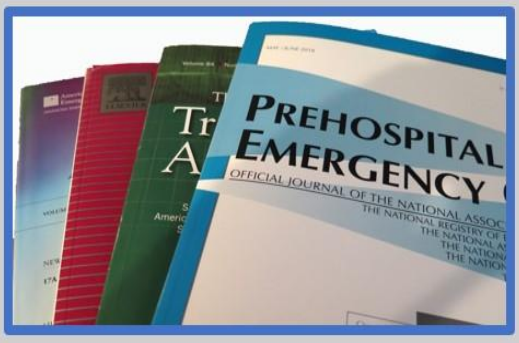
LITERATURE REVIEWS VOLUME 1

This is a compilation of literature reviews from the faculty of the International Prehospital Medicine Institute. These literature reviews are provided free of charge to encourage looking critically at current studies and how they apply to the forward-thinking EMS provider.

The literature reviews are arranged in topic areas with a linkable table of content. Each study includes a link to the original study.



LITERAURE REVIEW VOL. 1

Literature reviews published by IPHMI between October 2018 and September 2019

International Prehospital Medicine Institute

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AED

1. **Impact of Bystander Automated External Defibrillator Use on Survival and Functional Outcomes in Shockable Observed Public Cardiac Arrests.** Pollack RA, Brown SP, Rea T. et al. *Circulation.* 2018;137:2104–2113

This study sought to determine the survival and functional outcomes of patients with shockable observed public out-of-hospital cardiac arrest (SOP-OHCA) treated by bystanders using automated external defibrillators.

This study utilized out-of-hospital cardiac arrest (OHCA) data collected prospectively from nine regional Resuscitation Outcomes Consortium centers from 2011 to 2015. OHCA was defined as an incident in which cardiopulmonary resuscitation (CPR) was performed by EMS or defibrillation was attempted by EMS or a bystander. Patients included in the study were at least 18 years of age with non-traumatic arrest.

During the study period, a total of 49,555 cardiac arrests were identified, of which 4,115 took place in public and were observed. Of the observed public cardiac arrests, 2,589 presented with an initial shockable rhythm. Eighty-nine patients were excluded for do-not-resuscitate orders, patient dead on EMS arrival, missing data, or confirmed shockable rhythms that were not shocked by EMS or a bystander. The study cohort included 469 patients who were shocked by a bystander and 2,031 SOP-OHCA patients who were initially shocked by EMS for a combined total of 2,500 patients. Favorable functional outcomes using a modified Rankin Score and survivability to discharge were assessed from the patient's medical records.

Patients treated with initial bystander AED shock had functionally favorable survival that was greater (57.1%) than that of EMS delivered initial shock (32.7%). The biggest favorable outcome advantage between patients who received an initial bystander AED shock when compared to patients who received their initial AED shock from EMS appeared when comparing the patient groups with no identified subsequent disabilities (32.6% versus 14.4% respectively). Overall survival to hospital discharge was 66.5% for patients who received their initial shock from a bystander compared to 43.0% for patients who received their initial shock from EMS. In those cases of shockable arrest that were unwitnessed, there was no survival benefit of bystander shock in comparison with EMS delivered shock. In shockable arrest occurring in private locations there was a significant survival benefit when the arrest was observed by a bystander. As should be expected, survival for those victims treated by primary EMS shock declined as the EMS response time increased.

Several limitations were observed during this study. Functional outcome was based on the medical record at the time of discharge therefore any changes that emerged following hospital discharge could not be captured. The study was observational, thus the study could not determine if the survival advantage of bystander AED shock is solely the result of this action. Because the EMS systems involved in this study are also involved in different clinical trials, the EMS systems may be higher performing, so the results of this study may not be generalizable. Finally, this study could not determine if the quality of the EMS care provided affected the potential survival effects of bystander AED use.

This study demonstrated that survival with a favorable neurological outcome for patients who experience an out-of-hospital cardiac arrest with a shockable rhythm is greatest when an electrical shock can be delivered by bystander use of an AED as soon as possible following the arrest. The longer a patient is in cardiac arrest with a shockable rhythm before receiving an electrical shock the less chance of surviving with a favorable outcome. The healthcare community should continue to support the

placement of public assess AEDs and the education of non-medical individuals in the use of an AED, along with CPR.

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Airway and Ventilation Management

1. **Timing of advanced airway management by emergency medical services personnel following out-of-hospital cardiac arrest: A population-based cohort study.** Izawa, J, Iwami, T Gibo, K, Okubo, M, Kajino, K, Kiyohara, K, et al. Resuscitation 2018;128:16-23.

The American Heart Association's (AHA) Advanced Cardiac Life Support Course stresses that providers must be aware of the risks and benefits of advanced airway management (AAM) during a cardiac arrest resuscitation attempt. Although insertion of an advanced airway (supra-glottic devices or endotracheal intubation) can be accomplished during ongoing chest compressions, placement is frequently associated with interruption of compressions for many seconds. The AHA's published position is that there is inadequate evidence to define the optimal timing of advanced airway management in relation to other interventions during resuscitation from cardiac arrest. Studies have been conflicting. A study of 25,006 in-hospital cardiac arrests, showed earlier time to AAM (<5 minutes) was not associated with improved ROSC but was associated with improved 24-hour survival. In an urban out-of-hospital setting, AAM achieved in <12 minutes was associated with better survival than AAM achieved in ≥13 minutes. Another recent study found that delayed endotracheal intubation combined with passive oxygen delivery and minimally interrupted chest compressions was associated with improved neurologically intact survival after out-of-hospital cardiac arrest in patients with adult witnessed VF/pulseless VT. The current study investigates the timing of AAM and its association with favorable outcome from out of hospital cardiac arrest (OHCA).

The EMS system in Osaka, Japan serves 8.8 million residents in both urban and rural communities. Each ambulance is staffed with three EMS providers who are authorized to use an AED, and one of whom is an emergency life-saving technician (ELST). ELST's may insert an intravenous line, administer adrenaline, and place AAM devices for OHCA patients under on-line medical direction. All OHCA patients are transported to the hospital. The authors screened seven years of data from all consecutive OHCA cases aged ≥18 years for whom EMS personnel attempted CPR. Traumatic arrests, patients whose time from the call to EMS until the start of CPR by EMS was ≥60 min, whose time between the start of CPR by EMS and the achievement of AAM was ≥30 min, or whose Glasgow-Pittsburgh Cerebral Performance Category scale (CPC) at one-month after OHCA was unknown were excluded from the study. There were 27,471 patients with OHCA treated with an AAM. Cases were divided into Early AAM, 0-4 minutes (11,536) and Late AAM, 5-29 minutes (15,939).

Primary outcome was functionally favorable survival at one-month. The authors estimated adjusted odds ratio (OR) of survival from time of CPR to AAM using multivariable logistic regression. In the secondary analysis, they divided the time from CPR to AAM into early (0–4 min) and late (5–29 min). They then calculated propensity scores (PS) for early AAM and performed PS-matching. Time from CPR to AAM was inversely associated with functionally favorable survival (adjusted OR 0.90 for one-minute increments as a continuous variable, 95% confidence interval [CI] 0.87–0.94). In the PS-matched cohort of 17,022 patients, early AAM, compared to late AAM, was associated with functionally favorable survival: 2.2% vs. 1.4%; adjusted OR 1.58 (95% CI 1.24–2.02).

There were several limitations to the study. All patients were from a single EMS System. Not all providers used the same AAM device. Most providers inserted supra-glottic airways while a small number of trained ELST's were allowed to use endotracheal intubation. Because AAM happened only when patients were still receiving CPR, a time bias toward favorable outcomes with earlier return of spontaneous circulation (ROSC) could exist.

This single system study demonstrated slightly better functional survival of OHCA patients with earlier AAM. This paper adds to the conflicting data regarding this issue. Unfortunately, the authors

missed an opportunity to compare the outcome of OHCA patients who did not receive AAM with those who did as they chose not to analyze an additional 16,000 cases that were managed without AAM. The answer to the question of optimal airway management and the timing of that intervention for OHCA will have to await additional study.

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2. **Avoid the Goose! Paramedic Identification of Esophageal Intubation by Ultrasound.** Lema P, O'Brien M, Wilson J, et al. Prehosp Disaster Med. 2018;33(4):406–410.

Unrecognized esophageal intubation by EMS field providers remains problematic. While continuous waveform capnography is the "Gold Standard", the authors examine the use of point-of care ultrasound (POCUS) as a tool to identify location of endotracheal tubes placed by field paramedic personnel.

This prospective observational study took place between March 2014 and December 2015 using local paramedics volunteers with various demographics and years of experience. The end point of the study was correct identification of the randomly placed (trachea vs. esophagus) endotracheal tube on fresh cadaver models utilizing POCUS. Each of the fifty-eight (58) subjects were enrolled into one (1) of twelve (12) study sessions that was comprised of lecture and practical training session conducted by fellowship trained ultrasound emergency physicians. Separate cadavers were used for training and final study sessions.

A total of 228 intubations occurred during the study period. Of those, 113 were pre-placed in the trachea and 115 in the esophagus by the investigators with verification of placement by a second investigator. Paramedics were able to identify tube location in 158 (69.3%) by utilization of POCUS. The mean time to make an identification was 44.9 seconds. Of note, esophageal intubations were identified 9.47 seconds faster than tracheal intubations. When the study participants were allowed to manipulate the tube during the US procedure they were able to increase successful identification to 85.0%. When the results were dissected for demographics and paramedic experience, no difference in performance was found across all groups of novice ultrasound users.

The stated goal for the study was to assess paramedic ability to confirm correct ETT placement and inadvertent esophageal placement. The study shows that paramedic study participants can correctly identify placement of the ETT using POCUS when manipulation is performed 85% of the time. While the authors recognize that waveform capnography is the current gold standard for confirming correct ETT placement in the trachea, they comment that there are limitations of $EtCO_2$ monitoring: specifically that the availability of wave form capnography in the prehospital setting is low and that diminished pulmonary blood flow during cardiac arrest and the need for ventilation compromise its utility.

While this paper was published in 2018, it is important to note that the availability of EtCO2 monitoring equipment has increased since the start of the study in 2014. Most medical directors and State EMS offices have mandated the use of these devices, which has made $EtCO_2$ monitoring equipment available on most if not all units that perform ETT intubation. Further concern is the average time to perform the US exam at 44.9 seconds. This was a "laboratory" study where everything needed to perform the POCUS evaluation was readily at hand. Whether or not the 45 second time frame will hold true in actual field settings remains to be determined.

Pre-hospital use of POCUS to identify ETT location is limited. While this study shows that paramedics can be trained to identify ETT position using POCUS, it leaves many questions as to its efficacy over EtCO2 monitoring. Is the increased time to perform the exam warranted? Skill degradation needs to be studied and re-training intervals established. Would the subset of patients that $EtCO_2$ monitoring would not identify be worth the investment in ultrasound technology?

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3. **Comparison of The Force Required For Dislodgement Between Secured And Unsecured Airways.** Davenport, C, Martin-Gil, C, Wang, H, Mayrose, J, and Carlson, J. Prehosp Emerg Care. 2018;22:778-781.

Airway device placement is a crucial prehospital skill. Once a device is confirmed in place, it is paramount that it stays in place, as providers often have limited opportunities for successful airway management. In addition to the traditional endotracheal tube (ETT), more and more prehospital agencies are using supra-glottic devices for airway management. This study evaluates the force needed to dislodge correctly placed airway devices when using manufacturers recommend securing methods versus when they are unsecured.

This study utilized 4 common prehospital airway devices (endotracheal tube [ETT], laryngeal mask airway [LMA], King laryngeal tube [King] and iGel) to compare the force required to dislodge the airway from 5 different mannequins with and without a retention device. After spraying with a saliva substitute, the airways were placed in mannequins, correct placement was confirmed and, where appropriate, cuffs inflated per manufacturer recommendations. A digital force measuring device was attached to the distal end of each airway and pulled vertically and perpendicular to the mannequin until the airway device was dislodged, defined as at least 4 cm of movement of the airway device.

The authors determined that for the various supraglottic devices tested, it takes almost twice the dislodgement force (median force for dislodgement in pounds [interquartile range]) to move a secured airway versus an unsecured airway (King 21.7 secured VS 10.6 unsecured, LMA 16.6 secured VS 8.4 unsecured and iGel 8 secured VS 3.9 unsecured) and almost three times the force to dislodge the ETT (ETT 13.3 secured VS 4.5 unsecured). The King LT was the most resistant to dislodgement compared to the other airway devices in the study.

While the results of this study probably come as no surprise, it demonstrates the importance of securing all airway devices, including supra-glottic, in the pre-hospital setting and the relative ease with which an unsecured device may be dislodged, potentially leading to a patient care airway catastrophe.

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4. **Implementation of a Clinical Bundle to Reduce Out-of-Hospital Peri-intubation Hypoxia.** Jarvis JL, Gonzales J, Johns D, BS, Sager L. Ann Emerg Med. 2018;72:272-279

Prehospital rapid sequence intubation (RSI) is a controversial procedure. Peri-intubation hypoxia is a known complication of this procedure that is associated with poor patient outcomes. This study evaluated whether a disciplined approach to prehospital rapid sequence intubation employing a clinical bundle encompassing positioning, apneic oxygenation and delayed sequence intubation reduces peri-intubation hypoxia.

The authors report the results of a before and after study in suburban, central Texas involving a single EMS service. The study population included adults only who were undergoing prehospital intubation, excluding patients in cardiac arrest. Group 1 (before) period patients were intubated using standard RSI with apneic oxygenation at flush flow, ketamine, and a paralytic. The group 2 (after) patients were intubated using a strict, disciplined care bundle including patient positioning (elevated head, sniffing position), apneic oxygenation, delayed sequence intubation (administration of ketamine to facilitate patient relaxation and preoxygenation with a delayed administration of paralytics), and goal directed preoxygenation of greater than or equal to a SpO2 of 94%. If at any time the patient's SpO2

dropped below 94%, the RSI was abandoned, adjustments were initiated, and the patient was ventilated for 3 minutes (or longer) with a bag mask valve device with or without the insertion of a supraglottic device until the oxygen saturation once again reached 94%.

The before group (October 2, 2013, to December 13, 2015) included 104 patients and the after group (August 8, 2015, to July 14, 2017) included 87 patients. The demographics of both groups were similar in sex, age, weight, ethnicity, rate of trauma, initial oxygen saturation, rates of initial hypoxia, peri-intubation peak SpO2, pre-intubation pulse rate and systolic blood pressure, peri-intubation cardiac arrest, and first-pass and overall success rates. The after group experienced less peri-intubation hypoxia (44.2% versus 3.5%) and higher peri-intubation lowest SpO2 values (100% versus 93%). The authors concluded that, in this single EMS system, a care bundle encompassing patient positioning, apneic oxygenation, delayed sequence intubation, and goal-directed preoxygenation was associated with lower rates of peri-intubation hypoxia than standard out-of-hospital rapid sequence intubation.

While a randomized, controlled study is needed to validate these results, EMS agencies and systems that include rapid sequence intubation as an option for airway management should consider employing a disciplined care bundle approach to the procedure encompassing patient positioning, apneic oxygenation, delayed sequence intubation, and goal-directed preoxygenation for reducing peri-intubation hypoxemia and minimizing associated complications.

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5. A tale of two cities: prehospital intubation with or without paralyzing agents for traumatic brain injury. Bendinelli C, Ku D, Nebauer S, et al. ANZ J Surg (2018)

Prehospital endotracheal intubation (PETI) is a widely accepted paramedic skill. Many paramedic services have successfully adopted rapid sequence induction (RSI) drugs to facilitate PETI. The role of PETI in traumatic brain injury (TBI) is not clear. In Victoria, Australia, paramedics use RSI protocols to assist with PETI. The New South Wales, Australia, paramedics are not allowed to use RSI drugs. The authors hypothesized that RSI would increases PETI success rate in TBI patients and improve mortality.

The authors conducted a retrospective comparison study of adult TBI patients admitted to Victorian or New South Wales Trauma Centers over 3 years. Inclusion criteria included Glasgow Coma Scale (GCS) score of <9 and abbreviated injury scale head and neck of >2. Included patients were compared via univariate and logistical regression analysis to estimate odds ratio for mortality and length of intensive care unit stay. The study was approved by the Hunter New England Human Research Ethics Committee.

One hundred and ninety-two Victorian patients and ninety-one New South Wales patients were included in the study. The two groups were similar in demographics (gender, age), GCS score, prehospital hypotension, and injury severity. The Victorian paramedics (RSI) obtained PETI in 85.5 % of their patients compared to 22.2% of the New South Wales patients (No RSI). Despite the significant difference in PETI success rates, overall mortality did not differ between the two groups. Interestingly, mortality for patients with GCS score 3-5 was similar but for those patients with GCS score 6-8, mortality was higher in the RSI group (15% versus 3%) although the RSI group had a higher head/neck AIS score (5 versus 4). The incidence of prehospital and ED arrival hypoxia was similar between the two groups. However, the patients

who underwent RSI had a statistically significant longer stay in the intensive care unit than the patients who did not (364 hours versus 144 hours).

While not specifically investigated in this study, low oxygen saturations may be attributed to the risk of developing hypoxia during the intervention itself which has been reported in other studies as well.

Australian paramedics using RSI protocols had a much higher success rate for PETI when treating TBI patients than paramedics without RSI protocols, however PETI success did not equate to improved mortality rates. Prehospital intubation of patients with severe traumatic brain injury remains a controversial topic with arguments and data on both sides of the debate. Paramedics treating TBI patients should carefully weigh the patient benefit versus the risks associated with performing PETI, especially when the patient is already maintaining their own airway.

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Bleeding Control

1. **Prehospital tourniquet use in penetrating extremity trauma: Decreased blood transfusions and limb complications.** Smith AA, Ochoa JE, Wong S, et al. *J Trauma Acute Care Surg*. 2019;86:43-51.

The military experience with tourniquet use for extremity trauma with massive hemorrhage has been positive, with a demonstrated survival benefit if the tourniquet is placed prior to the onset of shock. Additionally, the military has shown there are a few, if any, significant long-term complications of tourniquet use. Following the publication of the Hartford Consensus statement in 2014, tourniquet use has been increasing in the prehospital and civilian setting. Additionally, the American College of Surgeons Stop the Bleed course has promulgated the teaching of tourniquet use to a widespread civilian audience.

