International Prehospital Medicine Institute

IPHMI EMS Literature Review

Keeping You Up to Date with Current EMS Literature and Studies

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2. **Outcomes of basic versus advanced prehospital life support in severe pediatric trauma.** Epstein D, Goldman S, Radomislensky I, et al. *Am J Em Med*. 2023;65:118-124.
3. **Association between prehospital airway type and oxygenation and ventilation in out-of-hospital cardiac arrest**. Song SRS, Kim KH, Park JH, Song KJ, Shin SD. *Amer J Emerg Med* 2023;65:24-30.
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1. **Characteristics and Outcomes of Prehospital Tourniquet Use for Trauma in the United States.** Hashmi ZG, Hu P, Jansen JO, Butler FK, Kerby JD, Holcomb JB. *Prehosp Emerg Care.* 2023;27:31-37.

Trauma is the leading cause of death in the U.S. for patients between the ages of 1 and 44 years and uncontrolled hemorrhage is the most common cause of preventable trauma death. Uncontrolled extremity bleeding is treatable in the field. The authors of this study sought to determine the effect of prehospital application of tourniquets on outcomes in trauma patients with hemorrhage.

The authors conducted a retrospective study using data from all trauma activations that were reported in the National Emergency Medical Services Information System (NEMSIS) 2019 database which included data on 34 million prehospital incidents reported by over 10,000 EMS agencies in 47 states and territories. The patients that had tourniquets applied were compared against an equal number of matched patients that did not have tourniquets applied.

Of 4,571,379 trauma activations, there were 7,161 tourniquets applied, amounting to 1.6 tourniquets per 1,000 trauma activations. A single tourniquet was placed in 6,395 patients (89.3%), two tourniquets were used in 701 cases (9.8%), and three or more were used in 65 victims (0.9%). Approximately half of the injuries in which tourniquets were used were gunshot or stab wounds of the extremities.

Tourniquet use was associated with higher overall survival to the hospital emergency department (83.6% vs. 75.1%, p<0.01), lower prehospital mortality (0.4% vs 1.0%. p <0.01), shorter scene time (15.4 ± 13.6 vs. 17.0 ± 14.2 minutes, p<0.01), and higher final acuity. If a tourniquet was placed after arrival to the trauma center, there was 4.5 times increased risk of death from hypovolemic shock. In addition, they found that over 140,000 patients that had documented extremity injuries with hemodynamic instability did not have tourniquets applied to their injured extremities.

Limitations of this study include the fact that the data is voluntarily submitted by EMS agencies which could potentially present a selection bias, although given the representation in the data set of over 10,000 EMS agencies, the reliability should be good. A second limitation relates to missing data points. Lastly, the NEMSIS database has > 50% missing data regarding hospital disposition, thus long-term outcome could not be reported.

This study demonstrates that tourniquet use by EMS personnel in the United States is associated with shorter scene times and improved survival to hospital. Unfortunately, this study also showed that overall tourniquet use was low and that many patients with limb injuries and hemodynamic instability go untreated. There are many patients that would likely benefit from wider use tourniquet use in the civilian prehospital setting.

2. **Outcomes of basic versus advanced prehospital life support in severe pediatric trauma.** Epstein D, Goldman S, Radomislensky I, et al. *Am J Em Med*. 2023;65:118-124.

Trauma remains the leading cause of death in children. Multiple retrospective studies in adults have demonstrated no survival advantage or improvement in neurological outcomes when transported by Advanced Life Support (ALS) versus Basic Life Support (BLS). Studies on the prehospital management of pediatric trauma patients are scant, with little data available to guide care. The objective of this study is to compare the outcomes of pediatric trauma patients following prehospital transport by ALS versus BLS.

This is a retrospective cohort study of data from the Israeli National Trauma Registry (INTR). Severely injured trauma patients were defined as any patient younger than 18 years of age with an Injury Severity Score (ISS) greater than 15. Severely injured trauma patients in Israel are transported to one of six Level 1 trauma centers (TC) and 15 Level II TCs. Israel does not designate specific pediatric trauma centers, so all TCs care for both adult and pediatric patients. Emergency Medical Services (EMS) in Israel are provided primarily by the Magen David Adam (MDA) organization, comprising paid ALS and BLS medics, as well as volunteers, medical corps teams, and some private carriers. MDA has 169 stations with a fleet of over 1000 ambulances. The assignment of BLS or ALS ambulances is dictated primarily by availability and proximity to the call. Some high-risk trauma patients (severe mechanism, high-risk anatomic injury, or altered vital signs) may preferentially receive ALS care if available. However, BLS crews do not delay care to wait for ALS, and transfer en route from BLS to an ALS ambulance is rare. For this study, the team providing care at the time of arrival to the hospital was credited with the transportation. Since patients transported by ALS ambulates are presumably at higher risk of death than those transported by BLS due to the severity of injury, the authors used logistic regression analysis modeling to compute the odds of death among ALS relative to BLS transported victims. They used this statistical method to control for potential confounders such as age, gender, type and mechanism of injury, receiving hospital designation level, and GCS.

