LITERATURE REVIEW VOL. 2

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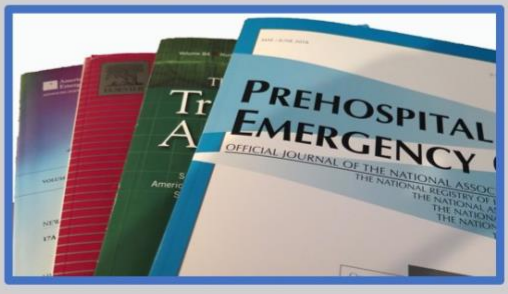
LITERATURE REVIEWS VOLUME 2

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.



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2. **Prehospital Plasma in Injured Patients is Associated With Survival Principally in Blunt Injury: Results From Two Randomized Prehospital Plasma Trials.** Reitz KM, Moore HB, Guyette FX, et al. J Trauma Acute Care Surg. 2020;88:33-41

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2. **Effectiveness of Prehospital Dual Sequential Defibrillation for Refractory Ventricular Fibrillation and Ventricular Tachycardia Cardiac Arrest.** Beck R, Ostermayer D, Ponce J, Srinivasan S, Wang H. Prehosp Emerg Care 2019;23:597-602.
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2. **The Reliability of the Pre-hospital Physical Examination of the Pelvis: A Retrospective, Multicenter Study.** Lustenberger T. Walcher F, Lefering R, et al. World J Surg 2016;40:3073-3079.
3. **Who Would Have Benefited from the Prehospital Use of Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA)? An Autopsy Study.** Henry R, Matsushima K, Henry RN ,et al. J Am Coll Surg. 2019;229:383-388.
4. **Identifying patients with time-sensitive injuries: Association of mortality with increasing prehospital time** Chen S. Guyette FX, Peitzman AB, Billiar TR, Sperry JL, Brown JB. J Trauma Acute Care Surg. 2019;86:1015-1022.
5. **Right hospital, right patients: Penetrating injury patients treated at high-volume penetrating trauma centers have lower mortality.** Fu CY, Bajani F, Tatebe L, et al. J Trauma Acute Care Surg 2019;86:961–966.

6. **Shotgun Wounds: Nationwide Trends in Epidemiology, Injury Patterns, and Outcomes From US Trauma Centers.** Schellenberg M, Owattanapanich N, Cremonini C, et al. J Emerg Med 2020;58:719-724.

AeroMedicine

1. **In-Flight Medical Emergencies. A Review.** Martin-Gill C, Doyle TJ, Yealy DM. *JAMA* 2018;320:2580-2590.

In-flight medical emergencies are not an uncommon occurrence. Travelling healthcare providers as well as flight crew personnel may be called upon to deal with a sick or injured passenger. This clinical review article examines the incidence and causes of In-Flight Medical Emergencies (IMEs).

The authors reviewed the available English language medical literature published between 1990 and 2018. The review included 317 articles. The total number of the IMEs examined was over 56,000.

IMEs are estimated to occur in approximately 1 in 604 flights and range from 24 to 130 incidents per 1 million passengers. The most common cause of IMEs were syncope/near syncope (32.7%), gastrointestinal complaints (14.8%), respiratory problems (10.1%), cardiovascular (7.0%), neurological (5.5%), and trauma (4.8%). Cardiac arrest in-flight was rare (0.2%). In flights with declared IMEs, one-third of the patients were transported by EMS to a hospital (of which only one-third were admitted).

Aircraft diversion to non-destination airports happened in only 4.4% of IMEs. The most common causes of diversion were cardiac arrest, obstetrical emergencies, cardiac symptoms and stroke. These diversions took place by the decision of the Pilot-in-Charge after consultation with on-flight volunteer medical personnel and third party ground-based medical consultation services. Of note, when at cruising altitude, it takes 20-30 minutes to descend and land, even if the closest airport is within sight, calling into question the need to divert for a cardiac arrest that could not be resuscitated within the first 20 minutes. The cost of diversion ranged from $20K to $725K just in direct airline costs, not including the cost of re-bookings of passengers when necessary.

Approximately seventy-five percent (75%) of incidences are attended to by on-flight volunteer medical personnel at the request of the flight crew. In approximately fifty percent (50%) of the cases the patient is attended to by a licensed physician, the remaining twenty-five percent (25%) are cared for by other medically trained emergency personnel. The other twenty-five percent (25%) are attended to by the flight crew only. In the U.S., volunteer medical responders are protected from liability by the Aviation Assistance Act (except for gross negligence or willful misconduct).

Further study to better guide the management of IMEs is warranted to include such issues as: what percentage of on-flight medical volunteers have training in dealing with emergency situations, what is the ideal composition of on-board medical emergency supply kits, does the use of ground-based medical consultation affect patient outcome, and can pro-active screening prior to flight decrease the incidence of IMEs.

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Airway and Ventilation Management

1. **Inclined position is associated with improved first pass success and laryngoscopic view in prehospital endotracheal intubations.** Murphy DL, Rea TD, McCoy AM, et al. *Amer J Emerg Med* 2019;37:937-941.

Endotracheal Intubation in the prehospital setting is typically taught and practiced with the patient in the supine position with the head placed into the "sniffing" position. In the hospital setting, an inclined position during emergency endotracheal intubation was associated with better views of the glottis, greater first pass success, and a reduction in airway-related complications compared to those intubated in the conventional supine position. Emergency department clinicians demonstrated that a greater degree of bed inclination was associated with higher rates of first pass success. In contrast, a randomized study of critical care fellows in an intensive care unit experienced a lower first pass success rate in the patients assigned to incline positioning. The influence of patient position has not been studied in the prehospital setting.

The authors conducted an IRB approved retrospective, study of patients who were intubated over a five-year period by Seattle Fire Department and King County EMS Division Paramedics. Paramedics within this system are trained and authorized to use rapid sequence induction (RSI) to facilitate endotracheal intubation when necessary. All intubation attempts are documented in system-based airway registries. Patient positioning, first attempt Cormack-Lehane laryngoscopic grade of airway view, and specific challenges to intubation are primary data elements in the airway registries. Positioning is categorized into either supine or inclined/upright.

Of 13,353 patients with at least one attempt at field intubation, 4879 were adult (age ≥ 18 years), non-traumatic, non-arrest cases and included in the study. Patients less than 18 years of age (445), in cardiac arrest (6,061) or trauma patients (1,968) were excluded from the study group. RSI was utilized in 97.2% of cases.

Overall, 1924 patients (39.4%) were intubated in an inclined position. First pass success was 86.3% among the inclined group versus 82.5% in the supine group. First attempt laryngeal grade I view was 62.9% in the inclined group compared to 57.1% for the supine group. Challenges to intubation were reported as more frequent in the supine group (42.3% versus 38.8%), as relates to the presence of fluids in the airway including secretions, emesis, or blood (18.5% versus 11.4%).

There are some limitations to this study. First, all data was self-reported and thus subjective in nature. All cardiac arrest and trauma patients were excluded. Subsequent review of these cases revealed that over 90% were intubated using the supine position.

Paramedic controllable factors such as patient position prior to first attempt at endotracheal intubation should be optimized for success. This study suggests an approximate 4% increase in intubation success by simply inclining the patient versus laying the patient supine, when performing RSI and patient condition allows. It further suggests that the challenge of fluids and secretions obstructing glottic view may be reduced with an inclined patient position.

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2. **Randomized Comparative Assessment of Three Surgical Cricothyrotomy Devices on Airway Mannequins.** Dorsam J, Cornelius S, McLean J, et al. Prehospital Emergency Care, 2019:23; 411-419.

The ability to effectively manage an airway is a critical skill in prehospital care. Few alternatives are left for a prehospital provider in the "Can't Ventilate, Can't Oxygenate" scenario other than Surgical Cricothyrotomy (SC). Military providers know that airway obstruction is the second leading cause of preventable death on the battlefield. Tactical Combat Casualty Care (TCCC) teaches SC as a way to ventilate and oxygenate a casualty when less aggressive airway maneuvers fail. While taught and practiced in TCCC classes, SC failure rates (18%) are unacceptably high in field use with critical patients.

Current TCCC guidelines recommend the Control-Cric Kit (CC) which uses the Crik-Key combined knife and hook to access and stabilize the tracheal lumen for stylet pre-loaded tube placement as the preferred choice. The Tactical CricKit (TCK) is commonly taught in TCCC classes. It uses a hook to open the surgical gap in the cricoid cartilage after dissecting to it with a surgical blade. The tracheal tube is then inserted through the gap with an obturator. Lastly, the Bougie-Assisted Technique (BAT) can be used to first access the exposed tracheal lumen with an Introducer Adult Bougie and then inserting a tracheal tube over the Bougie.

Dorsam et al studied 25 naval corpsmen in a laboratory setting as they performed SC on new airway mannikins using each of the previously described equipment and procedures. The corpsmen volunteers all received TCCC equivalent training and practice on the equipment, procedures and mannikins to be used in the study. Their prior experience in SC varied with one-third of participants having no prior experience with the procedure and only one having performed a cricothyrotomy on a live human. The study looked at the time required for the procedure from first touching the equipment to successful placement of the tracheal tube (manual ventilation verified by auscultation of breath sounds). A user survey of preferences for effectiveness, ease of use and reliability of the SC equipment was performed after completion of the study. Additionally, participants were given the opportunity to answer open ended questions regarding suggestions for improvement on the equipment and their thoughts on the study design.

Successful placement was achieved 76% of the time using the BAT, 40% with the TCK and 48% using the CC. For time of incision to successful ventilation, TCK was the fastest (74-120 sec), BAT was second (103 – 146 sec) and CC the slowest (135 – 213 sec). Prior SC experience was predictive of faster times. Participants rated TCK and BAT favorably for use, effectiveness and reliability. CC scores were all consistently lower.

Participant evaluations of the trainings were 88% positive agreeing that "This educational opportunity was useful". For the question, "If you could choose one kit which would it be?", zero (0%) chose the CC. The TCK was favored at 58% followed by BAT at 42%. It is worth noting that the SC equipment with the fastest insertion times and was most favored by the study participants (TCK) had the least successful placement rate at only 40%. It is possible that familiarity, prior experience with the TCK during previous TCCC training, and the fact that it is commonly found in field aid bags made it a favorite amongst participants.

This study demonstrates a number of important issues that every EMS agency must consider if cricothyrotomy is included as an authorized airway management procedure:

1. The importance of rigorous and on-going education and practice with this invasive, potentially life-saving technique;
2. Without on-going practice and familiarity with the equipment, the failure rate is extremely high;
3. The existing products for performing cricothyrotomy are inadequate and require significant improvement.

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3. The association of paramedic rapid sequence intubation and survival in out-of-hospital stroke.
Fouche PF, Smith K, Jennings PA, Boyle M, Bernard S. Emerg Med J 2019;36:416-422.

Prehospital care providers are called upon to provide care for patients suffering from strokes on a daily basis. The care given both in the prehospital and emergent in-hospital phases of care has changed dramatically in the recent years. This study looks at the use of Rapid Sequence Intubation (RSI) by prehospital paramedics in Victoria region of Australia and compares the outcome of those patients to stroke patients that did not undergo RSI.

This study of out-of-hospital RSI administered to patients suffering from stroke was conducted by retrospective review of ten (10) years (January 1, 2008 thru December 31, 2017) of prehospital and matching in-hospital data. Victoria is a region with nearly 6.5 million residents that is serviced by a single EMS service provider using a two tiered system with only the higher tier of Mobile Intensive Care Paramedics (MICP) being able to administer paralytics. Enrollment in the study cohort was limited to patients of any age that were transported by ambulance and were admitted to a hospital with a final diagnosis of stroke. Exclusions included any cases of transient ischemic attacks, strokes that could not be classified as either hemorrhagic or ischemic or those associated with traumatic brain injury. The primary outcome examined was survival to hospital discharge.

The study cohort included over 43,000 patients identified in the study period, of which, using propensity score matching, 727 patients were compared in each of the two study groups (RSI vs no-RSI). The average age of the overall study group was 73 years old with the RSI sub-group being 65.2 years of age. The male to female ratio was comparable (51.3 vs. 48.7 respectively). Ischemic stroke accounted for the higher percentage of patients at 70.4% compared to hemorrhagic stroke at 33.1%. Overall, two percent of stroke patients (2%) underwent RSI in the field.

While only two percent (2%) of those patients that suffered stokes in Victoria during this study period received RSI, the study brings up some interesting points. The type of stroke in which RSI was used dramatically favored hemorrhagic over ischemic etiology by over 40% (74.3 vs. 31.2%). The age of those who were intubated using RSI were nearly eight years younger. RSI was successful in 97.3% of the patients with a first-pass success of 89.4%. Ambulance response times and transport times with relatively similar in both groups (RSI vs. No-RSI), however the on-scene time was nearly three (3) times as long (57.9 mins. vs. 21.8 mins. respectively).

After analyzing their data, the authors conclude that there is a decreased likelihood of survival for stroke patients that received pre-hospital intubation using RSI. There are a number of studies in the hospital environment that demonstrate a decreased survival for those stroke patients that undergo intubation in the hospital, but this is the first that examined its use in the pre-hospital environment.

There are a number of limitations in this study. Patients that are sicker or perceived to be sicker will receive greater intrusive interventions such as RSI both in the field and in the hospital. This study demonstrated that fact. Endotracheal intubation in the pre-hospital environment remains controversial and is the focus of many ongoing studies with no final conclusion as to its efficacy. Of note, the end-tidal CO2 measurements deviated significantly from expected norms with 43.5% of patients in the RSI group having a “final” reading less than 35mm Hg, 1.7% having a reading less than 25mm Hg, and 3.6% having a reading greater than 45mm Hg. As is well known, derangements in EtCO2 have a profound effect on the outcome from traumatic brain injury. The effect of these EtCO2 values on mortality from stroke was not evaluated. One item that the authors did not call out from the data was the prolonged scene time for the RSI group. The scene time was over a half-an-hour longer (36.1 min) when the paramedics chose to utilize RSI. While it does require a longer time period to perform the RSI skill, the

average transport time to the hospital was less than the increased scene time required to perform the procedure. This brings into question the underlying protocol for the use of RSI in Victoria. Specifically, would expeditious transport to definitive care rather than RSI result in an increased survival of this sub-set of patients?

Further randomized trials are needed to determine if RSI is of benefit or detriment in patients suffering from stroke.

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4. Prehospital definitive airway is not associated with improved survival in trauma patients. Tsur AM, Nadler R, Tsur N, et al. J Trauma Acute Care Surg. Epub ahead of print. 2020;89:S237-241.

Establishment of a definitive airway in a trauma patient with a known or impending compromised airway remains a common practice throughout the world. It is routinely taught in prehospital trauma courses; however, data supporting this practice is scarce and conflicting. A definitive airway is defined as a tube successfully placed in the trachea with an inflated cuff below the vocal cords and is usually preceded by basic maneuvers. In the prehospital setting a definitive airway is obtained by either endotracheal intubation or cricothyroidotomy. The objective of this study was to investigate the association between a definitive airway in a prehospital trauma patient when it was determined by the prehospital provider that it was necessary and the patient's survival.

This is a retrospective review of all trauma patients treated by the Israel Defense Forces (IDF) Medical Corps from 2006 to 2018 for whom a prehospital attempt at a definitive airway was documented. The airway management protocol for the IDF is to initially attempt basic airway maneuvers such as suctioning, head-tilt chin-lift, jaw thrust, and oropharyngeal airway with bag valve mask ventilation. The indications for definitive airway management include impending airway failure not resolved by the basic airway interventions, apnea, or airway compromise. Of note, supraglottic devices such as a laryngeal mask airway (LMA), are only used by the Airborne Combat Rescue and Evacuation unit and therefore were not included in the study. The IDF treats both civilian and military patients, although only the military patients are followed long-term. Two subgroups were analyzed. The first group consisted of trauma patients who underwent only endotracheal intubation attempts without any attempts at cricothyroidotomy. The second subgroup analysis was of military trauma patients who were followed long-term in the registry. Since, only four female soldiers were treated, this analysis was limited to male soldiers.

A total of 15,793 patients were recorded in the registry between 2006 and 2018. Of these, 566 (3.6%) patients underwent attempts at a definitive airway (successful in 425 and unsuccessful in 141). Breaking down the options for definitive airway, endotracheal intubation only, cricothyroidotomy only, and both were attempted in 471 (83.2%), 31 (5.5%), and 64 (11.3%), patients respectively. The mechanism of injury was blunt 34% in penetrating in 50%. Documented injury patterns and patient characteristics were similar among the groups who underwent successful and failed definitive airway attempts. Prehospital survival rates were also similar between the groups (77.6% versus 78%, p= 0.928). In the subgroup of patients who underwent only endotracheal intubation without attempt at cricothyroidotomy, a successful definitive airway was not associated with improved prehospital survival. In the subgroup of soldiers who were analyzed long-term, a successful definitive airway was not associated with improved prehospital survival, 48 hour survival, or 30 day survival.

There are a number of limitations to this study. It is a retrospective chart review study and suffers from the inherent weaknesses associated with such a study. Long-term follow-up was only available for soldiers and not civilians. Many paramedics and physicians in the IDF are younger and less experienced so their results may not translate into a setting with experienced prehospital providers. Lastly, there are

a number of missing cases such that individual data points do not always add up to the total number of patients reported. This discrepancy and the rationale for not including these cases are not explained in the paper.

This study found a similar survival rate in trauma patients who needed a definitive prehospital airway in the opinion of the treating medic, whether or not that airway was successfully obtained. This similar survival rate was persistent after adjustment for injury characteristics and in the subgroups of endotracheal intubation attempts only, and of male soldiers with longer follow-up. Most significantly, this study noted that most patients survived even when the prehospital provider felt the patient needed a definitive airway but was unable to secure one.

In this study, patient survival was not improved by attempts to provide definitive airway control, which adds scene time and has known complications. We can add this study to the growing body of literature questioning the role of prehospital intubation and cricothyroidotomy in the trauma patient.

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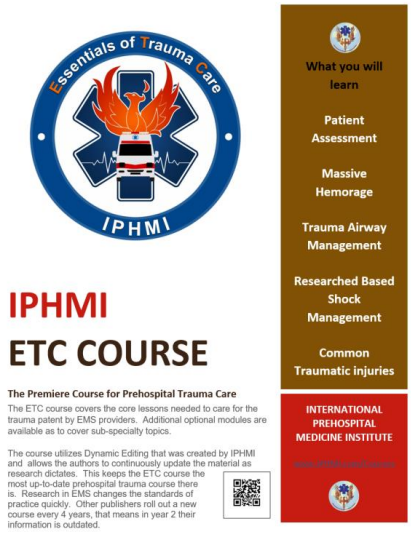
AMI

1. **HFSA/SAEM/ISHLT Clinical Expert Consensus Document on the Emergency Management of Patients with Ventricular Assist Devices.** Givertz M, DelFilippis E, Colvin M, et al . J Heart Lung Transplant 2019;38:677-698.