To date, few studies have examined the efficacy of tourniquet placement in the civilian setting. Those civilian studies which have been published included large numbers of blunt trauma patients, while the military data was focused primarily on penetrating and blast injuries. Some felt the military data would not translate to the civilian world due to differences in the injury patterns. Additionally, no civilian study has compared a prehospital trauma population who received tourniquet placement to a similarly matched population which did not receive tourniquet placement.

The authors examined a single institution's experience with prehospital tourniquet placement. Patients were included in the study if they had a commercial tourniquet placed for extremity injury in the prehospital setting. Patients were excluded if they had a tourniquet placed for a non-traumatic injury or a noncommercial tourniquet device placed. The primary outcome measure was blood product utilization. Secondary outcomes included the presence of shock on arrival, limb complications related to tourniquet use, systemic complications, hospital and ICU length of stay, and in–hospital mortality. Case-control matching was done between patients with penetrating extremity injuries that had a commercial tourniquet placed versus those who did not.

A total of 238 patients had tourniquets placed for extremity injuries during the study period. The average age was 34.5 years, mostly male and African-American. Of the patients in the study, 74% had penetrating trauma with gunshot wound being the most common type. Most tourniquets were placed by paramedics or EMTs (68.5%), with firefighters and police officers placing 27.3%. There was no documented placement of a commercial tourniquet by a bystander during this study period although a number of improvised tourniquets were identified (13.9%) and replaced with a commercial device by rescuers.

In comparing patients with penetrating extremity trauma who had a commercial tourniquet placed to those who did not, the tourniquet group was noted to require fewer blood product transfusions (2.0 units RBCs and 1.5 units plasma versus 9.3 units RBCs and 6.2 units plasma respectively) and had a higher average systolic blood pressure on arrival to the emergency department than the non-tourniquet group (120 mmHg versus 112). Tourniquet placement was not associated with an increase in nerve palsies or secondary infection rates. Interestingly, patients who did not receive a tourniquet had a higher incidence of fasciotomy (deep leg surgical incisions to relieve pressure from compartment syndrome) and secondary amputation compared to those who received tourniquet.

This study is an important contribution to the growing body of literature supporting the civilian prehospital use of commercial tourniquets for patients with penetrating extremity trauma. Lower blood product utilization, higher systolic blood pressure on arrival, and fewer limb complications occurred in

those patients who received prehospital tourniquet compared to those who did not. The old adage that application of a tourniquet should be considered only as a last resort is no longer true.

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2. **Effectiveness of Instructional Interventions for Hemorrhage Control Readiness for Laypersons in the Public Access and Tourniquet Training Study (PATTS). A Randomized Clinical Trial.** Goralnick E, Chaudhary MA, McCarty JC, et al. JAMA Surg. 2018;153(9):791-799.

With the recent national focus on controlling hemorrhage after mass shootings and point of care initiation of treatment for those, and all, trauma victims with severe hemorrhage, identifying optimal training methodologies using nationally available standardized courses as well as point of care (just in time) instructions is of paramount importance.

This randomized observational study was conducted at a large Massachusetts sports complex from April 2017 to August 2017 utilizing stadium employees and staff. Five hundred sixty-two (562) participants were enrolled in the study. Ninety-seven (97) participants were excluded due to prior hemorrhage control training. The remaining volunteers were randomized into 4 groups: (1)control group (no training or point of care instructions), (2)Audio instruction kits at the point of care,(3) Flashcards at the point of care, and (4) American College of Surgeons (ACS) Bleeding Control (B-Con) Course. There was no statistical difference in demographics between the four (4) groups. The study also examined degradation rates 3 to 9 months post training. Assessment and testing were conducted with a positive result being proper application of a tourniquet.

Of the four groups, the group that took the B-Con course had the highest correct tourniquet application rate at 87.7%. The control group had the lowest with 16.3%, and the audio and flashcard groups had 23.0% and 19.7% respectively. There were no statistical differences between the control group (no training or point of care instructions) and either the audio or flashcard groups. The main reason for failure to meet the end point goal of proper application of the tourniquet in all groups was the tourniquet being applied too loosely to effectively control bleeding. Of note, less than one-half of the participants in the audio or flashcard groups actually used the guidance provided.

After the initial evaluation, all three non-B-Con groups received standard B-Con training. Participants were then re-evaluated 3-9 months after their initial training using the original end point of proper tourniquet placement to determine skill retention. Overall 303 of the original 465 participants were re-evaluated. Of those retested 54.5% applied the tourniquet correctly post training.

The results of this study overwhelmingly show that live, in-person didactic training with a psychomotor (hands-on) skill application component had higher initial and retention testing results than the other three groups. It also showed that point of care instructional flashcards or audio prompts had little to no increase in the successful application of the tourniquet over the control group.

There has been a lot of discussion regarding the optimal length of hemorrhage control training for the lay responder. This study clearly shows that the combination of lecture and skills practice provided in the ACS B-Con course was superior to both flashcards and AED-style audio instructions. There are a number of additional points to consider:

1. The main reason for unsuccessful tourniquet application was the device being applied without the proper tension (too loose). This is consistent with other studies and the issue of correct tightness should be reinforced in all tourniquet training.
2. The optimal re-training interval is unknown and further study would be useful.
3. While point of care instructions that were delivered by flashcards or audio prompts showed no better results compared to the control group, several other options should be evaluated:

- A group using EMS Emergency Medical Dispatch real time guidance.

- A group that combined initial B-Con training with either audio or flashcard prompts in an attempt to decrease the 33.2% degradation rate at re-testing.

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3. **Civilian Prehospital Tourniquet Use Is Associated with Improved Survival in Patients with Peripheral Vascular Injury.** Teixeira PGR, Brown CVR, Emigh B, et al. J Am Coll Surg 2018;226:769-776.

Evidence of tourniquet use for hemorrhage control dates back several centuries and has been proven to reduce mortality in the modern combat setting. However, data demonstrating a survival benefit secondary to civilian tourniquet use is still lacking. This study was based on the hypotheses that civilian use of the tourniquet improves mortality in patients who sustained peripheral vascular injuries.

A multicenter retrospective review was conducted of all patients who sustained peripheral vascular injuries and were admitted to 11 Level I Texas trauma centers during a 6-year time period (ending December 2016). During this time period 1,026 patients were admitted with peripheral vascular injuries. The patients were then divided into two groups; patients who had a tourniquet placed prior to admission and patients admitted without a tourniquet. Multiple variables were analyzed to ensure equal comparison among both groups.

Of the 1,026 patients reviewed, 181 (17.6%) patients had a tourniquet applied prior to arrival at the trauma center. Average time a tourniquet was in place averaged 77.3 minutes (39.0 to 92.3 minutes). The unadjusted mortality in the patient group admitted with a tourniquet in place was 3.9% whereas the mortality rate in the group without a tourniquet was 5.2%. After conducting multivariable analysis to control for age, gender, other injuries, and traumatic amputation, the prehospital application of tourniquets was independently associated with survival. Traumatic amputations occurred in 98 patients with 35 of the 98 (35.7%) amputations having had a tourniquet placed in the field. Mortality for patients with a traumatic amputation was 2.9% if a tourniquet was applied versus 7.9% without one. Patients in the non-tourniquet group had a significantly lower rate of thromboembolic complications (3.4%) compared to the tourniquet group (7.2%). No significant differences were found in other comparisons between the two groups (e.g. length of hospital stay, pulmonary, cardiac or systemic complications).

Some limitations were identified in the study. Because of the retrospective design patients could not be assessed for specific tourniquet complications such as nerve palsy and compartment syndrome. Another limitation was the lack of information about the use of other prehospital hemostatic adjuncts and interventions such as hemostatic bandages and tranexamic acid.

The application and utilization of tourniquets for hemorrhage control in patients with peripheral vascular injures in the civilian prehospital remains an underused intervention. Multiple studies, both in military and civilian operations, have proved the mortality benefits of tourniquets to control hemorrhage. Tourniquets are safe to use if applied correctly and should be readily available for both medical and non-medical personnel. Hemorrhage control kits should be as readily available for public use as are AEDs.

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4. **Tourniquet usage in prehospital care and resuscitation of pediatric trauma patients - Pediatric Trauma Society position statement.** Cunningham A, Auerbach M, Cicero M, and Jafri M. *J Trauma Acute Care Surg.* 2018;85: 665-667.

Public preparedness for mass casualty incidents has increased significantly following many recent tragedies. In September 2015 the American College of Surgeons convened the Hartford Consensus group to develop "common sense recommendations" for "strengthening the security and resilience of US citizens" following mass casualty events. The "Stop the Bleed" initiative was developed from this group to teach basic hemorrhage control techniques to the public. As of now there is no mention of hemorrhage control in the pediatric population.

The Pediatric Trauma Society (PTS) conducted a literature review of pediatric tourniquet utilization using the US National Library of Medicine National Institutes of Health (PubMed) database. A total of 18 studies were evaluated by a group of four physician members of the PTS Guidelines Committee.

Six articles were reviewed from the combat experience in Iraq and Afghanistan. These studies demonstrated the use of commercially available tourniquets was effective not only in soldiers but also in pediatric combat casualties. Interestingly, adult- sized tourniquets were used effectively on pediatric patients without increased complications. The use of tourniquets was effective in controlling hemorrhage and in decreasing mortality in children in the combat setting. Pediatric survival rates were similar to that seen in adult literature. Tourniquet use increased survival by 92% over no tourniquet use and an additional 13% when applied in the prehospital setting over waiting until arrival to the emergency department. A study of 766 pediatric patients older than 8 years of age noted reduced resuscitation requirements from tourniquet use, most notably a decrease in blood transfusion and crystalloid requirements. Additional studies noted in-hospital tourniquet complications occur in 0.4% to 1.4% of all elective surgical uses. The most common complications resulted in soft-tissue injury (31%) or nerve damage (21%). This is similar to that noted in the adult tourniquet literature.

The PTS supports the use of prehospital tourniquets in children suffering exsanguinating hemorrhage from severe extremity trauma. They recommend direct pressure as a first step to control hemorrhage, with tourniquet placement indicated in those situations where direct pressure does not work. They also specifically note the risk of death from exsanguinating hemorrhage outweighs any slight complications which could occur from tourniquet use.

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5. **Can they stop the bleed? Evaluation of tourniquet application by individuals with varying levels of prior self-reported training.** McCarty JC, Caterson EJ, Chaudhary MA, et al. Injury, the International Journal of the Care of the Injured. September 2018 (article in press) 2019;50:10-15

Uncontrolled hemorrhage accounts for up to 64% of preventable trauma deaths. The US Military focused their training on hemorrhage control enabling them to decrease deaths due to uncontrolled hemorrhage by 63%. As a result of the military success in improving survival, there are now numerous courses that teach bleeding control techniques (i.e. "Stop the Bleed") to civilians in the hope that armed with this knowledge and training, they will act as immediate responders in the event of significant external hemorrhage after someone sustains an injury.

The Public Access and Tourniquet Training Study (PATTS) trial was a prospective randomized trial that identified skill decay in civilians trained in bleeding control, with only 54% of the participants being able to demonstrate the skills they learned three to nine months after the course. In this study, the

authors decided to do a subset analysis of the PATTS trial to determine whether various levels of self-reported prior training influenced correct application of tourniquets by civilians. They also hoped to determine how willing these civilians would be to assist when they come upon someone needing their attention.

For this study, participants in the PATTS trial were divided in into three groups based upon prior training as follows: (1) No prior training, (2) First Aid training only, or (3) First Aid and Hemorrhage Control training. All of the participants were employees of a major sports stadium and the study took place over five months. Of the 562 participants in the PATTS trial, 317 met the criteria for inclusion in this study. Participants with prior bleeding control training were excluded.

In comparing participants with no prior training to those with First Aid training, there was no statistical difference in their ability to correctly apply a tourniquet, 14% versus 25.2%. Those who had first aid and hemorrhage control training did better with 36% being able to correctly apply tourniquets. In addition, those with first aid and hemorrhage control training were more willing to assist than either of the other two groups. The authors concluded that prior hemorrhage control training is correlated with increased odds of correct tourniquet application and willingness to provide assistance.

This study shows that hemorrhage control training improves both correct application of a tourniquet and willingness to act. Unfortunately, without formal bleeding control education and training, the success rate is rather low. Clearly, much work remains if the pool of immediate responders is to be expanded and adequately educated in the various techniques of external hemorrhage control and the survival of trauma victims improved.

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6. **The trauma center is too late: Major limb trauma without a pre-hospital tourniquet has increased death from hemorrhagic shock.** Scerbo MH, Holcomb JB, Taub E, et al. *J Trauma Acute Care Surg.* 2017;83: 1165-1172.

The U.S. military revitalized the utilization of tourniquets for major extremity trauma following analysis of their data from the Iraq and Afghanistan wars. They note that survival in patients with exsanguinating extremity trauma is significantly improved with early (prehospital) use of tourniquets, with the greatest survival advantage noted in those who have a tourniquet placed prior to the onset of shock. Severe complications from tourniquet use, a long held dogma in trauma care, proved not to be true. They demonstrated tourniquets to be safe, effective, and life-saving. The question facing trauma providers is does this survival advantage translate to the civilian world? Military trauma is different than that encountered by the civilian medic. Transport times are longer, care under fire is more common (making it difficult to apply direct pressure), and the mechanism of injury is different (blast and penetrating trauma in the military versus primarily blunt trauma in the civilian population).

In this article, Scerbo and colleagues review their data from a busy, urban, Level 1 trauma center. They hypothesized that late tourniquet use, defined as tourniquet application after arrival to the trauma center, would have a higher death rate from hemorrhagic shock than tourniquet application in the prehospital setting. They reviewed their data over an 8-year period and classified tourniquet application as prehospital (T-PH) or trauma center (T-TC). Each case was classified as indicated (vascular injury requiring repair/ligation, operation on the extremity within 2 hours of arrival, or traumatic amputation), relative indication (major musculoskeletal/soft tissue injury requiring operation within 2-8 hours of arrival or documented large blood loss on-scene), or non-indicated. Measured outcomes were death from hemorrhagic shock, physiology upon arrival to the trauma center, and massive transfusion requirements.

Three hundred six patients received 326 tourniquets – 157 upper and 147 lower extremities. Median age was 34 and most patients had isolated major limb trauma. Blunt mechanism was most common (70%), primarily from motor vehicle collisions (63%). Two hundred fifty-two (89%) of the prehospital tourniquets were indicated. Patients who had an indication for tourniquet placement had a 4.5-fold increased risk of death if the tourniquet was delayed until trauma center arrival. Delay in tourniquet application was also associated with a longer ICU length of stay and higher plasma transfusion requirement.

This is the first large study to demonstrate the benefit of tourniquet application for severe extremity trauma in the civilian prehospital setting. Survival was 4.5 times higher for those who needed a tourniquet and received it in the prehospital setting. Delay in tourniquet application resulted in a higher mortality rate from hemorrhagic shock. If your service is one of the few remaining holdouts which does not have tourniquets available then this study should be carefully reviewed and should change your practice.

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Blood and Blood Products

1. **Prehospital Blood Product Administration Opportunities in Ground Transport ALS EMS –A Descriptive Study.** Mix F, Zielinski M, Myers L, et al. *Prehosp Disaster Med*, 2018;33(3):230-236.

Traumatic injury is the number one cause of death for individuals aged 1-44 years and the fourth leading cause of death overall, with uncontrolled hemorrhage being the major cause of preventable death. It has been estimated that hemorrhage accounts for approximately one third of civilian prehospital trauma deaths and 40.0% of deaths in the first day post-injury. In 2005, the concept of damage control resuscitation (DCR) was introduced which includes resuscitation with balanced blood product administration. Nearly 25% OF HEMS in the United States carry blood products including the MCMT service.

This retrospective chart review study looked at trauma patients transported by the Mayo Clinic Medical Transport (MCMT; Rochester, Minnesota USA) prehospital care system, including ground (Gold Cross Ambulance Service) and helicopter (HEMS - Mayo One) assets to determine if trauma patients benefit from blood product administration by ground ALS ambulances. Calls for service between January 1, 2011 through December 31, 2015 were reviewed. Inclusion criteria were: calls involving scene transport for acute traumatic injury, emergent dispatch request, patient age 18 years or older at time of patient contact, and predetermined physiological and/or mechanistic criteria. The physiological (hemodynamic [HD]) criteria were a heart rate (HR) ≥120 beats per minute and/or systolic blood pressure (SBP) ≤ 90 mmHg; the mechanistic criterion was penetrating trauma. Individual patient care reports were reviewed for all cases and those with minor mechanisms of injury were excluded. Cases meeting inclusion criteria were linked to their hospital charts for outcome data.

Fifty-one of 7,900 ground transport patients satisfied the inclusion criteria and had a known outcome. Of these 51 patients, 17 received blood product transfusions in the ED as part of the initial resuscitation. Patients meeting HR and SBP criteria were most likely to receive blood products in the ED (53.3%). In all, 74 of 753 HEMS patients met HD and mechanistic criteria for blood product administration of which 28 (40%) received blood during transport. There was a trend to increasing blood product use as physiologic severity increased, with 60.0% of patients meeting both HR and SBP parameters receiving transfusion, however this was not statistically significant. The mean transport times were slightly longer in the HEMS group (4.9 minutes). Overall, less than one percent (0.7%) of the ground ALS transports and 10.1% of the HEMS transports identified in the study met criteria for blood product administration. In this single site study population, HD parameters alone appear to overestimate the need for transfusion and did not predict subsequent ED blood product administration for trauma patients transported by ground ambulance.

As acknowledged by the authors, the complex logistical and regulatory requirements involved in blood product storage and administration limit the utility of blood product administration within the described ground system. They do recognize that some ALS ground transport systems have begun using blood products in the field but that each EMS system is unique and should be viewed as such. One possible development that may significantly simplify the use of prehospital blood product administration is the future availability of freeze-dried plasma.

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2. **Prehospital Plasma during Air Medical Transport in Trauma Patients at Risk for Hemorrhagic Shock.** Sperry JL, Guyette FX, Brown JB, et al. *N Engl J Med.* 2018;379:315-26.
3. **Plasma-first resuscitation to treat hemorrhagic shock during emergency ground transportation in an urban area: a randomized trial.** Moore HB, Moore EE, Chapman MP, et al. *Lancet.* 2018; 392:1-9.

