrhage control (pelvis, shoulder, axilla, buttocks, groin, neck), and 92 dressings (72.1%) were placed in nonjunctional areas (missing, n = 4). Nonjunctional dressings included 63 (47.4%) applied to the extremities, 14 (10.5%) to the back, and 4 (3%) to the head. Hemostatic dressing application was reported as successful in 88.6% (31 of 35 available; missing, n = 2) of junctional hemorrhage applications and in 91.9% (57 of 62 available; missing, n = 1) of extremity hemorrhage applications.

CONCLUSION: Hemostatic dressings seem to be an effective tool for junctional hemorrhage control and should be considered as a second-line treatment for extremity hemorrhage control at the point of injury.

LEVEL OF EVIDENCE: Therapeutic study, level V.

Anesth Essays Res. 2015 May-Aug;9(2):244-6.

I-gel saves the day: Bradycardia and apnea in a patient undergoing burr hole and evacuation for a subdural hematoma under scalp block.

Singh RB, Rizvi MM, Rasheed MA, Sarkar A

Abstract: Awake craniotomy is generally performed in scalped block, although it is safe, but this procedure can sometimes produce severe hemodynamic disturbances. Here, we reported a case of 32-year-old male, who came for burr hole and during the craniotomy performed under scalped block developed bradycardia and became apneic as manifested by the absence of ETCO2 and no chest excursions. An I-gel was inserted rather than intubating the patient and the case was managed very well and which showed the importance of supraglottic airway devices in our day to day practice.

Emerg Med J. 2015 Dec;32(12):955-60.

Challenging the dogma of traumatic cardiac arrest management: a military perspective.

Smith JE, Le Clerc S, Hunt PA

Abstracts: Attempts to resuscitate patients in traumatic cardiac arrest (TCA) have, in the past, been viewed as futile. However, reported outcomes from TCA in the past five years, particularly from military series, are improving. The pathophysiology of TCA is different to medical causes of cardiac arrest, and therefore, treatment priorities may also need to be different. This article reviews recent literature describing the pathophysiology of TCA and describes how the military has challenged the assumption that outcome is universally poor in these patients.

J Spec Oper Med. 2015 Fall;15(3):86-93.

Care of the Burn Casualty in the Prolonged Field Care Environment.

Studer NM, Driscoll IR, Daly IM, Graybill JC

Abstract: Burns are frequently encountered on the modern battlefield, with 5% - 20% of combat casualties expected to sustain some burn injury. Addressing immediate life-threatening conditions in accordance with the MARCH protocol (massive hemorrhage, airway, respirations, circulation, hypothermia/head injury) remains the top priority for burn casualties. Stopping the burning process, total burn surface area (TBSA) calculation, fluid resuscitation, covering the wounds, and hypothermia management are the next steps. If transport to definitive care is delayed and the prolonged field care stage is entered, the provider must be prepared to provide for the complex resuscitation and wound care needs of a critically ill burn casualty.

S Afr J Surg. 2015 Oct 8;53:13-8.

Time since injury is the major factor in preventing tranexamic acid use in the trauma setting: An observational cohort study from a major trauma centre in a middle-income country.

Thurston B, Chowdhury S, Edu S, Nicol AJ, Navsaria PH

BACKGROUND: Haemorrhage is responsible for about a third of in-hospital trauma deaths. The CRASH-2 trial demonstrated that early administration of tranexamic acid, ideally within 3 hours, can reduce mortality from trauma-associated bleeding by up to 32%.

OBJECTIVE: To explore whether, in our trauma network in a middle-income country, patients arrived at hospital soon enough after injury for tranexamic acid administration to be effective and safe.

METHODS: A prospective cohort study of 50 consecutive patients admitted to our trauma unit was undertaken. Inclusion criteria were as for the CRASH-2 study: systolic blood pressure <90 mmHg and/or heart rate >110 beats per minute, with injuries suggestive of a risk of haemorrhage. Patients with isolated head injuries were excluded. The mechanisms of injury, time since injury and any reasons for delay were recorded.

RESULTS: Thirteen (26%) patients presented early enough for tranexamic acid administration. Of these, only three patients presented within the 1st hour. Eleven patients had a documented time of injury >3 hours prior to presentation. We were unsure of the time of injury for 26 patients, although for most of these it was likely to be >3 hours before presentation.

CONCLUSIONS: The majority (74%) of bleeding trauma patients did not present within the timeframe allowed for safe administration of tranexamic therapy. Of those who did, most would have benefited from even earlier commencement of therapy. This raises the possibility that tranexamic acid may be more effective on a population basis if incorporated into prehospital rather than in-hospital protocols; future studies should explore the benefits and risks of this approach.

