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IPHMI Literature Review

Keeping You Up To Date with Current EMS Literature and Studies

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1. **A Simple Improvised Prehospital Method to Warm Intravenous Fluid.** Lyng JW, Perlmutter MC, West MA. *JACEP Open*. 2021;2. Open access. Full text available at: <https://doi.org/10.1002/emp2.12536>
 2. **Effectiveness of massive transfusion protocol activation in pre-hospital setting for major trauma.** Botteri M, Celi S, Perone G, et al. *Injury*. <https://doi.org/10.1016/j.injury.2021.12.047>
 3. **Characteristics of scene trauma patients discharged within 24 hours of air medical transport.** Gilliam C, Evans DC, Spalding C, Burton J, Werman H. *Int J Crit Illn Inj Sci*. 2020;10:25–31.
 4. **Out-of-hospital cardiac arrest due to hanging: a retrospective analysis.** Turner J, Brown A, Boldy R, Lumley-Holmes J, Rosser A, James A. *Emerg Med J*. 2022;39:106-110.
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1. **A Simple Improvised Prehospital Method to Warm Intravenous Fluid.** Lyng JW, Perlmutter MC, West MA. *JACEP Open* 2021;2. Open access. Full text available at: <https://doi.org/10.1002/emp2.12536>

Hypothermia is one of the three components of the “Trauma Triad of Death” and is often an unintended complication while providing care to the trauma victim. It may also be the easiest one to prevent in the prehospital setting. Patients, both trauma and medical alike, need to be kept warm. In addition to maintaining a warm ambient temperature in the patient compartment and the application of blankets, the administration of warmed IV fluids will help decrease the likelihood of patient hypothermia. All patients benefit from IV fluids that have been warmed and infused at close to normal body temperature, 37 C (98.6 F).

There are multiple IV fluid warmers and IV infusion warmers commercially available on the market. While effective, these products may not always be available to EMS providers due to their cost, storage space requirements and available power sources. For years, many EMS personnel have used the ambulance heating ducts and windscreen defrosters as improvised IV fluid warmers. The authors of this study attempted to create a benchtop model of this practice in order to test the effectiveness of this fluid warming technique and to compare the temperature of windscreen defroster heated IV fluids to fluids within the same vehicle at ambient temperature.

The authors used a 2005 Mercury Mountaineer as their test vehicle. They gathered 20, 1-liter bags of normal saline IV fluid. All the IV fluid bags were first acclimated to 21 C (69.8 F) for eight hours and stored in a cooler. Two bags at a time were removed from the cooler for the experiment and fitted with probes that measured the temperature of the fluid within the bags at 30 second intervals. The first bag was placed on the windshield defroster vent and the second on the non-heated center console of the vehicle. The vehicle was then driven on city streets along a pre-determined route with the windshield defrosters running. The duration of the test drive was 30 minutes. This test drive was repeated ten times on the same day and along the same route using 2 new bags for each test.

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The initial recorded temperature of the bags averaged 19.4° C (66.9° F). The temperature of the windscreen defroster bags ranged from 27.7° C (81.9° F) to 38.1° C (100.6° F) with a mean temperature of 32.6° C (90.7° F), 4.4° C lower than “normal” body temperature. The ambient temperature recorded for the bags on the center console was a temperature range of 20.1° C (68.2° F) to 22.3° C (72.1° F). The bags left at ambient temperature on the center console were significantly cooler at 30 minutes than the ones warmed on the windscreen defroster vents.

The authors acknowledge that while their simulation proved that using a vehicle’s windscreen defrosters as an improvised IV Fluid warmer was effective, they did not evaluate how long the fluids stayed warm or what the temperature of those same fluids would be at the distal end of IV tubing. They also did not account for variations in temperature within the IV fluid bag. This simulation was timed at 30 minutes. There is no way to know what the temperature of those same fluids would have been if left out of the cooler for longer periods of time, as would occur for the majority of a standard EMS shift posting.

Vehicle heating vents and defrosters can be effective as improvised IV fluid bag warmers. The downside is that fluid temperatures cannot be easily regulated or controlled during EMS operations. Temperatures will vary as the vehicle runs and is turned off. It may also pose a safety concern if the IV fluid bags block the windscreen vents resulting in fogging and icing of the windscreen.