(Combined Review) Optimal resuscitation of the trauma patient in hemorrhagic shock consists of minimizing the use of crystalloids such as Ringer's lactate and normal saline while transfusing blood components (packed red blood cells, plasma, and platelets). This resuscitation strategy minimizes the coagulopathy often seen in hemorrhagic shock. Lately research has focused on initiating this resuscitation in the prehospital setting, specifically the use of early plasma transfusion. Two trials were published in July 2018 examining the effect of prehospital plasma resuscitation in two environments: the aeromedical and urban. The Prehospital Air Medical Plasma (PAMPer) trial evaluated the survival benefit of plasma transfusion in trauma patients transported via helicopter. The Control of Major Bleeding After Trauma trial (COMBAT) assessed the use of prehospital plasma transfusion in an urban environment. Both studies were funded by the Department of Defense.

Inclusion criteria in both trials were similar. Eligible patients were any injured adult (age > 18) with suspected acute blood loss having at least one episode of hypotension (systolic blood pressure < 90 mmHg) and tachycardia (defined in these studies as a heart rate >108 beats per minute) or if they had any severe hypotension (systolic blood pressure < 70 mmHg) regardless of heart rate. Patients were randomized to receive either two units of thawed plasma or crystalloid along with the standard treatment. Patients in the COMBAT trial also had blood drawn on scene prior to administration of plasma or crystalloid to evaluate the presence of early coagulopathy. The primary outcome of both trials was mortality at one month.

PAMPer trial: 501 patients met all inclusion criteria and were enrolled: 230 received plasma and 271 received crystalloid placebo. 73% of patients were men, 82% had blunt trauma, and the median Injury Severity Score was 22, (with a score greater than 15 indicating severe injury). 35% also received a prehospital blood transfusion in accordance with local protocols. Surgeons performed urgent operative procedures in 58% of patients during the initial 24 hours of care. Being a helicopter trial, 111 patients were transferred from an outside emergency department but had similar demographic and injury characteristics to the 390 that were transported directly from the scene. Median prehospital transport time was 40 minutes.

The 30-day mortality was lower among patients who received thawed plasma compared to those who received standard resuscitation. Administration of prehospital plasma was associated with a 39% lower risk of death compared to those who received standard care. Mortality at 24 hours and overall in-hospital mortality was also lower in the plasma group compared to the standard group. Patients in the plasma group also received fewer units of blood components overall and fewer units of packed red blood cells within 24 hours. They also had a lower incidence of coagulopathy. There were no documented cases of significant transfusion -related complications.

COMBAT trial: 125 patients were enrolled (65 in the plasma group and 60 in the control group). The median time from injury to arrival at the hospital was 28 minutes for the plasma group and 24 minutes for the control group. Both groups had similar demographics and injury patterns. 53% were classified as severely injured (Injury Severity Score > 25) and 62% were in severe shock with a systolic blood pressure ≤ 70 mmHg. Interestingly, the early coagulopathy noted in previous studies was not present in these patients. Also of note, patients who received plasma only had a scene time three minutes longer than those who did not receive plasma.

As is standard for any randomized trial, an interim analysis of the results was conducted by the institutional review board and FDA. The trial was stopped early because no difference in outcome was noted between the two groups. Coagulation factors, transfusion requirements, and transfusion safety outcomes were similar among the groups. The authors found no benefit to prehospital plasma transfusion in an urban setting.

Summary: These two studies are timely and relevant for the prehospital provider. Both studies were very well done. They were simple studies, meaning the medics conducted their normal care of the trauma patient with the only intervention being the transfusion of plasma in those patients who were

randomized into that group. They demonstrate a survival benefit in severely injured trauma patients who received a prehospital plasma transfusion in the aeromedical setting but not in an urban environment. There are several possible reasons for these findings. An urban environment often has very short transport times with plasma and packet blood cells immediately available upon arrival to the emergency department. The findings in the COMBAT trial may not be applicable in the rural or austere environment. Additionally some believe there are better ways to identify patients in hemorrhagic shock then relying on blood pressure and heart rate parameters. What these other options are still remains to be determined. Finally, helicopter flight crews often have more experience, better equipment, and function in a more controlled environment than urban EMS providers which could explain the survival benefit in the PAMPer trial with helicopter plasma transfusion.

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Cardiac Arrest

1. **A Randomized Trail of Epinephrine in Out-of-Hospital Cardiac Arrest.** Perkins, G, Ji, C, Deakin, CD, et al. NEJM 2018;379:711-721.

Prior studies have raised concerns about the use of epinephrine for out-of-hospital cardiac arrest, specifically that while epinephrine may lead to a greater rate of return of spontaneous circulation, overall survival is not improved. As a result, the International Liaison Committee on Resuscitation called for a placebo-controlled trial to determine whether or not the use of epinephrine is safe and effective in these patients.

A randomized, double-blind trial involving 8,014 patients with out-of-hospital cardiac arrest was conducted in the United Kingdom. Paramedics from five ambulance services administered either parenteral epinephrine (4,015 patients) or a saline placebo (3,999 patients), along with standard cardiac arrest care. The primary outcome measurement for the study was the rate of patient survival at 30 days. A secondary outcome measurement was based on the rate of survival to hospital discharge with a favorable neurologic outcome.

In adults with out-of-hospital cardiac arrest, the use of epinephrine resulted in a statistically significantly higher rate of 30-day survival (130 patients/3.2%) than the use of placebo (94 patients/2.4%). However, there was no difference between the two groups in the proportion of patients who survived until hospital discharge with favorable neurologic outcome (epinephrine - 87 of 4007 patients/2.2%, placebo - 74 of 3994 patients/1.9%). Of note, severe neurologic impairment was more common among survivors in the epinephrine group than in the placebo group (epinephrine group - 39 of 126 patients/31.0%, placebo group – 16 of 90 patients/17.8%).

Some limitations were identified in the study. The patient's neurological status prior to cardiac arrest was not recorded, although presumably the two groups were large enough to have similar demographics. The study protocol called for 1mg IV bolus dosages of epinephrine. No additional dosages or administration routes were studied.

While epinephrine continues to maintain its status as a therapeutic intervention for non-traumatic cardiac arrest, this study adds to the growing body of evidence that suggests that when administered to cardiac arrest victims, long term survival with a favorable neurologic outcome is not improved (even though 30 day survival is better). While the exact mechanism for this difference is not clear, it may be due to epinephrine-related constriction of the microcirculation in the brain, thus impairing blood flow. As additional studies are performed and more evidence regarding the effect of epinephrine is obtained, its use for cardiac arrest may well be modified.

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2. **Effect of Bag-Mask Ventilation vs Endotracheal Intubation during cardiopulmonary resuscitation on Neurological Outcome After Out-of-Hospital Cardiorespiratory Arrest. A Randomized Clinical Trial.** Jabre P, Penaloza A, Pinero D, et al. JAMA. 2018;319(8):779-787

For many decades the "Gold Standard" of airway management both in the prehospital and hospital phase of resuscitation has been early and aggressive endotracheal intubation (ETI). However, it is believed that bag mask ventilation (BVM) is a less complex modality for maintaining the airway and ventilation while performing Cardio-Pulmonary Resuscitation (CPR) during the Advanced Cardiopulmonary Life Support (ACLS) phase of resuscitation. Several recent retrospective registry-based studies have suggested that outcome from cardiac arrest is poorer when ETI is utilized while others suggest a benefit.

This prospective randomized study compares the 28 day outcomes of over 2000 out of hospital cardiac arrest patients in two groups that were randomized to airway management with BVM versus ETI. The primary outcome measure was survival to and neurologic status at 28 days post arrest. The study was conducted in France and Belgium over a 22-month period utilizing ALS ambulance units configured with an ambulance driver, a nurse and an emergency physician. There were 1020 patients in the BVM group and 1023 into the ETI group. All patients enrolled were 18+ years in age. The authors found a significantly greater ROSC rate in the ETI group 38.9% vs. 34.2% in the BVM group. However, there was no difference in survival to hospital admission (BVM vs ETI: 28.9% vs 32.6%) and survival to day 28 (BVM vs ETI: 5.4% vs 5.3%). Of note however, the BVM group had a significantly higher rate of gastric content regurgitation (15.2% vs 7.5%, $p<0.001$). Thus the authors concluded that this study failed to demonstrate whether BVM or ETI was the preferred airway management technique in patients with OHCA.

There are a number of limitations to this the study when applying it to the general EMS service, particularly in the U.S. The first is the crew composition of the French and Belgium ALS response units. The ALS units include an Emergency Medicine Physician. Many of these physicians were initially trained as anesthesiologists. This study found a successful intubation rate of 91.8%. This is well above success rates in most other non-physician staffed EMS systems. The second limitation of this study was once ROSC was obtained in the BVM group, the patient was then intubated in the immediate post ROSC period. Thus, this study only evaluates the timing for ETI and not whether or not ETI should be performed. As the authors point out, additional study is needed since the optimal method of airway management for victims of OHCA has not yet been determined.

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Domestic Violence

1. **Paramedics as a New Resource for Women Experiencing Intimate Partner Violence.** Sawyer S, Coles J, Williams A, Williams B. J Interpersonal Violence 2018

Intimate Partner Violence (IPV) has an immense impact on women around the world. Paramedics often observe signs of IPV directly within patient homes offering a first glimpse into early recognition of IPV. Further, victims of IPV often choose not to be transported to emergency departments. Therefore, the cycle of violence continues for these victims. There has been a general lack of IPV education in

healthcare settings even while past research has supported a link with IPV education and earlier recognition of IPV victimization, hopefully resulting in increased referral of victims and decreased rates of IPV worldwide. This study is the first evidence-based guideline designed for paramedics in recognizing and referring IPV patients.

This study describes the development of a comprehensive, consensus-based guideline focused on the paramedic management of IPV patients. The authors utilized the World Health Organization's (WHO) clinical recommendations for health care practitioners in the management of IPV patients as a basis; removing recommendations not appropriate for paramedicine. The authors utilized the Policy Delphi Method to gain consensus from an expert panel in Australia. A total of 42 participants provided consensus on the draft guideline. Health care professionals including paramedics, research experts, service delivery experts and specialty group advocates provided consensus in three rounds. Modifications occurred in all aspects of protocol from each round to the next with the questioning method providing the longest to reach consensus.

Four sections were included in the final guideline: recognize, respond, refer, and record. The first section (recognize) lists indicators of IPV including the recognition of feelings and behaviors associated with mental health disorders such as depression, agitation, withdrawal, suicidal thoughts, self-harm, and drug or alcohol abuse. Additional indicators include unexplained chronic medical symptoms, physical trauma and sexual violence. Further, an additional indicator focusing on the perpetration of IPV by males, the use of fear or violence as a means of control, was included. .

The second section (respond) identified the preferred methods of discussion with IPV patients. A three-step process of discussion was proposed. The first step is to ensure the patient is alert and in a safe, private environment. The patient should feel comfortable and feel there is no imminent physical threat. The second step is to conduct a discussion with the focus being on fear and safety concerns rather than patient behaviors. The discussion should be open, indirect and contain no judgement. Experts stressed the need for skills-based training delivered by expert educators to ensure discussions are sensitive and appropriate.

The third section of the guideline (refer) lists local referral agencies that paramedics can recommend to patients verbally and/or via printed materials, to include counseling, police, legal advice, safety planning and emergency accommodation. Finally, the record section indicated appropriate documentation of IPV cases in the patient record, again modified from the WHO's documentation recommendations, to include appropriate documentation of injuries, police presence and the assurance of confidentiality.

The limitations of this study include the use of expert consensus rather than empirical evidence as well as the lack of IPV patient involvement. In addition, while the guideline recommends a suitable method of discussing IPV with patients, it cannot ensure that the discussion is sensitive and appropriate.

The recommendations from this study represent the first comprehensive, consensus-based guideline for paramedics (and in fact all responding medical personnel) in responding to IPV patients in the prehospital setting. Paramedics can play a crucial role in the recognition and referral of IPV resulting in increased referral rates for IPV victims and the potential prevention of further abuse. While paramedics routinely interact with victims of IPV and provide expert medical care and transportation to the Emergency Department, they are rarely prepared to provide pathways to referral services and

instead rely on emergency department staff to intervene on the patient's behalf. While this interaction in the Emergency Department provides the patient with needed resources, it does not address the needs of the patient that is not transported. The recommendations from this study provide an outline for others to follow in the development of a treatment plan for those victims of IPV who are not transported. Further research is needed to determine if early intervention by paramedics provides the desired outcome of decreasing IPV.

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Geriatrics

1. **Morbidity and Mortality Associated with Prehospital "Lift-assist" Calls.** Leggatt L, Van Aarsen K, Columbus M, Et al. Prehosp Emerg Care 2017;21:556-562.

Every day, EMS professionals respond to calls for individuals requiring assistance with mobilization. Many of these calls do not result in treatment or transportation to a hospital. The requesting individual is simply lifted or assisted up to a more mobile position. These calls are often referred to, and coded as, a "lift assist". It is possible the need for this sort of assistance may represent a sentinel event for covert disease processes, such as infection, or representative of the individual's decline in functional mobility. The challenge for EMS providers is to determine the specific nature or cause for the individual's inability to mobilize themselves and the need for transport for further evaluation.

For this paper, the authors looked at all "lift assist" calls from a single EMS agency over a one-year period, 804 of 42,055 (1.9%) EMS calls. Ambulance patient care reports were cross referenced with the local hospital medical records to identify patients that had an Emergency Room visit, admission to the hospital or hospital death within fourteen days of their "lift assist" response.

Many individuals had multiple "lift assist" responses. The mean age for individuals requesting "lift assist" was 74.8 years. The authors found 169 Emergency Room visits (21%), 93 admissions to the hospital (11.6%) and 9 deaths (1.1%) within fourteen days of the initial "lift assist" request. Of the 93 patients who were admitted to hospitals, 71 (76%) were discharged to nursing homes, retirement homes or assisted living facilities rather than back to their original domicile. Additionally, the authors looked at all reported out of hospital deaths. No "lift assist" patients were identified within this subgroup. The authors identified 113 prehospital patient care records charts (14%) that were missing at least one vital sign, of which, 28 (24.8%) were missing at least one additional vital sign. Forty-four of 160 prehospital charts for diabetic patients (27.5%) had no blood glucose level recorded.

"Lift assist" calls may be early indicators of conditions that require comprehensive medical evaluation and treatment. In this study, advanced age (elderly population) was found to be an indicator of both an Emergency Room visit and admission to the hospital within fourteen days of a "lift assist" response. The "lift assist" population should be assessed with the same level of care as those who call for specific medical complaints, as the need for a "lift assist" may represent covert pathology or increased risk for future injury. EMS providers should perform a complete history and physical examination looking for underlying pathology and document a full set of vital signs, including blood glucose and temperature when appropriate, for all "lift assist" responses.

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Ketamine

1. **Prehospital Use of Ketamine: Effectiveness in Critically Ill and Injured Patients.** Zietlow J, Burns K, Jenkins D, Zietlow S. Mil Med. 2019 Mar 1. 184(Supplement):542-544.

Ketamine is an anesthetic drug that has been widely used since the 1950s. It is classified as a dissociative agent, meaning it blocks environmental input from reaching the consciousness. It has both pain control properties as well as amnestic effects. It can be given intravenously (IV), intramuscularly (IM), or intraosseously (IO) and can be used in both pediatric and adult populations for pain control, psychiatric emergencies, and sedation for procedural use. The usual dose is 0.5-2 mg/kg given slow IV push over 1 to 2 minutes. This can be followed by repeat doses as necessary, with a usual time of action of 5-15 minutes. If IV/IO access cannot be obtained, an IM dose of 50 mg is usually equally effective.

Recently the Committee on Tactical Combat Casualty Care (TCCC) has added ketamine to the TCCC pain control guidelines for soldiers injured in combat. They currently endorse the use of acetaminophen (TylenolTM) and meloxicam for those with minor pain who can still perform in combat. Oral transmucosal fentanyl citrate (OTFC) is used for those in moderate to severe pain who are hemodynamically stable. Ketamine is recommended for combatants in moderate to severe pain who are also in hemorrhagic shock or respiratory distress.

While the use of ketamine has been very successful in the military setting, the civilian prehospital sector has been slower to adopt its routine use for pain control. This study was conducted by the Mayo One Medical Transport service, which provides helicopter and critical care ground transportation in a three state region of Minnesota, Iowa, and Wisconsin. They reviewed their experience with prehospital ketamine use from 2014-2016. During this time there were 167 incidents of ketamine administration for analgesia, sedation, or procedural use. The average patient population was 49 years old with 67% of the patients being male. Pediatric patients comprised 3% of the study group while patients above the age of 65 were 20% of the study group. Trauma was the most common indicator (69%) with medical patients making up the remainder (31%). Ketamine was used in 61% of patients after other medications, such as fentanyl, Dilaudid, or midazolam, were ineffective. The mean pain scale prior to ketamine use was 9/10, with the mean pain scale after use being 3/10. Eight (5%) patients had a decreased respiratory rate or oxygen saturation requiring bag mask ventilation after ketamine administration, but all recovered in less than 30 seconds. There were no hypotensive episodes reported. Additionally seven patients who were hypotensive became normotensive following ketamine use.

This study demonstrates the safety and effectiveness of ketamine use in the civilian prehospital setting. It has several advantages over narcotics in that it can be used in hypotensive trauma patients without lowering the blood pressure. In fact several patients had an improvement in blood pressure following ketamine administration. Additionally, ketamine is known to alleviate bronchospasm and reduce airway resistance in patients with underlying pulmonary disease. Because of this, it is ideal for rapid sequence intubation (RSI) in patients with COPD or asthma. Further studies are warranted to confirm these results; however ketamine appears to be safe and effective in the civilian prehospital setting.

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2. **Intravenous Low-Dose Ketamine Provides Greater Pain Control Compared to Fentanyl in a Civilian Prehospital Trauma System: A Propensity Matched Analysis.** Bronsky ES, Koola C, Orlando A, et al. Prehosp Emerg Care 2018, Published on-line. 2019;23:1-8.

Analgesia is an important consideration for patients in the civilian prehospital trauma system. The epidemic abuse of opioid medications in the United States has led to an increase of opioid tolerant patients, increasing reluctance to provide narcotic pain relief, and the need to develop an effective,

nonopioid analgesic alternative. Low dose ketamine can provide an analgesic effect comparable to the commonly used opioids such as morphine and fentanyl and unlike the narcotics is less likely to induce hypotension or respiratory depression. The United States military uses low dose ketamine effectively, and safely, for battlefield analgesia. This study hypothesized that ketamine and fentanyl would have differing analgesic effects in the civilian prehospital setting.