J Spec Oper Med. 2015 Fall;15(3):72-5.

Resuscitation During Critical Care Transportation in Afghanistan.

Tobin JM, Nordmann GR, Kuncir EJ

OBJECTIVE: These data describe the critical care procedures performed on, and the resuscitation markers of, critically wounded personnel in Afghanistan following point of injury (POI) transports and intratheater transports. Providing this information may help inform discussion on the design of critical care transportation platforms for future conflicts.

METHODS: The Department of Defense Trauma Registry (DoDTR) was queried for descriptive data on combat casualties with Injury Severity Score (ISS) greater than 15 who were transported in Operation Enduring Freedom (OEF) from 1 January 2010 to 31 December 2010. Both POI transportation events and interfacility transportation events were reviewed. Base deficit (BD) was evaluated as a maker of resuscitation, and international normalized ratio (INR) was evaluated as a measure of coagulopathy.

RESULTS: There were 1198 transportation events that occurred during the study period - 634 (53%) transports from the POI and 564 (47%) intratheater transports. Critical care interventions were performed during 147 (12.3%) transportation events, including intubation, cricothyrotomy, double-lumen endotracheal tube placement, needle or tube thoracostomy, central venous access placement, and cardiopulmonary resuscitation. The mean BD on arrival in the emergency department was - 5.4 mEq/L for POI transports and 0.68 mEq/L intratheater transports ($\rho < .001$). The mean INR on arrival in the emergency department was 1.48 for POI transports and 1.21 for intratheater transports ($\rho < .001$).

CONCLUSIONS: Critical care interventions were needed frequently during evacuation of severely injured personnel. Furthermore, many troops arrived acidotic and coagulopathic following initial transport from POI. Together, these data suggest that a platform capable of damage control resuscitation and critical care interventions may be warranted on longer transports of more critically injured patients.

Eur J Emerg Med. 2015 Sep 8. [Epub ahead of print]

Hemostatic dressings in civil prehospital practice: 30 uses of QuikClot Combat Gauze.

Travers S, Lefort H, Ramdani E, Lemoine S, Jost D, Bignand M, Tourtier JP

Abstract: To report the use and describe the interest of hemostatic dressings in a civilian setting, we provided medical prehospital teams with QuikClot Combat Gauze (QCG) and asked physicians to complete a specific questionnaire after each use. Thirty uses were prospectively reported. The wounds were mostly caused by cold steel (n=15) and were primarily cervicocephalic (n=16), with 19/30 active arterial bleedings. For 26/30 uses, hemostatic dressing was justified by the inefficiency of other hemostasis techniques. Those 30 applications were associated with 22 complete cessations of bleeding, six decreases of bleeding, and ineffectiveness in two cases. The application of QCG permitted the removal of an effective tourniquet that was applied initially for three patients. No side-effects were reported. The provision of hemostatic dressings in civilian resuscitation ambulances was useful by providing an additional tool to limit bleeding while rapidly transporting the injured patient to a surgical facility.

Eur J Trauma Emerg Surg. 2015 Oct 26. [Epub ahead of print]

Combat application tourniquet (CAT) eradicates popliteal pulses effectively by correcting the windlass turn degrees: a trial on 145 participants.

Ünlü A, Petrone P, Guvenc I, Kaymak S, Arslan G, Kaya E, Yilmaz S, Cetinkaya RA, Ege T, Ozer MT, Kilic S

INTRODUCTION: We aimed to define an ideal range of windlass turn degrees for 100 % success rates within the study population.

METHODS: CAT was applied at mid-thigh level. Data included age, lower extremity circumference (LEC), body mass index (BMI), and mean arterial pressure (MAP). Windlass turn degrees were measured in failed and successful participants. The failed participants' windlass mechanisms were twisted until the popliteal artery was occluded. Failure to success and additional turn degrees to secure the windlass mechanism of CAT was determined. Doppler ultrasound was used to examine the popliteal artery blood flow.

RESULTS: 145 servicemen have participated in the study. Initially, 70% successfully applied CAT. There was no statistically significant difference in BMI and MAP values between successful and failed participants. The mean LEC for failed and successful applications were 57.5 ± 4 and 56.8 ± 4, respectively. The required turn degrees for success ranged between 45° and 270°. After correction, the cumulative success rate of 93 and 100 % was reached at 990° and 1170° overall turn degrees.

DISCUSSION: In order to adequately stop limb hemorrhage, soldiers should be taught their optimal turn degrees.

Curr Opin Anaesthesiol. 2015 Oct;28(5):517-24.

Traumatic brain injury: physiological targets for clinical practice in the prehospital setting and on the Neuro-ICU.