A greater number of patients with end-stage heart failure (HF) live in our communities dependent upon Ventricular Assist Devices (VADs). VADs are commonly used as a Bridge to Transplant (BTT), to allow for cardiac recovery after a myocardial infarction, or for Definitive Therapy (DT) in those patients ineligible for transplantation. EMS providers at all levels should have a basic understanding of the physiology, mechanics and emergency management of VADs.

Givertz et al published this consensus document to educate clinicians, both in and out of hospital, about the emergency management of patients with mechanical circulatory support (MCS). The typical VAD consists of four components; a continuous flow pump surgically implanted at the patient's cardiac apex and ascending aorta, a percutaneous driveline connecting the pump to a controller, the controller and a battery pack / power-based unit. Patients, families and providers are taught how to trouble shoot and correct problems with the three external components of a VAD.



MCS patients should be evaluated as would any other patient. A focused history and targeted physical exam should be completed paying attention to findings specific to VADs. The continuous flow nature of most VADs creates a challenge obtaining vital signs because of the continuous flow nature of the circulation provided by the pump. Vascular Doppler sonography is often used to determine blood pressure with the opening first sound correlating to the patient's mean arterial pressure, which should be approximately 80 mm Hg or slightly less. Palpating a pulse is difficult; therefore a cardiac monitor should be applied. Pulse oximetry is often unobtainable or inaccurate. Clinical signs such as skin color and level of consciousness are important to assess the patient's physiology.

All VAD's will alarm when equipment failures and difficulties are identified. Both patients and their families are trained to correct these problems before patients are released to the community. Patients typically travel with spare batteries and device controllers, both of which can be easily switched to correct and prevent equipment failures.

Cardiac arrest and unstable dysrhythmias are often difficult to determine clinically. Pulselessness and the inability to obtain a blood pressure are normal findings in VAD patients. Unresponsiveness, apnea and the absence of a mechanical hum on cardiac auscultation are better indicators of cardiac arrest. The authors, as well as the American Heart Association, recommend manual CPR for VAD patients found as above. The authors do not recommend the use of mechanical chest compression devices with VAD patients. Symptomatic dysrhythmias, including ventricular fibrillation, should be treated using standard ACLS algorithms.

Advanced Trauma Life Support principals and protocols apply to all VAD patients who sustain a blunt or penetrating traumatic injury. All patients with VAD's receive anti-thrombotic therapy and this should be considered during trauma triage. The greatest risk to an MCS during a traumatic event is the dislodgment or damage to the pump and/or driveline. An X-ray of the driveline should be obtained upon arrival to the hospital to confirm pump position and integrity.

Infection and sepsis are common complications of MCS and can have serious implications for VAD patients, specifically DT patients. Common VAD related infections include driveline infections ranging from erythema of the skin, cellulitis and deep infections encompassing the fascia and muscle. Pocket infections involve the "pocket" where the pump is surgically implanted. These often result in fluid collecting within the pocket. Bloodstream infections occur in up to 30% of VAD patients, usually within the first three months of MCS implantation and may be related to the pump, driveline, pocket or other sources. MCS patients are also at risk for community-acquired infections such as urinary tract infections and pneumonias. The management for VAD associated infections is based on the type and extent of the infection.

This article provides information about implanted VADs, the best methods of assessing the function of the device as well as the patient's status, and the management of equipment-related emergencies. As more and more patients return to our communities with VAD's, providers be knowledgeable in managing device related emergencies that may occur in this patient population. Device specific field guides may be used as a resource for VAD related emergencies and can be found at www.mylvad.com/medical-professionals/resource-library/ems-field-guides.

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2. **Impact of Emergency Medical Services Activation of the Cardiac Catheterization Laboratory and a 24-Hour/Day In-Hospital Interventional Cardiology Team on Treatment Times (Door to Balloon and Medical Contact to Balloon) for ST-Elevation Myocardial Infarction.** Pulia M, Salman T, O'Connell TF, et al. Amer J Cardiol 2019;124:39-43.

It has been well demonstrated that the sooner a patient with an ST-Elevation Infarction (STEMI) reaches the interventional cardiac care team in the cardiac catheterization lab the less the myocardial ischemic time and the better the patient outcome. This has been coined the door-to- balloon time (D2B). In the past decade, some hospitals have staffed interventional catherization laboratories 24-hours per day with the goal of decreasing the D2B time. In this same time frame, EMS systems have developed the ability to obtain, interpret, transmit and activate the Interventional cardiac team prior to arrival at the receiving facility.

The authors of this study retrospective study endeavor to corollate the effect of EMS activation on Door to Balloon time but also EMS (first medical) patient contact to balloon time (FMC2B) in a facility with 24 hour per day catheterization lab capability. The study cohort consisted of patients with STEMI from April 2009 to December 2015 at Loyola University Medical Center who were cared for in their interventional cardiac Cath lab. During this time 190 patients were entered into the study. They were divided into two groups, depending on whether the catheterization lab activation was initiated by the Emergency Department or by the responding EMS service. The baseline characteristics of both groups were similar, with the exception that the EMS activation group patients were more likely to have chest pain as the primary presenting symptom (96% vs 84%). D2B times were significantly shorter in the EMS activation group (37 vs 57) minutes. When looking at FMC2B times, again patients received interventional procedures in a much shorter time frame (52 vs 67) minutes.

The EMS authors note several limitations. All data was obtained from a single center. The EMS group had a higher percentage of patients with a primary presenting complaint of chest pain than did the Emergency Department group which could have shortened the ED evaluation time. Those patients without chest pain likely required additional, more complex evaluation and testing.

This study demonstrated that EMS activation of an in-house interventional cardiac team results in decreased total myocardial ischemic time. Unfortunately, the study did not look at any differences in patient outcome. It can be reasonably concluded that any significant decrease in myocardial ischemic time should result in better outcomes; however this aspect requires further study. It is also clear that in systems without in-house interventional cardiovascular services, early activation of the interventional team by EMS providers could result in even greater reductions in ischemic time. A secondary question to be studied is why the EMS group had a greater number of patients with a primary complaint of chest pain vs. the emergency department group and whether or not EMS needs better education in the recognition of atypical presentations of myocardial infarction.

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Bleeding Control

1. **Stop the Bleed: The Effect of Hemorrhage Control Education on Laypersons' Willingness to Respond During a Traumatic Medical Emergency.** Ross EM, Redman TT, Matt JG, et al. Prehosp Disaster Med 2018;33:127-132.

The "Stop the Bleed" national campaign advocates that all citizens be trained in basic methods of hemorrhage control. The ideal educational program as well as the duration of instruction needed have not been identified. The objective of this study was to determine the willingness of laypersons to respond to a bleeding patient from a traumatic emergency after participating in a brief hemorrhage control educational program.

The authors recruited 236 participants who volunteered for the "Stop the Bleed" program at multiple venues in two Texas counties. Data collection occurred from September 2016 through March 2017. Participants completed a pre-course questionnaire regarding their comfort levels, knowledge, and attitudes about tourniquets. Participants were randomized prior to beginning the course and were provided one of three different commercially available tourniquets. The participants were then asked to place the provided tourniquet on a mannequin before beginning the course. Following the pre-course questionnaire and initial tourniquet placement on the mannequin, participants were provided a 20-minute didactic instruction on hemorrhage recognition and control techniques and provided time for hands-on instruction and practice of tourniquet application on both adult and child-size mannequins. Following the program completion each participant was asked to complete a post-course questionnaire with similar questions and knowledge assessment as the pre-course questionnaire. Eighteen participants were excluded from the study results because they held a previous medical certification. Of the remaining 218 participants an additional 14 did not complete a post-course questionnaire and were not included in the final analysis. Information from the pre- and post-course questionnaire and tourniquet performance was compared and results analyzed.

The pre-course questionnaire completed by the participants identified 8 common barriers to act that included (in descending order): do not feel adequately trained to help (63.3%), fear of making a mistake (45.4%), fear of causing more harm than good (42.2%), others would be more qualified to help (28.4%), fear of being sued (16.5%), fear of contracting a blood-related illness from the victim (12.4%), do not like blood (9.2%), and fear of being judged by others (5.0%). Pre-course survey items compared to the same post-course survey items showed a marked improvement.

Survey items	Pre-course % / Post-course %
Opinion on safety of TQ	
• Safe	72.5% / 97.5%
• Unsafe	2.3% / 0.5%
• Unsure	25.2% / 2.0%
Opinion on the willingness to use a TQ in real life	
• Yes	64.2% / 95.65%
• No	2.8% / 0.5%
• Unsure	33% / 3.9%
Tourniquet general knowledge assessment	
• Correct T/F answers	4.1 of 5 / 4.7 of 5
Tourniquet placement knowledge	

- Correctly identified images 3.1 of 4 / 3.6 of 4

This study also revealed a high rate of application failure of commercially available tourniquets when placed by untrained laypersons. In fact, successful placement occurred only in 17.7% of applications.

This study was limited in that it focused on adult-only participants. Other studies suggest that teaching younger students may have a greater impact on community preparedness. Participants were selected from the community that volunteered to take a program on controlling hemorrhage. The use of various testing sites may have had an influence on the success of the participants.

This study found that short educational programs can have a positive influence on a layperson's willingness to respond and their technical efficacy in applying a tourniquet in trauma situations. Future programs should be designed to address identified barriers to act. Community/public education programs complementing the "Stop the Bleed" campaign should continue to be a priority. Critical re-evaluation of how commercially available tourniquets are packaged with instructions for application is needed to improve the response by non-medically trained laypersons.

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2. A Preliminary Investigation of Civilian Clinician Perspective & Just-in-Time Guidance for Tourniquet Use to "Stop the Bleed". Lowndes B, Law K, Abdelrahman A, et al. Mil Med 2019;184(Suppl. 1):28-36.

Control of external hemorrhage is a key component in decreasing preventable death after traumatic injury. Tourniquet application has gained widespread acceptance as an important method of bleeding control from injured extremities.

This publication examines the use of Just-In-Time instructions for the application of tourniquets using various instructional sets. The investigators used PGY 1 Surgical residents, medical students and Research fellows during an educational event. The test groups were given a pre-enrollment questionnaire that determined the extent of prior training and utilization of tourniquets. A total of 30 subjects were enrolled in the first phase of the study and 20 in the second. In the first phase, the participants were randomized into 3 groups, each of which used a different instruction sheet. Group one used the CAT (generation 7) tourniquet instructional sheet that comes pre-packaged with the device. Group two was given the instructional sheet prepared by the American College of Surgeons (ACS). Group three used the Department of Homeland Security (DHS) directions. The subjects were briefed on the simulated trauma incident, given verbal instructions and an opportunity to ask task related questions prior to starting. The simulation consisted of a lower leg mannequin with a simulated hemorrhaging wound. Located next to the mannequin was a CAT-7 tourniquet, a set of instructions appropriate for the particular group, and a marker to denote the time of application. Prior to the second phase of the study, the ACS changed their instructional sheets. The second cohort was divided into two groups, the first using the original instructional set and the second the new revised one.

Analysis of the first cohort showed that in both those participants who had prior training in tourniquet application as well as those who were untrained, the ACS instructional sheet had the fastest completion time of the tasks at an average of 70 seconds. This was followed by the DHS sheet at 105 seconds and lastly the included CAT-7 instructions at 137 seconds. The ACS sheet also had a significantly lower combined failure rated across the 10 steps of tourniquet application evaluated in the study. The subjects in the second phase of the study demonstrated a lower average application time using the ACS version 2 instructions (73 secs.) over the ACS version 1 set (89 secs). However, both times were longer than that recorded using the ACS version 1 instructions in the first phase of the study.

Military experience and subsequent civilian use have clearly demonstrated that the quick and correct application of tourniquets give the patient with exsanguinating hemorrhage from an extremity

the best possible chance of survival. This study demonstrated that the ACS instructions (both version and 2) provided a quicker application time and demonstrated less missed or incorrectly performed steps compared to the DHS instructions or the included manufacturer instructions. The ACS sheets were primarily a pictorial depiction with few keywords or cues. The DHS sheet and the manufacturer's instructions are a combination of pictorial and instructional narrative.

The study does have some major limitations as far as its applicability to the general civilian population. First the subjects, whether or not they had any prior experience with tourniquet application, were none the less medically trained (medical students, surgical residents or fellows). Their advanced knowledge of the anatomy and physiology of bleeding combined with their ability to read, comprehend, and complete medical tasks differentiates them from most of the non-medically trained population. The simulation used during the study did not include the real-life expected endpoint of stopping the simulated bleeding because the mannequin used could not simulate occlusion of the extremity and thus the cessation of bleeding. It is also crucial to note that none of the three instruction sets were developed as or intended to be Just-In-Time instructions.

The development of the best possible Just-In-Time tourniquet application instructions, particulary for non-medically trained individuals, is imperative when dealing with sudden extremity trauma resulting in life threatening hemorrhage. This study showed that even medically sophisticated but tourniquet inexperienced individuals have difficulty successfully applying a tourniquet using existing directions as a Just-In-Time guide. Although not a component of this study, it lends support to the recommendation that hands-on training and education is required. This study may provide a road map for future studies that involve non-medically trained subjects. Finally, higher fidelity, inexpensive mannequins that allow for the measurement of blood loss and cessation of bleeding in the extremity should be developed and used.

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3. Abdominal Aortic and Junctional Tourniquets versus Zone III Resuscitative Endovascular Balloon Occlusion of the Aorta in a Swine Junctional Hemorrhage Model. Schectman DW, Kauvar DS, Guzman RD, et al. J Trauma Acute Care Surg. 2020;88:292-297.

Hemorrhage is a leading cause of death both on the battlefield and in the civilian trauma setting. A common cause of death in the military environment is death from bleeding in patients with junctional and non-compressible torso hemorrhage (NCTH) who die prior to reaching surgical care. Two adjuncts have been utilized to control life-threatening hemorrhage in these patients in the prehospital setting. The Abdominal Aortic and Junctional Tourniquet (AAJT) is a field- usable external abdominal device which is used to occlude the abdominal aorta and control pelvic and inguinal junctional hemorrhage. The Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) is a device which can be placed through a femoral artery into the lower aorta to occlude blood flow distally. Although the REBOA is primarily used in the hospital, it has been tried in the austere military environment and select civilian prehospital settings. Both devices work by

limiting arterial blood flow below the level of the device. While independent studies have confirmed the effectiveness of both devices, no study has compared the two directly.

This was an animal study utilizing anesthetized swine that underwent close hemodynamic monitoring while exsanguinated in a simulated military type injury pattern. The devices were then applied to control hemorrhage and the pigs were resuscitated using a standard protocol. The injury patterns for the swine included a controlled hemorrhage of 20 mL/kg followed by a mid-shaft femur fracture. Finally a laceration was made to the right femoral artery to allow the pig to bleed over a 15 minute period. Once the pig had lost 40% of their estimated blood volume a REBOA or AAJT was applied and the pig was resuscitated with whole blood transfusion. The REBOA was deployed in zone III (aortic bifurcation) which preserved blood flow to the proximal abdominal organs. The selected device was then removed and the pig monitored for six hours. Primary outcomes were survival, blood loss, hemodynamic performance, and laboratory parameters. All animals were euthanized upon completion of study.

All animals survived the initial hemorrhage and intervention period. One animal from each group died during the observation period. Both AAJT and REBOA produced near-complete hemorrhage control. As expected, a significant decrease in mean arterial pressure (MAP) was noted in all animals during hemorrhage. This decrease was reversed with the application of either the AAJT or REBOA in the absence of fluid resuscitation. All monitored hemodynamic values improved after resuscitation but did not normalize in either group. Laboratory values were similar among both groups although an earlier hypokalemia was noted in the AAJT group.

This was a combat casualty care relevant swine model of severe shock and junctional hemorrhage. The AAJT and zone III REBOA showed similar survival, junctional arterial hemostasis, and physiologic impact. Both improved the MAP however distal tissue perfusion to the lower extremities was better with the REBOA, as expected. Aortic balloon occlusion does not affect distal venous outflow while the AAJT's nonselective abdominal compression affects both arteries and veins.

Since both devices had a similar survival and physiologic profile, either would be acceptable in the combat austere environment and the civilian prehospital environment. While the REBOA is a more flexible option, it is much more difficult to use. Even in a controlled hospital setting it can be challenging to obtain femoral artery access in a hypovolemic patient. The AAJT is much easier to deploy and sterile technique is not required. Much less training is involved in learning the proper utilization of the AAJT In contrast to the extensive training required to properly use the REBOA. The primary limitation of this study is that it was a simulation of hemorrhage in an animal model. The comparative effectiveness of these devices in humans in the prehospital setting is unknown. Another limitation in the use of these devices relates to the metabolic derangements including lactic acidosis and hyperkalemia that occur. In this study, application time for these devices was limited to 60 minutes. Previous animal studies have shown that longer application times can lead to impaired spinal cord blood flow and paralysis.

In summary, both the AAJT and REBOA are effective in controlling abdominal and inguinal junctional hemorrhage. Device selection should be based on available resources, provider training, and the potential complication profile.

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4. Effectiveness of the combat application tourniquet for arterial occlusion in young children. Kelly JR, Levy MJ, Reyes J, Anders J. J Trauma Acute Care Surg. 2020;88:644–647.

The Combat Application Tourniquet (CAT) has proven its effectiveness in controlling limb hemorrhage in adults in both military combat and civilian trauma settings, both for penetrating and

blunt injury. An unanswered question has been the ability of the CAT to stop external hemorrhage in children.

After obtaining institutional review board approval, the authors of this study sought to enroll healthy children ages 1 through 8 years undergoing general anesthesia for elective orthopedic surgery. Permission was obtained from parents or legal guardians as well as from those participants age 7 years and older. Once anesthetized, a CAT was placed as proximal as possible on the limbs and tightened until Doppler pulses were no longer heard. After 30 seconds of arterial occlusion, the tourniquet was removed.

A total of 13 children, ages 2 to 7 years, participated in the study. Seven children were preschool age and 6 were school age. The CAT was applied to 11 upper limbs and 13 lower limbs. The arm circumference varied between 13 and 24 (average 16.3) cm (5.1-9.5 inches, average 6.4 inches). Leg circumference varied between 24.5 and 34.5 (average 27.9) cm (9.6-13.6 inches, average 11 inches). Complete arterial occlusion was achieved in all cases (100%).

Although this was not a prehospital study, the finding that the CAT can successfully provide arterial occlusion in children as young as 2 years of age in this study has applicability for emergency medical care providers of all types and levels. The study is limited by the small sample size, the use of only one commercial tourniquet, and the fact that a minimum effective limb circumference was not determined. However, in children and infants younger than those studied, in whom the CAT may not be able to be effectively applied, external hemorrhage control can usually be obtained by the application of direct pressure to the bleeding site.