This study was a 24-month, retrospective, observational review of prehospital adult patients (age>18 years) who presented with severe pain (numeric rating scale, 7–10) and were treated in the field solely with either low-dose ketamine IV or fentanyl IV and subsequently were taken to the Emergency Department (ED) of a Level I Trauma Center. A regional protocol and state waiver permitting the administration of prehospital ketamine for the management of severe pain was followed. For IV administration of ketamine, the protocol prescribes 0.3 mg/kg IV every 20 minutes as needed, with a maximum of 3 doses. For IV administration of fentanyl, the same protocol guidelines suggest 2 µg/kg bolus over the course of 1 to 2 minutes, with an additional dose every 10 minutes as needed.

There were 200 patients in the initial study sample, 45% received ketamine and 55% were given fentanyl. The outcome measure used for this study was analgesic effectiveness based upon the change in pain score from pretreatment to after treatment with a fifty percent reduction in pain considered to be a positive response to the analgesic. Prior to treatment, pain scores were similar in both groups. Of those patients receiving ketamine IV, 67% achieved at least a 50% reduction in pain compared with 19% of those receiving fentanyl IV. Similarly, 25% of patients receiving fentanyl IV reported no change in pain score, as compared to 8% of the ketamine IV patients.

The authors also looked at the pre and post analgesia vital signs (blood pressure, respiratory rate, pulse, and GCS) of all patients included in the study before and after treatment. Adverse events were only reported for 4 patients, all of whom were in the fentanyl IV group. Two patients experienced respiratory depression while the other 2 demonstrated hemodynamic instability. The 2 cases of respiratory depression did not necessitate active airway management or mechanical ventilation, but only supplemental oxygen. No patients in the ketamine group demonstrated any clinically significant adverse events.

This study demonstrates that low-dose ketamine IV is effective in reducing severe pain among adults while not significantly affecting vital signs and GCS. This study supports the implementation of and use of low-dose ketamine IV as a safe and effective alternative to opioids for civilian prehospital pain management.

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Lights and Sirens

1. **Is Use of Warning Lights and Sirens Associated With Increased Risk of Ambulance Crashes? A Contemporary Analysis Using National EMS Information System (NEMSIS) Data.** Watanabe BL, Patterson GS, Kempema JM, et al. *Ann Emerg Med* Article in Press, published on-line, https://doi.org/10.1016/j.annemergmed.2018.09.032 2019;74:101-109.

This study was undertaken to provide a contemporary, nationwide comparison of reported crash rates for US ambulances responding to or transporting patients from a 911 emergency scene with or without lights and sirens.

This is a retrospective study that analyzed data from the 2016 National EMS Information System (NEMSIS) which included nearly 30 million EMS activations from 9,993 EMS agencies servicing 49 states and US territories. Primary analysis included all dispatches of a transport-capable ground EMS

ambulance to a 9-1-1 emergency scene. Response to the scene and transport from the scene were evaluated separately as some responses did not result in transport. Interfacility transfers, intercepts, medical transports, standbys, responses by non-transport, rescue vehicles, mutual aid activations, supervisor responses, or transports by fixed-wing or rotor-wing air medical services were not included. Reported crash-related delays were used as a proxy measure of an ambulance crash, recognizing that minor crashes that did not result in a reported delay would go unaccounted for. The results were grouped into 2 major categories: response without use lights and sirens (No L&S) and response with use of lights and sirens, which was further subdivided into response with any use of lights and sirens to include partial usage during response (Any L&S) and full use of lights and sirens throughout the response (Full L&S).

The 2016 NEMSIS data set included 20,465,856 dispatches of a transport-capable ground EMS vehicle to a 9-1-1 scene. Lights and sirens data were available for 19,040,095 of the scene responses (93%). A crash-related delay occurred in 1,000 of the responses (5.3 per 100,000 responses). The crash rate for 9-1-1 scene response with use of lights and sirens (Any L&S / Full L&S) was greater than the crash rate for 9-1-1 scene response without use of lights and sirens (5.4 vs 5.5 vs 4.6 per 100,000 responses).

OF the 19,040,095 responses to a scene, there were 14,549,776 subsequent patient transports. Lights and sirens data were available for 13,892,345 of the 9-1-1 scene transports (95%). Crash-related delays occurred in 1,289 transports (9.3 per 100,000 transports).
The crash rate for 9-1-1 scene transport with use of lights and sirens (Any L&S / Full L&S) was greater than the crash rate for 9-1-1 scene transport without use of lights and sirens (17.1 vs 16.5 vs 7.0 per 100,000 transports).

Several limitations were identified during this study. The analysis of NEMSIS information relies on the accuracy and completeness of submitted data elements. There may be inconsistencies in how lights and sirens use or crash-related delays are reported. Also, NEMSIS does not include minor crashes that did not result in delay of response or transport. Confounding factors such as weather, traffic conditions, lighting conditions, or travel distance cannot be accounted for.

This study used data from the NEMSIS repository that contained the largest amount of response and transport data and from the largest number of multiple agencies in multiple locations and response areas. Using this larger data set provided a more comprehensive and valid analysis. This study demonstrated that the use of lights and sirens during response to 9-1-1 scenes and subsequent transport from the 9-1-1 scene clearly resulted in a higher incident of crash-related delays compared to response and transport without use of lights and sirens. In addition, when comparing the response phase data and analysis to the transport phase data and analysis, the number of crash-related delays was significantly higher in the latter, which is surprising given that only 23% of transports occur using lights and sirens compared to 77% of responses to the scene. Because of this reported difference, contributing factors need to be studied. One theory is that during the response phase there are usually two individuals in the front of the vehicle and both persons are watching for hazardous situations. During the transport phase there is typically only one person in the front of the vehicle controlling the driving and communications and could possibly be distracted more by the acuity of the patient and the need to get the patient to the receiving facility.

While this study of crash-related delays involving emergency vehicles clearly identifies a higher rate of crashes when using lights and sirens both in the response and transport phases compared to not using any lights and sirens, most importantly, this study does not answer the question: Does the use of lights and sirens truly provide a patient benefit that outweighs the risk? Bottom line, the use of lights and sirens during either the response phase or during the transport phase comes with an increased risk of being involved in a crash.

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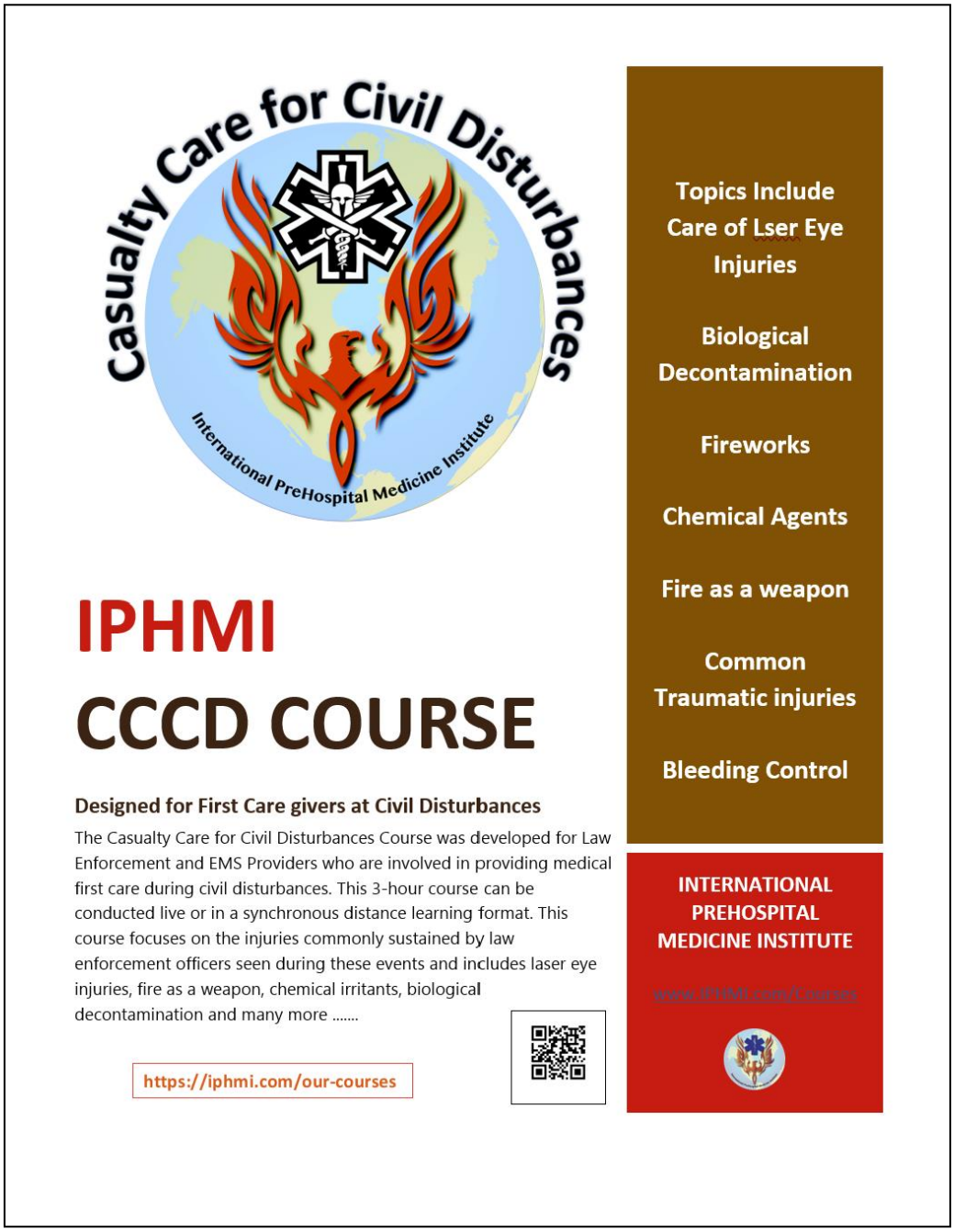

Mass Gatherings and Disaster Management

1. **A Qualitative Study of Paramedic Duty to Treat During Disaster Response.** Smith E, Burkle F. Jr, Gebbie K, et al. *Disaster Med Public Health Preparedness* 2018 Published on-line, https://doi.org/10.1017/dmp.2018.15

Disaster responses can place what may be overwhelming demands on emergency response personnel and, depending on the nature of the incident, can test personal commitment as a healthcare responder. Guidelines and Codes of Ethics are largely silent on this issue providing little to no guidance as to what is expected of EMS providers regarding how they should approach their duty to treat in the face of risk. This study explored how paramedics in Australia viewed their duty to treat during disasters.

The authors employed qualitative methods to gather perspectives from 44 Australian paramedics, age range 21 to 57 years, from five different states through seven non-compensated focus groups. Seventy-nine per cent of the participants were male and the remainder female. Of the 44 participants, 82% had more than 10 years of experience working as a paramedic.

Responses from the study participants to the question of what they thought of the concept of duty to treat during a disaster and their obligations in that regard varied widely. A few of the participants felt there was a clear duty to respond and treat while most felt their duty to act cannot be considered an absolute obligation. All participants felt that the decisions about their own safety and willingness to work during disasters was an individual choice. Some participants expressed conflict between their duty to respond as a healthcare provider versus their duty to their family. All participants expressed their belief that the ambulance service has an obligation to provide education, resources, and support for EMS providers in preparation for and during a disaster response as well as identifying and understanding risks based on the disaster or epidemic. Participants felt that education regarding duty to treat and appropriate equipment use (e.g. PPE) during a disaster must start with entry level programs and continue for experienced providers through continuing education programs.

Limitations identified in the study included that the comments came from a small group of paramedics, most of whom were male with 10 years or more of experience working as a paramedic. The study did not address moral or legal aspects that may influence a paramedic's decision to respond.

This study's findings were consistent with existing literature suggesting there is a lack of clarity and consensus of what is expected of healthcare workers during disaster or epidemic response. Prior surveys of hospital-based healthcare providers, including physicians, revealed that, depending on the nature of the incident, between 7% and 77% would not report for work. A majority of the study participants express beliefs that they do not have an unlimited duty to treat even though they recognize a professional obligation, to what extent was unclear. Ideally, evidence-based education should be developed and provided for all healthcare workers that better defines risks, protection resources, and limitations for disaster or epidemic responses as well as other responses that involve personal risks. This study was limited to moral and ethical discussions and decisions, legal responsibilities were not addressed. While this study was conducted with paramedics in Australia, it is likely that the results would be similar in other countries. Ultimately, the decision by EMS providers regarding professional obligations involving duty to treat will largely depend on their individual risk assessment, perception of risk, and their personal value system.

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2. **Impact of Patients Presenting with Alcohol and/or Drug Intoxication on In-Event Health Care Services at Mass-Gathering Events: An Integrative Literature Review.** Bullock M, Ranse J, Hutton A. Prehosp Disaster Med. 2017;33:539-542.

Mass gatherings, whether indoor, outdoors, music themed, political or sports related, will challenge the host community. Mass gatherings may be defined as events that have the capacity to place a strain on the planning and response resources of a community or country, due to the anticipated attendance within a designated timeframe. Does drug and alcohol use by attendees at mass gathering events have an impact on needed health services at the event and within the local community? Having a greater understanding of this patient population and the impact on in-event health care services will provide a valuable step in human and physical resource management for future mass-gathering events.

Bullock and colleagues performed a themed, 10 year literature review of mass gathering events and factors impacting the on-scene health services. Common themes were identified and reviewed and included the nature of the event, demographics of patients presenting to in event health services, alcohol and drug use, and environmental factors such as indoor or outdoor venues and weather and ambient temperature.

The authors reported that multiple articles demonstrated that heat and dehydration tended to go hand-in-hand with patients presenting to health care services at music festivals. Age and alcohol are linked in predicating patient presentations. If the crowd in attendance had a younger age demographic, the event was outdoors, and alcohol was served, patient presentations appeared to increase and have a greater number of substance-related issues. The level of care provided at in-event health services had a direct effect on the community. Having a higher quality skill mix of health professionals lead to an almost 73% decrease in hospital transfer rates when compared to on-site volunteer medical services.

Music related mass gathering events were the most affected by substance and/or alcohol intoxication, with high presentation rates and length of stays reported. Young adults, less than 25 years of age, are at greater risk for substance abuse related issues. Interestingly, the authors also discovered that where an increase in substance-related presentations occurred, length of stay in the on-site medical facility increased (average 90 minutes) while a decrease in transfers to hospital occurred (possibly related to higher level medical staffing).

In addition to the expected demographics of anticipated attendees and their access to alcohol and drugs, medical planners for mass gathering events should consider the level of health care deployed at the event. Other factors to consider include the location of the event, indoors vs. outdoors, and the expected weather during the event.

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3. **The Use of Field Triage in Disaster and Mass Casualty Incidents: A Survey of Current Practices by EMS Personnel** Ryan K, George D, Liu J, Mitchell P, Nelson K, Kue R. Prehospital Emergency Care 2018 Published on-line Feb 9, 2018;22:520-526.

The use of triage and triage tags to assign treatment and transport priories by emergency medical service (EMS) personnel during a mass casualty incident varies greatly when comparing application during training, drills, and exercises versus utilization during actual events.

The purpose of this study was to compare current field triage practices during both training and actual MCIs and identify any barriers to use; using data collected through an anonymous survey provided to 596 EMS personnel from 3 distinct types of paid full-time EMS programs. The overall survey response was 77.9% (464/596). Out of the 464 responses, 179 respondents (38.7%) indicated they had participated in both drills utilizing triage tags and one or more actual MCIs. Triage tags were used in

91.8% of drills compared with 34.1% of actual MCIs. Common reasons cited for not utilizing a "full triage" (to include use of a specific triage algorithm and completion of a triage tag) during an actual MCI event included proximity to the nearest hospital, did not use / not sure how to use, logistics, and issues related to triage tags including inadequate access, inadequate amount, and poor tag functionality. While MCIs are not common in most EMS agencies the unusually large number of respondents indicating they had been involved in an actual MCI was because one of the EMS programs participating in the survey was involved with providing on-scene patient care during the Boston Marathon bombing in 2013.

Despite triage algorithms and triage tags being a fundamental skill taught in both primary and continuing EMS education and in MCI training exercises, full triage and triage tags have often not been utilized in actual events. Although an absent triage tag does not imply that a triage system/algorithm was not utilized on-scene, it can result in inefficient on-scene management as newly arriving EMS responders may triage patients already evaluated and triaged but not tagged.

This study supports what most EMS providers already suspected; regardless of the system implemented, prior education and training, service protocols, and MCI response drills, full triage processes are often not utilized on-scene during real world events. We must continue to evaluate the difference between what is expected of on-scene providers during a MCI event and what is actually being done and correlate the result with victim outcomes.

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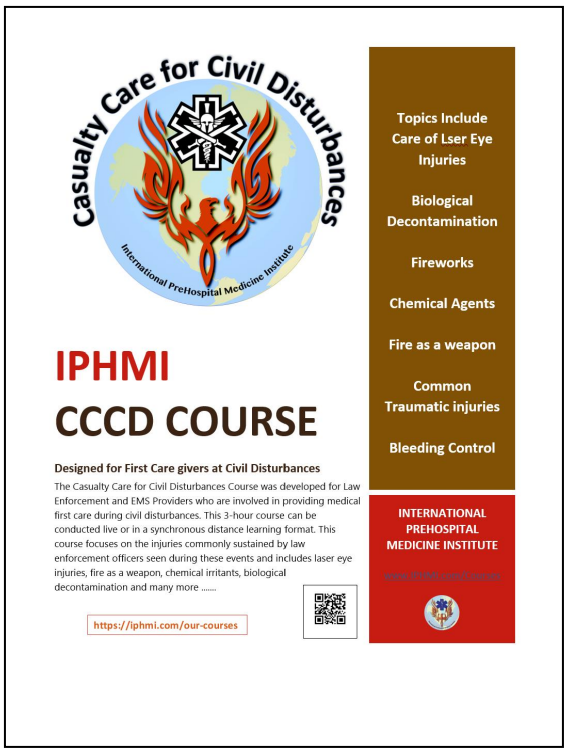

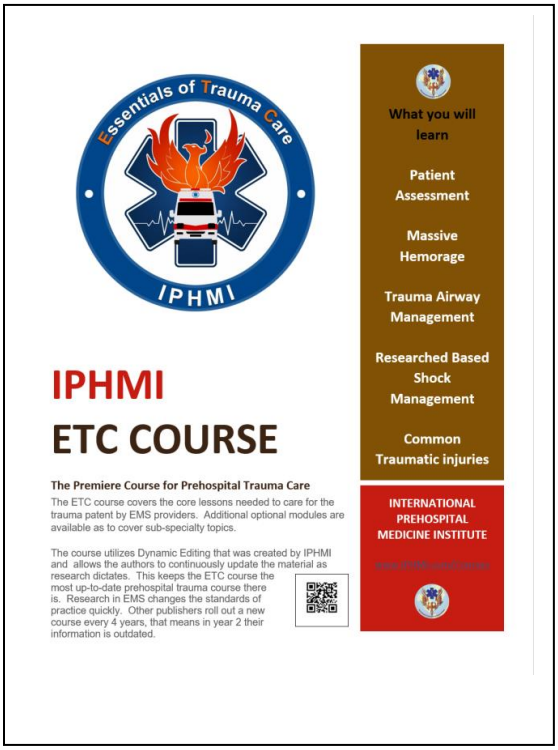

Narcan

1. **Basic and Advanced EMS Providers Are Equally Effective in Naloxone Administration for Opioid Overdose in Northern New England**. Gulec N, Lahey J, Suozzi JC, et al. Prehosp Emerg Care. 2018;22:2, 163-169.

