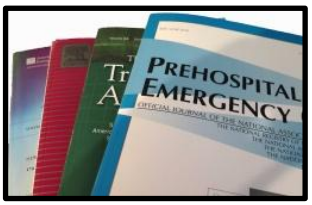
International Prehospital Medicine Institute



IPHMI Literature Review

Keeping You Up to Date with Current EMS Literature and Studies

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4. **Exertional Heat Stroke: Are We Cool Enough? Retrospective Observational Study of Patients of Running Events.** Dollée N, Alsma J, Goedhart R, Bultstra A, Haagsma JA, Hoek AE. *J Emergency Medicine* 2025;71:44–53

1. **Hypothermia on admission predicts poor outcomes in adult trauma patients.** Jose AM, Rafieezadeh A, Zeeshan M, et al. *Injury* 2025;56:112076.

Hypothermia, coagulopathy and acidosis combine to create the trauma triad of death. If left untreated, each contributes to the other resulting in a cyclic effect and ultimately organ failure and death of the severely injured trauma patient. The authors of this paper looked specifically at hypothermia with a hypothesis that hypothermia is associated with poor outcomes with trauma patients.

Hypothermia was defined as a core body temperature of <35^{o} C (Mild: <35 ^{o}C to >32^{o}C, Moderate $\leq$32^{o}C to 28^{o}C and Severe $\leq$ 28^{o}C). This retrospective observational study was IRB approved. Data were culled from the American College of Surgeons Trauma Quality Improvement Program from the period 2017 through 2021.

The primary outcome measure of the study was mortality. There were multiple secondary outcomes including; Emergency Department disposition, blood transfusions, hospital length of stay, direct ICU admission, ICU length of stay, length of time on a ventilator, and in-hospital complications. Inclusion criteria were adult trauma patients ($\geq$18 years of age) with an Emergency Department arrival temperature >22^{o}C and $\leq$40^{o}C. Temperature on arrival at the Emergency Department was defined as the first hospital temperature recorded within 30 minutes of patient arrival at the Emergency Department Patients were initially divided into two groups, normothermic (35^{o}C to 40^{o}C) and hypothermic (35^{o}C to 22^{o}C). A total of 3,043,030 patients met inclusion criteria. That group was further divided into the two subgroups resulting in 29,891 patients in the hypothermia group and 3,013,139 in the normal thermic group. Standard, de-identified patient demographics were also collected.

Exclusion criteria included dead on arrival patients, those with burns, inter-facility transfers with arrival temperatures >40^{o}C, and patients with incomplete data.

Adult trauma patients who arrived to the Emergency Department with hypothermia experienced 93% increased odds of mortality. Additionally, for every 0.5^{o}C decrease in body

temperature the chance of mortality increased by 25%. Secondary outcomes showed that hypothermic patients presented with higher ISS index, shock index and recent history of illicit drug use. They were more likely to be admitted directly to the ICU from the Emergency Department and experienced more in-hospital complications (ARDS, intubations, ventilator acquired pneumonia and returns to the ICU and operating room).

Limitations of this study include not having access to pre-hospital data and if any therapies used to limit patient hypothermia (external warming with blankets and / or heat sources or the use of warm IV fluids) were deployed. The exact timing of the first temperature taken on arrival at the Emergency department is not recorded in the database. Incomplete patient records were excluded which could introduce bias.

Hypothermia is one component of the trauma triad of death that pre-hospital providers can often help mitigate. Providers should include efforts to maintain normal patient temperatures while caring for victims of trauma. Simple actions may have a positive impact on trauma patient survival. Providers should be cognizant of ambient temperatures in the patient care environment. Air conditioning in the ambulance should be reduced to preserve patient body temperature. Once exposed and evaluated, patients should be re-covered and, if possible, warmed to reduce shivering and its increased oxygen demands on the body. Warmed IV fluids and blood products should be infused as a preference over room temperature fluids and chilled blood products. This study should be repeated to assess the impact of prehospital warming efforts on the outcome of trauma patients.

2. **Influence of pulseless electrical activity and asystole on the prognosis of patients with traumatic cardiac arrest: A retrospective cohort study**. Cheng H, Chiu PW, Lin CH. *Injury* 2025;56:112262.