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Blood and Blood Products

1. **Prehospital Blood Product and Crystalloid Resuscitation in the Severely Injured Patient: A Secondary Analysis of the Prehospital Air Medical Plasma Trial.** Guyette FX, Sperry JL, Peitzman AB, et al. Ann Surg. 2019 Apr 13. doi: 10.1097/SLA.0000000000003324. [Epub ahead of print]

Uncontrolled hemorrhage is the number one cause of preventable death in both the civilian and military trauma settings. Trauma centers have adopted the principles of damage control resuscitation, which includes minimizing crystalloid infusion while transfusing packed red blood cells (PRBC), plasma, and platelets. Additionally some centers have begun using whole blood in lieu of component therapy. These techniques are just beginning to be utilized in some prehospital systems.

Prehospital blood products (defined as PRBC, plasma, or both) are becoming more available in civilian helicopter EMS systems. Recently, the large PAMPer (Prehospital Air Medical Plasma) trial demonstrated an improvement in 30-day mortality for severely injured patient at risk for hemorrhagic shock who underwent prehospital plasma resuscitation. The investigators noted a 10% improvement in survival in patients who received plasma compared to standard crystalloid resuscitation. This study is a secondary analysis of their data looking specifically at which combination of prehospital fluid has the highest impact on survival.

The authors examined four possible resuscitation strategies. The options for resuscitation were crystalloid only, PRBC, plasma, and plasma with PRBCs (PRBC + plasma). All blood components were administered with or without additional crystalloid. Patients were eligible if they were transported by helicopter EMS to a PAMPer network trauma center, had hypotension (SBP 70-90 mmHg) and tachycardia (HR > 108 bpm), or severe hypotension (SBP < 70 mmHg) alone.

A total of 407 patients were enrolled in the study. There were 139 (34%) patients who received crystalloid only, 83 (20%) who received PRBC, 147 (36%) received plasma, and 38 (10%) received PRBC + plasma. The results demonstrated that all prehospital blood product groups had a significantly lower 30-day mortality than those who received crystalloid only resuscitation. The PRBC + plasma group had the greatest survival benefit with a 62% reduction in the risk of mortality. This was followed by the plasma group with a 43% reduction in the risk of mortality and the PRBC group with a 32% reduction in the risk of mortality.

This study confirms that any blood product resuscitation is superior to crystalloid resuscitation in terms of 30–day mortality. The greatest benefit was shown in those patients who received PRBC + plasma. Patients with findings of shock should receive prehospital blood products whenever possible. If both PRBC and plasma are available, patient should receive both. Crystalloid alone appears to be inferior to blood product administration. Additionally, the use of whole blood transfusion in the prehospital setting has gained traction and may be the superior option to component therapy. Further studies are required to explore this possibility further with expansion of blood and blood product administration from the helicopter EMS programs to ground-based EMS response systems.

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2. **Prehospital Plasma in Injured Patients is Associated With Survival Principally in Blunt Injury: Results From Two Randomized Prehospital Plasma Trials.** Reitz KM, Moore HB, Guyette FX, et al. J Trauma Acute Care Surg. 2020;88:33-41

We previously reviewed two major articles analyzing the effect of prehospital plasma transfusion in seriously injured trauma patients. Both studies had a similar design but took place in very different environments. The Control of Major Bleeding After Trauma (COMBAT) Trial was a single center trial in an urban ground ambulance environment. Patients were randomized to either two units of plasma or standard ground transport care involving crystalloid resuscitation. The Prehospital Air Medical Plasma (PAMPer) Trial was a helicopter based study of multiple different aeromedical teams in which patients either received plasma or standard care which involved crystalloid and in some cases packed red blood cell transfusion. Inclusion criteria for both studies were similar and enrolled trauma patients who were hypotensive and tachycardic (SBP < 90 mmHg and HR > 108) or patients who were severely hypotensive without tachycardia (SBP < 70 mmHg). Results varied among the studies. The PAMPer Trial showed a survival benefit to prehospital plasma transfusion in the aeromedical setting while the COMBAT Trial was stopped early as showed no benefit to prehospital plasma transfusion in the urban ground ambulance environment.

In this study the authors combined data from both the COMBAT and PAMPer Trials to further analyze whether there is a benefit to prehospital plasma in severely injured trauma patients. The primary outcome measured was 28-day mortality with secondary outcome analysis including 24 hour mortality, prehospital transport time, and blood transfusion requirements.

A total of 626 patients were in the combined studies. The mean prehospital systolic blood pressure was 80 mmHg, mean Injury Severity Score 22 (major trauma = ISS score>15), and an overall mortality of 24.8%. Blunt mechanism of injury was the most common (75%), with nearly all being from motor vehicle collisions. The 25% who injured due to penetrating trauma were equally divided among gunshot wounds and stab wounds. As expected, the majority of patients in the PAMPer study were blunt and the majority of patients in the COMBAT trial were penetrating.

In those who suffered blunt injury, prehospital plasma transfusion was associated with a 24% reduction in the risk of blood transfusion as compared to those who received standard care. Most significantly, prehospital plasma transfusion was associated with a survival benefit in both short-term (24 hours) and long-term (28 day) mortality in blunt injured patients. The authors specifically noted a 32% improvement in long-term survival in severely blunt injured patients who received prehospital plasma. There was no survival benefit noted among penetrating trauma patients who received a prehospital plasma transfusion.

There are several theories as to why blunt injured patients may benefit from prehospital plasma transfusion while those with penetrating injury do not. In these studies, the blunt injured patients were older, had more significant injuries including traumatic brain injury, and longer overall prehospital transit times, and overall higher mortality. The systemic inflammatory changes associated from blunt injury may be different than those in penetrating injury. Penetrating trauma has a higher rate of bleeding amendable to rapid surgical control versus blunt trauma. Additionally, most penetrating trauma occurs in an urban environment with shorter transport times which may limit the relative benefit of prehospital plasma transfusion.

Unfortunately, there remain significant logistic challenges and obstacles to the widespread implementation of prehospital plasma administration including the fact that, at least in the United States, plasma is a frozen product which has strict storage requirements and must be thawed prior to use.

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Carbon Monoxide Poisoning

1. **The Impact of Treatment with Continuous Positive Airway Pressure on Acute Carbon Monoxide Poisoning.** Caglar B, Serin S, Yilmaz G, Torun A, Parlak I. Prehosp Disaster Med.2019;34:588–591.

Carbon Monoxide (CO) poisoning is a worldwide problem affecting over 50,000 patients annually. Carbon Monoxide is a byproduct of combustion and can come from many sources, from dwelling fires to malfunctioning heating systems. CO has over 200-times greater affinity for hemoglobin than does oxygen and has a half-life of four to five hours. Current prehospital therapy for CO poisoning is the administration of 100% oxygen to decrease the half-life of CO in the bloodstream to approximately 40 to 60 minutes. In severe cases patients may be transported for hyperbaric therapy.

This prospective study enrolled 80 patients who presented to the emergency department with a diagnosis of CO poisoning and an arterial blood gas carboxyhemoglobin (COHb) above 10%. Patients were excluded from the study if they were under 18 years of age, pregnant, complained of syncope, seizure, shortness of breath or chest pain. Further exclusions included unstable vital signs or GCS less than 15. The patients were divided into two (2) groups of 40 patients each: group one receiving standard care of 15 lpm of oxygen via a non-rebreather mask and group 2 receiving 100% oxygen at 12 cm H2O using continuous positive airway pressure (CPAP). Three patients in the CPAP group were excluded from analysis because of mask intolerance. COHb levels were measured non-invasively using a portable pulse CO-oximeter prior to treatment and at 30 minutes. Patients in the CPAP group demonstrated a reduction in median COHb levels of 13% (initial COHb 22%, repeat 9%) vs. 6% (initial COHb 14%, repeat 9%) in the 15 lpm mask group at the 30 minute mark.

This study demonstrates that the application of CPAP with 100% oxygen appears to decrease the half-life of CO attached to the hemoglobin. It should be noted however that this study excluded critical patients and those with a higher susceptibility to CO as well as not evaluating late neurological disorders. With CPAP being a common prehospital modality, it would seem a logical progression to include early application on the scene and during transport as a prehospital therapy for patients with suspected CO poisoning. Remembering that this study was a hospital ED study, further evaluation should be undertaken in the prehospital environment.

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2. **Comparison of non-invasive CPAP with mask use in carbon monoxide poisoning.** Turgut K, Yavuz E. Amer J Emerg Med 2020;38: 1454-1457.

Carbon monoxide (CO) is an odorless, tasteless, colorless gas that is produced anytime a fossil fuel is burned. It is also an inhaled poison, resulting in greater than 50,000 emergency department visits in the United States alone. Once in the human body, CO forms carboxyhemoglobin (COHb) by binding to hemoglobin with 200 times greater affinity than oxygen.

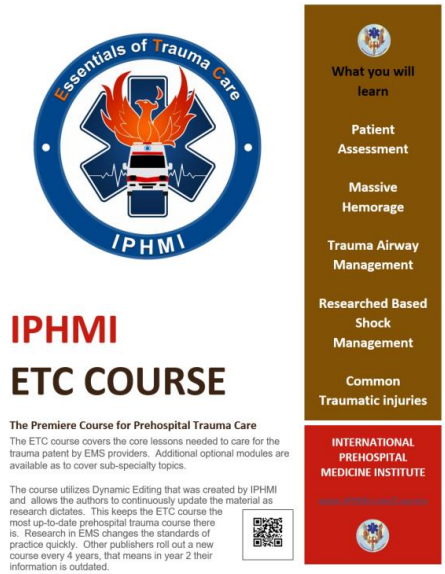
Patients with mild CO exposures often complain of headache, dizziness, muscle pain, and neuropsychological effects. Higher levels of CO poisoning may lead to confusion and death. CO poisoning may also result in neurological sequelae in some cases causing lifelong disabilities. In addition to the physical exam and history, the measured COHb level is used to diagnose CO poisoning. COHb levels of 3% or greater in non-smokers and 10% in smokers strongly suggest CO exposure.

Treatment for CO poisoning is aimed at removing the CO from hemoglobin, thus preventing hypoxia. This is typically accomplished by providing supplemental oxygen via mask or nasal cannula. This oxygen delivery method accelerates CO removal from hemoglobin but does not lessen the chance of

neurological sequelae. Hyperbaric oxygen (HBO2) has been used to treat some patients. One prior study reported that HBO2 resulted in a 46% reduction in neurologic sequelae. HBO2 requires a hyperbaric chamber not immediately available to most emergency departments.

Continuous positive airway pressure (CPAP) is frequently used to treat pulmonary edema and can be used to deliver oxygen at a higher pressure than a mask or nasal cannula. The authors of this paper hypothesized that CPAP would decrease CO levels sooner than oxygen delivered via a standard nonrebreather mask (NRB).

This was a 12-month (C/Y 2019), observational prospective research project in the emergency department of a Turkish tertiary care center. The study was approved by the local Research Ethics Committee. Adult emergency department patients with CO poisoning were included in the study. In addition to medical history and physical examination, the carboxyhemoglobin saturation (SpCO) level of these patients was measured with a portable CO-oximeter (MasimoSET rainbow Rad-57 Pulse CO-oximeter, Masimo, Irvine, CA). Awake patients with SpCO levels between 20% and 35% were included in the study. Patients were divided into two groups, NRB and CPAP based on order of presentation to the hospital. The NRB group received 15 LPM of oxygen. The CPAP group was treated with a non-invasive mechanical ventilator (LTV 1200 portable ventilator) using the CPAP mode (FiO2: 100%, PEEP: 5 cm) using a full face mask. The patient's initial COHb level was measured by venous blood at the time of arrival as well as CO-oximeter. Subsequent and repetitive SpCO measurements (30-minute intervals) were obtained via the CO-oximeter. Based on past clinical experience with CPAP tolerance, CPAP was only used for 90 minutes in the CPAP group, and then oxygen was continued via a non-rebreather mask. Both groups received at least 90 minutes of therapy.



Forty-five patients were enrolled in the study (24 for NRB and 21 in the CPAP group). Median age was 40 years. The number of smokers was higher in the CPAP group than the NRB group (33.3% VS 16.7%). Presenting complaints for all patients were headache (68.9%), nausea and vomiting (15.5%), dyspnea (8.9%), and dizziness (6.7%). The initial SpCO level averaged 25% (range 21–33%). The CPAP group demonstrated a greater decrease in SpCO at 30 minutes than the NRB group [16% (range 12–27%) vs 21% (range 15–28%) respectively, $p<0.001$]. The 60-minute measurements were also lower in the CPAP group [10% (range 7–25%) vs 17% (range 11–26%), $p< 0.001$]. Again at 90 minutes, the CPAP group had significantly lower values [7% (range 2−23%) vs 13% (range 9–25%), $p< 0.001$]. The CPAP group had the fastest decrease from 0 to 30 min [median difference: 8% (range 3–14%), $p< 0.001$]. This improvement in CO levels relieved presenting complaints faster, resulting in earlier discharge from the emergency department (127.6 minutes in the CPAP group vs 201.3 minutes in the NRB group).

This study demonstrated that both the non-rebreather mask and CPAP method are effective in reducing CO levels in the blood. The CPAP method decreased CO levels faster than the NRB method resulting in quicker relief of symptoms and shorter emergency department stays. Limitations of the study include the small number of patients enrolled and that it did not address any possible reduction of neurological sequelae as a result of faster reduction of blood CO levels.

CPAP may be an effective treatment option for CO poisoning in the pre-hospital environment. Providers should note that the CPAP equipment used in this study was able to deliver oxygen at an FiO2

of 100%. It is unknown if the use of standard CPAP equipment with lesser FiO2 delivery capabilities would have the same results or be less advantageous than O2 via an NRB.

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Cardiac Arrest

1. **Effect of bystander CPR initiated by a dispatch centre following out-of-hospital cardiac arrest on 30-day survival: Adjusted results from the French National Cardiac Arrest Registry.** Noel L, Jaeger D, Baert V, Debaty G, Genin M, Sadoune S, et al Resuscitation 2019;144:91-98.

The American Heart Association (AHA) describes five links for survival in Out of Hospital Cardiac Arrest (OHCA);

1. Recognition of cardiac arrest and activation of the emergency response system,
2. Early cardiopulmonary resuscitation (CPR) with an emphasis on chest compressions,
3. Rapid defibrillation,
4. Basic and advanced emergency medical services and advanced life support, and
5. Post-cardiac arrest care.

In France, 40,000 – 50,000 people annually are affected by OHCA. French EMS is two tiered with Fire Department Basic Life Support Ambulances (BLS) with follow on scene care provided by ACLS trained Mobile Medical Teams (MMTs) . Each county has its own Dispatch Center (DC) which will guide callers through Chest Compression only CPR for suspected OHCA. Additionally, all OHCA patients are recorded in a French National Cardiac Arrest Registry (Re'AC).

The authors conducted a retrospective, comparative, multicenter study using data from Re'AC for the time period from 1 January 2012 through 1 May 2018. Patient inclusion criteria were medical OHCA and patients who received ACLS care. Exclusion criteria were deceased individuals, non-medical OHCA, no ACLS, no CPR for greater than 60 minutes and patients with Do Not Resuscitate orders.

Patients included in the study were subdivided into three groups;

- Group A patients did not receive bystander CPR,
- Group B patients received bystander-initiated CPR, and
- Group C patients received bystander CPR after being prompted by a dispatch center.

Outcome data was evaluated for 30-day survival and neurological outcome (Cerebral Performance Category or CPC score of 1 or 2 was considered to be a good outcome). Of the identified 85,634 OHCA patients in the study's time frame, 18,185 met the inclusion criteria and were included in the study.

Thirty-day non-adjusted survival rate was highest with Group B patients (11.5%). Group C patients had slightly lower thirty-day survival (9.3%). Group A patients survival was the lowest (3.9%). After adjustment for potential confounders, 30 day survival for groups A, B, and C were 5.1%, 8.9% and 7.4% respectively. A non-shockable rhythm was documented in 70.5% of the overall patient population. Ventricular Fibrillation or pulseless V- Tach was seen in 25% of group A patients, 34% of Group B patients, and 36% of Group C patients. The authors noted that over 70% (71.7%) of the bystander CPR performed for Group C patients was done by family members. Of those patients who survived, a CPC score of 1-2 was recorded in 76% of Group A, 84% of Group B, and 83% of Group C.

This study has a number of limitations. This was a retrospective study and is limited by the data points entered into the cardiac arrest registry. In addition, while a shockable rhythm was found in between one quarter and one third of patients, no information was provided about time to defibrillation.

As the AHA recommends, early (bystander) CPR in OHCA is one of the key links to survival. EMS programs should continue to promote bystander CPR and layperson CPR training. Additionally, EMS dispatch centers should work to quickly identify OHCA patients and direct the caller to immediately initiate compression only CPR. This study shows that despite a delay in initiating CPR until directed to do so by an emergency medical dispatcher, outcomes are very similar to the survival when CPR is immediately begun by a bystander.

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2. Effectiveness of Prehospital Dual Sequential Defibrillation for Refractory Ventricular Fibrillation and Ventricular Tachycardia Cardiac Arrest. Beck R, Ostermayer D, Ponce J, Srinivasan S, Wang H. Prehosp Emerg Care 2019;23:597-602.

Improving survival from out of hospital cardiac arrest (OHCA) remains a challenge for many, if not most, EMS systems. Early recognition, bystander CPR and early defibrillation are key factors for successful out of hospital resuscitation and survivability of the patient. Occasionally, patents remain in ventricular fibrillation (VF) or ventricular tachycardia (VT) despite repeated shocks from a defibrillator. Dual sequence defibrillation (DSD) has been advocated as an intervention to convert refractory VF/VT, although the literature as to its success is conflicting. DSD is typically attempted by placing two sets of defibrillation pads from two separate manual defibrillators in opposing positions on the torso, anterior-lateral and anterior-posterior, followed by sequential biphasic defibrillations at 360 joules each. This study is an effort to determine if DSD is a reliable treatment option for patients in refractory ventricular fibrillation (RVF).

The authors conducted a four-year, IRB consent waived, retrospective study of all patients treated for OHCA by the Houston, TX Fire Department (HFD) EMS service. They looked at patient outcomes including return of spontaneous circulation (ROSC), survival to hospital admission, survival at 72 hours, and survival to hospital discharge. They defined RVF as patients who remained in VF following three defibrillations. The HFD DSD protocol requires on-line medical control consultation for two defibrillators to deliver simultaneous, 360 joules, biphasic shocks.