Opioid overdose deaths have been described as an epidemic in the United States, and are now the leading cause of accidental death. Naloxone is a medication often given in the prehospital phase of care to reverse the effects, particularly respiratory depression, of opioid overdose. *The National EMS Scope of Practice Model* recommends that only Advanced Life Support (ALS) level be allowed to administer Naloxone. This recommendation has important implications for rural areas which typically have fewer available ALS providers. This study evaluated the effectiveness of naloxone administration by basic life support (BLS) providers as compared to ALS providers.

The authors of this study conducted a 33-month, retrospective study of all patients who received Naloxone in the three rural states of Vermont, New Hampshire and Maine. These three Northern New England states use the same electronic prehospital medical record system with consistent data entry fields, and all allow both ALS and BLS providers to administer naloxone (BLS via the intranasal route only). They assessed response to naloxone using three patient outcome measures: (1) Change in initial respiratory rate (RR) from less than 12 breaths per minute (BPM) to greater than or equal to 12 BPM; (2) Improvement of Glasgow Coma Scale (GCS) from initial to final value; and (3) Response to medication as per the global assessment (GA) documented by the EMS provider as “improved” or “not improved” after Naloxone administration.

The study group reviewed and included 231 BLS, and 2,833 ALS Naloxone administrations. Naloxone administration was considered appropriate in cases where the RR is less than 12 and the GCS is <15. Forty-two percent of cases treated by BLS providers and 43% of cases treated by ALS providers met this criterion with no difference between the provider groups. Both BLS and ALS cases saw a 64% improvement in GCS following naloxone. The BLS group saw a 43% increase in RR while the ALS group documented a slightly higher 48% improvement. The BLS providers documented an 80% improvement in GA while the ALS group rate of GA improvement was 67%.

The study shows that Rural BLS providers were as effective as ALS providers in improving the outcome measures of RR, GCS and GA following naloxone administration to patients with suspected opioid overdose. *The National EMS Scope of Practice Model* should be reviewed and updated to include naloxone administration via the intranasal route as a BLS skill. Expanding the administration of naloxone to BLS providers is further warranted by the fact that many communities offer naloxone to lay relatives to administer in the event of opioid overdose. Not allowing medically trained BLS providers to also administer the medication no longer makes sense.

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Patient Assessment

1. **Differences in Prehospital Patient Assessments for Pediatric Versus Adult Patients.** Ramgopal S, Elmer J, Escajeda J, Martin-Gill, C. J Pediatrics 2018;199:200-205.e6

EMS providers deliver care to patients of all ages. Approximately 10% of those patients are classified as pediatric. Pediatric patients that utilize the EMS system are generally more acutely ill than those who are transported by other means.

This study is a retrospective review of ground transports of pediatric patents by 20 urban, suburban, and rural EMS agencies in Southwestern Pennsylvania between April 2013 and December 2016. The goal of the study was to determine the rate of documentation of vital signs including heart rate, respiratory rate, and systolic blood pressure. Secondary outcomes also measured GCS and pain scores. A pediatric patient was defined as less than eighteen (18) years of age. The patients were further sub- categorized as: neonates (≤30 days), infants (1 month to <1 year), toddlers (1 to <2 years), early childhood (2 to <6 years), middle childhood (6 to <12 years) and adolescents (12 to <18 years). Twelve diagnostic categories were recorded; medical, trauma, respiratory, allergic, GI, cardiovascular, neuro, psychiatric, toxicology, syncope and other.

Of 371,746 patients transported, 21,882 were pediatric patients. This study demonstrated that the documentation of vital signs increased with age. The measurement and documentation of systolic BP shows the most drastic change between the early age groups (neonate, infant and toddler) as compared to early childhood, middle childhood, adolescent and adult. Measurement of BP took place only 50.4% of the time in the neonate compared to 98.9 in the adult patients. Documentation of all three vital signs also increased with increasing age from 49.6% in neonates to 97.7% in adults with measurement of vital signs from middle childhood and older nearly equivalent to the adult population. Of note, pulse oximetry had lower rates of documentation, even in pediatric patients with respiratory complaints.

This paper again demonstrates a deficit in prehospital care that has been documented in the past, but often ignored, specifically the measurement of complete vital signs (especially BP and oxygen saturation) in the pediatric age group, particularly the very young. As the patient grows older, obtaining these measurements increases, until reaching adult equivalencies in the 6-12 year old age group. The failure to adequately document vital signs raises a number of questions that this study does not answer.

1. What are the barriers to obtaining vital signs on these smaller and younger pediatric patients?
2. Does this lack of obtaining vital signs change the outcome of these particular pediatric patients?
3. Are the vital signs that were obtained and documented accurate within acceptable variances compared to the actual vital signs?

This paper points to the need for further research in the three areas above as well as an aggressive educational effort to improve EMS provider pediatric assessment.

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2. **Cut and Rip and Cut Alone Techniques Versus Usual Practice in the Removal of Trauma Patient Clothing.** Sibley A, Jain T, Nicholson B, Atkinson P. *Canad J Emerg Med.* 2018;20(4):600-605.

Rapid exposure of a trauma patient by EMS providers is paramount in completing the primary assessment. No standard exists regarding what technique is best to rapidly remove clothing. The purpose of this study was to compare two techniques of clothing removal to usual paramedic practice using standard trauma shears to see if any of the techniques was quicker.

This study was a randomized, timed, observed, comparison of two different techniques using new trauma shears, cut and rip (CAR) and cut alone (CAL) to remove the clothing of a trauma patient compared to usual EMS practices (UP) using standard trauma shears. A total of 24 individuals (8 per group) were recruited to participate in the study. 23 of the participants are included in the study. One participant was dropped from the results due to failure to follow protocol. Participants comprised of current Advanced Care Paramedic students for the CAR and CAL groups and practicing Paramedics for the UP group. An identical full-body adult mannequin placed on a standard cot was utilized and dressed in similar type clothing for each attempt. Timing was started when the cutting device touched the clothing and was stopped when the patient/mannequin clothing was completely removed and a log-roll performed to expose the back. Based on the timed observations, the CAR technique (average time of 104 seconds) was faster than both the UP technique (average time of 124 seconds) or CAL technique (average time of 136 seconds).

There are a number of issues with the study. The total number of participants was low. The mannequin utilized does not replicate the differences in anatomy encountered by EMS providers. The study did not replicate the traditional environment most EMS providers operate in when assessing a trauma patient. While the mannequins were dressed in a number of different types of materials, clothing made of leather or very thick materials was not tested, nor was any of the clothing wet as would be the case if it were blood-soaked. This study also did not address the important issue of attempting to preserve evidence such as knife or bullet holes when removing clothing.

While this study looked at two specific techniques (CAR & CAL) compared to usual practices by experienced paramedics, it did not replicate important factors encountered by EMS providers when assessing and treating trauma patients. Based on this study it would be difficult to support a specific change in current practice by EMS providers. Even though this study demonstrated that the "cut and rip" technique was slightly faster (approximately 30 seconds), the fact remains that EMS providers should use whatever technique is best for removal of clothing based on the patient, their choice of clothing, the surrounding environment, and available resources and should have experience in more than one technique. No single technique has been established as the "Golden Standard" for the removal of clothing and may not be feasible due to the ever changing patients and conditions encountered by EMS providers.

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3. **Characteristics, Prehospital Management, and Outcomes in Patients Assessed for Hypoglycemia: Repeat Access to Prehospital or Emergency Care.** Sinclair J.E., Austin M, Froats M, et al. Prehosp Emerg Care. Published on-line Sep 2018.

Currently, Canada does not have a treat-and-release protocol for EMS personnel to use when managing diabetic patients who present with hypoglycemia. In addition, the safety of this practice remains unclear. Also, of concern is the cost associated with prehospital assessment, treatment, and transportation as well as the cost of emergency department assessment of patients that receive no

additional treatment. This study was performed to describe the characteristics, management, and outcomes of patients with hypoglycemia treated by paramedics and to determine the predictors of repeat access to prehospital or emergency department care within 72 hours of initial paramedic assessment.

A retrospective review of prehospital care reports from the Ottawa (Canada) Paramedic Service and records from 4 emergency departments located in Ottawa, Canada was conducted for a 12-month period (January 1, 2011 through December 31, 2011). Patient selection for consideration was based on adults (18 years old or >) that had at least one documented blood glucose level of less than 72 mg/dl (4.0 mmol/L) with or without a history of diabetes and who had been assessed by paramedics regardless of treatment or transport. A total of 1,177 patients were identified that met the initial inclusion criteria. After applying exclusion criteria (age less than 18 years, need for active airway intervention, absent vital signs, present of terminal illness), the final sample for review was 791 patients.

Of the 791 patients assessed and treated by paramedics for hypoglycemia, 235 patients (29.7%) refused transport while 556 patients (70.3%) were transported to one of the 4 participating emergency departments. The mean glucose level upon prehospital assessment was 50 mg/dl (2.8 mmol/L). Interestingly, 487 patients (61.6%) had a history of diabetes and 343 patients (46.1%) were on insulin, while 304 reported no history of diabetes. Of the 556 patients transported to an emergency department 134 (24.1%) were admitted to the hospital, 9 (1.6%) died in the ED (sepsis, myocardial infarction, intracerebral hemorrhage), 383 (68.9%) were discharged from the ED, and 29 (5.2%) left without being seen by a physician or left against medical advice. Of the 383 patients discharged from the ED 199 (51.9%) had no additional treatment/management in the ED with the exception of blood work. Overall 43 (5.4%) patients required repeat prehospital and/or emergency department care within 72 hours of the initial hypoglycemic event. Of the 43 repeat patients, 8 patients (18.6%) were for re-occurring hypoglycemic event. Analysis showed that compared to patients who did not require repeat access to care, those who did often had a history of seizures and alcohol dependency, were more likely to have been given oral glucose gel by paramedics, and were likely not on insulin.

Because of the retrospective nature of the study, there is the possibility that adverse events could have been missed. The definition of hypoglycemia utilized for his study was lower than traditionally use in previous studies 72 mg/dl or less versus 80 mg/dl or less). Repeat patients may have been missed if they were transported by a different service program to a hospital outside of the study group.

This study found that patients with a prehospital hypoglycemic event, particularly those on insulin, were less likely to need repeat EMS or emergency department care after their initial treatment by paramedics. Additionally, a significant number of patients treated for hypoglycemia by paramedics and transported to the emergency department were discharged without any additional treatment. These findings suggest that treatment-and-release of patients experiencing a hypoglycemic event may be safe and appropriate. Additional studies should be considered to establish predisposing patient conditions to support treat-and-release protocols by paramedics to assist in decreasing emergency department visits and cost associated with transport and ED visits as well to identify causes of hypoglycemia in patients without documented diabetes.

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4. **A Two-Center Validation of "Patient Does Not Follow Commands" and Three Other Simplified Measures to Replace the Glasgow Coma Scale for Field Trauma Triage.** Hopkins E, Green SM, Kiemeny M, Haukoos JS. Ann Emerg Med. 2018 Sept; 72(3):259-269.

The Glasgow Coma Scale (GCS) is a routine part of the trauma assessment for both prehospital providers as well as the hospital trauma team. Additionally, the GCS is a critical component of the

prehospital trauma triage algorithm as written in the Centers for Disease Control and Prevention National Field Trauma Triage Guidelines. There have been many criticisms of the GCS. The GCS is complicated to calculate and unreliable. It has several subjective elements and has a low interrater reliability. Even the most experienced trauma providers have difficulty remembering all components of the GCS. The GCS predicts survival well at the extremes of its scores but is very poor at predicting survival in its midrange. In 2016 Kupas et al demonstrated from a statewide database of 393,877 patients that a GCS motor score less than 6 ("patient does not follow commands") had similar performance in prediction of trauma outcomes to the full GCS.

The goal of this study was to perform an external validation of the motor GCS score less than 6 as a predictor of trauma center need. Additionally the authors tested the accuracy of three other out-of-hospital scoring systems: motor GCS less than five, the Simplified Motor Score, and the "alert, voice, pain, unresponsive" (AVPU) assessment. These four systems are noted below:

1) mGCS < 6
    - Patient does not follow commands
2) mGCS < 5
    - Patient does not obey or localize
3) Simplified Motor Score
    - Obeys commands
    - Localizes pain
    - Withdrawal to pain or less response
4) AVPU
    - A - alert
    - V - responds to verbal stimuli
    - P - responds to painful stimuli
    - U - unresponsive to all stimuli

The authors included all adult and pediatric trauma patients identified in the trauma registries from two regional level I trauma centers. Outcome measures included emergency intubation, clinically significant brain injury, need for neurosurgical intervention, Injury Severity Score greater than 15, and mortality. Clinically significant brain injury was defined as a skull fracture or basal or skull fracture with corresponding evidence of brain laceration, hemorrhage, or contusion; cerebral laceration or contusion; subarachnoid hemorrhage; subdural hemorrhage or epidural hematoma; and other unspecified intracerebral hemorrhage after injury. Neurosurgical intervention was defined as the need for craniotomy, intracerebral pressure monitoring, ventriculostomy, or any other procedure performed in the operating room by the neurosurgeon. Placement of skull tongs or halo traction devices for spine injury was not counted as a neurosurgical intervention. When analyzing the AVPU score the authors used: A= alert: total GCS=14 or 15; V= verbal response: verbal GCS score greater than 1 but with total GCS score less than 14; P= painful response: anything not "a", "v", or "u"; U= unresponsive: GCS=3.

The authors found that motor GCS score less than 6 was essentially identical to the GCS score less than or equal to 13 for the prediction of the five outcomes being studied. Similarly, the motor GCS score less than 5 demonstrated nearly identical results to motor GCS score less than 6. The AVPU scoring showed essentially equivalent results to the standard GCS score less than or equal to 13 metric. Limitations of this study include the need to impute data due to missing data in approximately one-third of the patients. Also only two trauma centers were used and their patient populations may not be applicable to all populations.

This study validates the prior study by Kupas et al, who found that a simple calculation of a GCS motor score less than 6 ("patient does not follow commands") predicted trauma outcomes as effectively

as the current standard of GCS score less than or equal to 13. Prehospital trauma triage could be simplified by switching to this modified "patient does not follow commands" triage system.

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5. **Value of prehospital assessment of spine fractures by paramedics.** ten Brinke J.G., Gebbink W.K., Pallada L, Saltzher TP, Hogervorst M, Goslings JC. European Journal of Trauma and Emergency Surgery - August 2017 Full text available at: https://link.springer.com/content/pdf/10.1007%2Fs00068-017-0828-0.pdf

Over the last several decades, protocols regarding spinal immobilization have evolved from being based primarily on mechanism of injury to the use of selective spinal immobilization protocols. The argument for this change was the lack of scientific evidence in support of spinal immobilization, the low numbers of immobilized patients that actually have spinal injuries, and the potential for injury or complications brought on by the devices used to immobilize patients. Interestingly, there is equally, little to no evidence to support the shift to exam based protocols either. This study sought to address that by evaluating the accuracy of prehospital evaluations for potential spinal fractures performed by Dutch paramedics.

This was a prospective cohort study that looked at all patients that presented with prehospital spinal immobilization to a single Level II Trauma Center between January 2013 and January 2014. Paramedics recorded their assessment of the probability of spinal fractures and their assessments were compared with diagnoses and patient outcomes at the hospital.

One hundred and ninety patients were immobilized in the field, of which 139 were included in the study. Paramedics predicted that 102 patients would likely have spine fractures. There were a total of 24 patients with spinal fractures and the paramedics identified 22. Both of the missed fractures occurred in fall from heights MOI. Of the 115 patients that did not have fractures, paramedics assessed 80 of them as likely having fractures. The authors concluded that paramedics have a low degree of accuracy predicting the presence of spinal fracture. Further, based on these results, they suggest that implementation of a protocol based on paramedic predictions will not reduce the overuse of spine immobilization.

The limitations of this study included the high number of exclusions based on incomplete data, they did not consider the experience of the paramedics in their data collection, and the fact that many patients with a high potential for spine injuries were taken to a level I trauma center and were thus excluded.

As the authors noted, this study is consistent with what other studies have shown. Health care providers in general cannot accurately predict spinal fracture. It appears that the change from protocols based on MOI to exam based protocols has not resulted in better identification of patients who do or do not require spinal immobilization. We have yet to find the right answer to make sure we do what patients need, no more, no less.

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6. **Accuracy of Prehospital Identification of Stroke in a Large Stroke Belt Municipality.** Mould-Millman NK, Meese H, Alattas I, et al. Prehospital Emergency Care, 2018, DOI: 10.1080/10903127.2018.1447620 2018;22:734-732

Strokes are the fifth leading cause of mortality in the United States, and the leading cause of long-term disability. There is a thirteen state "Stroke Belt" across the southeastern United States.

While the overall incidence of strokes has decreased in the last twenty years, the incidence of stroke has instead increased in the African American population residing in the Stroke Belt. The sooner a stroke is recognized and access to specialized, definitive care is obtained; the greater the likelihood of minimizing disability. The study assessed whether Emergency Medical Dispatchers (EMD) and Prehospital Providers working in a large municipality, within the Stroke Belt, accurately identify patients suffering from an acute stroke and transport them a Stroke Center.

The study examined all medically related 911 patients classified as "Stroke" transported by Grady EMS (Fulton County, Atlanta, Georgia) between 1 January 2012 and 31 December 2012. The study was a retrospective, observational cohort based study granted a waiver of consent by the Emory University Institutional Review Board and the Colorado Multiple Institution Review Board. A database was created to link records between Grady EMS, Grady Hospital Emergency Department and the Grady Hospital Stroke Registry. Exclusion criteria included patients less than 18 years of age, that had previous or concurrent head injury, transferred from another inpatient facility and/or had incomplete records in any of the three databases.

