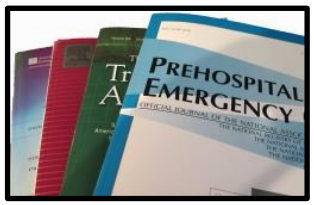
International Prehospital Medicine Institute



IPHMI Literature Review

Keeping You Up to Date with Current EMS Literature and Studies

Vol. 6.7

1. **Ketamine Compared With Morphine for Out-of-Hospital Analgesia for Patients With Traumatic Pain. A Randomized Clinical Trial**. Le Cornec C, Le Pottier M, Broch H, et al. *JAMA Network Open.* 2024;7(1):e2352844. Full text available on-line at: https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2814327
2. **Prehospital Ultrasound: A Narrative Review.** von Foerster N, Radomski MA, Martin-Gill C. Prehosp *Em Care.* 2024;28:1-13.
3. **LUCAS Device Use Associated with Prolonged Pauses during Application and Long Chest Compression Intervals**. Morgan S, Gray J, Sams W, Uhl K, Gundrum M, McMullan J. *Prehosp Emerg Care* 2024;28:114-117.
4. **Optimizing Mass Casualty Triage: Using Discrete Event Simulation to Minimize Time to Resuscitation**. Igra NM, Schmulevich D, Geng Z, et al. *J Am Coll Surg.* 2024;238:41-53.

1. **Ketamine Compared With Morphine for Out-of-Hospital Analgesia for Patients With Traumatic Pain. A Randomized Clinical Trial**. Le Cornec C, Le Pottier M, Broch H, et al. *JAMA Network Open.* 2024;7(1):e2352844. Full text available on-line at: https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2814327

Effective pain management for patients with traumatic injuries is an important prehospital intervention. Over time, a range of techniques, from basic methods such as ice packs and splinting to the administration of IV analgesics, have been developed. In recent years, a discussion regarding the optimal analgesic has gained prominence. While morphine sulfate (MS) has traditionally been the preferred drug for trauma pain relief over many decades, ketamine has emerged as a viable alternative.

In this prospective, multicenter, randomized, single-blind study, the authors sought to assess whether ketamine matches the efficacy of MS for traumatic pain management. , Eleven (11) out-of-hospital emergency medical services (EMS) centers in France participated in the study from November 23, 2017, to November 26, 2022. These centers serve as ambulance bases, each equipped with one or more mobile intensive care units. These units typically have a minimum team configuration of an ambulance driver, a nurse, and an emergency physician. Patients were considered eligible for inclusion if the attending EMS provider determined that they fulfilled the following criteria: aged 18 years or older, conscious with a Glasgow Coma Scale score of 15, and reporting acute traumatic pain with a verbal numeric rating scale pain score of 5 or higher. Patients were not included if they met any of the following criteria: unstable vital signs (systolic blood pressure <90 or >200 mm Hg, pulse rate <50 or >150 beats/min, and respiration rate <10 or >30 breaths/min), pregnancy, breastfeeding, inability to assess their pain using verbal numeric rating scale scores, or allergy to morphine or ketamine. Morphine was given as a 2 or 3 mg intravenous dose every 5 minutes depending on patient body weight and ketamine was given as an initial 20 mg dose over 2 minutes followed by 10 mg every 5 minutes until analgesia was obtained.

During the study, 251 patients (128 patients in the ketamine group and 123 in the morphine group) were enrolled, of which 247 had available data. Women accounted for 111 patients (44.9%) and 136 were men (55.1%). The administration of intravenous ketamine was found to be noninferior to intravenous morphine in providing pain relief. After 30 minutes, adverse reactions were noted in 41% of patients receiving ketamine and 17% of patients receiving morphine. The most common reaction was emergence phenomenon in the ketamine patients and nausea in the patients that received morphine

The authors acknowledge several limitations of the study. Firstly, the inclusion of a physician in the ambulance team may reduce the generalizability of the findings to EMS systems in the United States, where the number and training of out-of-hospital clinicians differ significantly. Secondly, the doses of morphine administered involved small initial doses that were based on French recommendations, which that might not provide rapid analgesia. Thirdly, the single-blind design of the study could introduce performance bias. Fourthly, while the study utilized a noninferiority design, it was unable to demonstrate superiority in clinical secondary endpoints. Lastly, follow-up was restricted to the out-of-hospital phase, limiting the study's conclusions, as patients in the ketamine group may have received opioids during subsequent hospital care.

These results indicate that there are no significant clinical differences in the analgesic effectiveness of these two medications. However, a higher incidence of minor adverse events was observed in the ketamine group compared to the morphine group, although these events did not necessitate intervention. This trial indicates that ketamine could serve as a viable alternative to opioids for managing acute traumatic pain in adult patients in out-of-hospital settings, potentially aiding in opioid reduction efforts.

2. Prehospital Ultrasound: A Narrative Review. von Foerster N, Radomski MA, Martin-Gill C. Prehosp Emerg Care. 2024;28:1-13.

Point-of-care ultrasound has become widely used in the emergency department. While some emergency medical services (EMS) agencies have implemented prehospital ultrasound, its role in out-of-hospital care has not been clearly defined.