The study group was divided into two subsets, patients who received DSD and those that were treated with standard defibrillation. During the four year study period ending December 2016, 314 patients were identified as OHCA presenting with RVF. After excluding four patients for missing data or being underage for the study, 310 patients remained. The average age for all patients was 62 years of age. Seventy-one patients received at least one attempt at DSD. The remaining 239 patients received standard defibrillation. Bystander CPR was performed on 54% of the DSD group and on 49% of the standard defibrillation group.

ROSC occurred in 39% of the DSD group and in 60% of the standard defibrillation group. There was no statistical difference between the two groups in survival to hospital admission, 72-hour survival or survival to discharge, although DSD trended to be lower in all survival categories.

In this study, RVF patients were less likely to gain ROSC with DSD than standard defibrillation. The authors observed no difference in discharge outcomes and concluded that DSD may not be beneficial for patients in RVF.

HFD is an urban EMS system with many resources and the ability to bring multiple defibrillators and personnel quickly to the scene of an OHCA. Even with that depth of resources, DSD failed to improve

the occurrence of ROSC, or survival to discharge, in OHCA patients in RVF. Systems with fewer resources may have challenges implementing a DSD protocol, which may or may not have a patient survival benefit. Additional research is needed to determine if, and when, DSD is beneficial in the treatment of RVF in OHCA.

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3. Decreasing time to first shock: Routine application of defibrillation pads in prehospital STEMI.
Felder S, Van Aarsen K, Davis M. Canad J Emerg Med 2020;22:82-85.

Prehospital cardiac arrest patients have had a substantial increase in positive outcomes over the past decade as a result of team focused and choreographed efforts by EMS personnel. The time to initial defibrillation is a proven prime metric in increasing survivability. The authors set out to determine if the routine placement of defibrillation pads in patients presenting with ST-elevation myocardial infarction decreased time to initial shock in the event of cardiac arrest.

The authors conducted a 4 year retrospective analysis of 446 adult patients (age greater than 17 years) that had a prehospital diagnosis of STEMI. Halfway through this time period, the standard protocol changed to have providers routinely apply defibrillation pads to patients with suspected STEMI. The time to defibrillation, when needed, for the before and after groups was compared. Of the 446 patients, 11 experienced an out of hospital cardiac arrest (OOHCA). Pads were placed after cardiac arrest in 7 patients and before arrest, upon initial diagnosis of STEMI, in 4 patients. The time to initial defibrillation in the "pads on protocol" was significantly faster than in those who did not have pads placed prophylactically (mean time 17.7 seconds versus 72.7 seconds). All 4 patients enrolled in the "pads on" study survived to discharge compared to 6 of the 7 patient in the delayed application group.

This study was limited by the very small size of the two study groups and the lack of analysis for other variables that might have affected the results.

The study demonstrated that there was a significant reduction in time (55 seconds faster on average) to the initial defibrillation in patients with pads applied prior to cardiac arrest compared to those who had defibrillation pads placed after arrest. However, cardiac arrest in STEMI patients is a relatively rare event, estimated to be approximately 4%, therefore a cost-benefit analysis regarding the use of defibrillation pads is warranted. A much larger study is needed to determine the ultimate benefit in terms of patient outcome.

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COVID

1. **Respiratory Support for Adult Patients with COVID-19.** Whittle JS, Pavlov I, Sacchetti AD, Atwood C, Rosenbert MS. J Amer Coll Emerg Phys Open Published on-line April 2020, https://doi.org/10.1002/emp2.12071.

Care of patients with COVID-19 presents many challenges. As with any disease disseminated by airborne droplets, a focused treatment plan, particularly as it relates to the airway and patient ventilation, needs to be in place. A crucial component of this treatment plan involves the safety of the Health Care Providers (HCP) caring for the coronavirus-infected patient. The authors of this clinical review paper discuss strategies for the delivery of respiratory support for patients with COVID-19 infection and focus on commonly used airway and oxygenation treatments and the disbursement of infected droplet particles associated with those procedures using a high-fidelity mannequin.

Oxygen delivery is a primary treatment modality for the care of those in respiratory distress. The goal is to maintain an oxygen saturation greater than 90% and greater than 92% in the pregnant COVID-19 patient. The authors looked at available oxygen delivery devices and the relative disbursement distance of aerosolized particles generated by each. They conclude that the device that produces the least amount of spread at less than 10cm is the Non-rebreathing mask (NRBM) using an oxygen flow rate of 10L/minute. This is followed by high flow nasal oxygen (HFNO) at 17cm at the highest flow rate of 60L/minute, however it was noted that if the canula became dislodged the distance would increase. Nasal cannulas provide up to 45% FiO2 to patients in mild to moderate distress however particle dispersal with a nasal cannula can reach as far as 40cm at 5 lpm flow rate. Venturi masks can deliver precise oxygen concentrations but can produce a particle reach of 40cm at 10 lpm. A simple oxygen mask produces particle distances of 40 cm at 10 lpm. Nebulized medication treatments are a cornerstone of treating patients with bronchospasm; however, they are a high-risk procedure in the face of COVID-19 or any viral condition. Modeling shows a dispersion of particles up to 80 cm at flow rates needed for optimal medication delivery. Closed systems or the use of a facemask may decrease the distance. Finally, the use of non-invasive positive pressure ventilation (NIPPV), to include CPAP or BiPAP, demonstrates the highest dispersion of particles at up to 95 cm, depending on device settings and patient condition.

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TREATMENT MODALITY	**POTENTIAL DISPERSION DISTANCE (in cm)**	
	Centimeters	**Inches**
Non-Rebreather Mask	5-10	2.5-4.5
High-flow Nasal Oxygen Systems	5-17	2.5-8
Nasal Cannula	30-40	15-18
Simple Mask	40	18
Venturi Mask	30-40	15-18
Nebulizer treatment	>80	>36
NIPPV/CPAP/BiPAP	60 - >95	27->43

EMS services currently respond to many patients with COVID-19 that require supplemental oxygen or airway management and may also be required to provide interfacility transport of patients receiving any of the treatment modalities discussed in this paper. There are several of these modalities that EMS providers commonly employ. The use of each of these for a particular patient should be evaluated using a risk vs. benefit decision, taking into consideration the patient's need and the availability of a comparable treatment with a lower risk profile for aerosolization and dispersal of infected particles. The management of a hypoxic patient with known or suspected coronavirus infection should follow a standard progression of steps, beginning with a non-rebreather mask and progressing to more advanced interventions as necessary to maintain oxygen saturation above 90%. Traditionally, EMS providers administer aerosolized bronchodilator medications for wheezing, usually by oxygen powered jet nebulizer. An alternative therapy that should be considered in coronavirus patients is the use of metered dose inhalers (MDI). CPAP, often utilized by EMS providers, has the greatest distribution of particles; this, combined with the limited patient care space in the patient compartment of an ambulance, makes CPAP intervention a high-risk treatment modality. Some newer CPAP and NIPPV devices have an exhalation port that will accept a viral filter, thus decreasing particle dispersion and reducing any potential exposure.

Conflict of Interest Statement: Two of the authors disclosed working relationships with companies that produce HFNO delivery systems.

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Drug Overdose

1. **Incidence of mortality due to rebound toxicity after 'treat and release' practices in prehospital opioid overdose care: a systematic review.** Greene JA, Deveau BJ, Dol JS, Butler MB. Emerg Med J 2019;36:219-224.

Deaths due to opiate overdoses have increased dramatically worldwide in the last five years placing a stress on EMS systems and first responders who respond daily to this epidemic as well as emergency departments that receive transported patients. Many of these patients are awakened on the scene by first responders and EMS personnel following the use of the opioid antagonist naloxone. Patients who are awakened and then refuse transport for further medical treatment and monitoring represent a conundrum for EMS providers and their Medical Directors as to the safety of this request.

The authors of this paper conducted a systematic literature review to discover the frequency of rebound toxicity resulting in death or serious adverse event within 48 hours after patients receive naloxone and are not transported to a medical facility. The authors found 1401 papers, reviewed eighteen, and selected seven (7) articles that met the inclusion criteria for the study. These seven (7) studies resulted in a total of 4912 patients from both the USA and Europe. All patients were attended to by either Paramedics or Prehospital Care Physicians. The average age was thirty-six (36) with males accounting for 80% of cases. Of these 4912 patients, four (4) patients (0.081%) died within the 48 hours set as the parameter for the study. Three of the four patients were classified by the medical examiner as death likely due to rebound toxicity of the opioid involved.

This review demonstrates that within the cohort of patients included in this study, most suspected of using heroin, very few patients experienced any significant rebound toxicity. However, the authors point out that the studies reviewed for this paper pre-dated the recent widespread use of fentanyl as a recreational drug. Fentanyl has an extended of half-life of nearly 4 times that of heroin and double that of morphine. In addition, methadone has a half-life of several days. While this review demonstrates that

the prehospital release of patients who have overdosed on heroin and been awakened by the use of naloxone appears safe without worry of severe rebound reaction, it cannot provide the same reassurance for fentanyl, morphine or methadone. Given that it is often difficult, if not impossible, to accurately determine what drug was actually used, implementing the findings of this study must be considered with great caution. Further studies need to be conducted using data from patients that have utilized longer acting opioids.

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EMS Systems

1. **US National Study of the Association Between Income and Ambulance Response Time in Cardiac Arrest.** Hsia RY, Huang D, Mann C, et al. *JAMA Netw Open*. 2018;1(7):e185202. doi:10.1001/jamanetworkopen.2018.5202

There are few conditions dealt with by EMS responders that are as time sensitive as non-traumatic cardiac arrest. Each minute of delay in response increases mortality.

This retrospective study was designed to compare ambulance response time for patients in cardiac arrest to determine if there is a difference between areas of high income vs. low income. The study used the 2014 National Emergency Medical Services Information system data for this study comparing cardiac arrest responses by zip code and then correlating the zip code to average income within that area. The study looked at 4 benchmark time parameters (response time, on-scene time, transport time, and total EMS time) as well as stratifying response time by 4, 8 or 15 minute..

During the study period, 63,600 cardiac arrests from 46 states were analyzed. Fifty-nine (59) percent were deemed from high income areas and 12.9 percent from low income zip codes. Patients in the higher income zip codes were nearly twice as likely to have private insurance and those in the poorest zip codes were over twice as likely to be on Medicaid. Average response time to lower income areas was slightly longer than higher income locations (9.08 vs 8.24 minutes). . Of note, a higher percentage of responses occurred within 8 or 15 minutes in the higher income areas (78.1% vs 72.4% and 96.7% vs 92.7% respectively).After controlling for weekday and time of day, the total EMS time for cardiac arrest was 3.8 minutes longer in those zip codes with poorer populations

While the study does not report outcomes, one can speculate that a longer response time to a cardiac arrest event would result in a decreased chance for a positive outcome. This is likely also to be true for other time sensitive situations that are commonly encountered in EMS. While the data point to longer response times for cardiac arrest in poorer zip codes, it does not describe the factors that may contribute to this finding. Many factors could lead to these increased response times including: geographic barriers, rural vs. suburban vs. urban settings, vertical access issues, stationing and distribution of EMS resources, funding for EMS in various zip codes, and availability of first response services. Further study is needed to better define the reasons for inequities in EMS ambulance response and methods to address these differences.

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2. EMS Can Safely Transport Intoxicated Patients to a Sobering Center as an Alternate Destination.
Smith-Bernardin SM, Kennel M, Yeh C. Ann Emerg Med 2019;74:112-118.

Emergency Medical Services (EMS) responses to intoxicated individuals are a common occurrence for EMS units across the USA. Currently in most instances, these patients are evaluated by EMS and either turned over to law enforcement or, more commonly, transported to nearby Emergency Departments for further evaluation and treatment as necessary, and in most cases monitoring until sober up and ultimately discharged. It is an all too common sight on a weekend night to have a significant percentage of the E.D. beds occupied by patients with acute alcohol intoxication. While a percentage of these patients need acute medical care that only an emergency department can provide, many only need monitoring and rehydration until the alcohol is metabolized.

Some large cities have introduced Sobering Centers for suspected uncomplicated acute alcohol intoxication as an alternative to Emergency Department admission. Unfortunately, in many jurisdictions EMS personnel are prohibited from transporting patients to these centers directly. The authors of this study evaluated those patients brought into the Sobering Center by EMS, referred from an emergency department, or transferred from the sobering center to an emergency department for an acute condition that is outside the scope of the sobering center.

The sobering center in this study is located in San Francisco and has been actively been accepting patients since 2003. The 12 bed center is staffed by RN's and Medical Assistants and provides oral rehydration, vital sign monitoring, minor wound care, meals and support for activities of daily living. EMS units acting under approved triage protocols are allowed to transport patients to this alternative destination directly.

During the three year study period from July 2013 to June 2016, 11,596 visits (3,268 unique patients) were treated at the center. Thirty-five (35%) of these patients were transported to the sobering centers directly from the point of EMS contact. The majority of patients were managed at the sobering center without complication. Of the 506 patients that were secondarily transported from the sobering center to an emergency department, 151 were initially referred to the center by EMS. Criteria for transfer included; abnormal vital signs, active vomiting, pain not associated with chest pain, and altered mental status. A high percentage of the patients transferred had more than one of these indicators. There was one fatality during the study period involving a patent that was referred by EMS; however this was determined to be from subsequent cocaine intake after admission to the center.

This study had a number of limitations. Admission to the sobering center was based on clinical suspicion of acute alcohol intoxication without confirmation such as breathalyzer analysis. No final deposition data was obtained from the hospitals after transfer from the sobering center. EMS admission protocols and sobering center secondary transfer protocols do not exactly match. Finally, there was no evaluation or data provided regarding patients transported by EMS for alcohol intoxication to the emergency department instead of the sobering center.

With many cities struggling to deal with acutely intoxicated patients, sobering centers are an alternative to admission into a traditional emergency department, thus allowing for better utilization of the available emergency beds. This study shows that patients can be safely triaged by EMS personnel working under approved medical protocols to sobering centers. Further studies that compare the final outcome of intoxicated patients contacted by EMS that are transported to the sobering center versus the emergency department are warranted. This could help to further refine the field triage scheme to better direct patients to the most appropriate care site.

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Geriatrics

1. **Old Age with a Traumatic Mechanism of Injury Should Be a Trauma Team Activation Criterion.**
   Bardes J, Benjamin E, Schellenberg M, Inaba K, Demetriades D. J Emerg Med, 2019;57:151-155.

Based on the anatomical and physiological changes our bodies undergo as we age, elderly patients are at greater risk for mortality and severe injury from traumatic events. The American College of Surgeons (ACS) Committee on Trauma (COT) recommendations for Trauma Team Activation (TTA) do not include age as a criterion.

The authors' urban, ACS verified Level 1 Trauma Center, adopted an age > 70 years criterion for Trauma Team Activation. Given the cost of trauma team activations, both fiscally and in resources expended, the authors examined the question of whether this locally adopted criterion correctly identifies patients at risk or does it over-triage an excessive number of patients for TTA? The authors conducted a five-year, Institutional Review Board approved, retrospective, review of all trauma registry patients > 70 years of age at their institution, with the exception of patients seen for a ground level fall.

The study identified 739 patients that met the age criterion. The three most common causes of injuries were pedestrians struck by a vehicle (41.4%), falls from heights (25.7%) and motor vehicle crashes (14.4%). The overall over-triage rate was 30%.

Patients were categorized into two groups. The first group (n=198) included patients that met standard trauma triage criteria (TTA-S). Standard criteria include systolic blood pressure < 90mm/hg, heart rates > 120 beats/minute, Glasgow Coma Scale <9, gunshot wounds to the neck or torso or any transferred patient receiving blood products. Mortality in the TTA-S group was 60.1%. The over triage rate for this group was only 4%.

The second group of 541 patients were trauma team activations for age > 70 (TTA-A). This group had a mortality rate of 9.1%. While this group had a lower mortality rate, it still represented a population with significant traumatic injuries. Greater than half (56.6%) required admission to the Intensive Care Unit. Only 50% of this group were discharged directly home; 22.2% went to a rehabilitation facility first and 15.9% were discharged to skilled nursing facilities. Forty patients (7.4%) went emergently to the operating room, 9.1% died and 13.3% required endotracheal intubation in the emergency room. The over triage rate for this group was calculated at 39.6%, whereas for the standard activation group the overtriage rate was 4%.

Often, elderly trauma patients do not meet the standard physiologic criteria for trauma team activation. Initial vital signs may be within "normal" limits for a variety of reasons despite having serious underlying injuries. Comorbidities such as beta blocker controlled hypertension, atherosclerotic vessels limiting vasoconstriction and the potential for chronic dehydration can contribute to a delayed response to blood loss. The authors rightly point out that various other factors, notably age, may confound the assessment of the trauma patient and hence the decision to activate the trauma team. This paper supports the use of Trauma Team Activation criteria that include age as a criterion. Previous publications (Resources for the Optimal Care of the Injured Patient ACS COT) recommend acceptable over triage rates to be between 25% and 35%. This urban trauma center feels that their TTA-A criteria's over triage rate of 39.6% is not excessive and acceptable to help decrease mortality in this vulnerable population.

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2. Long-term outcomes among injured older adults transported by emergency medical services.
Newgard CD, Lin A, Yanez ND ,et al. Injury, Int. J. Care Injured. 2019;50:1175-1185.

Each day thousands of older adults are involved in traumatic events requiring care and admission to hospitals nationwide. The entry into the trauma system typically follows the standard prehospital trauma triage format when transport by EMS is necessary. Little is known however about the long-term mortality of these older adults after treatment and transport by EMS systems and management by the trauma system.

The authors conducted a retrospective population based cohort study evaluating twelve (12) month mortality of older adults (greater than 65 years of age) after a traumatic event who were transported by an EMS agency. The study was conducted in the Pacific North West utilizing 44 EMS agencies and 51 hospitals for the calendar year ending December 31, 2011 with follow up of enrolled patients for one year through December 31, 2012. The seven counties selected for inclusion in the cohort included Metropolitan, Urban, Suburban and Rural. The primary outcome was time-to-death measured from time of initial injury to outcome during the next 365 days.

During the study period, 20,808 calls for service for adults over the age of 65 by the EMS agencies with a primary complaint of injury or trauma were recorded. Of these 15,649 were transported to a hospital by EMS and entered into the EMS cohort for this study. Women accounted for 68% of patients, two thirds of all patients had comorbidities, and the average age was 82 years. The primary cause of injury was from falls (84.5%). Mortality rates were 1.6% during their hospitalization, 5.1% at 30 days, 9.6% at 90 days and 20.3% at one year. The most common causes of death were cardiovascular incidents and dementia. This one year mark of 20.3% compares to only 7.2% of all trauma age groups in the State Trauma Registry. There were very few deaths in the field with only 21 (0.1%) in the older adult cohort. Over 56% of the patients were initially seen at a non-trauma hospital with only slightly over 12 % being initially cared for at a level I or II trauma center.