All patients ideally should receive IV fluids should be infused fluids as close to normal body temperature as possible to minimize the potential for inadvertent hypothermia. EMS agencies and providers should strive to use controllable and predictable products and techniques to warm and administer their IV fluids. The crucial temperature for IV fluids is the temperature they are at when they enter our patient’s body. Providers should also consider ways to insulate IV tubing or use heating mechanisms at the most distal portion of the tubing.

2. Effectiveness of massive transfusion protocol activation in pre-hospital setting for major trauma.

Botteri M, Celi S, Perone G, et al. *Injury* <https://doi.org/10.1016/j.injury.2021.12.047>

The most common causes of death from trauma are traumatic brain injury and acute hemorrhage. Hemorrhagic shock accounts for 30-40% of all trauma deaths with half of these occurring in the prehospital setting. Severe hemorrhage results in trauma induced coagulopathy (TIC), which impairs the ability of the remaining blood to form clot. This coagulopathy begins in the prehospital phase of care with up to 30% of all trauma patients exhibiting diminished blood clotting ability by the time they arrive to the hospital. Mortality is increased by four times in this patient population. Blood transfusion strategies in the hospital focus on correcting this coagulopathy while replacing lost blood. Treatment strategies involve massive transfusion protocols (MTP) combined with early damage control surgery. The MTP varies by hospital but involves transfusion of a set ratio of packed red blood cells to plasma and platelets.

This study analyzed a 7-year period of prehospital initiated MTP at a busy Italian trauma center. In their system, prehospital providers identify patients who may benefit from early MTP activation. They administer prehospital tranexamic acid (TXA) help prevent clot breakdown but do not transfuse blood products themselves. Based on their criteria the trauma provider will have blood products ready to transfuse upon patient arrival. The trauma team leader reevaluated the patient immediately upon arrival to the hospital and if they concurred with the EMS findings an immediate transfusion was initiated. Patients must have two of the following EMS-identified criteria for MTP activation:

- hypotension (systolic blood pressure < 90 mmHg) after a failed response to a fluid bolus of crystalloid
- heart rate > 110 bpm

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- uncontrollable hemorrhage
- penetrating wound
- hypovolemic shock class III or IV per the Advanced Trauma Life Support (ATLS) guidelines of the American College of Surgeons

During the 7 year study period, the MTP was activated 242 times. Ultimately, 219 patients were included in the analysis, after 18 underage patients and 5 non-trauma patients were excluded. The trauma team leader agreed that 146 of the 219 patients (66.7%) met the required criteria for immediate transfusion. The most sensitive predictor of need for immediate transfusion was the Shock Index (SI), defined as the heart rate divided by systolic blood pressure. A SI > 0.9 was the best predictor of need for immediate transfusion.

The authors interpreted the results of their study as confirming that determination of the need for MTP can be predicted by prehospital providers as evidenced by the criteria being correct in two-thirds of the cases. These data suggest that prehospital activations of MTP will reduce time to transfusion. Those who met criteria received an average of 7 units of blood components.

This study has several limitations. It is a retrospective study and there was no analysis to prove a survival benefit in those patients who were identified early for meeting transfusion criteria versus those who are identified by the trauma team upon arrival to the hospital. The authors did not calculate an Injury Severity Score (ISS) for the patients to determine the level of severity of injury requiring transfusion.

The aim of the study was to demonstrate the accuracy of their suggested prehospital parameters in predicting the need for massive blood transfusion, however, those criteria were wrong one-third of the time. This has serious patient safety implications as transfusion is not a benign event and blood products are a limited resource. This study, by itself, should not change current practice.

3. Characteristics of scene trauma patients discharged within 24 hours of air medical transport.

Gilliam C, Evans DC, Spalding C, Burton J, Werman H. *Int J Crit Illn Inj Sci.* 2020;10:25–31.

Helicopter transport has an important role in trauma care however, air ambulance utilization comes with significant associated safety risk and high costs for both the transport itself as well as once arrival at the receiving destination occurs. Unfortunately, a not-insignificant number of patients transported by air end up being discharged from the hospital within 24 hours of arrival.

The goal of this study was to determine the characteristics of trauma patients that were discharged within 24 hours to reduce over-triage and over utilization of air medical transport. Data were collected retrospectively from the trauma registries of the two trauma centers serving Columbus, Ohio for all trauma patients transported directly from the scene by air medical transport between January 1, 2016 to December 31st, 2016.