EMD identification of stroke symptoms was done via standardized, scripted questioning of callers, which triggered a simultaneous series of prehospital activities (EMD assisted pre-arrival instructions and a rapidly dispatched Advanced Life Support [ALS] Ambulance to the scene). Evaluating paramedics would then confirm or refute the stroke symptoms guided by a prehospital stroke protocol. The protocol included the last known well time, the Cincinnati Prehospital Stroke Scale (CPSS), vital signs, blood glucose level, and rapid transport to a stroke center.

A total of 548 patients were included in the study. Paramedics adhered to all elements of the stroke protocol in 76.4% of patient contacts. 475 of those patients were transported with an EMS impression of Stroke and 73 with an impression other than Stroke. Sensitivity and Positive Predictor Value for stroke identification were 76.2% and 49.3% respectively. For EMD it was 48.9% and 24% respectively.

The study concluded that EMD and EMS personnel in a large Stroke Belt city had a relatively high sensitivity in identifying acute stroke patients. Paramedic accuracy was augmented by EMD recognition as well as positive CPSS screening. Of note, paramedics were less likely to accurately identify stroke in women when compared to men or when the etiology was hemorrhagic in origin.

Early identification of stroke patients by EMD and relaying that information to responding prehospital providers may hasten assessment for stroke by EMS personal on scene and direct patient flow to stroke centers, saving time and brain. With available screening tools EMD and prehospital providers should be able to identify patients suffering from acute stroke, especially in an area with a population predisposed to stroke.

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Response Time

1. **Association between Emergency Medical Service Response time and Motor Vehicle Crash Mortality in the United States.** Byrne J, Mann C, Dai M, et al. JAMA Surg. 2019;154(4):286-293.

The leading cause of trauma morbidity and mortality in the U.S. (and world-wide) is motor vehicle crashes (MVCs). Emergency Medical Services (EMS) ambulance response is an important bridge between the time of injury and the time to definitive care. This study looked to evaluate the relationship between ambulance response time (RT) and death from MVC.

This study is a retrospective study evaluating EMS response time and mortality from motor vehicle crashes in 2268 counties in the USA during a three year period from January 2013 to December 2015. The study used data obtained from the National Emergency Medical Services Information System (NEMSIS) and the National Highway Traffic Safety Administration Fatality Analysis Reporting data. Inclusion in the study was limited to crashes involving standard motor vehicles and excluded motorcycles, heavy trucks, pedestrians and bicyclists as well as refusals of service and transport to urgent care centers.

During the study period there were over 2.25 million ambulance responses to MVC's. The average response time for these responses was 9 minutes. Rural/Wilderness counties had an average longer response times, had greater scene and transport times and generally had less access to a level 1 or 2 trauma center. The mortality rate was 11.9 per 100,000 person-years for counties with RT ≥12 minutes

versus 4.9 for counties with a RT <7 minutes. Higher speed limits were associated with higher mortality while one-third lower mortality was found in counties with access to a level I or II trauma center.

The authors conclude that patients involved in MVC's with longer EMS response times in both rural/wilderness and urban/suburban locations have a significantly increased mortality after adjusting for such confounders as rurality, on-scene time, and transport times. Another important aspect that requires further study is the response time of first responders/care givers to MVCs. The available data for this study only looked at ambulance response times and not time to first care.

While EMS response time is one piece of the puzzle, it is not the only piece. An overall realignment of the trauma system focusing on getting the critically injured patient timely on-scene care and ongoing care at an appropriate level 1 or 2 trauma center must be considered. A comprehensive analysis of all variables, the modifiable aspects of response, and the associated costs of improving EMS response times and trauma care should be undertaken.

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Spinal Motion Restriction

1. **Spinal Motion Restriction in the Trauma Patient – A Joint Position Statement.** Fischer PE, Perina D, DelbridgeTR, et al. Prehosp Emerg Care 2018;22:659-661.

In the past, the American College of Surgeons Committee on Trauma (ACS-COT), the American College of Emergency Physicians (ACEP), and the National Association of EMS Physicians (NAEMSP) have individually and collaboratively and provided their recommendations and guidance on prehospital spinal stabilization and the processes and tools used to accomplish this. In an effort to bring some uniformity to the various recommendations, the three organizations convened an expert panel to review the available evidence, combined with expert opinion, in order to prepare a consensus statement. The following summarize their recommendations:

1. Spinal column injuries can progress to severe neurological injuries with excessive movement of the spine.
2. Current techniques used to restrict spine motion do not "immobilize" the spine hence their preference for the term Spinal Motion Restriction or SMR.
3. In addition to backboards, scoop stretchers, vacuum splints and other devices can be used to provide SMR.
4. Indications for SMR include:
    a. Altered LOC
    b. Subjective midline neck or back pain or objective tenderness to palpation
    c. Focal neurologic signs and/or symptoms such as paresthesias or paralysis.
    d. Deformity of the spine
    e. Distracting injuries or circumstances such as language barriers.
5. SMR should be applied to the entire spine including properly sized C-Collars on a supine patient.
6. Particular care should be taken during all patient transfers. Backboards, scoop stretchers and vacuum mattresses are recommended to minimize rotation of possibly injured spines.
7. While it may be feasible to remove the patient from a device such as a backboard or scoop stretcher and place them onto the ambulance cot, consideration should be given to the potential for additional injury with each transfer. In an effort to minimize the number of such transfers, when transport times are short, devices could be removed at the hospital rather than in the ambulance.

8. Hospital should be prepared to quickly and safely remove these devices from patients on arrival and to provide proper SMR from that point on.
9. SMR is not indicated in penetrating trauma patients.
10. In the case of children, age alone is not a factor. While communication might be challenging, this alone does not mandate SMR. Properly sized C-collars should be used in children if they complain of neck pain, unnatural position or deformity of the neck, altered LOC. Injury should be suspected in high-risk motor vehicle collisions, diving injuries and substantial torso injuries.

This position statement has been endorsed by a large number of national organizations including various trauma, EMS, pediatric and nursing organizations (please see the full consensus statement for the complete list).

The issue of spinal motion restriction and the best methods to accomplish this has been a topic of significant discussion and controversy, with some recommending that it be no longer utilized. This paper makes a strong statement for assuring that we at least do no further harm after a patient has sustained trauma and attempt to protect our patients from additional unintended injury caused by excessive motion and multiple unprotected transfers. All EMS providers and medical supervisors should read and understand the recommendations made in this joint consensus statement.

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Tactical Training and Care

1. **A Descriptive Analysis of Tactical Casualty Care Interventions Performed by Law Enforcement Personnel in the State of Wisconsin, 2010-2015.** Stiles CM, Cook C, Sztajnkrycer MD. Prehosp Disaster Med 2017;32:1-5.

Tactical casualty care training programs have grown in popularity and importance over the last decade. While there are several different courses being offered based on the level of medical expertise of the intended audience, they all follow the guidelines originally described in the Tactical Combat Casualty Care (TCCC) curriculum and are updated regularly. While there have been studies that looked at the effectiveness of the training in preparing providers to perform assessments and skills, this study looked at the effectiveness of the interventions on patients treated by law enforcement.

This study was a descriptive analysis of a convenience sample of cases managed by police officers trained in TCCC after the provision of successful patient care, between January 2010 and December 2015. Fifty-six episodes of care were reported by 19 agencies with four cases involving injured police officers (7.1%) with the other 52 or 92.9% involving civilians or suspects.

Forty-five (82.1%) of the patients sustained extremity injuries with forty-two receiving tourniquets and 15 hemostatic dressings. Seven patients had improvised tourniquets, of which, only one was effective. Chest seals were used in 7 patients, one of whom developed signs of a tension pneumothorax following placement of an unvented seal.

The authors reported several limitations to their study. First, because it is a convenience sample of patients, voluntarily reported, it is biased towards agencies that are aggressive and invested in this training. Secondly, the study specifically evaluated “saves” and the captured cases therefore have a positive outcome bias. It is possible/probable that negative outcomes were not reported. This study would also have missed cases where skills could have been but were not applied. Lastly, the information submitted was a summary statement and not detailed patient reports.

The authors concluded that their study demonstrates the lifesaving potential for trained and properly equipped law enforcement personnel. Whether there was a single or multiple victims, the TCCC skills were effective in caring for trauma patients.

While this study points to the potential lifesaving capabilities of well equipped, trained responders, it is rather limited in scope. It included only patients that were voluntarily reported and perceived to have a positive outcome after the interventions provided. The TCCC guidelines and interventions have clearly been shown to improve trauma patient outcome in the military combat setting. While we believe that the same benefit will be seen, in order to truly review the effect and value of these interventions on civilian trauma victim outcomes, a large prospective study is needed.

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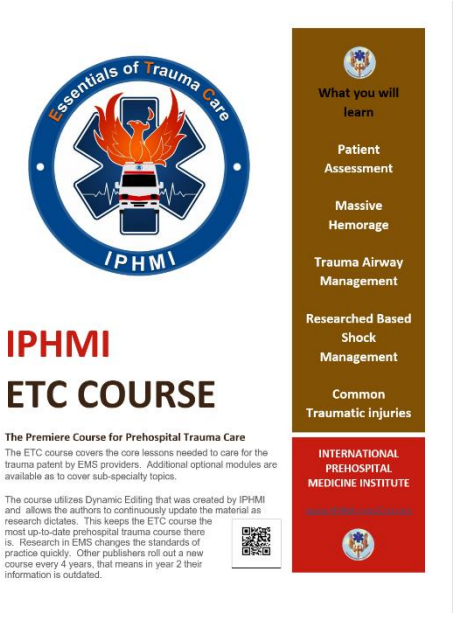
Tasers

1. **Emergency Medical Services Experience With Barb Removal After Taser Use By Law Enforcement: A Descriptive National Study.** El Sayed M, El Tawil, Tamim H, et al. *Prehosp Disaster Med* 2019;34:38-45.

Conducted electrical weapons (CEWs) are increasingly used by law enforcement officers to control unruly suspected criminals or to neutralize violent situations as a non-lethal weapon alternative to use of a firearm. CEWs utilize two methods of deployment depending on the device: the "drive stun" mode that works by direct contact with the subject and the "probe mode" that fires two probes from the weapon. The "Thomas A. Swift Electric Rifle" or TASER uses the latter method and is the most widely available device. It is estimated that there are more than 140,000 TASERs in use by law enforcement officers in the US and an additional 100,000 TASERs owned by civilians worldwide. The TASER fires two metal barbs, which once embedded in the individual's skin, deliver high voltage, low current shocks via 19 electrical pulses per second over a five-second period causing involuntary muscle contractions, pain, and non-lethal incapacitation. Little has been reported about the experiences of EMS providers following the discharge of a TASER and the assessment and treatment of the victim to include barb removal.



This was a retrospective study using 5 consecutive years (2011-2015) of National Emergency Medical Services Information System (NEMSIS) data from 48 US states and territories with information from 114,142,520 EMS activations. The study reviewed 648 EMS activations with confirmed TASER use and where the TASER barbs were removed by EMS.

The prevalence of EMS responding to events where a TASER was discharged and the EMS provider removed the TASER barbs was relatively small but increased over the study period from 4.55 per 1,000,000 activations in 2011 to 6.2 per 1,000,000 activations in 2015. There were no reported barriers to patient care in most TASER activations. Male patients outnumbered female patients 4:1. The provider's common primary impression was traumatic injury (66.3%) or behavioral/psychiatric disorder (16.8%). In addition to TASER barb removal procedures performed by EMS providers included

assessment (47.2%), venous access (21.8%), and cardiac monitor (21.5%). IV fluids were the most common medications administered (12.1%) followed by oxygen (8.3%) and narcotic pain medications (8.2%). Few patients (4.2%) required additional physical restraints or chemical restraints (2.5%). Over one-half of the activations (56.3%) resulted in transportation of the patient mainly to a hospital (91.2%). In 14% of the activations the patient was treated and transported by law enforcement. This rate may under-estimate the actual rate of TASER use since this study only reported those activations where the TASER barbs were removed by EMS providers. Standard operating procedures of different law enforcement agencies may also have affected this rate. Some agencies allow officers to remove TASER barbs themselves without calling EMS. Other agencies require officers to transport all affected individuals to a hospital for barb removal and EMS activation is requested only for life-threating conditions or when medical care is required on-scene. Additionally, most law enforcement agencies that use TASERs require medical assessment in the emergency department prior to barb removal for barbs embedded in sensitive body areas such as the face. There was one death reported in this study that may or may not have been related to the CEW.

Limitations identified in the study include the fact that using NEMSIS data from multiple states and territories and information submitted to the data base varies in reporting compliance and completeness. Only incidents where TASER barbs were removed by EMS providers were included in the review, thus patients who underwent barb removal at a hospital were likely not to have been captured.

The documented incidents where EMS was activated following TASER discharge for removal of TASER barbs are extremely rare. Currently most EMS protocols require leaving TASER barbs in-place if embedded in sensitive areas such as the eye, hands, feet, or genitalia. Based on the limited data available it appears removal of TASER barbs by EMS providers, when appropriate, poses no additional risk to the patient. EMS providers should be familiar with local policies and procedures related to TASER use as well as with other non-lethal weapons that may be utilized by law enforcement.

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Tranexamic Acid

1. **Prehospital administration of tranexamic acid in trauma patients: A 1:1 matched comparative study from a level 1 trauma center.** El-Menyar A, Sathian B, Wahlen BM, et al. *Am J Em Med.* Published on-line April 30, 2019. https://doi.org/10.1016/j.ajem.2019.04.051 2020;38:266-271.

The current recommendations for severely injured trauma patients with hemodynamic instability and non-compressible hemorrhage include limited fluid resuscitation, permissive hypotension, rapid transport to the nearest appropriate trauma center, and now often recommend early administration of tranexamic acid (TXA),. Data from previous studies suggest TXA is most beneficial if given within three hours of injury, which makes its use in the prehospital setting especially relevant. Other data suggest TXA is not beneficial and may in fact increased complications such as deep venous thrombosis (DVT) or pulmonary embolism (PE).

This is a retrospective study conducted in Qatar of all adult trauma patients receiving prehospital TXA. Qatar EMS is staffed by critical-care paramedics and Emergency Medical Technicians. TXA was

given to all adult trauma patients with ongoing significant hemorrhage who were in shock (systolic blood pressure < 90 mmHg and/or heart rate > 110 beats per minute), or considered to be at risk of significant hemorrhage, and who are within the three hour window of injury. Patients who met these criteria but did not receive prehospital TXA and required a blood transfusion were used as the control group to compare against those patients who met criteria and did received prehospital TXA.

During the study period, 204 patients were identified and matched into similar groups based on patient characteristics and injury severity - 102 patients received prehospital TXA while a similar group of 102 patients did not receive prehospital TXA. The median injury severity score was 22 and median serum lactate was 3.4 mmol/l, indicating the cohort was moderately injured and at least in a mild state of shock. However the median hemoglobin was 11.8 g/dl which shows many patients were not severely bleeding. Massive transfusion, defined as 10 or more units of red blood cells (PRBC) given over a 24-hour period or >40 ml/kg PRBC given in two hours or less, was required in 29% of the patients. The median number of PRBC transfused was five units.

The results of the study show that those patients who received prehospital TXA had a lower need for massive transfusion than the control group. In-hospital mortality was slightly better in the group that received TXA but did not reach statistical significance. Additionally, the group that received TXA had a slightly higher incidence of a venous thromboembolic event, such as a DVT or PE, but this also did not reach statistical significance. Approximately 50% of all patients required early operations, indicating they were severely injured. Among those who did require surgery, the requirement for blood transfusion was lower in those patients who received prehospital TXA compared to the control group.

There are some limitations to this study which limit its usefulness. It is a retrospective study with a matched cohort of patients who did not receive TXA. This limits the ability to fully draw any conclusions as patients were not randomized to treatment and the care providers were not blinded to the treatment being given. A criticism of the CRASH-2 trial is that only 50% of the patients received a blood transfusion, indicating the results may be skewed due to the high number of patients enrolled who were not truly critically injured. In this study, 37% of TXA patients did not receive a blood transfusion, which is also relatively high. Additionally the median initial hemoglobin was 11.8, which is normal, and information about the coagulation status of the patients was not provided.

In summary, this study demonstrates that prehospital TXA administration was associated with less in-hospital blood transfusions compared to a control group who did not receive prehospital TXA. However, it did not demonstrate an improvement in survival. The definitive role of TXA in prehospital trauma care requires additional, larger clinical trials.

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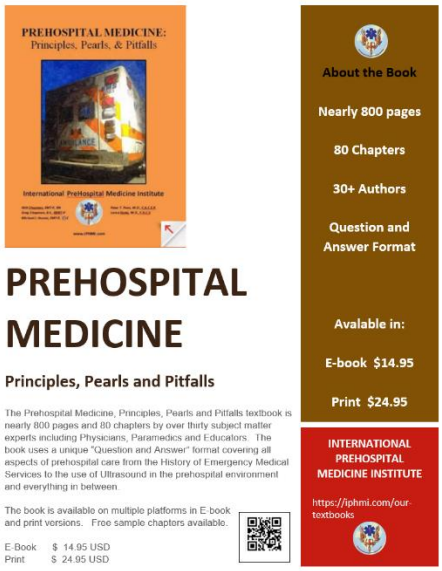
2. **No intravenous access, no problem: Intraosseous administration of tranexamic acid is as effective as intravenous in a porcine hemorrhage model.** Lallemand MS, Moe DM, McClellan JM, et al. J Trauma Acute Care Surg. 2018; 84:379-385.

Trauma induced coagulopathy (TIC) occurs in severely injured trauma patients who have lost a significant volume of blood due to acute hemorrhage. The causes of TIC are multifactorial. The development of TIC in a severely injured patient is associated with increased blood transfusion requirements, longer intensive care units days, more ventilator days, a greater degree of organ dysfunction, and a higher risk of death.

Tranexamic acid (TXA) is an antifibrinolytic drug commonly used in cardiac, orthopedic, and gynecologic surgery. TXA prevents the breakdown of clot as it is being formed by the body. Previous research has demonstrated a survival benefit in the critically ill trauma patient if they receive TXA within three hours of injury. Many EMS systems now utilize TXA in the prehospital setting. Traditionally TXA is

given via the intravenous (IV) route. This can be challenging in both the civilian and military prehospital setting as intravenous access can be difficult to obtain in a hypovolemic patient. Additionally, many military blast-type injuries cause severe damage to multiple extremities making IV access difficult, if not impossible. In 2013 a Department of Defense expert panel identified major "gaps" in research regarding TXA. One gap they identified was the lack of data on the pharmacology and efficacy of TXA administered via the intraosseous (IO) route. The objective of this study was to evaluate the pharmacodynamics and efficacy of TXA in the IO versus IV routes in a large animal hemorrhagic shock model.



