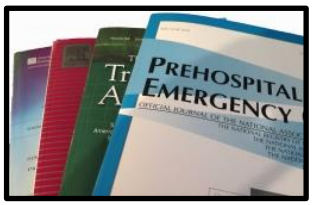
International Prehospital Medicine Institute



IPHMI Literature Review

Keeping You Up To Date with Current EMS Literature and Studies

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1. **Quality comparison of the manual chest compression and the mechanical chest compression during difficult transport conditions.** Burak B, Ishak S, Mehmet E. J Emerg Med 2020;58:432-438.

In the United States alone, there are approximately 350,000 cases of out-of-hospital Cardiac Arrest (OHCA) annually. EMS providers respond to patients in cardiopulmonary arrest found in varied locations. Often, the patient location involves extrication down stairs, around corners, and always, loading into an ambulance prior to transport to a hospital. Effective chest compression is one of the important five links for survival for patients who sustain OHCA. It is difficult to continually perform high quality chest compressions during extrication and while transporting in a moving ambulance.

Measuring the quality of CPR performed by EMS providers is difficult. Most studies looking at the quality of EMS CPR assess patient survival rates. There are very few studies that look at compression rate, depth and hands on time; the three most important factors for quality CPR.

The authors of this study attempted to measure and compare the quality of CPR, compression rate, depth and hands on time of paramedics extricating a simulated patient down 2 flights of stairs. They then compared those findings to a Mechanical Chest Compression Device (MCCD) performing CPR on the same mannikin, carried by the same two paramedics down and out the same 2 staircases. Each method was repeated 20 times. The paramedic group consisted of ten male and ten female paramedics. Each paramedic had greater than five years' experience in an urban EMS system (Ankara, Turkey EMS). The MCCD utilized was the LUCAS Chest Compression System

(Physio-Control/Jolife AB, Lund, Sweden). For this study, the SimMan Essential (Laerdal, Stavanger, Norway) was used as a patient simulator. The mannikin can measure compression depth, compression rate and hands-on time. The manikin weighed 40 kg. The mannikin was secured to a backboard for extrication and carried down a total of 54 steps for each of the 40 trials (10 female chest compressors, 10 male chest compressors and 20 MCCA).

The average chest compression rate for the paramedics was 142.0 compressions/min (IQR 134.9–148.7 compressions/min). The MCCD performed a consistent 102.3 compressions/min (IQR 102.2–102.5 compressions/min). The average depth of compression for the paramedics was 25.2 mm (IQR 23.2–30.9 mm). The MCCD maintained a compression depth 52.0 mm for MCCD (IQR 51.4–52.6 mm). Both the compression rate and depth were statistically significantly different. The percentage of hands on the chest time for the paramedic group was 92.0% (IQR 86.5–100%). The MCCD maintained 100% contact with the mannikin.

The American Heart Association guidelines recommend a chest compression rate of 100-120 compressions/min. Compression rates greater than 120/min reduce compression depth and venous return to the heart, coronary perfusion pressure, and myocardial blood supply. Less hands-off the chest time increases defibrillation success, return of spontaneous circulation, and hospital discharge rates.

The authors also discovered a difference in chest compression performance-based on the paramedics' gender. On average male paramedics compressed the mannikin's chest faster and with greater depth than their female counterparts (142 compressions/min vs 110.1 compressions/min with compression depth of 29.2 mm vs 20.2 mm). There was no significant difference in terms of hands-on the chest time between genders.

While limited by the small size of the study groups, the results should not surprise any provider who has attempted to extricate a cardiac arrest victim down stairs and out to a waiting ambulance while attempting to perform high quality CPR. The mechanical device out-performs humans in its ability to deliver chest compressions at a pre-set and fixed optimal rate and depth, consistent with American Heart Association recommendations, while making continuous contact with the patient's chest, especially during difficult extrications and patient movements.

2. **Evaluating tourniquet use in Swedish prehospital care for civilian extremity trauma.** Wellme E, MillV, Montán C. Europ J Trauma Emerg Surg. 2020.

Trauma is the leading cause of death in Sweden for citizens in their second through fifth decade of life, as in most other developed countries. A prior study demonstrated that 50% of the preventable deaths from trauma were caused by uncontrolled hemorrhage. Tourniquets for prehospital application were first introduced into the Stockholm EMS service in 2015; however formal guidelines for their use have not been published in Sweden.

The authors conducted a retrospective cohort study of all adult patients with limb injuries and tourniquet application transported and admitted to a single hospital. The goal was to evaluate the prehospital providers' use of tourniquets, any complications that occurred and the effect on blood transfusion requirements Study data were obtained from both prehospital electronic documentation and from in-hospital data from August 2015 to December of 2017.