The authors of this study conducted a review of the literature to report the state of the science on prehospital ultrasound. They performed a keyword search on MEDLINE from inception to August of 2022. They identified and screened 2,564 records. After reviewing abstracts and full texts along with an additional 7 articles gleaned from bibliographies, they ended up with 193 papers included in their review.

The predominant setting for prehospital ultrasound was air medical and critical care transport. They credited this finding to the advanced level of training of these crews, often including physicians and the high acuity of these patients as providing a good group of patients to measure the potential benefits of prehospital ultrasound. Approximately 75% of helicopter EMS agencies in Europe utilize ultrasound. In contrast, the use of ultrasound is less prevalent in the USA as the crews are often comprised of Critical Care Nurses and Paramedics that are generally not trained in the use of ultrasound.

As for the uses of ultrasound on ground transport EMS, potential benefit was considered in trauma assessment, obstetrical emergencies and critical preterm infants as well as for dyspnea, cardiac arrest, fracture assessment, abdominal pain and stroke. The environment of a helicopter presents assessment challenges to auscultation which can be potentially solved by the use of ultrasound. It may be used to evaluate tube placement after intubation and the presence of a possible pneumothorax.

Most of the studies reviewed were feasibility studies that focused on the clarity of the images or simulations with comparisons to in-hospital examinations. While these studies report that ultrasound use in ambulances is feasible, there is a limited amount literature looking at out of hospital

implementation at the ATLS level. In the studies that have been done, technical difficulties, poor scanning technique, user error, variable accuracy of interpretations likely due to lack of experience, and skill atrophy were cited as problems. Education and training in ultrasound is variable with training that was short (≤5 hours) and some that is longer (1-2 day) using live, healthy actors. In addition, expense is an issue.

This paper is limited by that fact it is a narrative review of the available literature. They found that there was a significant bias in the available literature as these were mostly case studies and feasibility studies.

The authors concluded that the use of ultrasound in critical care transport is the most promising prehospital sector. They further concluded that "eFAST" (or its variants) and lung ultrasound may be the most promising exams for prehospital management changes. Technological advances and decreasing size, weight and ultimately the cost of ultrasound equipment for ambulances will make its use more common. Improvements in training curricula for novice ultrasound users, and improving methods to limit skill decay, will further spur an increase in prehospital ultrasound use.

This review clearly shows the feasibility of prehospital ultrasound and the various uses to which it can be put. It must be noted however that this review did not make mention of the time requirements to perform the various ultrasound studies and any impact it may have on prehospital scene times. In addition, the most common use for ultrasound has been the eFAST for trauma. It is important to remember that while an ultrasound that is positive for fluid (blood) in abdomen is helpful and indicative of an intra-abdominal injury, a negative study does not rule out the possibility of a serious intra-abdominal traumatic injury. Systematic reviews focused on clinical and operational questions are needed to better justify the implementation of ultrasound in the prehospital setting.

3. **LUCAS Device Use Associated with Prolonged Pauses during Application and Long Chest Compression Intervals.** Morgan S, Gray J, Sams W, Uhl K, Gundrum M, McMullan J. Prehosp Emerg Care 2024;28:114-117.

The use of mechanical chest compression devices is becoming more frequent in the treatment of Out of Hospital Cardiac Arrest (OOHCA). These devices are capable of uninterrupted chest compressions at the American Heart Association (AHA) recommended rate of 100 – 110 compressions per minute. The depth of those compressions is also standardized. In theory, the mechanical compressions can be maintained during extrication from the scene of the OHCA, during most advanced interventions and while in transit to the hospital. Other advantages of mechanical chest compressions over manual chest compressions include reduced provider fatigue and injury from repetitive motion, freeing up a provider to provide other treatments modalities and the ability for providers to remain seated and belted while transporting patients undergoing resuscitation due to OHCA.

The authors of this paper focused on compression pauses during OHCA with a mechanical compression device compared to manual compressions. They looked closely at pauses in compressions whenever the device was applied, and when the resuscitation transitioned from manual compressions to mechanical compressions. They also examined when and if compressions were paused for procedures, such as airway maneuvers and the AHA recommended two-minute rhythm and pulse checks.

This was a 4-month, institutional review board waived, retrospective review of one agency's OOHCA's. The agency in question was an urban fire department that is the EMS provider for their city (approximately 65,000 EMS runs per year). This agency routinely uses Stryker LUCAS mechanical chest compression devices, and their personnel are well versed in their application and use. The authors reviewed cases that were uploaded into Physio Control's CodeStat software. They looked at

compression-pause segments (10 seconds of compressions followed by at least 5 seconds of no compressions) in each resuscitation.

During the 4 month study period in 2021, the department responded to four hundred ninety-eight reported cases of OOHCA. All but 58 cases were excluded after meeting exclusion criteria (210 obvious death, 94 not in cardiac arrest, 83 no CPR process file, 22 trauma, 16 LUCAS not used, 8 no patient found and 7 resuscitation greater than 10 minutes). Of the 58 cases that did meet inclusion criteria, the medium patient age was 62.5 years. Forty seven percent were female and 66% were non-white. The most common presenting rhythm was asystole (59%) followed by pulseless electrical activity (26%) and then ventricular fibrillation (15%). The OHCA was witnessed by EMS 14% of the time and 31% of the included cases were witnessed by bystanders. EMS arrived to find bystander CPR in progress for 48% of the bystander witnessed cases.