Eighteen adult pigs were used in this study. Each pig was anesthetized and underwent a controlled 35% blood volume hemorrhage and maintained at a mean arterial pressure of 40 mmHg to mimic shock. Additionally, tissue-plasminogen activator (tPA) was administered to induce a hyperfibrinolytic state similar to the one seen in a patient in severe hemorrhagic shock. The blood was analyzed to confirm the hyperfibrinolytic state, at which point TXA was administered via either a randomly chosen IO or IV route. The blood of each pig was analyzed after the administration of TXA with coagulation parameters evaluated.

The authors found that the administration of TXA via the IO route achieved a serum concentration of the drug high enough to reverse the hyperfibrinolysis, even in a shock state. The IV group had a slightly higher peak serum concentration, likely do to a lower blood flow to the bone seen during shock. However, administration of TXA via either route did reverse the hyperfibrinolysis.

In conclusion, this study found that IO administration of TXA achieves similar results to IV administration in a swine model. There are applications for IO administration of TXA in both the civilian and military prehospital settings.

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3. **Effects of tranexamic acid on death, vascular occlusive events, and blood transfusion in trauma patients with significant haemorrhage (CRASH-2): a randomised, placebo-controlled trial.** CRASH-2 trial collaborators. *The Lancet*, 2010; 376:23-32 Full text available at: https://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736(10)60835-5.pdf

Severe traumatic hemorrhage drastically alters the ability of the body to form clot. In a normal condition, our body is simultaneously creating clot when necessary but also breaking down that clot to prevent occlusion of blood vessels. This mechanism is disrupted in the severely bleeding patient. Tranexamic acid (TXA) is an inexpensive and safe medication which has been used for decades in cardiothoracic, orthopedic, and gynecologic surgery. TXA works by preventing the body from naturally breaking down clot as it forms. By doing this, TXA helps control bleeding. In the last decade TXA has gained momentum for use in the severely bleeding trauma patient.

The CRASH-2 trial was published in the *Lancet* in 2010 and was the first large trial evaluating TXA use in the severely injured patient. It was a blinded, partially randomized trial involving 274 hospitals in 40 countries (the United States was not involved due to informed consent rules). During this study 20,211 adult trauma patients were enrolled and received either TXA (10,060 patients) or placebo (10,067 patients). Patients were enrolled if they had major hemorrhage (systolic blood pressure < 90

mm Hg or heart rate > 110 beats per minute) or were suspected to have major hemorrhage based on clinical suspicion of the provider. The trial is considered partially randomized because the treating physician could decide to administer or withhold TXA based on their clinical suspicion of bleeding. The patients were only randomized if the physician did not have a strong opinion that they patient may or may not need TXA. The outcome being measured was death within 4 weeks of injury. The authors found that those who received TXA had improved survival over those who received placebo (mortality 14.5% vs 16%). Death specifically due to bleeding was reduced in those who received TXA (4.9% vs 5.7%). The authors also noted a survival advantage in those who received TXA within 3 hours of injury, with the most significant benefit seen in those given TXA within 1 hour of injury. For reasons that remain unknown, those who received TXA more than 3 hours after injury had a worse outcome.

The CRASH-2 trial has several criticisms which should be noted. The study was not a true randomized study, as the provider could decide the course of treatment if they wished. This weakens the validity of any large study. While there were a large number of patients enrolled, less than 50% had unstable vital signs (hypotension or tachycardia) or even required a blood transfusion. One could argue the survival data is not accurate since so many patients received TXA who likely did not need it. Of those who died, only 35 % actually died from bleeding (traumatic brain injury was the most common cause of death). This again questions the patient selection and whether the survival benefit is accurate. Finally, critics note that the authors required 20,000 patients to prove a 0.8% survival benefit. The number needed to treat, which is defined as the number of patients who need to receive the drug in order to show benefit in one patient, is very high at 67.

The CRASH-2 trial is a very important trial for the prehospital provider to understand. The results of this trial altered trauma resuscitation worldwide by encouraging physicians to provide a safe, inexpensive medication which may slow clot breakdown in the hemorrhaging patient. TXA administration is especially relevant in the prehospital setting because it derives the greatest benefit from early administration (within 3 hours of injury). Careful analysis of the trial methods and results do show areas of concern and provide a good lesson for those wanting to learn more about how to critically analyze medical literature. This is a large, multicenter, international, randomized trial evaluating the effect of a relative safe and inexpensive drug. On the surface the data appear to be clearly in support of the use of TXA. The weaknesses in the study cannot be ignored and needing to treat 67 patients to potentially show a small survival benefit in one patient may ultimately doom the use of TXA in the trauma population.

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Trauma

1. **Identification of thoracic injuries by emergency medical services providers among trauma patients.** van Rein EA, Lokerman RD, van der Sluijs R, et al. *Injury.* 2018 Dec 6. In press, https://doi.org/10.1016/j.injury.2018.12.003 2019;50:1036-1041

The thoracic body region is the second most commonly injured area of the body, second only to the head. Injuries of the thoracic region are time sensitive and have the highest mortality of any injured area of the body. In the United States, level I and II trauma centers routinely care for patients with thoracic

injuries. In other countries, such as the Netherlands, these injuries are cared for in level I trauma centers. Triage protocols use two criteria to identify thoracic injury: 1) penetrating trauma to the chest, and 2) flail chest. Many thoracic injuries are difficult to identify as these injuries often do not affect vital signs or have obvious external findings. As many as 40 to 45% of severe thoracic injuries are missed by the prehospital provider, regardless of whether the provider is a paramedic or physician (as in many European EMS systems).

This is a multicenter study from the central Netherlands over a two-year period. They have one level I Trauma Center, which is equipped to care for patients with a severe thoracic injury, and nine level II or III trauma centers which are not equipped to handle severe thoracic injuries. All trauma patients age 16 years and over transported with the highest priority (lights and sirens) to a trauma center in this region were included in the study. By analyzing where prehospital providers transported these injured patients, the authors are able to deduce the accuracy of prehospital triage of thoracic injuries. The authors reviewed the ambulance reports to see if the medics suspected a thoracic injury. These were then compared to the patient charts from the hospital to confirm if a thoracic injury was present.

A total of 2766 patients were included in this study, of which 465 were diagnosed with a thoracic injury. The mean age was 49 years and 58% were male. EMS providers were able to identify 55% of all patients with thoracic injury (52% of those with a mild or moderate thoracic injury and 65% of the patients with a severe thoracic injury). Overall EMS providers missed 45% patients with a thoracic injury. Prehospital predictors of a severe thoracic injury included age, male gender, oxygen saturation, respiratory rate, Glasgow Coma Scale, fall > 2 m, pedestrian struck by a car that impact speed > 10 km/hr (6 mi/hr), and entrapment in the vehicle.

There were a few limitations to this study. If a trauma patient was transported to a hospital outside of the study region, they were excluded which could influence the reported results. The paramedic identification of thoracic injury was performed in retrospect based on review of the prehospital record which often did not describe the suspected severity of the injury.

This study confirms earlier data revealing the difficulty of prehospital triage identifying thoracic injuries. Identification of a thoracic injury is difficult as most patients have near-normal vital signs and lack of obvious external injury findings. Unless the patient has obvious penetrating trauma or a flail chest, their injury may not be obvious. This study illustrates weaknesses in our trauma triage protocols and additional criteria may be necessary to identify those patients with a thoracic injury.

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2. **Revisiting Traumatic Cardiac Arrest: Should CPR be initiated**? Konesky KL, Guo1 WA. European J Trauma Emerg Surg. 2017 (epub ahead of print) 2018;44:903–908

Traumatic cardiac arrest (TCA) is encountered frequently in the normal delivery of EMS and Emergency Department care. Overwhelming literature, as well as position papers from the American College of Surgeons and the National Association of EMS Physicians, has suggested that resuscitation from TCA is futile, consumes a large amount of resources, and produces few patients surviving to discharge from the hospital. This study attempts to determine the incidence, predictors of CPR failure, and outcomes following TCA.

This study is a retrospective study conducted over a 5-year period from July 2010 to June 2014. The study population included 124 adult trauma patients with blunt (56.6%) or penetrating (44.4%) injury who sustained TCA either on the scene, en route to, or in the Emergency Department of a Level 1 Trauma Center. Excluded from the study were those victims under the age of eighteen (18) years, hangings, and patients with severe burns. The most common presenting rhythms encountered were pulseless electrical activity (PEA, 55%) and asystole (34%) with ventricular dysrhythmias and sinus

tachycardia (8.9% and 2.4% respectively) also noted. The study found that there were no statistical differences in mortality rates between these four groups. The study also pointed to statistically equal survival rates between blunt and penetrating trauma patients. Thirty-nine patients (31.4%) had ROSC, however only nine (9) (6.5%) survived to discharge with complete neurological recovery. The study pointed to a higher survival rate after CPR in the blunt trauma subgroup with the mechanism of injury from falls vs. motor vehicle-related trauma. In the penetrating trauma group, higher survival was noted with wounds to the head, neck and extremities vs. the torso. The most common procedures noted by the authors were transfusion (49) and tube thoracostomy (24). Statistically significant predictors of mortality were prolonged field time (injury to ED arrival) and injury severity score greater than 15 (which is not determined in the field). The authors note the limitations of the study included data from only one trauma center and the study period being over the transition time period of the American Heart Association implementation of the 2010 CPR guidelines focusing on chest compressions over ventilation. The authors concluded that based on these results, CPR should be initiated on all trauma patients who have, in the past, had historically dismal outcomes.

The results and recommendations of this study are in contrast to numerous other studies that point to the futility of CPR in TCA. There are however a number of some short comings from an EMS perspective. The study did not report the EMS protocols for initiation or termination of resuscitation efforts on the scene. Only those victims that were transported to the trauma center were included in the study. This could easily introduce bias if EMS could select those patients who would be transported and those who would be pronounced on the scene. No data was presented with reference to prehospital procedures performed prior to arrival at the ED or the protocols that the prehospital providers followed for traumatic cardiac arrest, thus limiting the applicability and generalizability to other EMS systems. This study does however point to the need to conduct more comprehensive studies on prehospital CPR on the TCA patient and better define the criteria for initiating and terminating resuscitation efforts on these victims.

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3. **Accuracy of pre-hospital trauma notification calls.** James MK, Clarke LA, Simpson RM, et al. Amer J Emerg Med 2018, Published on-line. 2019;37:620-626.

Notification of receiving hospitals of the transport and impending arrival of seriously injured trauma patients is an important step in the overall system of management for trauma patients. Pre-arrival notification allows the receiving hospital to prepare for the patient's arrival as well as inform and activate needed services with the goal of optimizing the care the victim receives. To date, no study has looked at the appropriateness, accuracy and completeness of these notifications.

In this study, the researchers included trauma patients that presented to the emergency department at an urban level 1 trauma center over a two year period, all of whom required the two highest levels of trauma activation (Tier 1 – critical patients with immediate surgical attending response; Tier2 – high risk patients with chief surgery resident response). Communication from the field to the ED staff came directly from EMS providers or from EMS dispatchers via phone and the information provided was recorded on internal pre-notification forms.

Over the course of this study, 2,186 trauma activations were initiated. Of these, pre-arrival notification occurred in 71.9% (1,572 cases) with 28% (614) providing no notification at all. They reported that while nearly one third of the patients arrived without any notification, those that did have prearrival notification often provided reports that were prone to errors that prevented adequate preparation for the patient's arrival. Incorrect information resulted in 1.7% (20) of the patients being under-activated and no notification resulted in 27% (593) being underactivated.

The limitations of this study include that these data represent a single, specific geographic region and a single trauma center and therefore may not be generalizable. The also recognized that error by the ED staff when recording the prearrival information cannot be ruled out. In addition, communication difficulties related to language and/or influence of drugs or alcohol may also have affected the ability of the EMS personnel to get information from the patient or bystanders that would have been helpful to the hospital.

This study has shown that EMS providers in this particular system provide inadequate or incorrect information about their patients that results in significant underactivation of the trauma team by the trauma centers. The authors suggest that training offer a solution particularly with their BLS providers who were more prone transmitting incorrect or incomplete information about their patients

Early notification to the receiving hospital by EMS personnel of the transport and impending arrival of a seriously injured trauma victim is essential to ensure adequate preparation and appropriate team assembly in the emergency department. It is disturbing that, at least in this one system studied, inaccurate information is often being provided to the receiving hospital and in many cases notification is not occurring at all. Ensuring optimal survival of trauma victims requires the participation of an entire team of healthcare responders and that begins with the prehospital personnel.

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4. **Emergency Medical Services Simple Thoracostomy for Traumatic Cardiac Arrest: Post-implementation Experience in a Ground-Based Suburban/Rural Emergency Medical Services Agency.** Dickson RL, Gleisberg G, Aiken M, et al. J Emerg Med 2018;55:366-371.

The insertion of a thoracostomy (chest) tube is the standard treatment for pneumothoraces in the hospital environment, but is not commonly performed in the prehospital environment in the USA. This retrospective study examined the use of Simple or Finger Thoracostomy (ST) in patients in traumatic cardiac arrest with suspected tension pneumothorax and compared it to a control group of patients treated with needle thoracostomy (NT).

This study was conducted in a large metropolitan area with data from June 2013 to July 2017. ST was performed on fifty-seven (57) patients with traumatic cardiac arrest and compared to a historical group of fifty (50) patients who underwent NT. The ST group used a surgical incision at the fourth intercostal space midaxillary line with a blunt finger dissection and clamp penetration to reach the pleural space. The NT was performed with a standard 14-g, 4.5 cm angiocath in the second intercostal space midclavicular line or the fifth intercostal space midaxillary line. Of the 57 patients that received ST, 40 (70%) were blunt trauma and 17 (30%) were penetrating. The presenting rhythm was Pulseless Electrical Activity rhythm (PEA) in 65% of the patients, asystole in 26% and VF or VT in 4%. Of the study group 75% had bilateral ST performed. Thirty-two (32) percent of the patients had air return and 25% had ROSC with 11% surviving to 24 hours. Four of the 57 (7%) were discharged from the hospital with normal intact mental status. Of the survivors all were blunt trauma that presented with an initial rhythm of PEA. When comparing ST vs. NT that there were no differences between transport times for each group, NT 15.33 vs ST 17.04 minutes. Procedures were on scene vs. during transport were also similar. There was no statistically significant difference in ROSC between the two groups, NT 9/50 vs. ST 14/57, however while not statistically significant 4 patients in the ST group were discharged to home vs. none in the NT group. There were no reported injuries to EMS personnel during the study period. There were three (3) complication noted in the ST group, two (2) being extrapleural placement without reaching the plural space and one (1) case of diaphragm and liver injury.

The results of the study are interesting on many aspects. First this study demonstrated that chest decompression in Traumatic Cardiac Arrest victims only obtained the desired outcome of ROSC in those

patients that presented with Blunt Trauma with a presenting rhythm of PEA. While not statistically significant, the only survivors to discharge were in the ST group (7%) vs. the NT group (0%). Of interest, in the group that received NT, the procedure was performed with a 4.5 cm, 14 gauge angiocatheter. While the authors concede that the catheter length used in NT during this study period was sub-optimal, had a longer catheter been utilized during the study period, the NT statistics may have changed (the Tactical Combat Casualty Care program recommends the use of an 8cm long, 10 - 14 gauge catheter for needle decompression of the chest). The authors point to the reported failures of NT to enter the chest and the complications rates of 3-30% for tube thoracostomy as justification to perform ST over either procedure in the field. Given the limitations of this study (small sample size and inadequate needle length), additional studies need to be performed before ST can be recommended to replace NT in the standard ground transportation EMS systems in the US.

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5. **Needle Thoracostomy: Does Changing Needle Length and Location Change Patient Outcome?**
Weichenthal LA, Owen S, Stroh G, Ramos J. Prehosp Disaster Med 2018;33:237-244.

Needle thoracostomy (NT) for suspected tension pneumothorax is commonly performed in the prehospital setting. This pre- and post- observational study examines whether the location (mid-clavicular line vs. mid-axillary line), length and diameter of catheter as well as the timing of the NT resulted in increased survival.

The study was conducted in a central California EMS system. Over the study period three-hundred and five (305) trauma patients were treated with NT per local protocols. The "before" group was comprised of one hundred sixty nine (169) patients who underwent NT in the mid-clavicular line (MCL) group with a 14 gauge IV catheter that was at least 5.0 cm in length. The second or "after" group consisted of one-hundred thirty six (136) patients that were decompressed using a 10G IV catheter that was at least 9.5 CM long in the 5th intercostal space in the mid-axillary Line (MAL). It is important to note that the group one patients were decompressed only after initial "stabilization" on the scene and after placement into the transporting vehicle whereas the group 2 patients were decompressed on scene while the initial stabilization was being performed. The mortality of patients in both groups was 79%. This death rate is somewhat higher than other studies, but it is important to note that almost two thirds (59%) of those patients enrolled in the study presented in traumatic cardiac arrest. The study also enrolled both blunt and penetrating trauma patients. The patients in the MAL had a lower ISS and as noted by the authors NT was performed more often post training on the MAL approach. Positive outcome was more likely in patients who had a lower ISS and who had an improvement in clinical status after NT was accomplished. No complications were identified in either group as a direct result of NT.

The results of this study are somewhat surprising given that three NT variables were changed, each of which would be expected to improve trauma patient outcome, specifically longer catheter, choice of NT site, and timing of insertion. Prior studies have shown that shorter catheters and needle placement in the 2nd ICS fail to enter the thoracic cavity as much as 60% of the time. In addition, performance of the procedure earlier in the management process would be expected to improve the potential survival. Despite making these changes in management in the group 2 patients, outcome in both groups was the same. Unfortunately, no information about prehospital times or the specific time from arrival of responders to NT was provided. Not surprising is that survival was better in those patients who had a lower ISS (less severe injuries) and in those patients who had a positive clinical response to the decompression. This paper provides us little new information to better guide our prehospital trauma patient management.