There were 1042 adult trauma patients were transported from the scene by helicopter to one of the two trauma centers during the time studied. Of these patients, 226 (21.7%) were discharged from the hospital within 24 hours of their arrival to the trauma centers. Males made up 71.7% of cases, only 4 patients were over the age of 70 years, and 96.9% sustained blunt trauma. The most common mechanisms of injury were motor vehicle crashes which comprised 44.7% of cases and falls which accounted for 20.4%. The mean systolic blood pressure (SBP) was 138mmHg and the mean heart rate was 92 beats per minute. Only two patients had a SBP<90mmHg. The average amount of fluid given was 335 ml. The average cost per transport was slightly less than \$28,000 and 21% of patients transported were self-pay and became responsible for this expense. In addition, the cost for trauma center care was over and above the transport cost.

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Limitations of this study include potential documentation errors in the charts they reviewed specifically citing the lack of uniform recording of vital signs. They were also unable to consider under-triage in this cohort as the data was only collected from level one trauma centers and not from other hospitals in the region that may have received patients by helicopter.

This study confirmed that a significant number of patients transported to level one trauma centers directly from the scene are discharged within 24 hours of their arrival to the trauma center. Virtually none of the patients transported and discharged within a day had a SBP <90mmHg, receive more than 500 to 1000 ml of fluid, or were age 70 years or greater. Future studies should determine which of these or any other characteristics can be used to reduce over-triage to a more acceptable level, while not having an adverse effect on under-triage.

4. Out-of-hospital cardiac arrest due to hanging: a retrospective analysis. Turner J, Brown A, Boldy R, Lumley-Holmes J, Rosser A, James A. *Emerg Med J.* 2022;39:106-110.

Hanging has long been a commonly used method of suicide. Previous studies have shown that unconscious victims of hanging that are not in cardiac arrest frequently recover with minimal to no neurologic deficit. However, the literature is sparse on prehospital resuscitation on victims who have suffered a hanging incident associated with subsequent cardiac arrest.

This retrospective review attempts to develop insight into the treatment and outcome of cardiac arrest due to hanging as compared to other types of out of hospital cardiac arrests. Data were obtained from the UK out-of-hospital cardiac arrest data base. A search was conducted for cases of hanging from January 1, 2013 through June 30, 2018.

During the study period one hundred eighty-nine (189) patients were identified as meeting the study criteria. Of those ninety-five (95) patients were transported. Of the ninety-five (95) transported four (4) patients survived to discharge. Forty (40) of the patients transported never demonstrated spontaneous circulation in the prehospital setting. None of these forty survived. When comparing cardiac arrest from hanging to cardiac arrest from all causes, the authors found that the percent of patients presenting with a shockable rhythm was 1.6% vs. 25.6% respectively. Interestingly, spontaneous circulation at hospital hand off was similar (27% vs. 27.5% respectively). However, the survival to hospital discharge was significantly lower at 2.2% vs 8.4% respectively. The authors also evaluated the airway management methods utilized in the hanging victims. Endotracheal intubation was the primary mode of ventilation with one hundred nineteen (119) attempts; of which seventy-nine (79 [66.4%]) were successful. Supraglottic airways were attempted in one hundred and five (105) of the patients with one hundred and four (104) successful. One patient required a transtracheal approach to attempt oxygenation, but the method of access was not described. Only one (1) patient had failure to ventilate by any method.

Unfortunately, this study is limited by the fact that outcome data were available for only 43 of the 95 cases that were transported to the hospital.

While the percentage of patients of hanging injury in this study who presented in cardiac arrest regained spontaneous circulation prior to hand off at the hospital was equal to all other forms of cardiac arrest during the study period, fewer survived to hospital discharge, most likely due to the neurological damage from the hypoxic event of hanging. In addition, the 66.4% rate of successful endotracheal intubation is lower than many would consider ideal, however it matches closely to the AIRWAYS-2 study conducted in the same time period (72% success rate). This suggests that management of the airway in this group of hanging victims, whether by endotracheal intubation or supraglottic airway, was no more difficult than in any other victim of out-of-hospital cardiac arrest.

The authors recommend further prospective studies to better identify the factors that affect treatment and outcome of hanging victims who present in cardiac arrest. In addition, given the

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extremely low survival, a determination of the criteria as to whether or not transport to the hospital should be undertaken with these patients is warranted.