An older adult patient who is transported by EMS after a traumatic event has over a 20% chance of mortality within one year of the incident. While the study does not investigate what could be done to decrease mortality numbers, certainly there are some common-sense factors that can be implemented. First since the highest incidence of trauma in this group came from falls, fall prevention programs should be implemented in the community much similar to other trauma prevention programs currently in place. The study pointed out that the majority of the patients in the study were initially transported to non-trauma hospitals and evaluation of the destination protocol for older adults may need to be revised, much as pediatric trauma triage has been. However, some studies have suggested that older adults with orthopedic injuries, specifically hip fractures actually have better outcomes at non-trauma centers. Further evaluation of EMS trauma triage criteria and destination for older patients, combined with a multi-faceted approach in the initial hospital care of these patients, needs to be considered.

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Health and Well-being of EMS Providers

1. **Death by Suicide—The EMS Profession Compared to the General Public.** Vigil NH, Grant AR, Perez O, et al. Prehosp Emerg Care 2019;23:340-345.

Suicide is the second leading cause of death for people aged 15-34 and is the tenth leading in all age groups in the USA. This has increased over fifteen (15) percent in the eight years from 2008 to 2016. Public safety personel have been identified in many studies to have a significantly higher suicide rate than the general population.

The authors of this study analyzed data compiled from the Arizona Bureau of Vial Records with the permission of the Arizona Department of Health. This retrospective study was conducted analyzing mortality data from the AZ-Electronic Death Registry data base between January 1, 2009 and December 31, 2015. During the study period there were 350,998 deaths in the adult population (over the age of 18). Non-EMTs accounted for 349,793 of the reports and EMTs (included EMTs and Paramedics) accounted for 1205 of the deaths. In the non-EMT group, suicide was listed as the cause of death in 7755 (2.2%) of cases. Of the 1205 cases identified as EMTs, sixty-three (63) deaths were directly identified as suicides. This represents 5.2% off all deaths in the EMT cohort. The EMT group had a higher percentage of males 93.5% vs. 52.8% and were younger that the non-EMT cohort. The mechanism of suicide were similar between the EMT and non-EMT cohorts in the study data set. Firearms were the most prevalent method of suicide (57.6% in the non-EMT group and 66.7% in the EMT cohort) followed by suffocation and poisoning. After adjusting for age, race and ethnicity, EMTs still had a significantly higher suicide rate than those in the non-EMT group.

The national epidemic of suicide has substantially increased to this day. As this study has identified, suicide is even more prevalent amongst EMTs and Paramedics. Programs must be developed to help managers and supervisory staff identify risk factors for suicide and the various stressors in EMS providers that can lead to suicidal ideation and attempt and institute these programs to provide critical evaluation and counseling for the EMS providers who provide vital emergency services to our communities.

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Infectious Disease

1. **Emergency medical services oxygen equipment: a fomite for transmission of MRSA?** Gibson CV. Emerg Med J 2019:36:89-91.

Every day in Emergency Medical Systems (EMS) around the world, oxygen is administered to patients who are in extremis from a variety of situations ranging from moderate trauma to cardiac arrest and everything in-between. Oxygen therapy has been one of the cornerstone treatments by EMS providers since the early days of emergency response and continues to this day. This observational study looks not at the benefits or lack thereof of oxygen administration, but rather at the possible wide-spread contamination of the oxygen equipment used in its delivery.

The author of this study examined the surface of all onboard oxygen cylinders in a small ambulance service (9 ambulances) in the state of Alabama in the USA for the presence of methicillin-resistant Staphylococcus aureus (MRSA). Prehospital personnel routinely decontaminate equipment and other surfaces that come into direct contact with the patient or bodily fluids; however that typically does not

include oxygen tanks and regulators. Each ambulance in this study was equipped with two portable oxygen cylinders for use at the patient's side when tending to patients outside of the ambulance compartment. Samples were obtained from 9 cylinders used in ambulances. Further samples were taken from other surfaces in the patient care compartment and included other portable equipment and supplies. Of the oxygen cylinders tested, 100% were positive for methicillin-resistant Staphylococcus aureus (MRSA). The author compared this to other portable equipment in the ambulance and none grew MRSA. The only area in the back compartment of the ambulance that revealed the presence of MRSA was the floors of the patient compartment. The authors then cultured seventy (70) portable oxygen tanks stored at an off-site vendor, of which sixty-seven (67) grew MRSA.

While this study only looked at one, relatively small, ambulance service, the degree of MRSA contamination is alarming. While there are limitations to the study due to the small sampling size (one agency and vendor), it does bring into question the protocols and policies in place for the decontamination of oxygen delivery equipment (tanks and regulators) by both the ambulance providers and the oxygen vendors. It is apparent by the lack of contamination on other pieces of equipment and the patient compartment itself that a formal decontamination program for other areas of the patient care compartment is effective. Perhaps, more alarming is the finding of tanks at an offsite vendor that are contaminated with MRSA; one would assume a tank coming back from a vendor would be clean and uncontaminated and this study disputes that hypothesis. This study begs for further examination and evaluation by enrolling a larger sample size across many service providers and vendors to determine if this is a widespread issue or isolated to this one service. Ambulance providers should examine their own internal policies and protocols regarding the decontamination procedures of their oxygen administration equipment.

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2. **N95 Respirators vs Medical Masks for Preventing Influenza Among Health Care Personnel A Randomized Clinical Trial.** Radonovich Jr LJ, Simberkoff MS, Bessesen MT, et al. JAMA. 2019;322(9):824-833.

For many people, including the otherwise healthy, influenza (flu) is a serious disease resulting in hospitalization and, in some cases, death. Healthcare workers are at risk of contracting the flu from infected patients and coworkers alike and, if infected, may transmit the virus to those they care for. Many healthcare organizations require, and many more encourage, all employees to receive an annual flu vaccine or wear a mask during all patient contacts and while in common areas of their institutions. The United States Centers for Disease Control and Prevention (CDC) report that from 2017-2018 flu vaccination amongst healthcare workers overall was only 78.4%. Organizations that require flu vaccinations rose to 94.8% vaccination coverage. Flu vaccination compliance was highest amongst the more extensively trained healthcare professionals. Physicians, pharmacists and nurses had 96.1% - 90.5% compliance. Less trained providers had lesser compliance to flu vaccinations; 71.1% for assistants and aids.

For those healthcare providers that choose not to receive an annual flu vaccination, or are unable to receive one due to known allergies or pre-existing health conditions, the question remains how can they best protect themselves from contracting the flu while at work? A 2009 article in the Annals of Internal Medicine concluded that along with good and frequent handwashing, donning a mask may help to prevent individuals from contracting the flu.

While existing clinical evidence is inconclusive, this study attempted to determine if disposable N95 Respirators were more effective, or less effective, than medical (surgical) masks in preventing the flu amongst outpatient healthcare providers in close proximity to persons with respiratory illness. The

authors conducted a cluster randomized, multicenter pragmatic effectiveness trial. This outpatient study was conducted between the spring of 2011 and summer 2016 at seven healthcare systems throughout the United States. Participants were all full-time employed adults (age 18 or greater) and who routinely work within six feet of patients. Exclusions from the trial were medical, or anatomical, conditions that prevented the safe and effective donning of an N95 respirator. Participants were cluster randomized to N95 respirator or medical mask groups. Study groups were directed to wear their assigned protective devices during the 12 weeks that viral respiratory illnesses were predicted to be at their greatest for the year.

Participants who self-reported symptoms of respiratory illness had nasal swabs collected within 24 hours of reporting symptoms. Additionally, 2 random swabs were obtained from each participant within the 12-week study period for each year. The primary outcome was the incidence of confirmed influenza by laboratory analysis.

Adherence to the study design was reported on daily surveys by participants; 22,330 surveys for The N95 respirator group and 23,315 for the medical mask group. "Always" was reported 65.2% of the time by those participants using the N95 respirator and 65.1% of the time for the medical mask groups. The incidence of laboratory confirmed influenza infection occurred in 8.2% of the N95 respirator group and 7.2% of the medical mask group.

The study suggests that neither N95 respirators nor medical masks are superior to the other for preventing viral respiratory infection / illness amongst participants when worn consistently with clinical practice guidelines. Annual flu vaccination remains the best option for healthcare workers to prevent contracting the flu from patients and coworkers. For those that are unwilling, or unable, to take the flu vaccine, medical masks appear as effective as and are less costly than N95 respirators when worn appropriately during patient contacts.

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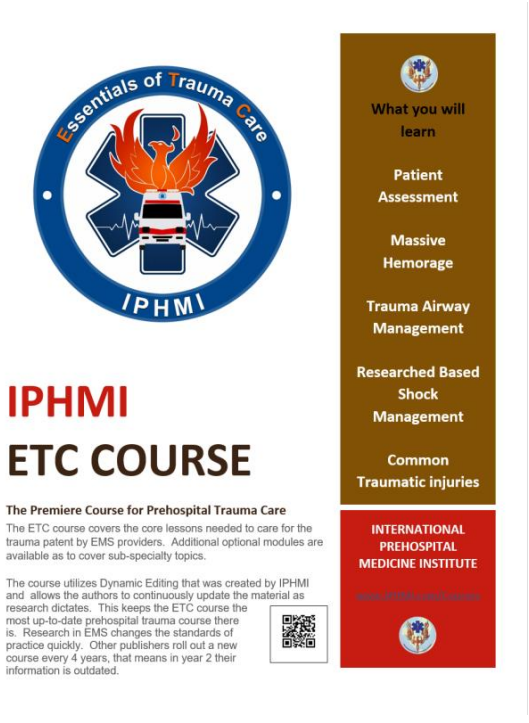

Ketamine

1. **A Systematic Review and Meta-analysis of Ketamine as an Alternative to Opioids for Acute Pain in the Emergency Department.** Karlow,N, Schlaepfer,C, Stoll,C, Doering,M, Carpenter,C, Colditz,G, et al Acad Emerg Med 2018;25: 1086-1097. doi: 10.1111/acem.13502

Many patients present to Emergency Medical services (EMS) or the Emergency Department (ED) with pain as a chief complaint or have pain as a result of an injury or medical condition. For many years, opioids have been used successfully to provide relief from acute pain. With the recent increase in opioid dependency, often iatrogenic in origin, a non-opioid and effective alternative medication for relief of acute pain is desirable. Recent evidence suggests that ketamine may be a safe and effective alternative for opioid analgesia.

Karlow et al conducted a systematic review and meta-analysis of the medical literature to quantify the one-hour efficacy of a single, low dose of IV push ketamine for pain relief. To be included in the meta-analysis, trials had to meet five criteria:

- They had to be randomized control trials.
- The trials needed to compare the effectiveness of a single dose of ketamine to an opioid which was converted to morphine equivalent dosing with a change in either the Visual Analog Score (VAS) or Numeric Rating Score (NRS) of pain within 60 minutes of administration.
- The trials had to be done within an ED.
- The patients had to be all adults with a presenting complaint of pain.
- Lastly, all studies had to be published in English.

Conversely, exclusion criteria for trials were no documented VAS or NRS, the use of a placebo group, or the co-administration of another drug within twenty minutes of ketamine or opioid administration. Three trials met the inclusion and exclusion criteria and included 261 adult patients.

Based on their meta-analysis, the authors believe low dose ketamine is a safe and effective treatment option for acute pain in the ER and is not inferior to using morphine. They felt that their results were consistent with other, broader reviews.

This study adds to the growing body of evidence that low dose ketamine is a viable alternative to opioids in both the Emergency Department and with EMS for acute pain relief.

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Mass Gatherings and Disaster Management

1. **A Remote Scene Size-up Using an Unmanned Aerial Vehicle in a Simulated Mass Casualty Incident.** Sibley AK, Jain TN, Butler M, et al. Prehosp Emerg Care 2019;23:332-339.

In recent years Unmanned Aerial Vehicles (UAVs – also referred to as drones) have been increasingly used for both military and civilian applications. Many of the civilian public safety applications involve searching for and subsequent guiding of rescue teams to lost or injured victims in remote areas. Civilian law enforcement has used drones to locate wanted suspects hiding from authorities, sometimes at night using infrared technologies. Fire services have been using UAV's both in structural and wildfire situations for a number of years to assess hazardous situations and mitigate deployment dangers to firefighting personnel. Some EMS agencies are studying the use of UAV's to deliver life-saving medical equipment, such as automated external defibrillators, to the scene of the incident prior to EMS arrival.

This study looks at the potential utilization of UAVs during a mass casualty incident as a tool to conduct remote assessment and triage of simulated patients. The authors simulated a terrorist attack on a college campus; with the script not allowing EMS providers the ability to enter the scene due to multiple unexploded improvised explosive devices (IEDs). A commercially available UAV piloted by a certified Royal Canadian Mounted Police (RCMP) Pilot was used to locate and film the 15 highly moulaged, simulated patients using line-of-sight control. The location was initially viewed from an altitude of 200 meters (656 feet) for 3 minutes to gain an overall view of the location. After 3 minutes, the UAV would descend and conduct a systematic grid search of the area. When a hazard was identified or a victim located, the UAV would then hover at a distance of 3-5 meters (10-16 feet) for 15-30 seconds to record the points of interest. This video was then saved for later viewing by the study participants.

The primary outcome measure of the study was to correctly identify responses to the first step of the SALT triage algorithm - global sorting. Secondary outcomes included the ability to accurately report body injury location, identified scene hazard, and was as the victim and hazard location.

Ninety six participants were enrolled in the study. The participants were almost equally divided between males (52%) and females (48%) and were made up of participants at a medical conference. The majority (47%) were primary care paramedics. Others were various healthcare providers including physicians and nurses. The enrolled participants were given a one-hour (1) presentation on the SALT triage system. After the presentation, the participants were asked to review the video obtained previously. Of the 96 participants, 79 (82%) were able to correctly sort at least 12 of the 15 simulated patients and 75 (78%) identified at least 3 of 4 hazards at the scene.

This study demonstrates that the use of UAV's in the mass casualty environment may be a viable tool as the technology and flight rules continue to evolve. Further studies should include actual real-time assessment by participants as well as factors such as weather, use of the UAV indoors, and battery life.

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Medication Errors in PreHospital Care

1. **Factors influencing medication errors in prehospital care. A retrospective observational study.**
   Ramadanov N, Klein R, Schumann U, Valdez ADA, Behringer W. Medicine. 2019; 98(49):e18200. doi: 10.1097/MD.0000000000018200. Published on-line, open access.

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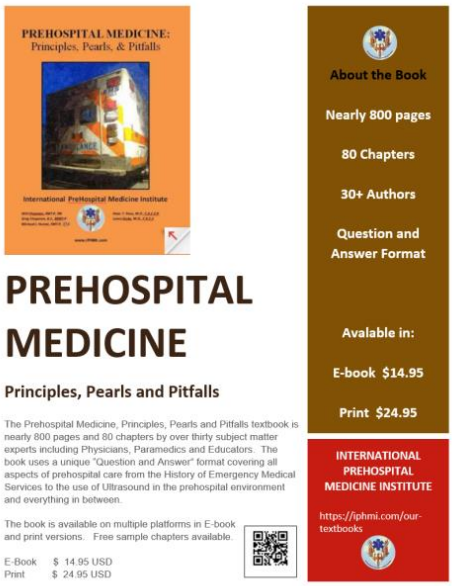
Errors of medication administration in the prehospital, emergency medical setting are thought to be common, however supporting data is lacking. Literature shows a range of errors from 9.1% to 77.5% in the hospital and emergency department. Medication errors are preventable and cause patient harm. Factors that contribute to the errors are medication knowledge deficiencies, patient knowledge deficiencies, wrong calculations, nomenclature issues, and others. Additionally, factors that contribute to medication errors in the urgent or emergent prehospital environment are misuse (incorrect dose, route, or contraindicated medication), underuse (omission of a beneficial medication), and overuse (administration of an unnecessary medication).

This retrospective observational study was conducted in the EMS Center in Bad Belzig, Germany. The German institution for medications and medicine products (BfArM) estimates that annually 500,000 preventable errors lead to emergency department (ED) admission. The aim of this study is to determine

the frequency and factors influencing medication errors in the prehospital environment. The German EMS system is an emergency physician led system. The physician and a paramedic rendezvous with an ambulance staffed by two additional paramedics at the scene respond only to select critical patients during their 24-hour shifts. All other responses are managed by paramedics. Prehospital emergency physicians are trained in traditional medical specialties and then have special education, considered a "supra-specialty", in emergency medicine.

Data were collected from 1760 EMS calls from 2013-2015. Prehospital patient care reports and discharge summaries were reviewed from Bad Belzig or other select local hospitals. Patients were excluded for reasons of multiple discharge diagnoses, lack of admission to or ambulatory treatment in the ED, lack of recorded diagnosis, death of the patient during EMS deployment, or incorrect/unreadable patient data. This resulted in 708 patients being included in the study. Medication Appropriateness (MA) for medication administration was determined by the consensus of three experienced prehospital emergency physicians. MA was considered present when all guidelines were adhered to, and absent either when an obligatory medication was omitted or a contraindicated medication was administered. Dosing correctness was not considered. Influencing factors in the study were physician related factors (including Diagnostic Agreement), patient related factors, and deployment related factors.



Of the 708 patients, 337 (47.6%) were male, 371 (52.4%) were female. The mean age was 68. Two hundred and twenty patients (31.1%) took ? 4 medications per day, 488 (68.9%) took more than 4 medications per day on a regular basis. In total 1058 doses of 37 different medications were administered in the field. The inter-rater reliability for MA of the three reviewing physicians was 0.96. MA was absent in 220 of 708 patients, meaning that there was a medication error 31.1% of the time. There were four factors that were felt to have a significant influence on errors. The first was an incorrect diagnosis by the prehospital emergency physician. A second factor was physician experience. Resident physicians had fewer medication errors than their specialist counterparts, perhaps because resident physicians were deployed twice as often as the specialists and thus had more field experience. Another factor was patient age. Twenty-seven percent of errors occurred in patients ≤75 years, whereas the error rate was 36.0% in those greater than76 years of age. Polypharmacy, pharmacokinetics and pharmacodynamics of geriatric patients played roles. Finally, deployment times were noted as a factor. The majority of errors were seen between 3 am and 6 am and were attributed to a lack of sleep as ambulance shifts began at 07:30. An item of note, when Diagnostic Agreement (DA) between the prehospital and the hospital assessments was present, MA was absent in 20.9% of patients. When DA was absent, errors were made in 53.9% or patients.