A total of 3167 patients were included in the study. Of the included patients, 2062 (65%) were transported by an ALS ambulance. Of these, 206 (10%) were transported by helicopter EMS. A Level 1 TC was the destination hospital for 2393 (76%) of cases. The most common mechanisms of injury were motor vehicle collision (MVC) (53%) and falls (29%). Penetrating injuries comprised only 7% of total pediatric responses, and 83% of those were transported by ALS teams. ALS crews transported a higher number of moderate and severely injured patients, defined as those with an ISS 25-49 and ≥ 50. Endotracheal intubation was performed by ALS teams is 483 (23%) of patients. Intravenous (IV) fluids were administered to 779 (38%) of patients in the ALS group. After statistical adjustment for demographics, type and mechanism of injury, receiving hospital level, GCS, and ISS, patients transported by ALS ambulances were over twice as likely to die compared to patients transported by BLS crews (OR 2.27).

This study is one of the first to demonstrate no survival benefit for pediatric trauma patients transported by ALS ambulance crews compared to BLS crews. Multiple studies have already demonstrated this in adult trauma patients. The adult data could not be extrapolated to the pediatric population as their cause of death from trauma is different than the adult population (head injury and falls versus hemorrhage). Studies have shown that prehospital intubation of the adult trauma patient and initiation of IV access with or without administration of fluids, all increased mortality. Even administration of prehospital plasma only shows some benefit in prolonged transport times (20 minutes or greater). There are likely multiple reasons for the increased mortality with prehospital ALS care and may be related to increased scene times and dilution of clotting factors with IV fluid is given.

Limitations of this study include its retrospective nature. Additionally, Israel is primarily an urban trauma system, with relatively short transport times, so the results of this study may not apply to EMS systems in rural or austere environments. The pediatric patients in this cohort were primary blunt injuries, with very few penetrating injuries.

In summary, this study from Israel of pediatric trauma patients showed a greater that two times risk of death if transported by ALS vs BLS ambulances. It corroborates previous data in adult trauma patients. Further studies are warranted, but providers should be cognizant of this when treating pediatric trauma patients.

3. **Association between prehospital airway type and oxygenation and ventilation in out-of-hospital cardiac arrest**. Song SRS, Kim KH, Park JH, Song KJ, Shin SD. *Amer J Emerg Med* 2023;65:24-30.

Response to out-of-hospital cardiac arrest (OHCA) is common in EMS systems around the world. In recent years improvements in outcomes have resulted from the implementation of early CPR and the availability of AED's to the civilian population. Studies of the effectiveness of treatments provided by EMS providers have demonstrated mixed results when dealing with airway management techniques.

The authors conducted a multicenter retrospective observational study in South Korea to compare the prehospital use of three (3) different airway techniques and their effect on oxygenation, ventilation and patient outcomes in victims of non-traumatic cardiac arrest. The South Korean EMS system is Fire Department-based with the highest level of training being equivalent to the AEMT American model. Over the course of the study period, a multi-tiered response was adopted in 2017 and an advanced life support program in 2020. All cardiac arrests are required to be transported to an ED. Field personnel are not allowed to discontinue CPR unless there is a return of spontaneous circulation. Medication administration requires direct orders from a physician

The authors looked at three (3) methods of airway management: bag mask ventilation (BVM), endotracheal intubation (ETI) and supraglottic airway (SGA). The specific type of SGA was not defined in the paper. The primary outcome was good oxygen levels (PaO2 levels greater than 60 mmHg on the initial arterial blood gas [ABG] performed in the ED). The second outcome evaluated was good ventilation (PaCO2 less than 45 mmHg on the ABE at the receiving Emergency Department (ED)). The third outcome was 72 hour survival.

During the study period of October 2015 to June 2021, there were 15,368 patients with OHCA admitted to participating EDs. Of these, 7372 patients were included from the study. Exclusions included:

- missing ABG analysis on arrival at the ED (n=3,722)
- ED arrival with ROSC (n=1,255)
- Arrest witnessed in ambulance (n=1.052)
- Inter-hospital transport (n=697)
- Non-EMS transport (n=626)
- Pediatric age (n=328)
- DOA in ED / DNR (n=250)
- Extreme EMS time (n=66)

There are a number of limitations to this study, the primary being missing ABG values for over half of the OHCA's during the study period. The second was that data was not collected on the timing of the insertion of the airway device, the number of attempts (two maximum are allowed) or if a secondary device was used as a rescue device after failure of the primary device. Other limitations included the non-standardized time to ABG collection at the receiving facility along with documentation of device placement on arrival at the ED.