Outcomes following traumatic cardiac arrest (TCA) remain poor despite advances in resuscitation. Most cases of TCA present with a non-shockable rhythm – asystole or pulseless electrical activity (PEA), while a shockable rhythm (ventricular fibrillation) is more common in medical cardiac arrests. The American College of Surgeons Committee on Trauma (ACSCOT) considers PEA to be a sign of life and recommends ongoing resuscitation. Prior studies show both improvement in survival to discharge in patients with PEA compared to asystole, while other studies demonstrate no difference in survival. This study sought to analyze the prognostic effects of PEA and asystole in patients with TCA.

This is a retrospective cohort study from a single trauma center in Tainan, Taiwan over a six-year period. Patients with TCA transported by local EMS were enrolled in the study. Patients were excluded if they were in a non-traumatic cardiac arrest, had prehospital return of spontaneous circulation (ROSC), were under 18 years of age, were pregnant, or were suffering from an atypical trauma mechanism (burns, hanging, drowning, electrocution, or lightning strike). Additionally, patients with a shockable rhythm (ventricular fibrillation and ventricular tachycardia) were excluded. Initial cardiac rhythm was defined as the rhythm on arrival to the emergency department. The primary outcome was ROSC at any time after reaching the hospital. Secondary outcomes were the achievement of sustained ROSC (circulation greater than 20 minutes), survival to hospital admission, survival to hospital discharge, and favorable neurological status after discharge (defined as cerebral performance category [CPC] I or II) at one month.

A total of 136 patients met inclusion criteria. Nearly all patients (n=128, 94%) were blunt trauma, while 8 patients (6%) had penetrating injuries (5 gunshot wounds and 3 stabbings). PEA was the most common presenting rhythm (n=78, 57%) followed by asystole (n=58, 43%). There was no difference between the groups in terms of sex, age, trauma mechanism, or time of ED arrival. There was also no difference in treatment provided between the PEA and asystole groups, such as airway management, chest tube placement, thoracotomy, blood transfusion, and spine immobilization.

The PEA group had a significantly higher ROSC rate than the asystole group (49% vs 26%, p=0.012). However, while PEA remained slightly higher, the sustained ROSC rate (36% vs 22%, p=0.132) and survival to hospital admission (28% vs 19%, p=0.298) did not reach statistical significance. Two patients in the PEA group survived discharge, although each had a CPC score of III and IV at the time of discharge, indicating a poor neurological outcome. Both TCAs were due to airway-related issues, with ROSC achieved after an airway was obtained.

This study had several limitations. It was a retrospective study with the associated limitations in such a study. It was also a single-center study in Taiwan, so results may not translate to other trauma systems. The total number of patients was small, which makes it difficult to extrapolate significant findings. Finally, the initial EMS cardiac rhythm was not recorded, with the initial rhythm being that upon arrival to the ED.

In conclusion, this study demonstrates that among patients in TCA with a non-shockable rhythm, PEA is associated with a higher initial rate of ROSC compared to asystole, but this does not translate to the more clinically significant findings of prolonged ROSC or survival to hospital admission and discharge. The findings are consistent with many other studies and also demonstrates that meaningful survival from TCA remains very low regardless of the initial cardiac rhythm.

3. **Paramedic Judgment as a Basis for Trauma Triage: Is it an Effective Strategy?** Schaefer MP, Lamy C, Mederos-Rodriguez D, Berne JD *The American Surgeon* 2025;91:795–806.

The American College of Surgeons Trauma Triage Criteria are designed to help EMS personnel determine the need for transport of trauma patients to a trauma center while minimizing both overtriage and undertriage. Some trauma systems prefer to use criteria they developed and also include paramedic judgement as an option for determining patient destination. The primary research objective of this study was to evaluate overtriage and undertriage using their standardized criteria versus paramedic judgement.

The study retrospectively looked at their trauma registry database from January 1, 2019 to January 5, 2023. The variables collected included, demographic information, BMI, ISS, field trauma alert level, hospital trauma alert type, need for blood transfusion, need for angiography, and need for cerebral monitors. In addition to comparing their standardized criteria to paramedic judgment to the initial determination of over- and undertriage, they also evaluated the two methods on the need for emergent interventions defined as: brain surgery, chest tube placement, blood transfusion (5 or more units of packed red blood cells), central line insertion, endotracheal intubation, or need for an angiogram."

There were a total of 13,619 patients in the registry during the study period. Their inclusion criteria were adults $\geq$ 18 y/o admitted to a large urban trauma center with a level I or II trauma alert. During the study period there were 9,767 Level I and Level II adult patients. Patients less than 18 y/o were excluded as were patients that were transferred in, emergency department patients without trauma alerts, prisoners or inmates, pregnant patients, and patients that likely had errors in data entry or missing data. After exclusions, 2,810 patients were included in the study.