During the study period 662 patients with extremity trauma were transported to the trauma center, of which 303 patients were admitted to the hospital and met study criteria. Of these patients, 56 (50 males) had tourniquets applied in the prehospital phase. The primary documented reason for tourniquet placement was uncontrollable hemorrhage (77%) and traumatic amputation (9%). The ambulance service placed 48%,, 32% were placed by the police, and 11% by bystanders. In nine cases (16%), the tourniquet was improvised using a belt, bed sheets, or a dog leash (four of

which were subsequently replaced by a commercial device by EMS personnel). The primary mechanism of injury was penetrating trauma with edged weapons slightly more common than gunshot wounds at 37.5% and 30.4% respectively. Other injuries resulted from traffic crashes (17.9%) and other traumatic events. Direct pressure was attempted prior to tourniquet application in 34% of the patients who had a tourniquet applied. Tourniquet time varied between 15 to 100 minutes, however in over 50% of cases, total tourniquet time was missing from the medical records.

The authors conclude that there were few complications from the application of tourniquets for less than 100 minutes. No limb amputations resulted from the use of a tourniquet (although 7 patients did undergo amputation because of the nature of their injuries). The authors noted that 30% of the applications in this cohort were for non-life-threatening injuries that could have had the bleeding controlled by direct pressure and in fact, in four cases, the tourniquet was removed by ED personnel immediately upon patient arrival to the hospital. The authors point to limitations of the study due to its retrospective nature and issues with missing or absent data collection in the four data bases used for this study. Of note, there is no description that tourniquet training was provided for the ambulance service in the first year of deployment and the authors report that as of the date of the paper no formal prehospital guidelines for tourniquet application have been developed or published.

This article demonstrates that, as noted by multiple military studies and other civilian studies, tourniquets in the civilian prehospital environment are advantageous to patient survival and safe to use with a low complication rate if application time is less than 2 hours. The study also demonstrates that in 30% of the patients, tourniquet application may have not been the needed to control the hemorrhage. Protocols and guidelines need to emphasize that the first step to control hemorrhage should be direct pressure with the only exception being hemorrhage control during care under fire, which is rarely encountered in the non-tactical civilian environment.

3. **Prehospital Protocols Reducing Long Spinal Board Use Are Not Associated with a Change in Incidence of Spinal Cord Injury.** Castro-Marin F, Gaither JB, Rice AD, et al. Prehosp Emerg Care 2020;24:401-410.

Over the past several decades, controversy raged over whether aggressive spinal immobilization was helpful or harmful. This debate initially resulted in changes to immobilization protocols instead taking on the name “Spinal Motion Restriction” or SMR. Guidelines that followed have diminished the emphasis on mechanism of injury as a criterion to implement SMR and, most recently, called for more discretion in deciding to use spinal motion restriction devices and practices.

The authors of this study evaluated whether SMR protocols that eliminate or reduce the use of long spine boards would lead to an increase in spinal cord injury. They conducted a retrospective observational study looking at EMS ground agencies before and after SMR protocols were adopted and obtained data from the state EMS database along with hospital discharge data on trauma patients managed from January 1, 2013 to December 31, 2015 . Patients were excluded if the date of SMR protocol implementation was unknown, if they were duplicates or if they occurred during a 3 month run-in period. They used the hospital ICD 9/10 codes to identify and include patients with traumatic injury, possible spinal trauma and verified spinal trauma.

From over a million patients in the databases, 104,315 unique encounters were identified with traumatic injury and SMR protocol implementation. Of these, 51,199 patients were identified as possible spinal trauma and 5,178 patients had verified spinal trauma. The incidence of spinal cord injury pre and post SMR adoption respectively was 0.20% and 0.22% for traumatic injury, 0.40% and 0.45%for possible spinal trauma and 4.04% and 4.37% for verified spinal trauma.

The authors concluded that: "In this limited study, no change in the incidence spinal cord injury was identified following implementation of Spinal Motion Restriction protocols. Prospective evaluation of this question is necessary to evaluate the safety of Spinal Motion restriction Protocols".

The authors noted several limitations to their study. First, the data did not include information on how closely the SMR protocol was followed by EMS personnel. Second, ICD 9/10 codes were relied on to determine outcomes and independent verification of acute spinal cord injury was not performed. Third, EMS agencies voluntarily provide patients for inclusion in the state EMS database which might reflect higher performing agencies and potentially better outcomes. Fourth, their methodology could fail to identify some spinal cord injured patients. Finally, they could not verify that all agencies trained all providers in the same way without altering the curriculum or methods of training.

The premise that well trained EMS providers can determine the extent of potential injury and risk of further injury and make good choices about how to best care for patients with potential spinal cord trauma appears to be supported. Having said that, the incidence of spinal cord injury after trauma varies from as low as 0.1% to as high as 7.5% depending on the mechanism of injury and the severity of the trauma. Furthermore, the incidence of spinal cord injury as a result of failure to appropriately protect the spine is even lower. A massive study with huge numbers of patients would be necessary to demonstrate that the changes in SMR had a detrimental effect on the outcome of trauma patients. The limitations of this study make it clear however that better prospective evaluation and ongoing real-time monitoring of what happens in the field and patient outcomes is needed in order to make the most appropriate decisions regarding protocols, curricula and training.