While this study centers on medication errors performed by physicians in the prehospital environment in Germany, it is imperative to recognize that medication errors occur at all levels of prehospital providers in all countries. All possible measures should be taken to prevent them. Regardless of the urgency of the situation, adherence to "the six rights" must be employed each and every time (the right patient, the right medication, the right dose, the right time, the right route, and the right documentation). In this study, the majority of errors in medication administration take place in the early morning hours when fatigue from a 24 hour shift is at its maximum. Providers and agencies should strengthen awareness of this problem and identify solutions to mitigate these instances. Improving

communication between all responders involved, considering the patients' pre-existing conditions, and promoting a culture of patient safety is imperative. Additionally, further studies should be conducted across other agencies to explore additional possibilities for process improvement.

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Medico-Legal Issues

1. **Adherence to "No Transfer to Hospital" Advance Directives Among Nursing Home Residents.**
   Nemiroff L, Marshall EG, Jensen JL, Clarke B, Andrew, MK. J Amer Med Directors Assoc 2019;20:1373-1381.

As the population ages, more older adults are admitted to long term care (LTC) facilities, many with advanced directives (AD) designed to guide their care. This study investigates the adherence by nursing homes to a "no transfer to hospital" advanced directive and patient transfers to the hospital by paramedics.

The study was a retrospective review of 748 patients (71.9% women) with a mean age of 83 years in ten (10) nursing homes located in Nova Scotia Canada from three separate time periods starting in September 2008 and ending in February 2012. . Of the cohort, 691 (92.4%) had documented ADs. Excluded patients did not have ADs in place at the time of the study. Of those included in the study, 67.8% had dementia and 88.5% were deemed moderately to severely frail.

Paramedics were called for 556 (80.5%) of these patients; of this group 409 were transferred to a hospital. Of 356 patients with ADs specifying "do not transfer to hospital", EMS was called for 284 (79.8%) and, of these patients, 210 (73.9%) were transported to the hospital. This represents 51.3% non-compliance with AD directives. The majority of those transferred to the hospital were due to trauma rather than medical issues. Falls accounted for the greatest percentage of these whereas patients transferred for medical conditions were predominantly respiratory in origin followed by infection delirium and fever.

In the group of patient transferred to the hospital against their AD, 24.8% were done on a physician order. Patient and or family request for transfer amounted to only 6.6% with nursing staff at the facility requesting the remainder of the transfers. Of the patients transferred against their Ads, approximately 50% were reported as "better" on their return to the nursing facility whereas 36% were reported as unchanged, worse or died after transfer.

This study calls into question the effectiveness of and adherence to advanced directives, especially as they deal with patients sustaining trauma. Paramedics can be faced with an ethical dilemma when presented with a request for hospital transport with a patient that has a "No Transport" AD in place. Better defined ADs that list exceptions to the "no transfer" directives, such as transfer in cases of acute trauma or for specialized imaging and testing, need to be built into the directives. Discussion with the patient and their family regarding the potential for hospital transfer should take place at the time of initiation of the AD prior to an incident.

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2. **Pediatric Prehospital Refusal of Medical Assistance: Association with Suspected Abuse or Neglect.**
   Mix F, Myers LA, Luke A, Sztajnkrycer MD. Prehosp Emerg Care 2017;21:688-692.

In 2015, it is estimated that approximately 638,000 children (age less than 18 years) were victims of abuse or neglect in the United States. This number represents a 3.8% increase from five years before. Of these children, 75.3 % were victims of neglect, another 17.2% suffered from physical abuse, and approximately 1670 died as a result. Forty-eight of the 50 US states have mandatory reporting rules for medical and public safety workers whenever they identify children of Suspected Abuse and Neglect (SAN). It is thought that between 1 and 5% of all pediatric trauma seen in Emergency Departments may be victims of child abuse.

While adult EMS patients have the autonomy to elect to refuse medical assistance (RMA), children do not. Instead, it is their parent or guardian that makes that decision for them. The authors of this paper looked at the incidence of parental or guardian RMA to see if this could be a predictor of SAN. They conducted a five-year retrospective, cross-sectional analysis of a single EMS agency's pediatric RMA calls. They then used age and complaint matched control groups from transported patients with similar chief complaints to determine if subsequent SAN reports were documented in the patient's Electronic Medical Record (EMR).

Of 1904 pediatric EMS calls, refusal of care occurred in 241. Outcome data were available for 202 of these patients. Twenty-one RMA patients were considered to be SAN (11.4%). The authors did not see a difference in SAN between RMA patients and their age-matched controls (21 vs. 24). The same was true for the complaint matched control group (21 vs. 26). Fifty percent of the SAN patients had a documented follow-up plan. Sixty-three percent of the non-SAN patients had one. For those patients with a follow up plan, 85.7% of the SAN patients acted upon their plan while 84.4% of the non-SAN group followed their plan. The SAN group did not see additional Emergency Room visits, unless that was part of their follow-up care plan.

In this study's patient population, parental or guardian RMA, either single incident or multiple incidents, for pediatric patients was not a reliable predictor of SAN. SAN patients were less likely to have a documented follow-up care plan but if they did, the plan was carried out. They did feel that their EMS patient population had a higher incidence of SAN than the 1% to 5% that has been previously reported for emergency departments and that there are opportunities for improved detection and reporting at the field provider level.

Patient care providers at all levels need to be aware of Pediatric SAN and their state's reporting requirements. This study should compel EMS systems to look at outcome data through their CQI process to determine how well their providers are discovering and reporting pediatric SAN.

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Narcan

1. **Pulmonary Complications of Opioid Overdose Treated With Naloxone.** Farkas A, Lynch MJ, Westover R, et al. Ann Emerg Med. 2020 Jan;75:39-48.

Opioid abuse has become a major public health crisis and overdose has become an increasing cause of death. This crisis has increased the use of naloxone to reverse signs of opioid overdose administered by EMS providers, first responders and the general public. The widespread use of naloxone has helped decrease the incidence of death associated with overdose of opioids. Naloxone has long been thought to have few or no side effects although pulmonary edema, aspiration, and acute respiratory distress syndrome have all been associated with both opioid use alone and naloxone reversal. In the past few years, studies have reported that higher doses of naloxone have been needed to achieve the desired clinical effect. The primary focus of the study was to investigate if higher dosages (above 4.4 mg) were associated with and increased risk of pulmonary complications.

This was a retrospective observational study which took place in the City of Pittsburg, population 380,000. The Bureau of EMS provides an all ALS response that utilizes two (2) paramedics on each ambulance who can administer naloxone intravenously. The Bureau of Fire provides BLS first response service with basic EMTs that are allowed to administer intranasal naloxone. The study was conducted by review of all electronic prehospital medical records from April 1, 2013 until December 3, 2016 searching for the words “naloxone”, “Narcan”, or the code for naloxone administration. The search was limited to patients transported to three major hospital emergency departments in the city where access to inpatient medical records was available.

There were a total of 1,980 EMS records identified, of which 1,456 were considered to be likely opioid overdose and were included in the study. Of these, 485 (26.5%) were identified as having pulmonary complications. These complications were defined as pulmonary edema, aspiration pneumonia and aspiration pneumonitis. The primary pulmonary complication was aspiration pneumonia or pneumonitis (461 of 485). Patients who received 4.4 mg or greater of naloxone had statistically significant higher pulmonary complications (42% versus 26%). Of note, patients who received an initial dose of naloxone greater than 0.4 mg also were found to have a higher incidence of pulmonary complications (27% versus 13%).

While this study demonstrates higher pulmonary complications in patients receiving high dose naloxone, it is important to recognize that this study does not demonstrate a direct causal relationship. Naloxone itself may not cause the increase in aspiration, but rather it results from the abrupt opioid withdrawal syndrome precipitated by the naloxone. Furthermore, these complications may result from the increased toxicity of or increased amount of the opioid itself. The goal of naloxone administration is to reverse respiratory depression associated with the opioid overdose, not complete reversal of all opioid effects. Respiratory depression can be reversed with smaller doses of naloxone and this should be the goal of treatment.

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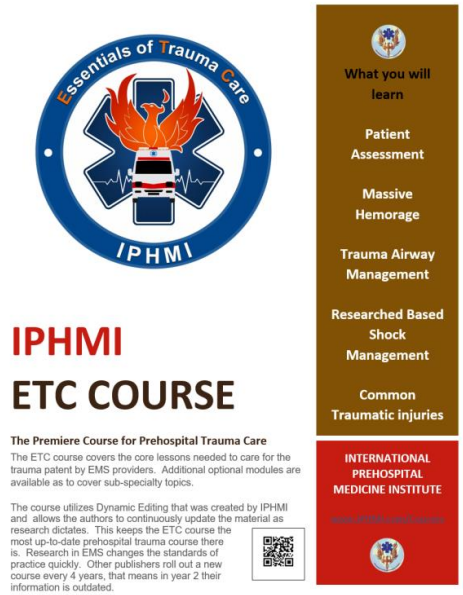
Patient Assessment

1. **The Reliability of Noninvasive Blood Pressure Measurement Through Layers of Autumn/Winter Clothing: A Prospective Study.** Woloszyn P, Baumberg I, Baker D, Phil M. Wild Environ Med.2019;30:227-235.

Non-invasive blood pressure (NIBP) measurement has long been available to prehospital providers. Nearly 15 years ago major defibrillation manufactures began incorporating NIBP into units aimed at and marketed to the EMS providers. All manufacturers' literature currently suggests that the cuff should be placed directly on the patient's bare skin. While this is easily accomplished in the Emergency Department or clinic or in summer months, undressing a patient during winter months to obtain a blood pressure on a bare arm would be time consuming and may also lead to hypothermia in colder climates.



The authors of this prospective study compared the values obtained from NIBP while wearing simulated winter clothing and a bare arm in both healthy volunteers and emergency department patients. One hundred and one (101) healthy volunteers were recruited for the first phase of this study. A second group in this study included fifty (50) patients seen in the ambulance, emergency department patients and admitted ICU patients. The study did not have any inclusion or exclusion criteria and all volunteers were accounted for in the final results. A Zoll X-Series defibrillator monitor with integrated Welch Allyn automated blood pressure was used for all subjects of this study. Two test sleeves were developed to simulate 2 and 3 layers of clothing that would normally be worn in the fall/winter season and were used with each study subject.

Within the group of 101 volunteers that were enrolled in the study, twenty-four (24) had a BP greater than one hundred and forty (140) mmHg and none (0) had a BP less than 90 mmHg. Within the patient group forty-two (42) were medical patients and eight (8) were trauma. Severity of the illness or injury was not listed in the study. Twenty-four (24) of the patient group were unconscious, five (5) had a systolic BP of less than ninety (90) mmHg and three (3) demonstrated clinical signs of shock. Overall there was no significant difference between the BP measurements obtained on the bare arm versus the simulated winter clothing. Of interest was that eight (8) patients in the ICU setting had indwelling arterial lines with continuous waveform pressure monitoring which could be used to compare BP readings. In this group one patient had a BP of 90 mmHg. This patient demonstrated a higher NIBP by 11- 20 mmHg on the systolic BP and 25-26 mmHg on the diastolic using the two sleeves. The information regarding the other two patients that showed clinical signs of shock was not called out directly in the study.

The authors of this study conclude the study shows "that NIPB can be reliably measured through layers of sleeves on the arm even if autumn/winter clothing is being worn". Limitations of the study included only one model of NIBP device used and that hypotensive patients only represented 10% of the total patient group.

While this study demonstrates that the majority of participants could reliably have their BP measured non-invasively over winter clothing, it does not definitively demonstrate that these findings are accurate in patients in shock. Care should be taken when using NIBP over clothing and clinical

gestalt should be used when making treatment decisions. A study using patients who are in extremis should be conducted to determine the reliability of NIBP measurement in these patients.

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2. A potential method of identifying stroke and other intracranial lesions in the prehospital setting. Saviluoto A, Harve-Rytsala H, Laaperi M, et al. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine. 2020;28:article 39.

Prehospital personnel are often called to evaluate patients with altered level of consciousness. Common causes of prehospital altered level of consciousness include seizures, hypoglycemia, alcohol intoxication, drug overdose, and an intracranial lesion such as stroke. Identifying the specific cause can sometimes be extremely challenging. Early diagnosis of a stroke is critical as an outcome benefit has been demonstrated if the patient can be rapidly transported to an appropriate hospital capable of caring for a neuro critical-care patients. The authors of this study hypothesized that the initial prehospital systolic blood pressure (SBP) and pulse along with the patient's age could be used to predict the presence of an intracranial lesion (stroke) in an unconscious patient.

This was a retrospective case-control study comparing the initial prehospital SBP, heart rate, and age of patients with and without an intracranial lesion. This study utilized the FinnHEMS database where all missions of every helicopter emergency medical service (HEMS) in Finland are entered. The authors included only the patients from the busiest HEMS unit in Finland (FinnHEMS 10) as they had the most carefully validated data of intubated patients. The study period included all patients from 2014 as well as patients from March 2015 to December 2016. All adult patients (age > 16 years) with an altered mental status who required intubation were included. Excluded patients were those with obvious trauma and status post cardiac arrest with return of circulation. The first SBP and heart rate acquired by the first EMS unit on scene was used for the study. The patients were grouped into two cohorts: those having an intracranial lesion (stroke or any other lesion that could raise intracranial pressure) and those without. A scoring system was then devised to predict the probability of an unresponsive patient having an intracranial lesion or stroke as their underlying cause.

During the study period, 1071 patients were intubated by the HEMS crew. After excluding the patients who did not meet criteria, 425 patients were analyzed. Of these, 127 (30%) were noted to have an intracranial lesion and 298 (70%) as not having a lesion. Of those with an intracranial lesion, 41 had an intracerebral hemorrhage, 31 had a subarachnoid hemorrhage, and 21 had a cerebral infarction. In addition, 21 patients had an intracranial injury (18 with subdural hematomas) and 8 with other etiologies. These patients were found to have a higher SBP, lower heart rate, and higher age. The authors developed the HeSA scoring system (derived from Heart rate, Systolic BP, and Age) to predict which unresponsive patients may have an intracranial lesion.

Variable		**HeSA-Score Points**
Systolic Blood Pressure	< 140 mmHg	0
	140-170 mmHg	1
	> 170 mmHg	2
Heart Rate	≥ 100/min	0
	< 100/min	1
Age	< 50 years	0
	50-70 years	1
	> 70 years	2

A score ≥ 2 is consistent with a sensitivity of greater than 0.9 for an intracranial lesion, while a score of 3 gives a good combination of sensitivity (0.8) and specificity (0.79). This correlates to clinical common sense – a patient with an intracranial lesion is often hypertensive with a slower heart rate consistent with the Cushing reflex.

There are several limitations to this study. It is a retrospective chart review of a database. The study population consisted of patients too obtunded to get an adequate physical exam looking for signs of a stroke as well as those patients requiring intubation. It is not known if this scoring system could be applied to less ill patients. Finally, a single HEMS unit was used in the study, which creates a possible source of bias. This scoring system will need to be validated in other patient populations.

This is an interesting study focusing on obtunded patients requiring prehospital intubation and attempting to predict if they are having a stroke. While it has many serious limitations, if this scoring system proves accurate, it could help direct these patients to a neuro-critical care center for more expedited care.

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3. Utilizing End-Tidal Carbon Dioxide to Diagnose Diabetic Ketoacidosis in Prehospital Patients with Hyperglycemia. Hunter C, Putman M, Foster J, et al. Prehosp Disast Med 2020;35:281-284.

Diabetic ketoacidosis (DKA) is a serious, sometimes life-threatening medical problem typically experienced by patients with Type 1 diabetes and less commonly Type 2 diabetes. DKA happens when blood sugar rises (hyperglycemia) without an appropriate corresponding insulin response. This results in the breakdown of fat which produces ketones causing metabolic acidosis. Once the body's bicarbonate buffering system becomes overwhelmed, end tidal CO_2 ($ETCO_2$) levels will decrease since less carbon dioxide can be produced. Usually, altered mental status along with laboratory findings of hyperglycemia, decreased blood PH, and ketonuria lead to the diagnosis of DKA. When encountering a patient with altered mental status, prehospital providers typically perform a quick and simple blood glucose level (BGL) as part of their exam.

The goal of this study was to see if the inclusion of $ETCO_2$ levels could be used to facilitate an accurate pre-hospital diagnosis of DKA and earlier treatment of this life-threatening condition. The authors conducted an IRB approved, retrospective cohort study of hyperglycemic patients encountered by a single urban EMS service that were transported to a single, tertiary medical center. Inclusion criteria consisted of adults (18 years or older) with a BGL >200 mmol/L and a full set of prehospital vital signs including $ETCO_2$. Chart review was conducted via a single abstractor, blinded to the hypothesis of the study and trained by the principal investigator.

One hundred and nineteen patient charts met the inclusion criteria (one case was excluded due to missing hospital data). Of the 118 eligible patients, six (5%) were ultimately diagnosed to be in DKA. The level of prehospital $ETCO_2$ was significantly lower in DKA diagnosed patients (15mmHg) compared to those patients that were not (35mmHg).

The study suggests that low $ETCO_2$ levels are indicative of DKA in prehospital patients with hyperglycemia. For patients ultimately diagnosed with DKA, $ETCO_2$ levels were less than 25mmHg. However, while finding that all patients diagnosed with DKA had prehospital $ETCO_2$ values less than 25 mmHg, the authors were unable to predict the threshold $ETCO_2$ value for an accurate diagnosis of DKA, given the small number of patients with the disease. $ETCO_2$ may have value in adding evidence to further suggest the diagnosis of DKA in conjunction with an accurate patient history, exam and vital signs to include a blood glucose level.

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Pediatrics

1. **Appropriate Needle Length for Emergent Pediatric Needle Thoracostomy Utilizing Computed Tomography.** Mandt M, Hayes K, Severyn F, Adelgais K. Prehosp Emerg Care 2019;23:663-671.

Tension pneumothorax, while relatively rare, is a preventable cause of death in trauma patients. In the adult population, there is ongoing discussion about the best location for life saving needle thoracostomy and the ideal needle length. Multiple studies have tried to address both questions. Advanced Trauma Life Support (ATLS) recommends using a 14-gauge, 5cm needle in the 5th intercostal space in the mid- to anterior axillary line. The Committee on Tactical Combat Casualty Care recommends at least a 14-gauge, 8.25 cm needle in either the5th intercostal space in the mid- to anterior axillary line or the 2nd intercostal space in the mid-clavicular line. Standard 14-gauge IV catheter needles are 3.8 cm long and inadequate in length to access the pleural cavity of most adults. Little research has been done to determine the appropriate length needle for needle thoracostomy in the pediatric population. This study evaluates what length needle will reliably access the pediatric pleural space without damaging the underlying structures.