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6. **Undertriage of Firearm-Related Injuries in a Major Metropolitan Area.** Lale A, Krajewski A, and Friedman LS. JAMA Surg. 2017 May 1;152(5):467-474

Prehospital trauma triage criteria are designed to ensure that any critically injured patient or any patient who may potentially have serious injuries is transported to a trauma center. Multiple studies have shown a survival benefit for patients treated at a trauma center over a non-trauma center. The Centers for Disease Control and Prevention (CDC) publish the "Guidelines for Field Triage of Injured Patients" which specify which patients should be preferentially transported to a trauma center. Anatomic criteria requiring trauma center transport include penetrating trauma proximal to the knee or elbow.

This is a five year retrospective study reviewing patients in Cook County, Illinois (city of Chicago) who sustained a firearm-related injury. The authors specifically looked at patients who were undertriaged, meaning they met trauma triage criteria for transport to a trauma center but were instead transported to a non-trauma center. Their study population also included those patients who were transferred to a trauma center after receiving the initial care at a non-trauma center.

During the five-year period 9,886 firearm-related injuries occurred in Cook County. There were 2842 patients (28.7%) who received care at a non-trauma center and 7044 patients (71.3%) who received care at a trauma center. Those who were treated at a non-trauma center were less severely injured although 884 (31.1%) did meet the anatomic criteria for transport to a trauma center. Of the 4934 Cook County residents who met anatomic triage criteria, approximately 1 in 6 were treated at a non-trauma center. The South and West areas of Cook County are the areas most likely to have patients treated at a non-trauma center. For those familiar with the geographic distribution of trauma centers in Chicago, there was no trauma center in the southern portion of the city in 2009-2013 when this article was researched. The authors note that patients treated at non-trauma centers were less likely to die than patients treated at a trauma center. This is due to trauma centers treating a much more severely injured cohort of patients with a higher risk of death. A key finding of the study is that fewer patients died during the first 24 hours at a trauma center compared to a non-trauma center.

This study had surprising results. It demonstrated that undertriage of trauma patients occurs even in a major, developed, urban trauma system. Reasons for this are unknown but are likely due to a combination of EMS mistriage and a portion of patients being transported to the wrong hospital by private vehicle prior to EMS arrival on scene. Additionally distance to the nearest trauma center could play a factor, particularly in Chicago where there was no trauma center in the South side of town at the time of this study. The study demonstrates the need for continual quality improvement and self-assessment among all trauma systems.

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7. **Permissive hypotension versus conventional resuscitation strategies in adult trauma patients with hemorrhagic shock: A systematic review and meta-analysis of randomized controlled trials.** Tran A, Yates J, Lau A, Lampron J, Matar M. J Trauma Acute Care Surg. 2018;84:802-808.

It was not that long ago that the standard prehospital treatment of bleeding trauma patients was to administer two liters of normal saline and run it wide open. For the last 20 years however, recommendations have been made to halt these massive infusions of IV fluids to bleeding patients. The argument is that these large infusions of crystalloid can "pop the clot" by raising blood pressure or increase the rate of bleeding, essentially flushing the red blood cells and clotting factors out of the patients and replacing them with IV fluid.

The authors of this paper conducted a literature review identifying randomized controlled trials that compared large volume fluid resuscitations with resuscitations following permissive hypotension protocol in trauma patients. The studies, both civilian and military, included adults who sustained blunt or penetrating trauma with suspected hemorrhage. The outcome measurement was mortality in hospital or within 30 days along with blood loss volumes, utilization of blood products, and complications of either administration or restriction of fluids.

The authors found 722 publications and ultimately evaluated 1,152 patients from five randomized controlled trials that met criteria for this review. Four of the five studies documented a lower mortality with hypotensive resuscitation, however due to small sample sizes, only one of them reached the level of statistical significance. Two of the studies reported lower blood loss with hypotensive resuscitation and three trials reported fewer blood products transfused.

While the strength of this review is that only randomized studies were looked at, which should provide the highest quality evidence; the small numbers of patients in these studies create results that are underpowered.

This review suggests that there is a survival benefit, lower reported blood loss, and reduced blood product and crystalloid utilization with lower blood pressure targets compared to traditional resuscitation guidelines which return blood pressure to normal or near-normal levels. However, because the studies evaluated were underpowered and of varying quality, there is a need for higher quality and higher powered (more patients) research to be done before a specific resuscitation regimen can be agreed upon.

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8. **Fatal Wounding Pattern and Causes of Potentially Preventable Death Following the Pulse Night Club Shooting Event.** Smith ER, Shapiro G, Sarani B. Prehosp Emerg Care 2018;22:662-668.

The goal in responding to civilian public mass shootings (CPMS) is multi-faceted. Law Enforcement has always held the lead role in the suppression of the threat. EMS and Fire have historically been staged at an area outside of this threat zone until the scene had been made safe. This paradigm has changed in recent years through the introduction of Rescue Task Force type models. These models put EMS providers in the warm zone to provide lifesaving care to and the extrication of victims to areas of safety for further care and ultimate transport to definitive care. This study is a retrospective study that attempts to determine survivable injuries from the Pulse night club shooting by analyzing autopsy reports that were obtained by freedom of information request to the county Medical Examiner's office.

The authors reviewed all 49 deceased persons from this event. Each author independently reviewed each case to determine the potential survivability of the victims' wounds based upon receiving emergency medical care within ten (10) minutes and definitive care within sixty (60) minutes. These are

the same time parameters that are generally recommended for all trauma in the developed world. The authors concluded that the fatal wound location was 41% chest/upper back, 24% head, 12% lower back, pelvis buttock and genitals, 12% neck, 8% extremity and 4% face. Sixteen of the 49 deaths (32%) were felt to be potentially preventable had care been rendered within the time parameters set in the study. The largest percentage of these patients (56%) had isolated lung injury without documented major underlying vascular injury. The authors conclude that these patients likely died either from hypoxia due to open pneumothorax or tension pneumothorax. Twenty five percent (4 of 16) of the potentially preventable fatalities classified died from exsanguination from an extremity or junctional hemorrhage. Two (2) of these were amenable to the application of a tourniquet while the remaining two were junctional and would require wound packing and or alternative techniques of bleeding control. The remainder of the victims classified as potentially survivable were either head injuries or GSW to the neck causing airway compromise.

The findings from the study of this incident demonstrate that preventable fatalities from extremity hemorrhage in the civilian setting is much lower than in the military setting. Wounds to the lungs were deemed to be the largest number of potentially survivable injuries if care was initiated in 10 minutes or less after wounding. This is in contrast to the military experience that pointed to bleeding control of extremity wounds as the largest survivable wounding pattern. This difference is most likely is due to two factors, as pointed out by the authors. The first being the use of body armor by military victims, thus providing protection to the thorax, and the second being the close proximity of the shooter to the civilian victim. In addition, all US military personnel engaged in combat are trained and equipped via Tactical Combat Casualty Care (TCCC) in the immediate self-application of a tourniquet or to a wounded comrade as well as other methods of hemorrhage control. This is currently not the case in the civilian environment. Training has begun through the American College of Surgeons Bleeding Control Course and the Stop the Bleed campaign. The results of this study suggest that while bleeding control is important, the management of lung injuries and airway maintenance also need to be considered as a high priority.

Limitations of this study include the fact that survivability was determined by expert opinion based only upon the autopsy report from the Medical Examiner's Office. No prehospital or hospital data was obtained, and it was difficult to determine whether or not attempts at resuscitation occurred on most of these victims. A second limitation of the study was the application of time to EMS contact and time to definitive care of 10 and 60 minutes respectively. These numbers are often difficult to achieve when responding to a single GSW victim, not to mention situations with multiple victims complicated by an unstable active shooter situation. Lastly, this report describes a single incident that may or may be representative of all multiple shooting events.

The goal of expanding the continuum of care for trauma victims needs to include everyone from the citizen immediate responder to the entire public safety community and will be gradually realized with the further implementation of the Stop the Bleed Campaign and Bleeding Control Course (B-Con) by the American College of Surgeons.

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9. **Under triage in trauma: Does an organized trauma network capture the major trauma victim? A statewide analysis.** Michael A. Horst, PhD, Shreya Jammula, Brian W. Gross, et al. *J Trauma Acute Care Surg.* March 2018;84:497-504.

For as long as triage has been used to determine where and when trauma patients should be transported, the issue of over and under triage has been a concern. There have been arguments made on whether it was better to have an acceptable level of under-triage or over-triage. The discussion is

important because there are clearly risk/benefit repercussions. Critical trauma patients may not get the care they need if under-triaged and other patients, if over-triaged, may unnecessarily use resources better reserved for other patients.

This study was a statewide analysis of trauma patients in Pennsylvania from 2003 to 2015 using two databases: one that contains all patient admissions in the state and the second that records all patients admitted to trauma centers. It is a mature trauma system that has in place for over three decades. Patients were grouped according to ISS: those with ISS >9 and then those with ISS >15.

The trauma hospital database reported that 38 trauma centers had 173,022 patients admitted with an ISS>9 and 99,449 with an ISS >15 while the statewide database reported 185 hospitals admitted 255,263 patients with ISS>9 and 149,772 with an ISS>15.

The authors were "astonished" to find that, in such a mature system, 30% of patients with moderate (ISS>9) and severe (ISS>15) trauma were transported to non-trauma centers. This finding is consistent with previous research that has shown a national pattern of 1/3 of moderately or severely injured trauma patients not being transported to a trauma center.

Limitations in this study included the trauma criteria used by the two databases which may have excluded cases which should have been included. Personal identifiers were removed making it impossible to link to the two patient data sets to determine if patients that were initially transported to a non-trauma center were subsequently transferred to a trauma center. Another limitation to this study was the use of ISS calculated at discharge as a triage criterion for admission to a trauma center. Lastly, the authors were unable to draw any conclusions about undertriage and mortality because of limitations in the available information from the state-wide database.

This study appears to agree with most that, even with appropriate state-wide trauma protocols in place, significant under triage is still taking place. If the ultimate goal is to achieve "zero preventable deaths", then significant improvement in trauma triage must occur and moderately to severely injured patients must be transported to a trauma center.

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10. **Association of Prehospital Mode of Transport with Mortality in Penetrating Trauma, A Trauma System-Level Assessment of Private Vehicle Transportation vs Ground Emergency Medical Services.** Wandling M, Nathens A, Shapiro M, Haut E. JAMA Surg. 2018;153(2):107-113.

Time to definitive care is seen as important in the outcome of patients with penetrating trauma. Trauma center emergency departments operating in an urban environment often see "drop offs" of patients suffering from gunshot or stab wounds who were transported by private vehicles. In addition, in some cities, police transport of these types of trauma victims is commonplace rather than ambulance transport. Patients taken to a hospital by automobile generally have little to no medical care provided either before or during transport, unlike those victims transported by ambulance. This study looked to compare the outcome of patients transported by ground EMS services versus by private vehicle to level 1 and 2 trauma centers in the 100 most populated metropolitan areas of the United States

This retrospective cohort study compared 103,029 patients who were 16 years of age or greater and had a gunshot (GSW) or stab wound. Data was taken from the National Trauma Data Bank from Jan. 1, 2010 and Dec. 31, 2012 or level 1 and 2 trauma centers in these Metro areas. The study group was predominantly male (87.6%) with a mean age of 32.3 years of age. Traditional ground EMS transported 86,097 (83.6%) versus 16,932 (16.4%) transported by private vehicle. Mean Injury Severity Score (ISS) was significantly lower in the private vehicle vs EMS transport mode (5.5) vs (10.1). The unadjusted mortality for both gunshot wounds and stab wounds was lower for patients taken by private vehicle (GSW-4.5%, SW-0.2%) compared to ambulance transport (GSW-19.3%, SW-2.9%). After risk

adjustment, individuals with penetrating trauma transported by private vehicle were less likely to die than those transported by traditional ground EMS (odds ratio 0.38; 95% Cl, 0.31-0.47).

This study clearly suggests that, in metropolitan areas, penetrating trauma victims transported by private vehicles to Level 1 and 2 Trauma Centers have a greater likelihood of survival. There were, however, some limitations to this study. This study did not include all penetrating trauma patients that were transported to hospitals in the urban areas studied, only those transported to a level 1 or 2 trauma center that report their data to the NTDB. It is assumed that there would be a trauma triage system in place requiring those patients transported by EMS to be taken to level 1 or 2 Trauma Centers; the same is likely not true with those transported by private vehicle. These patients are often transported to the closest hospital, not necessarily a Trauma Center. As such, these patients were not captured in the study. Another limitation to this study was the lack of prehospital time data for both transport methods. The study also raised the question if the increase in mortality in the EMS group was related to the presumed increased in time to definitive care (response time + time on scene) or if some facet of care rendered by EMS providers contributes to this outcome. In either case further studies are warranted before private vehicle transport of penetrating trauma victims can be widely advocated. Lastly, it is important to remember that this study does not apply to victims of blunt trauma.

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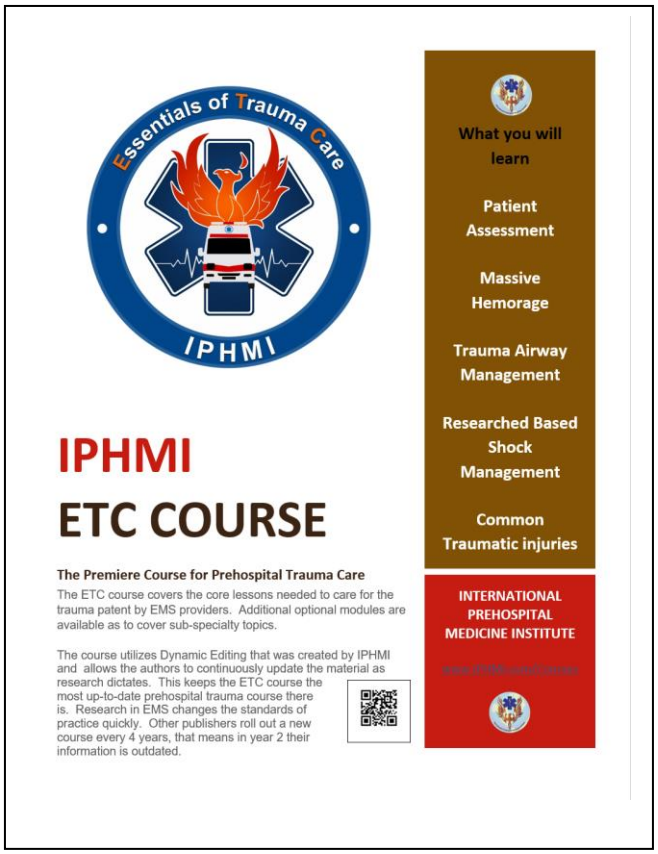

Triage

1. **Intuitive versus Algorithmic Triage.** Hart, A; Nammour, E; Mangolds, V & Broach, J. *Prehosp Disaster Med*, 2018;33(4):355-361.

EMS providers in the United States are currently taught, and most use, a structured algorithmic approach to triage at mass casualty incidents (MCI). The goal of MCI patient triage is to accurately assign a triage category within 30 to 60 seconds after each patient contact. Most of these triage systems utilize some combination of circulation, respiratory effort, and mentation as the basis to assign the triage category. Patients are commonly categorized as Immediate, Delayed, Minor, Expectant or Dead. Triage algorithms should be easy to recall and use and minimize over-triage (assigning a well patient to an urgent category) and under triage (the assignment of an ill patient to a less urgent category). Over-triage wastes resources and under-triage results in missed opportunities to use available resources for patients that urgently need them. There is no literature that demonstrates the effectiveness of algorithmic triage in real world incidents.

This study evaluated and compared the speed and accuracy of the algorithmic Simple Triage and Rapid Treatment (START) method with an "intuitive" triage method relying on the overall first impression assessment of an experienced pre-hospital provider. Adult volunteers, both patients and responders, were recruited for an active shooter MCI simulation. A clustered, randomized simulation was completed comparing START and intuitive triage. Paramedic participants were evaluated for both speed and accuracy of patient triage. Identical "mirrored" scenarios were run multiple times using a different set of randomized Massachusetts paramedic responders (START group vs Intuitive group). START is taught, practiced and the mandated EMS triage system in Massachusetts and was the control group for this study. Instructions to the "intuitive" paramedic group were: "Use your own intuition of who should be assigned what triage category, but do not use START triage."

The overall mean speed of the triage process was found to be significantly faster with intuitive triage (72.18 seconds) when compared to START (106.57 seconds). This effect was especially dramatic for Immediate (94.40 vs 138.83 seconds) and Delayed (55.99 vs 91.43 seconds) patients. In total, 84 patients were triaged. There were 17 episodes of disagreement between intuitive triage and START, with no statistical difference in the incidence of over- and under-triage between the two groups in a head-to-head comparison.

Intuitive triage was demonstrated to be faster than algorithmic (START) triage, while still providing a high degree of agreement with START between triage categories. This study may also demonstrate the importance of having high level, experienced prehospital providers complete the initial field triage at MCI events, regardless of which triage system is used.

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WMD

1. **Contingency Medical Countermeasures for Mass Nerve-Agent Exposure: Use of Pharmaceutical Alternatives to Community Stockpiled Antidotes.** Schwartz M, Sutter M, Eisnor D, Kirk M. Disaster Med Public Health Preparedness. Published on-line October 2018. 2019;13:605-612.

Having sufficient stockpile of medical countermeasures for the treatment of multiple patients poisoned by an acetylcholinesterase inhibiting nerve agent following a mass chemical exposure is a

challenge for all communities. While there are current first-line pharmaceutical agents (atropine, diazepam, pralidoxime) available for nerve agent exposure they are limited in number and may not be sufficient for a large-scale exposure. Alternative pharmaceutical agents, administration routes, and delivery devices need to be explored.

An ad hoc expert working group was convened and performed a review of published articles and discussed alternate pharmaceutical agents that met the Public Health Emergency Medical Countermeasures Enterprise (PHEMCE) requirements for nerve agent countermeasures. Available evidence was reviewed and discussed to support the utilization of nontraditional first-line nerve agent antidotes and administration routes during a large-scale release of an acetylcholinesterase inhibiting nerve agent. Alternatives to atropine include cyclopentolate, glycopyrrolate, propantheline and ipratropium or tiotropium. Alternative benzodiazepines to diazepam include midazolam and lorazepam.

Utilization of alternate pharmaceutical agents (if readily available) and routes of administration can be of benefit during the treatment of multiple patients following a large-scale release of a nerve agent. Unfortunately, most EMS programs will not be able to utilize the findings of this study group without involvement of local medical direction and changes to local protocol and possible change in the EMS provider's scope-of-practice. In addition, most of the alternative medications are not routinely available on EMS vehicles.

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“What have you done for the good of mankind today?”
Norman E. McSwain, M.D., F.A.C.S.
1937-2015