4. **The effect of emergency medical system transport time on in route clinical decline in a rural system.** Kai TR, Broady MJ, Davenport DL, Bernard AC. *J Trauma Acute Care Surg.* 2020;88: 734-741.

The concept of the "golden hour" of trauma theorizes that all trauma patients should receive definitive care within 60 minutes of injury in order to achieve the highest possible survival rate. While the "golden hour" has never been validated in studies, the premise remains sound – specifically, that rapid prehospital transport to a hospital capable of providing definitive care (often surgical) improves survival and should be the goal of any trauma system. In the United States, 84% of the population lives within one hour of a Level I or II trauma center.

The American College of Surgeons Committee on Trauma, in partnership with the Centers for Disease Control and Prevention, developed the Field Triage Decision Scheme (FTDS) to help guide prehospital personnel in deciding which patients should preferentially be transported to a trauma center. The FTDS utilizes a four step approach based on the physiological status of the patient (Step 1), anatomical location of injuries (Step 2), mechanism of injury (Step 3), and "special considerations" (Step 4) such as patient age or co-morbidities. Step 1 (physiologic criteria) include Glasgow Coma Scale (GCS)< 14, Systolic Blood Pressure (SBP) < 90 mmHg, and respiratory rate (RR) < 10 or > 29 in an adult.

This study reviews the results from Kentucky, a state with a large rural population. In Kentucky, only 60-74% of the population resides within an hour of a Level I or II trauma center. Kentucky has a higher trauma mortality rate than the national average. Some theorize that this is due to the longer prehospital transport times in this primarily rural state. Additionally, the two Level 1 trauma centers in Kentucky are located in cities in close geographic proximity (Lexington and Louisville). There is a Level 2 center in the far eastern portion of the state and four Level 3 centers clustered in the center

part of the state. This leaves a large geographic area of the state without ready access to even a Level 3 trauma center. Level 1 and 2 centers are roughly equal in services provided and survival rate. Level 3 centers have fewer overall services but are still able to provide surgical coverage.

The investigators sought to (1) determine EMS compliance with the FTDS relative to the appropriate transport destination (trauma center) and (2) determine the degree of patient clinical decline from the increased transport times in a rural state. The authors hypothesized that EMS compliance with the FTDS was less than 100% and clinical decline is rare when the transport time is less than 60 minutes (the golden hour).

The authors conducted a retrospective study of de-identified National EMS Information System (NEMSIS) data for EMS transports in Kentucky during the calendar year 2017. A total of 34,822 EMS incident records met criteria and were available for review. The authors divided these transports into helicopter EMS (HEMS) transport versus ground EMS (GEMS) transport. They also subdivided the groups into those who met the FTDS Step 1 physiologic criteria versus those who did not. They defined GCS decline as a decrease of 2 or more points. A decrease in SBP of 22 mm HG or RR of 3 met their criteria for a decline in condition. These criteria have previously been validated from the National Trauma Data Bank. Step 1 patients who were transported to a Level 1, 2, or 3 trauma center were classified as reaching the "appropriate" hospital.

The most common mode of transport was GEMS (93%) versus HEMS (7%). As expected, HEMS transports took longer to arrive and were of longer total duration than GEMS. Overall, 7.5% of patients met the FTDS Step 1 criteria for transport to a Level 1-3 trauma center with the rate increasing as dispatch to scene arrival time increased. Clinical decline was noted in 1.7% of patients. This was more common in those who met the FTDS Step 1 criteria (12.2%) compared to the non-Step 1 patients (0.8%).

In their analysis of the patients meeting the FTDS Step 1 criteria, the authors noted GCS < 14 to be the most common reason for trauma center transport, followed by hypotension, then tachypnea. Decrease in GCS was the most common reason for decline in clinical condition, with 8% of Step 1 patients having a GCS decline during transport.

Just over half (53.7%) of patients who met Step 1 criteria were actually transported to a trauma center. They note the most common reasons for transport to an inappropriate (non-trauma center) facility to be "closest facility" (57.8%) and "patient/family choice" (18.4%). HEMS was the most compliant with transporting the patient to the appropriate hospital (90.7%).

There are some limitations to this study. Outcome data was not available. The authors were unable to follow-up on the patients to see if transport to an inappropriate facility or declining condition en route actually contributed to a worse outcome. This was a retrospective review of a large database, so some clinical variables may be missing or inaccurate.

This study of a statewide rural trauma system found that patients meeting criteria for trauma center transport were only transported to the appropriate facility half the time. This could be due to geographical distance to a trauma center in many areas of the state, or possibly a general non-compliance with the guidelines. The authors also noted that patients didn't decline after an hour, but rather began to decline throughout their prehospital transport, thus indicating that trauma patients do not really have a "golden hour or 60 minutes" but rather a "golden period" that varies from patient to patient depending upon the nature and magnitude of their injuries, baseline physiologic status, and underlying health conditions.