Similar to recent adult needle length studies, the authors used computed tomography (CT) to determine the chest wall thickness of pediatrics less than 13 years of age. Their goal was determine the needle length required to access the pediatric pleural space at the two widely accepted needle thoracotomy locations, 2nd Intercostal Space – Mid Clavicular Line (2ICS-MCL) and 4th Intercostal Space – Anterior Axillary Line (4ICS-AAL). This was a five-year, retrospective study done of all pediatric (less than 14 years of age) CT's at an ACS verified Level 1 Trauma Center and regional pediatric trauma center. CT's excluded from the study included findings of chest wall mass, muscle disease, pectus deformity, anasarca, prior open thoracotomy, inadequate imaging, or missing height documentation. Height documentation was required to group patients according to the standard Broselow Length Based Tape (LBT).

Reviewers looked at a total of 273 chest CTs. Of those, 23 were excluded, resulting in a study population of 250 scans and 498 total measurements, 2ICS-MCL and 4ICS-AAL. Patients were grouped by size corresponding to standard Broselow LBT color-coded categories. Patients in the Gray/Pink (< 68cm) group had a median chest wall thickness at the 2nd ICS-MCL of 1.57cm and 1.67cm at the 4th ICS-AAL. The Red/Purple group (68.1 - 90cm) measured 1.96cm at the 2nd ICS-MCL and 1.73cm at the 4th ICS-AAL. Yellow/White (90.1 - 115cm) was 2.12cm at the 2nd ICS-MCL and 1.91cm at the 4th ICS-AAL. Finally, the combined Blue/Orange/Green group (> 115cm) was 2.45cm at the 2nd ICS-MCL and 2.19 at the 4th ICS-AAL.

Based on these findings, the authors recommend that standard-length 3.8 cm, 14 or 16 gauge IV needles be used to access the pediatric (<13 years old) pleural cavity, regardless of color-coded group as measured by Broselow LBT. Longer needles may result in a greater complication rate and should only be considered for pediatric patients that are morbidly obese. This study is another example of the importance of recognizing the need that all EMS services and prehospital personnel are prepared for the unique requirements of pediatric patients.

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2. **Characterization of Children with Septic Shock Cared for by Emergency Medical Services.** Depinet H, Eckerle M, Semenova O, Meinzen-Derr J, Babcock L. Prehosp Emerg Care 2019;23:491-500.

Sepsis and septic shock continue to be a costly, deadly and progressive disease process that is often overlooked, or difficult to identify, in the pre-hospital setting. Sepsis in pediatric patients is even more difficult to recognize and treat by EMS. Sepsis is the systemic progression of an infection identified by a multitude of related clinical findings. Septic shock is that continued progression resulting in cardiovascular dysfunction and eventually collapse. Early recognition and care of septic patients including antibiotic therapy are key to reducing sepsis mortality and improving patient outcomes. Many EMS agencies have adopted screening tools to aid providers in identifying sepsis in the adult population in order to alert receiving facilities. Unfortunately, similar screening adjuncts to assist prehospital providers in identifying pediatric sepsis do not exist.

The authors conducted a three year, IRB approved, retrospective analysis of pediatric septic shock patients, ages 0 to 21 years, that either self-presented, or arrived by 150 EMS agencies, at an urban United States pediatric emergency department (ED). The goal was to identify patient characteristics, the care they received and treatment outcomes between EMS arriving patients and patients that self-presented to the emergency Room. They also looked at EMS assessments for common sepsis indicators and how those indicators compare to ED triage scoring.

The study identified 854 patient that met criteria for entry into the study. Of these, 165 (19.3%) arrived via EMS, but complete and usable EMS data was only available for 116 of those patient contacts. Children arriving by EMS were more likely to have public insurance, were less likely to have been referred by another healthcare provider, and were more likely to be male. EMS arriving patients were also more likely to be hypotensive on arrival to the ED, 10.3% vs. 4.5%. Tachypnea and tachycardia rates were similar for both groups of patients. The EMS arriving patents had similar ED triage scoring as the self-presenting group. However, EMS patients were more likely to be initially treated in the resuscitation suite (69.8% vs. 21.9%) and receive their initial fluid bolus sooner (33 minutes vs. 58 minutes). EMS patients were also more likely to be given vasopressors (15.5% vs. 7.6%) and be placed on a ventilator within the first 24 hours of their hospital stay (31% vs. 8.1%).

While not specifically identifying parameters for or developing an EMS Pediatric Sepsis Screening Tool, the authors did identify the frequency that variables commonly used in such tools were documented by EMS. Heart rate was reliably captured by EMS. Hypotension, while a late sign of sepsis, was often only captured by EMS as a systolic measurement and would need to be both a systolic and diastolic reading. Patient temperature (hyper- or hypothermia) was only captured by EMS in 33% of their patients. Blood glucose levels were only obtained on 22% of the EMS patients. A pre-hospital pediatric sepsis tool will need to be succinct and contain variables that are easily, and reliably, obtained by pre-hospital providers. The authors did not specifically address point of care lactate measurements; however they did acknowledge that as this technology becomes more readily available to EMS, it should most likely be included in sepsis screening tools.

A pediatric sepsis screening tool for prehospital providers would offer a useful adjunct for identifying this potentially life-threatening problem. Such a tool must include standard parameters obtained by EMS and EMS must reliably measure and report these data.

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3. **Outcomes after prehospital tracheal intubation in suburban/rural pediatric trauma.** Hawkins RB, Raymond SL, Hamann HC, et al. J Surg Research. 2020;249:138-144.

The leading cause of death in pediatric patients over the age of one year, responsible for nearly 10,000 deaths in the United States annually, is trauma. The need for endotracheal intubation is an indicator of injury severity and increases the risk of morbidity and mortality. There are many options for pediatric airway management including bag-mask ventilation, supraglottic airway device placement, as

well as endotracheal intubation. Intubation on scene can increase prehospital time and delay access to definitive care. In the urban setting, many have advocated the use of only bag-mask ventilation for pediatric trauma patients as transport times are often short. The best airway for pediatric trauma patient in a suburban or rural setting where the transport time maybe longer is not clear. The purpose of this study is to evaluate outcomes among pediatric trauma patients requiring endotracheal intubation in a suburban/rural trauma system.

This was a retrospective chart review of all pediatric trauma admissions to a level I Trauma Center over a ten-year period. Patients were divided into three categories: intubation at the scene, intubation at a referring hospital, or intubation at the trauma center. Data collected included age, gender, mechanism of injury, injury severity, complications, and mortality.

Over the 10 year period, 288 patients (mean age 9.5 years, 60% male) were included in the analysis. Thus, mechanism of injury was motor vehicle collision (45%), followed by fall, burn, and all-terrain vehicle collision. Most patients (54%) were intubated at the scene of injury, 19% were intubated at a referring hospital, and 25% were intubated at the trauma center. Patients intubated on scene had a higher injury severity score and a lower GCS. Patients intubated on scene also had a higher mortality rate (30%) compare with those intubated at a pediatric trauma center (5.6%). In examining airway complications by provider, 52% of complications occurred in patients intubated by EMS personnel, 9% by those intubated by a resident physician, and 33% in those intubated by an attending physician.

This study is being reviewed as an example of why it is important to completely read and analyze a study prior to accepting the conclusions of the authors. This study is an example of selection bias, in which the sickest patients have the worst outcomes. The study notes a higher rate of complications when a patient is intubated in the prehospital setting or by an attending physician at the pediatric trauma center. The lowest rate of complications occurred when the patient was intubated by a resident physician (a physician in training). Clearly this doesn't make complete sense. The most difficult intubations in a trauma center are often done by the attending. Patients who require prehospital intubation are often sicker than those who can wait until arrival to the hospital so naturally they will have a worse outcome.

In summary, this study states that patients in a suburban/rural setting intubated in the prehospital setting (and in referring hospitals) have higher mortality and morbidity. However, after multivariate analysis, patient age, injury severity, and neurologic status were the main prognostic factors, not location of intubation. Further studies are needed to determine the optimal airway management for pediatric trauma patients in a suburban/rural setting.

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Physicians on Ambulances

1. **What is the impact of physicians in prehospital treatment for patients in need of acute critical care? – An overview of reviews**. Valentin G, Jensen LG. International J. Tech Assessment Health Care 2019;35:27-35.

Worldwide, EMS systems are structured in many different configurations. Some use Basic Life Support (BLS) providers only, others offer Advanced Life Support (ALS) using paramedics, and some staff with physicians (anesthesiologists or emergency medicine physicians) or a combination of non-physician and physician providers. The authors of this paper conducted a review of the medical literature to determine if physicians decrease mortality when deployed to care for critical patients in the prehospital phase of medical care.

The authors conducted a literature search for review articles that evaluated the impact of physician level prehospital care compared to non-physician care. Using the EMBASE and MEDLINE data bases produced over 1600 references. After reviewing the identified publications for inclusion and study bias, 10 articles met the inclusion criteria for this study.

The authors looked at outcomes in five (5) categories of critical response as identified by the European Resuscitation Council:

- Cardiac Arrest,
- Chest Pain,
- Respiratory Insufficiency,
- Stroke, and
- Severe trauma to include TBI.

The- included reviews were then grouped into three categories;

- Physician-based treatment versus non–physician-based treatment,
- ALS versus BLS (physician-based ALS versus non–physician based BLS or physician-based ALS versus non–physician-based ALS), and
- Physician-based prehospital endotracheal intubation (ETI) versus non–physician-based prehospital ETI.

The articles did not discriminate between modes of transportation (air vs. ground) or crew and response criteria (primary versus secondary physician response).

The authors conclude that current evidence suggests a benefit from prehospital physician care in cardiac arrest patients and, to a lesser degree, in severe trauma. There was insufficient evidence from this review of any improvement in outcome with physician interventions during the prehospital phase in the other categories; chest pain, respiratory insufficiency and stroke. The studies reviewed did indicate that physician success rate at endotracheal intubation was significantly higher than that of non-physician providers.

This review shows that greater evaluation of EMS systems worldwide needs to be completed, looking at crew configuration and response profiles to better determine the effect on mortality and also morbidity. One of the difficulties identified in this systematic review is the differing training of the various groups of prehospital providers. Most of the studies reviewed took place in the USA, Europe and Australia. While the initial training of physicians is somewhat comparable, there was no mention of post graduate training or specialization. For example, many of the physicians that provide prehospital care in Europe are anesthesiologists, which may account for some of the difference in intubation success rates. For non-physician EMS providers, it is less clear how the training varies among the many different studies and countries included. Future studies should attempt to perform a gap analysis to assess the differences in care between physician and non-physician ALS and determine why there is an improved outcome with on-scene physician interventions. This knowledge would be instrumental in determining future curriculums for non-physician providers with the hope of closing the gap in outcomes between the two groups. Finally, none of the studies reviewed attempted to perform a cost-benefit analysis regarding the use of physicians in the field.

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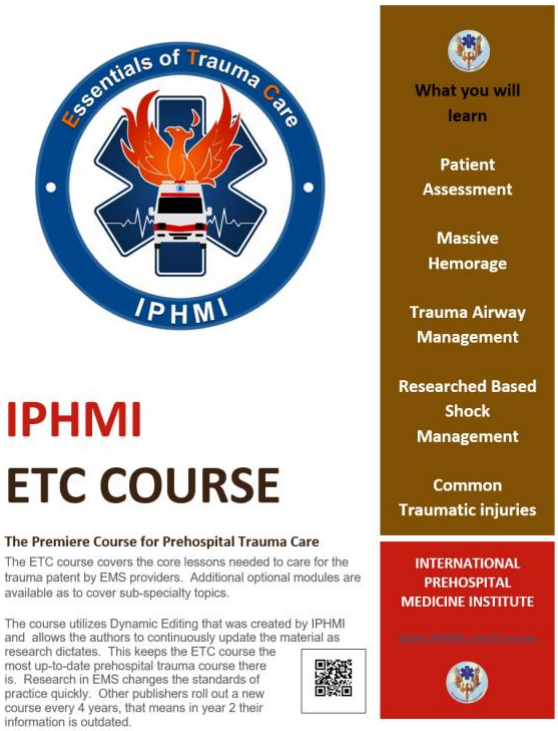
Spinal Motion Restriction

1. **Does prehospital spinal immobilization influence in hospital decision to obtain imaging after trauma?** Drain J, Wilson ES, Moore TA, Vallier HA. Injury. 2020;51:935-941.

Healthcare providers utilize spinal mobilization as a means of potentially preventing or worsening neurological injury following trauma. Spine immobilization can include the application of a cervical collar alone, or complete immobilization with a cervical collar and spine board. While this practice has been a mainstay of prehospital trauma care for over 40 years, little if any data exist to support the practice. Once at the hospital, the cervical spine typically is cleared either with physical examination, plain cervical spine radiographs, or cervical spine CT scan. The most common radiologic test to clear the cervical spine is now the CT scan, which has a sensitivity of 98- 100% for detecting fracture. Unnecessary utilization of the CT scan does have downsides. The cost to the patient and the overall health care system is significant, and it exposes the patient to radiation. The authors in this study hypothesize that patients who arrive with a prehospital cervical collar are more likely to undergo CT scanning regardless of the clinical need.

This is a retrospective study of all trauma patients transported to an urban, level 1 trauma center over a four-month period. Patients were categorized based on severity of injury, complaint location, and injury mechanism. Category 1 patients (n=244) were the most severely injured and had anatomic and physiologic injuries suggesting severe injury. Category 2 patients were also injured but less severely (n=721). Category 3 patients (n=463) were those who had no obvious injury but injury was suspected based on mechanism. Overall, 1438 patients were enrolled in the study. Category 1 patients were most often male (83%) and sustained gunshot injuries (56%). The proportion of Category 1 patients who received a CT scan was lower than those in Category 2 or 3 (likely due to the higher rate of penetrating trauma in Category 1). The proportion of patients receiving CT scans in Categories 2 and 3 was similar so they were combined during the data analysis.



Seventy-five percent of patients arrived with a cervical collar in place. Those who had a cervical collar received a cervical CT scan 80% of the time and those arriving without a collar received a scan 30% of the time. A total of 35 patients (2.43%) had a cervical spine injury; 26 of them had a clinically significant cervical spine injury (1.81%). This is consistent with national data from other trauma centers. Those patients who did not receive a CT scan were followed for two years looking for a clinically significant missed injury. No missed injuries were found during the two year follow-up. Category 1 patients received 15 cervical CT scan per diagnosed cervical spine injury while Categories 2 and 3 patients received 46 surgical CT scans per diagnosis. When looking specifically at motor vehicle collisions, 66 patients received a scan per one injury diagnosed.

The most significant predictor of cervical spine injury was a patient complaint of pain or known injury above the clavicles. No patient without a complaint above the clavicles had a cervical spine injury. Additionally, 161 of the 458 patients (35%; 11% of total) with a complaint only below the clavicles still received cervical CT imaging and none of them had a cervical spine injury.

The authors then looked at the effect of prehospital cervical collar placement on future imaging upon arrival to the trauma center. They noted that Category 1 patients who had gunshot wounds above

the clavicles underwent cervical CT imaging in a greater proportion if they arrived wearing a cervical collar than those who arrived without a cervical collar (66% vs 14%), suggesting a bias toward imaging patients based on prehospital treatment. This is significant because prior studies have shown no benefit to prehospital cervical collar placement in penetrating trauma. Among the Category 2 and 3 patients with an injury above the clavicles, those injured in motor vehicle collisions (88% vs 70%) , low-energy falls (83% vs 59%), and assault (86% vs 37%), received CT scans more frequently if they arrived with a prehospital cervical collar in place. Additionally, Category 2 and 3 patients without an injury above the clavicles still received cervical spine CT imaging if they arrived with a prehospital cervical collar already in place: motor vehicle collision (66% vs 21%), low-energy fall (82% vs 35%) and pedestrian versus motor vehicle (56% vs 13%).

This study demonstrates that the physician decision to obtain CT imaging of the cervical spine is influenced by prehospital application of a cervical collar. Perhaps the visual cue of a patient arriving to the trauma center with an immobilized cervical spine may unnecessarily bias the physician to obtain imaging despite the lack of clinical indication. Published guidelines exist regarding indications for cervical spine imaging in trauma patients. Most notably, the Canadian C–Spine Rule has the greatest sensitivity (99–100%). This decision-making rule has also been tested with paramedics and has achieved near 100% sensitivity for identifying trauma patients at high risk for cervical spine injury. However, many EMS protocols still require routine application of a cervical collar despite the data against the practice. As this study shows, these patients often don't need to receive unnecessary, expensive, and perhaps harmful CT scans simply because EMS applied a cervical collar. If prehospital providers can be given greater autonomy in deciding whether to place a cervical collar perhaps the downstream effect of unnecessary imaging in the trauma center could be avoided.

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Tactical Training and Care

1. **Evaluation of an Integrated Rescue Task Force Model for Active Threat Response.** Bachman MW, Anzalone BC, Williams JG, et al . Prehosp Emerg Care 2019;23:309-318.

Integrated (police and EMS) response to an active shooter incident is gradually becoming an operational standard across the USA. The use of the Rescue Task Force (RTF) model has been implemented in most major cities without objective data to support its use. The authors of this study evaluate the performance of the RTF in response to an active shooter incidence utilizing predetermined performance measures.

This observational study was conducted over an 18 day period using 69 separate scenarios events that evaluated 388 EMS providers and 468 Law Enforcement Officers (LEOs) within a system that serves a population of 1 million. One month prior to the simulation, the EMS and LEO providers received separate live didactic and hands on training presentations on their specific role in the RTF. The scenario that was repeated for each group of providers evaluated command staff, LEOs in the threat suppression role and two RTFs comprised of EMS personnel and LEOs. The event took place with 11 simulated casualties in a two story building of 13,000 sq./ft. Evaluators recorded the performance of 30 predetermined objective data points during the evolutions.

The study's data showed the following median times in minutes:

From time of dispatch to:

The establishment of unified command	4.1

RTF assembled	9.4
First victim contact	11.9
Victim moved to CCP	16.6
Victims ready for evacuation	21.6

Patient care:

Appropriate Tourniquet application by EMS	97%
Appropriate Tourniquet application by LEO	89%
Inappropriate Chest Decompression by EMS	4%
Unnecessary Initial Treatment	15%

Tactical Data points recorded including tactical communication in %:

Correct communication (safe to treat)	70%
Incorrect operation actions to maintain tactical formation	49%
Inappropriate patient evacuation	20%

This study demonstrates that the trauma and medical care rendered in a simulated active shooter event appears to be on par with normal EMS operational guidelines. The only exception appears to be unnecessary initial treatment of patients given that nature of the incident. This desire to provide more than basic life-saving care is commonly seen in mass casualty situations of all types, not just active shooter incidences. Of note, an area of concern relates to the operational management during the tactical situation. The RTF failed to maintain an appropriate tactical formation in almost one half (49%) of the time and tactical communication was well below desired benchmarks. This study demonstrates that a greater emphasis must be placed on tactical movement and operational communications during both didactic and scenario-based training for active shooter events.