They found six hundred thirty-three compression pause segments (517 with LUCAs and 116 with manual compressions). Twenty cases had no evidence of manual compressions before application of LUCAS. The authors postulate that this may be indicative of LUCAS being applied before, or at the same time as, the cardiac monitor. The authors identified "significant" interruptions in compressions while the LUCAS was applied. Current AHA guidelines for cardiac arrest resuscitation recommend pauses in compressions to assess for rhythm changes and return of pulses. Once the LUCAS was applied, the authors found prolonged periods of compressions without pauses for rhythm and pulse checks. It was noted that this system uses changes in capnography as an indicator of the return of spontaneous circulation. They also acknowledged the need for regular rhythm checks to determine if the patient has converted a shockable rhythm due to resuscitation efforts. Manual chest compressions were frequently interrupted which may be a result of 30:2 chest compression to breath ratios prior to placement of an advanced airway.

Limitations of this paper include a one agency data set, a relatively short retrospective period and a low number of included OOHCA's. They also acknowledge technical difficulties within the agency in gathering data.

Agencies that deploy mechanical chest compression devices should be well practiced in the transition from manual chest compressions to mechanical chest compressions. That transition should coincide with pauses in chest compressions for rhythm and pulse checks. Providers using mechanical chest compression devices should be cognizant of how long the device runs uninterrupted and plan for the AHA recommended two-minute intervals for rhythm and pulse checks. Both of these scenarios should be monitored and tracked via a robust OHCA quality assurance program.

4. **Optimizing Mass Casualty Triage: Using Discrete Event Simulation to Minimize Time to Resuscitation**. Igra NM, Schmulevich D, Geng Z, et al. *J Am Coll Surg.* 2024;238:41-53.

A mass casualty incident is defined as any incident in which patient care needs exceed the availability of local resources. Blood product availability is crucial to minimize morbidity and mortality during a mass casualty incident. Urban-based MCI planning often utilizes several regional hospitals and trauma centers, each with different blood product resource availability. Computer-based simulations enhance the opportunity for planners to optimize blood product allocation during MCIs. This study simulated multiple different MCI locations and strategies for prehospital victim distribution with the hypothesis that using hospital-based blood product inventories to guide on-scene patient distribution decisions will minimize time to in-hospital transfusion.

The authors developed a Discrete Event Simulation (DES) computer simulation model designed to model casualty flow from the scene of an MCI through their hospital treatment, including blood transfusion. The model compared different on-scene triage strategies which could be used during a

realistic MCI. The authors simulated a blast event in the city of Boston in 4 locations used for mass public gatherings with triage to 6 area hospitals.

Three triage strategies were used. The first strategy assigned all patients to be transported to the nearest hospital with patient capacity (*Nearest*). The second strategy utilized an equal distribution of patients to all 6 receiving trauma centers regardless of the casualty's proximity to any of those hospitals (*Equal*). The third strategy assigned casualties to be transported to one of three hospitals with the highest blood supplies while equally distributing the moderately injured to one of the 6 trauma centers equally (*Supply*). The event simulation calculated an MCI at one of the 4 venues, estimated geographic distance to each of the 6 trauma centers, and noted their blood product availability at the time of the simulation. They used the currently accepted ration of 1:1:1 blood product transfusion ration (packed red blood cells, plasma, and platelets). The two outcomes for the study were the proportion of severely injured patients treated in the first 60 minutes with 10 U PRBC, 10 U plasma, and 10 U platelets and the proportion of moderately injured patients treated in the first 360 minutes with 3.5 U PRBC, 3.5 U plasma, and 3.5 U platelets.

The simulation ran 1200 simulated MCIs with a mean of 302 casualties including 15 severely injured patients, 57 moderately injured patients, and 22 deaths. *Nearest* triage resulted in all casualties being treated at the 3 closest hospitals to the MCI. *Equal* triage resulted in each of the 6 centers receiving a similar number of casualties. *Supply*-guided triage resulted in each of 3 hospitals with the most blood product availability receiving the most severely injured casualties. *Nearest* triage resulted in significantly fewer overall casualties being treated with blood transfusion in the target time (55% vs *Equal* 86% vs *Supply*-Guided 91%). The authors concluded that *Nearest* hospital triage was inferior to *Equal* distribution or a *Supply*-Guided strategy.

This is an interesting but complex paper using computer simulation to analyze the best prehospital triage strategy during an MCI. The authors concluded that the preferred triage method to ensure the most severely injured patients received the most blood products was either *Equal* distribution to all trauma centers regardless of geographic proximity or to use a *Supply*-guided strategy based on blood product availability of the three most-ready trauma centers. Transporting casualties to the *Nearest* trauma center resulted in the lowest number of severely injured patients actually receiving a timely transfusion.