The authors concluded after multivariate logistic regression statistical analysis of the data that the ETI group had a higher probability of obtaining the study defined "good oxygenation and ventilation" than the BVM sub-group. The SGA group demonstrated a greater chance at lower PaO2 and higher PaCO2 levels. Patient survival at seventy-two (72) hours demonstrated a higher survival for the BVM and SGA group at 18.5% and 15.4% compared to 12.9 for the ETI sub-group.

Taken at face value, for example by only reading the abstract, this study would suggest that patients who underwent ETI had improved oxygenation compared to patients treated with bag-mask ventilation or SGA. In reading an article such as this one however, it is crucial to look at all of the provided data. In the results section and table 1, the following data are provided regarding the initial ABG in the ED:

Bag-mask:	pH=6.9	PaO2=38.3 mmHg	PaCO2=78 mmHg
ETI:	pH=6.9	PaO2=42.7 mmHg	PaCO2=75 mmHg
SGA:	pH=6.9	PaO2=41.8 mmHg	PaCO2=81 mmHg

Expected values for "good" oxygenation would be a PaO2 of 75 to 100 mmHg; "good" ventilation would be a PaCO2 of 35 to 45 mmHg, and normal pH would be 7.35 to 7.45. The patients in this study were therefore profoundly acidotic, hypoxic, and hypercarbic. If not corrected urgently, these values are incompatible with life. Unless an error was made in reporting these values, this study should not prompt anyone to make a change in their airway management protocol for OOHCA.

4. **Head and thorax elevation during cardiopulmonary resuscitation using circulatory adjuncts is associated with improved survival.** Moore JC, Pepe PE, Scheppke KA, et al. *Resuscitation* 2022;179:9-17.

For the last six decades, healthcare providers and the lay public have all been taught to place the victim of cardiac arrest flat on a hard surface and to begin cardiopulmonary resuscitation (CPR). Even with the use of layperson CPR and the increasing deployment of automated external defibrillators (AEDs), the chances of surviving an out of hospital cardiac arrest (OOHCA) are approximately 10%. Of that 10%, even less will escape the event neurologically intact.

The authors of this paper looked to improve cardiac arrest survival by utilizing a different patient position than the Conventional CPR (C-CPR) position of prone on a hard surface. Past animal studies have looked positioning the cardiac arrest victim in a head and thorax elevated position, using active compression and decompression CPR and the deployment of an impedance threshold device during ventilation. The theory is that combining these three practices enhances venous drainage from the head, thus decreasing cerebral perfusion pressure, while also improving perfusion to the thorax via gravity.

IRB approval was obtained to conduct a consent waived, prospective study utilizing Automated Controlled Elevation (ACE) of the head and thorax of prehospital patients being treated with CPR (ACE-CPR). In addition to ACE-CPR, patients were ventilated with an in-line impedance threshold device. The process involved the following steps:

- With a goal of not interrupting CPR for greater than 6 seconds, the patient was transitioned to a Lucas 2 chest compression device with an Automated Patient Positioning Device (APPD) in place.
- When placed into position, the APPD raised the patient's head and thorax 12 cm and 8 cm respectively.

- After 2 additional minutes of Lucas chest compressions, the APPD is activated to raise the patient's head and thorax, over 2 minutes, to 22 cm and 9 cm respectively (ACE-CPR).

Ten EMS agencies were chosen for the study. Of the ten, only six had usable data due to delayed training and deployment of ACE-CPR in 4 agencies. The six agencies contributing data routinely used ACE-CPR and included the time from 9-11 call to the initiation of CPR. Study subjects treated for out of hospital cardiac arrest in the study were all age greater than 18 and not incarcerated. Pregnant females were eligible for inclusion. The control group was chosen from cardiac arrest registries with EMS agencies that provided high quality C-CPR according to American Heart Association Standards. All control group patients that sustained OOHCA were greater than 18 years of age and were not prisoners. To avoid time bias, the authors tried to match patients based on time from 9-11 call to the initiation of EMS CPR. Patients that experienced return of spontaneous circulation via shock, prior to ACE-CPR, were not enrolled into the study.

Over the course of fifteen months, 227 cases of ACE-CPR met inclusion criteria and were matched with control patients via propensity score analysis. The authors found that the shorter the time of 9-11 call to the initiation of ACE-CPR up to 18 minutes resulted in a better chance of survival to hospital discharge. ACE-CPR also resulted in a greater likelihood of return of spontaneous circulation, hospital discharge and better neurological function than patients in the control C-CPR group. This finding held true for patients that presented in both shockable and non-shockable rhythms.

Limitations of the study included observational data versus a randomized trial, small data groups, and data matching via propensity score. Additionally, study sites were similar, but they did not all use the same pre-hospital protocols.

The authors believe this study demonstrates that ACE-CPR, deployed rapidly, can increase the likelihood of survival from OOHCA. The procedure can be initiated by first responders. Given the relatively small sample size, additional study with larger groups of patients should be undertaken.