Wijayatilake DS, Jigajinni SV, Sherren PB

PURPOSE OF REVIEW: Over many years, understanding of the pathophysiology in traumatic brain injury (TBI) has resulted in the development of core physiological targets and therapies to preserve cerebral oxygenation, and in doing so prevent secondary insult. The present review revisits the evidence for these targets and therapies.

RECENT FINDINGS: Achieving oxygen, carbon dioxide, blood pressure, temperature and glucose targets remain a key goal of therapy in TBI, as does the role of effective prehospital care. Physician led air ambulance teams reduce mortality. Normobaric hyperoxia is dangerous to the injured brain; as are both high and low carbon dioxide levels. Hypotension is life threatening and higher targets have now been suggested in TBI. Both therapeutic normothermia and hypothermia have a role in specific groups of patients with TBI. Although consensus has not been reached on the optimal intravenous fluid for resuscitation in TBI, vigilant goal-directed fluid administration may improve outcome. Osmotherapeutic agent such as hypertonic sodium lactate solutions may also have a role alongside conventional agents.

SUMMARY: Maintaining physiological targets in several areas remains part of protocol led care in the acute phase of TBI management. As evidence accumulates however, the target values and therefore therapies may be set to change.

J Foot Ankle Surg. 2015 Nov-Dec;54(6):1106-10.

Administration of Tranexamic Acid Reduces Postoperative Blood Loss in Calcaneal Fractures: A Randomized Controlled Trial.

Xie B, Tian J, Zhou DP

Abstract: The present randomized controlled trial was undertaken to evaluate the effect of tranexamic acid (TXA) on reducing postoperative blood loss in calcaneal fractures. A total of 90 patients with a unilateral closed calcaneal fracture were randomized to the TXA (n = 45) and control (n = 45) groups. The corresponding groups received 15 mg/kg body weight of TXA or placebo (0.9% sodium chloride solution) intravenously before the skin incision was made. Open reduction and internal fixation was performed for all patients and selective bone grafting was performed. The patients were examined 3 months after surgery. The intraoperative and postoperative blood loss, blood test results, and wound complications were compared between the 2 groups. The complications of TXA were also investigated. No statistically significant differences were found in the baseline characteristics between the TXA and control groups. Also, no significant difference was noted in the intraoperative blood loss between the 2 groups. However, in the TXA group, the postoperative blood loss during the first 24 hours was significantly lower than that in the control group (110.0 ± 160.0 mL versus 320.0 ± 360.0 mL; $p < .001$). The incidence of wound complications was also reduced compared with that in the control group (7.3% versus 23.8%; $p = .036$). No significant difference was found in the incidence of thromboembolic events or adverse drug reactions between the 2 groups. We concluded that preoperative single-dose TXA can effectively reduce postoperative blood loss and wound complications in patients with calcaneal fractures and that no significant side effects developed compared with the control group.

JAMA. 2015 Oct 27;314(16):1701-10.

Effect of a Buffered Crystalloid Solution vs Saline on Acute Kidney Injury Among Patients in the Intensive Care Unit: The SPLIT Randomized Clinical Trial.

Young P, Bailey M, Beasley R, Henderson S, Mackle D, McArthur C, McGuinness S, Mehrtens J, Myburgh J, Psirides A, Reddy S, Bellomo R; SPLIT Investigators; ANZICS CTG

IMPORTANCE: Saline (0.9% sodium chloride) is the most commonly administered intravenous fluid; however, its use may be associated with acute kidney injury (AKI) and increased mortality.

OBJECTIVE: To determine the effect of a buffered crystalloid compared with saline on renal complications in patients admitted to the intensive care unit (ICU).

DESIGN AND SETTING: Double-blind, cluster randomized, double-crossover trial conducted in 4 ICUs in New Zealand from April 2014 through October 2014. Three ICUs were general medical and surgical ICUs; 1 ICU had a predominance of cardiothoracic and vascular surgical patients.

PARTICIPANTS: All patients admitted to the ICU requiring crystalloid fluid therapy were eligible for inclusion. Patients with established AKI requiring renal replacement therapy (RRT) were excluded. All 2278 eligible patients were enrolled; 1152 of 1162 patients (99.1%) receiving buffered crystalloid and 1110 of 1116 patients (99.5%) receiving saline were analyzed.

INTERVENTIONS: Participating ICUs were assigned a masked study fluid, either saline or a buffered crystalloid, for alternating 7-week treatment blocks. Two ICUs commenced using 1 fluid and the other 2 commenced using the alternative fluid. Two crossovers occurred so that each ICU used each fluid twice over the 28 weeks of the study. The treating clinician determined the rate and frequency of fluid administration.