Of the 2810 patients, 1,220 patients were triaged by paramedic judgement and 1,590 were triaged using standard criteria. The analysis showed that overtriage for both groups exceeded the CDC and ACS-COT guidelines of 25%-35%. Paramedic judgement cases resulted in 68.93% being over triaged compared to 54.8% when using the standardized criteria. Overall, 61% of the patients were over triaged. In comparison, only 0.6% of the patients were under triaged which is below the threshold established by the CDC and ACS-COT of 5%. After controlling for variables, the paramedic judgement group was more than twice as likely to overtriage than when using standard criteria. They also found that patients in the paramedic judgement group needed fewer blood transfusions, central lines, or angiograms.

An important limitation of this study is that the authors were unable to determine paramedic tenure and experience which could drastically affect the overtriage and undertriage rate. In addition, they stated that most paramedics in the system are basic life support certified and not advanced cardiac life support certified which could affect triage decision-making.

The authors concluded that their standard criteria provided a more accurate and precise prehospital triage methodology than paramedic judgement, but that further study was needed. Unfortunately, they did not evaluate the ACS Trauma Triage Guidelines which are in more widespread use nationally. Finally, they closed with the reminder that: "Lowering overtriage while keeping undertriage below 5% will allow the hospital to properly allocate resources, while providing the highest quality care."

4. **Exertional Heat Stroke: Are We Cool Enough? Retrospective Observational Study of Patients of Running Events.** Dollée N, Alsma J, Goedhart R, Bultstra A, Haagsma JA, Hoek AE. *J Emergency Medicine* 2025;71:44–53

Exertional heat stroke (EHS) is a life-threatening condition that, if not recognized and treated early, can result in the death of the patient. Current in-hospital treatments include immersing the patient in a cold-water bath to facilitate rapid cooling, thereby bringing the patient's temperature to less than 104 degrees F. While this approach works well in a hospital or fixed facility, using it in the prehospital environment creates logistical problems and transport issues. The author's primary goal was to assess the use of ice-soaked rotating towels initially and during transport of those demonstrating signs of heat stroke. The endpoint was to decrease the patient's body temperature to below 104°F within thirty minutes by using rotating ice-soaked towels.

This retrospective observational study included participants aged 18 years and older who received medical care at running events with distances ranging from 2.6 miles (4.2 km) to 26.2 miles (42.195 km). Data was collected from five events held in the Netherlands between 2016 and 2019. Prior to each event, the medical team received instructions on the protocol for early recognition and treatment of exertional heat stroke (EHS). Tympanic temperatures were obtained to measure body temperature. Patients diagnosed with EHS were treated immediately by applying rotating ice water-soaked towels to the body and head, avoiding the face, and changed every 2 to 3 minutes. In addition, ice packs were placed in the axillary and groin regions for further cooling.

During the study period, a total of 374,534 runners participated in the running events. A total of 48 patients demonstrated a measured temperature above 104°F. Twelve patients did not meet the criteria for EHS, resulting in a study cohort of 36 patients. It is worth noting that none of the events included in the study had an ambient temperature exceeding 65°F.

The authors demonstrated that all of the 36 patients who met the inclusion criteria were cooled using ice-soaked towels within 30 minutes. Furthermore, 91% were cooled to 102.1°F or less at the 30-minute mark. None of the 36 patients died during the study.

Limitations include the retrospective nature of the study, the non-standardization of the tympanic thermometers used, the relatively young and healthy nature of the participants, and the application of ice-soaked towels by EMS personnel before presentation to the aid area and body temperature measurement.

Exertional Heat Stroke is a problem not only during organized athletic events, but also for workers in high-heat environments for extended periods of time. This includes firefighters who consistently work in high-heat environments. While the use of immersion in cold water may more quickly decrease body temperature, the practicality of this approach in the prehospital setting creates obstacles for EMS personnel or other aid personnel at race events. The use of rotating ice-soaked towels may be a logistically acceptable alternative. Of importance in this study was the ambient temperatures on race days. None were greater than 65°F, with most in the low to mid-50s. The race events included in the

study were large events with dedicated aid areas, staffed by physicians, nurses, and other medical personnel. While the use of physicians at large events is often seen, smaller local events often rely on EMS staffed by EMTs and Paramedics. These EMS providers must be aware of the possibility of EHS and be prepared to assess and treat it initially and during transport. Appropriate supplies and protocols must be in place to achieve the best possible outcomes.