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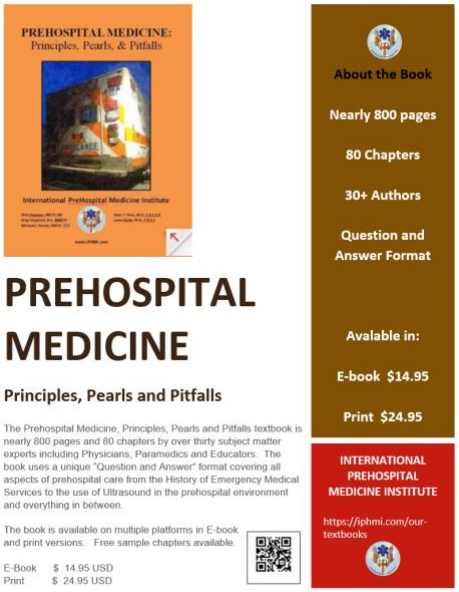

Tranexamic Acid

1. **Effects of tranexamic acid on death, disability, vascular occlusive events and other morbidities in patients with acute traumatic brain injury (CRASH-3): a randomized, placebo-controlled trial.** The CRASH-3 trial collaborators. Lancet 2019;394:1713-1723

There are more than 60 million new cases of traumatic brain injury (TBI) worldwide each year. The most common causes are motor vehicle collisions and falls, and the incidence is increasing. Intracranial bleeding is a common complication of head trauma and can start from the moment of impact and continue for several hours after injury. Tranexamic acid (TXA) reduces bleeding and blood loss by inhibiting the breakdown of fibrin blood clots (fibrinolysis). Prior studies, including the CRASH-2 trial, have demonstrated a survival benefit in bleeding trauma patients who receive TXA within three hours of injury. While controversial, the CRASH-2 trial did set the groundwork for many future trials demonstrating possible benefit of TXA administration in trauma.

The CRASH-3 trial was an international, multicenter, randomized, placebo–controlled trial on the effects of TXA on death and disability in patients with TBI. Adults with TBI who were treated within three hours of injury, had a Glasgow Coma Scale (GCS) score of 12 or less or with intracranial bleeding noted on CT scan, and no major extracranial bleeding were eligible. The primary endpoint was death due to TBI within 28 days of injury. Of note, the authors amended the enrollment criteria midway through the trial. Their original criteria called for inclusion in any patient treated within eight hours of injury. This will be discussed again later, but has been a major criticism of the study. The authors also examined secondary outcomes such as the incidence of vascular events (myocardial infarction, stroke, deep vein thrombosis, and pulmonary embolism). Patients with a GCS of 3 or bilateral nonreactive pupils were excluded because they were unlikely to survive regardless of the treatment provided. Patients were randomized to receive either TXA or a matching placebo (0.9% NaCl). The TXA dose consisted of an initial loading dose of 1 g over 10 minutes followed by a 1 gm intravenous infusion over eight hours.

This study randomized 12,787 patients from 175 hospitals in 29 countries to receive either TXA (n=6,406) or placebo (n=6,331). Of these, 9,202 (72.2%) were enrolled within three hours of injury. Overall, the authors did not find a clear improvement in survival in patients with TBI who received TXA. However, in patients who had bilateral reactive pupils and a mild-to-moderate head injury (GCS 9-15), the authors did note a potential reduction in the risk of injury related death with TXA compared to those who received placebo (18.5% vs 19.8%). The authors found no benefit of TXA administration in patients with a severe head injury (GCS 3-8). Early treatment of patients with mild to moderate head injury was more effective than later treatment but there was no obvious specific time specified. Of note, while there was a decrease in the risk of death, there was no difference in neurologic function between the two groups. The authors found no evidence that TXA increased the rate of deep venous thrombosis and pulmonary embolism, or myocardial infarction.

This study has some limitations as well as many good qualities. It is another large, international, randomized study showing potential benefit of TXA administration, this time in patients with mild to moderate TBI. However these results must be kept in the context of knowing the authors changed the primary outcome in the middle of the study (administration within 8 hours changed to 3 hours). The results trended towards an improved mortality from mild-to-moderate TBI in patients who received TXA within three hours of injury however the author's blanket statement that TXA is beneficial in mild-to-moderate head injury is inaccurate. There was no analysis of the blood clotting properties of these

patients with a thromboelastogram (TEG) to see if fibrinolysis was actually occurring. If it was not occurring, TXA would not be indicated.

In conclusion, TXA may offer a survival benefit in patients with mild-to-moderate TBI who receive their initial dose within three hours of injury, although neurologic function appears to be similar when comparing TXA to placebo. Further studies must be done to validate the claims made in this study. Additionally, further research must be done to see if TXA is beneficial in the prehospital setting.

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Trauma

1. **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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2. The Reliability of the Pre-hospital Physical Examination of the Pelvis: A Retrospective, Multicenter Study. Lustenberger T. Walcher F, Lefering R, et al. World J Surg 2016;40:3073-3079.

It is thought that a careful and thorough physical examination can reliably detect unstable pelvic injuries and that undetected pelvic injuries are usually minor or stable and do not requiring immediate intervention. However, the data supporting this consideration is based on in-hospital evaluation with thorough no data available regarding the reliability of prehospital pelvic physical examination to detect pelvic fracture.

The Trauma Registry of the German Trauma Society which includes hospitals located primarily in Germany (90%) but also hospitals in Belgium, Finland, Luxembourg, Slovenia, Switzerland, and the Netherlands has been collecting data, including pelvic injury since 2002.

The inclusion criteria for this study were" primary admission, blunt trauma, ISS ≥ 9 and information available regarding the out of hospital suspected injury pattern." These criteria were met by 35,490 cases. The patients were grouped according to the injury suspected by the physician at the scene and the final hospital discharge diagnosis. Patients were categorized as suspected pelvic injury which they deemed a false positive, pelvic injury missed which they termed false negative or correctly diagnosed pelvic injury or true positive.

A total of 11,062 (31.2%) of the identified trauma patients had either suspected or proven pelvic injuries. Pelvic fracture was confirmed in the Emergency Department in 7,201 patients or 20.3% of the total. A pelvic injury was suspected in the prehospital setting in 7,784 (22.2%) of the 35,490 patients. . Of the 7,201 patients with a documented pelvic fracture, 3,781 (52.5%) were not suspected based on the examination performed in the field. A total of 3,861 patients that were suspected to have pelvic fractures in the field were not confirmed in the hospital.

The authors state that while the evidence published to date suggests that a clinical assessment can rule out significant pelvic injuries in the blunt trauma patient, they challenge this conclusion as based upon in-hospital rather than prehospital findings. The number of missed pelvic fractures in this prehospital study was significant. They recommend that when treating severely injured blunt trauma patients in the field, some type of mechanical pelvic stabilization should be considered regardless of the results of the physical exam of the pelvis.

This study has a number of limitations All of the data used were collected and reviewed retrospectively. The quality and extent of the pelvic exams was not performed in a standard fashion across the patient population. This study was derived from a Physician-based EMS response system. Given that fact, any extrapolation of these results to an emergency medical technician or paramedic based EMS system is inappropriate. This type of study should be repeated using the various levels of personnel found in other prehospital systems.

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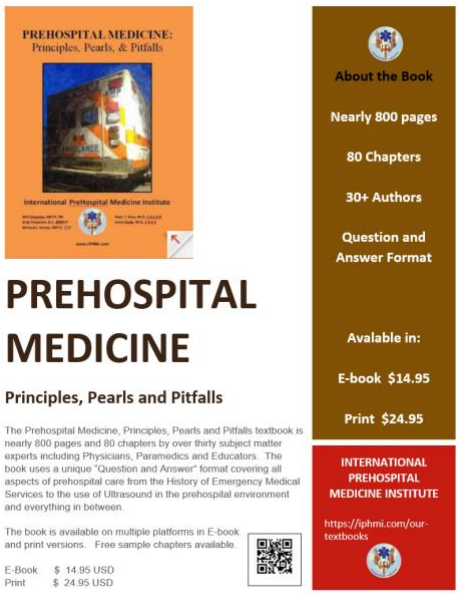
3. **Who Would Have Benefited from the Prehospital Use of Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA)? An Autopsy Study.** Henry R, Matsushima K, Henry RN ,et al. J Am Coll Surg. 2019;229:383-388.

Hemorrhage is the second leading cause of traumatic death in the civilian population, behind traumatic brain injury. The two types of hemorrhage are compressible and non-compressible. The most common type of compressible hemorrhage is an extremity injury in which bleeding can be controlled by direct pressure or a tourniquet. Non-compressible torso hemorrhage (NCTH) is bleeding which cannot be controlled by direct pressure or tourniquet and includes bleeding within the chest, abdomen, or pelvis. Prehospital management options for NCTH are very limited and mortality is nearly 50% in civilian NCTH. Recently, resuscitative endovascular occlusion of the aorta (REBOA) has become a useful adjunct in trauma centers for temporary control of NCTH until surgical control of bleeding can be achieved. Some have advocated the use of REBOA in the prehospital setting to achieve early control of NCTH. Proper patient selection remains a challenge however.



This is a retrospective study conducted at the Los Angeles County Level I Trauma Center. All trauma patients with prehospital cardiac arrest were evaluated (n=198). Those with no signs of life in the field by EMS examination were excluded (n=125), leaving 73 total patients to evaluate. These were patients who had signs of life in the field prior to cardiac arrest. Autopsy results were reviewed to determine cause of death. They defined a REBOA candidate as a patient with abdominal organ injuries and/or pelvic fractures as a source of NCTH and no associated severe head injury, defined as a Glasgow Coma Scale (GCS) ≥ 9.

Based on autopsy findings, 27 (13.6%) patients could have been candidates for prehospital REBOA. These were primarily blunt trauma patients (63%) with a mean transport time of 20 minutes. The majority of these patients (85%) sustained high-grade abdominal solid organ injuries (liver and spleen), with 65% having significant pelvic trauma. Some patients had a combination of both injury types. The authors identified three variables predicting benefit of prehospital REBOA in this patient population: GCS ≥ 9, systolic blood pressure (SBP) < 90 mmHg, and SpO2 of > 90%. Notably, having ≥ 2 of these 3 variables had a positive predictive value of 100% for being a possible REBOA candidate.

There are limitations to this study. This was a retrospective study utilizing autopsy data. Prospective trials are still needed. Patients with severe head injury were excluded from the study, although prospective trials may demonstrate a survival advantage to early hemorrhage control with REBOA. Finally, EMS response and scene times were not available and transport time was short (average of 20 minutes) and the results may not be generalizable to rural and austere settings where transport time is longer.

This study concludes that greater than 10% of patients with suspected NCTH who have a prehospital cardiac arrest following signs of life may benefit from early REBOA placement in the field. Prior prehospital REBOA placement has been limited to the austere military setting as well as a few advanced European EMS services staffed by physicians. Future prospective studies are necessary prior to concluding that prehospital REBOA is beneficial.

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4. **Identifying patients with time-sensitive injuries: Association of mortality with increasing prehospital time.** Chen S, Guyette FX, Peitzman AB, Billiar TR, Sperry JL, Brown JB. J Trauma Acute Care Surg. 2019;86:1015-1022.

It is well recognized that survival from trauma is time sensitive. The sooner a critical trauma patient reaches the operating suite or definitive care, the better the patient's chance of recovery to a full and productive life. For the last 30 years EMS work has worked under the premise of the "Golden Hour" principle, where rapid extrication and transport techniques were utilized, limiting the time spent on the scene The performance of treatments in the back of the ambulance while in route to the trauma center was and is commonplace, although challenging and in some cases difficult at best to perform in a moving ambulance.

The authors of this retrospective observational study attempt to determine what existing prehospital trauma triage criteria can identify patients that are likely to have increased mortality associated with increased prehospital time, while correcting for potential survival bias.

The study reviewed all patients 16 years old and older from the National Trauma Databank (NTDB) from 2007-2015. Patients that were excluded included burn patients, patients with missing total prehospital times, and prehospital times greater than three (3) hours. For the purpose of this study, the authors defined total prehospital time as the time from dispatch of EMS to the arrival of the patient to the hospital. After taking the above factors into account and correcting for survival bias, a study population of 517,863 patients with a prehospital time of less than 30 minutes was analyzed. Twenty five percent (23%) presented with penetrating injuries.

The authors found that patients with a systolic BP (SBP) of less than 90mmHg, a GCS score of eight (8) or less or non-extremity penetrating trauma had an increased odds of mortality associated with increasing prehospital times. Of interest, patients with a GCS score ≤8 who were intubated by ground ambulance responders compared to those patients who were not intubated; however this finding was not found in those individuals transported by helicopter EMS. While an exact reason for this difference cannot be explained by this study, the authors speculate that the difference in training and the availability of medication assisted intubation may be factors.

Limitations of this study relate to the retrospective observational design and the NTDB for availability of full data. For example, 9% of potential study patients were missing prehospital time and not included in the analysis. In addition, trauma patients with prehospital times greater than 30 minutes were not included and may represent a group that could benefit by shorter prehospital times.

This study does not change the practice of modern prehospital trauma care. It does, however, reaffirm that in the subset of patients with a SBP less than 90 mmHg, a GCS of eight (8) or less, or penetrating trauma to the head, neck or torso, incremental increases in prehospital time can directly impact overall survivability of these patients. This study also reaffirms that, although it is commonly referred to as the "Golden Hour", many patients do not have 60 minutes in which definitive care can be provided but rather it is a "Golden Period" which in some patients may exceed 60 minutes and in some patients be much shorter.

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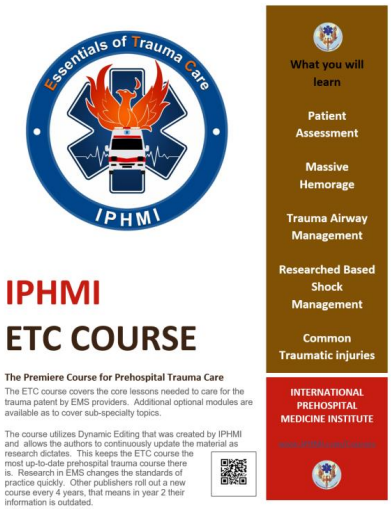
5. **Right hospital, right patients: Penetrating injury patients treated at high-volume penetrating trauma centers have lower mortality.** Fu CY, Bajani F, Tatebe L, et al. J Trauma Acute Care Surg 2019;86:961–966.

In the early days of EMS, patients were often transported to the closest hospital or the hospital of their choice, regardless of their illness or injury. As modern EMS systems developed, a shift took place and patients were preferentially transported to specialty hospitals that had the ability and expertise to care for specific patient presentations. Trauma centers and trauma systems were among the first to develop.

The authors of this retrospective cohort analysis investigate the differences, if any, in survival of patients with penetrating injury between Level I and II trauma centers that receive a high volume of penetrating trauma compared to those that do not.

The authors enrolled patients from the local Cook County Hospital (CCH) trauma registry along with those from the National Trauma Data Bank (NTDB). All patients from 2011 to 2015 with penetrating trauma from level I and II trauma centers were enrolled. Exclusions were patients who were dead on arrival at the hospital and those with missing records or key information. In terms of number of penetrating trauma patients treated, the top twenty-five (25) percent of trauma centers that treat over 167 penetrating injuries per year were compared to the bottom twenty-five (25) percent of trauma centers that treated less than 37 penetrating traumas per year. There are twenty (20) trauma centers that manage over 400 penetrating trauma patients per year.



Trauma centers in the high-volume group treated significantly more patients presenting with hypotension (9.0% vs. 7.6%) and patients that had a higher injury severity scale (ISS) at 8.9 vs. 7.7. Patients that required ventilatory support were also greater in the higher volume trauma center group (17.4% vs. 13.7%). The authors demonstrated that patients who presented with higher ISS (>25) had a survival advantage (71.7% vs. 66.8%) when treated at trauma centers in the high-volume group.

The study demonstrates that trauma centers that care for a greater number of penetrating trauma patients have better outcomes in those patients who have sustained severe injuries. This study has implications in terms of EMS destination policy and whether or not the choice of destination for penetrating trauma victims should be limited to specific trauma centers to maximize the volume and experience of that center's staff and thus optimize patient outcome.

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6. **Shotgun Wounds: Nationwide Trends in Epidemiology, Injury Patterns, and Outcomes From US Trauma Centers.** Schellenberg M, Owattanapanich N, Cremonini C, et al. J Emerg Med 2020;58:719-724.

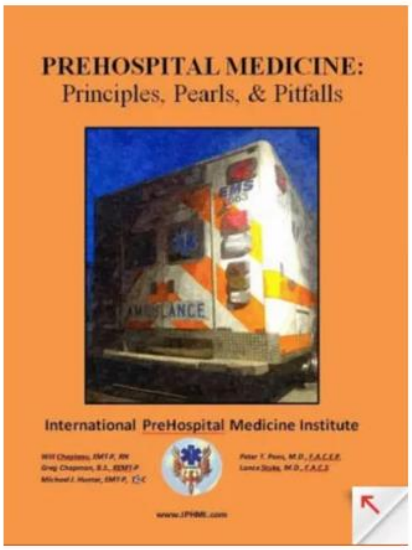
While all penetrating trauma is of concern to prehospital providers, ballistic trauma in general, including the variations in wounding patterns, the outcomes of certain weapons, and the demographics of victims have been well described. . The authors of this retrospective observational study looked at the wounding patterns, severity and populations that sustain their injuries from shotgun wounds.

The authors queried the National Trauma Data Base (NTDB) for patients that sustained injuries from shotgun blasts during the years of 2007 to 2016. . Data collected included demographic information, body systems injured, outcome as well as wounding intent.

The data base revealed a total of 15,463 patients injured during the study period. Patients were excluded from the study if they were transferred from an outside hospital or had a missing procedure code, leaving 11,292 patients enrolled for analysis. Males predominated (88%). Intentional assault accounted for 60% of cases, accidents for 19%, and self-inflicted 17%. Overall, 14% of the study group died due to their injuries. Of those, 669 (7%) were pronounced in the Emergency Department and 256 (3%) were dead on arrival. Three thousand two hundred and ninety-two (3292) required surgical intervention, most within 24 hours of admission. Of note, at the time of emergency department arrival, only 13% of patients were tachycardic and 11% were hypotensive.

The most severely injured body area was the head; whereas the most commonly injured body areas were the lower extremities and then the upper extremities. The abdomen and chest, respectively, were the two most common areas that needed surgical intervention. Almost 80% of patients were injured in more than one body area.

This study clearly demonstrates the subset of wounds caused by shotguns is different than that of other firearms. The scatter and variable size of shotgun pellets complicates the assessment and management of these patients. Patients have a higher likelihood of presenting with apparently stable vital signs; therefore vigilance during transport is necessary to recognize any change in patient condition.



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