MAIN OUTCOMES AND MEASURES: The primary outcome was proportion of patients with AKI (defined as a rise in serum creatinine level of at least 2-fold or a serum creatinine level of ≥3.96 mg/dL with an increase of ≥0.5 mg/dL); main secondary outcomes were incidence of RRT use and in-hospital mortality.

RESULTS: In the buffered crystalloid group, 102 of 1067 patients (9.6%) developed AKI within 90 days after enrollment compared with 94 of 1025 patients (9.2%) in the saline group (absolute difference, 0.4% [95% CI, -2.1% to 2.9%]; relative risk [RR], 1.04 [95% CI, 0.80 to 1.36]; P = .77). In the buffered crystalloid group, RRT was used in 38 of 1152 patients (3.3%) compared with 38 of 1110 patients (3.4%) in the saline group (absolute difference, -0.1% [95% CI, -1.6% to 1.4%]; RR, 0.96 [95% CI, 0.62 to 1.50]; P = .91). Overall, 87 of 1152 patients (7.6%) in the buffered crystalloid group and 95 of 1110 patients (8.6%) in the saline group died in the

hospital (absolute difference, -1.0% [95% CI, -3.3% to 1.2%]; RR, 0.88 [95% CI, 0.67 to 1.17]; P = .40).

CONCLUSIONS AND RELEVANCE: Among patients receiving crystalloid fluid therapy in the ICU, use of a buffered crystalloid compared with saline did not reduce the risk of AKI. Further large randomized clinical trials are needed to assess efficacy in higher-risk populations and to measure clinical outcomes such as mortality.

Med Sci Monit. 2015 Oct 14;21:3095-103.

Safety and Efficacy of Tranexamic Acid in Total Knee Arthroplasty.

Yu X, Li W, Xu P, Liu J, Qiu Y, Zhu Y

BACKGROUND The prevalence of total knee arthroplasty (TKA) is increasing, which is one of the most frequent operations in orthopedic practice. To further investigate the safe and effective role of using tranexamic acid (TA) in reducing transfusion rate and blood loss in total knee arthroplasty.

MATERIAL AND METHODS This meta-analysis was conducted according to the Cochrane methodology. Twenty-eight superior quality and well designed randomized controlled trials (RCT) were collected to analyze for this study. Patients who had undergone primary unilateral TKA were chosen. The software, RevMan 5.2, was used to analyze collected data. RESULTS Finally, 28 RCTs were collected to analyze for this study. Total blood loss was dramatically decreased via the application of TA, by a mean of 420 ml [95% CI: -514 to -327]. A significant reduction about blood transfusion rate was also found in patients who received TA. [RD: -0.26, 95%CI: -0.33 to -0.19]. Moreover, no significant differences were found between TA and control groups in incidence of deep vein thrombosis (DVT) and pulmonary embolism (PE).

CONCLUSIONS This meta-analysis demonstrates that the application of TA in TKA could decrease total blood loss and transfusion rate. On the other hand, the application of TA is not associated with high incidence of DVT or other adverse events. TA should be taken into account in routine use in primary knee arthroplasty to benefit the patients.

Prog Orthod. 2015;16:34.

Comparison of the effects of preemptive acetaminophen, ibuprofen, and meloxicam on pain after separator placement: a randomized clinical trial.

Zarif Najafi H, Oshagh M, Salehi P, Babanouri N, Torkan S

BACKGROUND: This study aims to evaluate and compare the effect of pre-procedural administration of acetaminophen, ibuprofen, and meloxicam in reducing pain after separator placement.

METHODS: Three hundred twenty-one patients who needed orthodontic treatment and aged above 15 were randomly assigned to one of the three study groups: group A: 650 mg acetaminophen, group B: 400 mg ibuprofen, and group C: 7.5 mg meloxicam. All subjects received a single dose of medication 1 h prior to separator placement. Using visual analog scale, patients recorded their pain perception during rest, fitting posterior teeth together, and chewing at time intervals of immediately, 2, 6, 24, and 48 h after separator placement.

RESULTS: There was no significant difference between acetaminophen, ibuprofen, and meloxicam in post-separator placement pain control when administered 1 h before the procedure. In all the groups, at rest, pain level elevated after separator placement and reached its peak at 24 h and then subsided until 48 h. But during chewing and fitting of the posterior teeth, some of the groups reached a peak in pain at 48 h. No significant difference was found in pain experience between males and females.

CONCLUSIONS: Meloxicam can be used as an effective analgesic in orthodontic pain control considering it has less gastric side effects compared to the conventional nonsteroidal anti-inflammatory drugs.

TRIAL REGISTRATION: Iranian Registry of Clinical Trials, IRCT2015041821828N1.