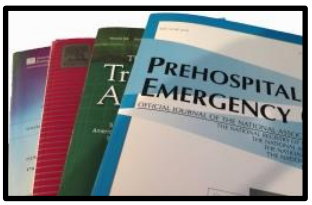
International Prehospital Medicine Institute



IPHMI EMS Literature Review

Keeping You Up to Date with Current EMS Literature and Studies

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1. **Defibrillation Strategies for Refractory Ventricular Fibrillation.** Chesjes S, Verbeek PR, Drennan IR, et al. *New Engl J Med.* 2022; Published on-line ahead of print.

Of the nearly 350,000 unexpected cardiac deaths each year in North America, nearly 100,000 are due to cardiac arrest with ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT). Although there have been advances in defibrillation technology, as many as half of these patients may remain in refractory VF despite multiple defibrillation attempts. While amiodarone and lidocaine have been used to try to prevent re-fibrillation, neither medication has been shown to improve patient survival to hospital discharge or neurologically intact survival.

Proposed techniques to improve termination of refractory VF include double sequential external defibrillation (DSED) and vector-change (VC) defibrillation. Double sequential external defibrillation (DSED) provides rapid sequential shocks from two defibrillators placed in two different planes (anterior-lateral and anterior-posterior). Vector-change (VC) defibrillation involves switching the defibrillation pads from the anterior-lateral to the anterior-posterior position and is thought to defibrillate a portion of the ventricle that may not be completely defibrillated by pads in the standard location.

The objective of this study is to evaluate DSED and VC defibrillation as compared to standard defibrillation in patients who remain in refractory VF during out-of-hospital cardiac arrest. The study is a three-group, cluster-randomized, controlled trial involving six paramedic services in Ontario, Canada. The region is a mix of urban and rural patients with a combined population of 6.6 million people. The EMS agencies treat approximately 4100 patients annually with out-of-hospital cardiac arrest, of whom 15% presented in VF. Prehospital care is provided by advanced care paramedics with Advanced Cardiac Life Support (ACLS) training and primary care paramedics with basic life support skills, including the ability to defibrillate. The patients were adult aged patients (age greater than 18 years) with non-traumatic out-of-hospital cardiac arrest. Refractory VF was defined as an initial rhythm of VF or pulseless VT that was still present after three standard defibrillations separated by 2-minute intervals of

cardiopulmonary resuscitation (CPR). Each EMS agency changed over every 6 months to one of the three treatment groups (standard defibrillation, DSED, or VC) during the 32 month study period.

Chest compressions were initiated prior to placement of the defibrillator pads. The rhythm was analyzed at standard 2-minute intervals. When indicated, the first three defibrillations were done with the pads placed in the standard (anterior-lateral) position. Patients who remained in VF were then defibrillated according to which group they were randomized to (continued standard defibrillation, DSED, or VC). The primary outcome measure was survival to hospital discharge. Secondary study outcomes were absence of VF on subsequent rhythm analysis, return of spontaneous circulation, and a good neurologic outcome at hospital discharge.

The study enrolled 405 patients. It was stopped early by the data and safety monitoring board due to staffing challenges after the Covid-19 pandemic. Each of the three study groups was equally represented in the randomization. The mean age of the patients was 63.6 years, and 84.4% were men. Overall, 67.9% of out-of-hospital cardiac arrests were witnessed by bystanders, and 58% of the patients received bystander CPR. A total of 18 patients (13.3%) in the standard group survived to discharge, compared to 38 patients (30.4%) in the DSED group and 31 patients (21.7%) in the VC group. Secondary analysis showed termination of VF in 92 patients (67.9%) in the standard group compared to 105 patients (84%) in the DSED group and 115 (79.9%) in the VC group. Return of spontaneous circulation occurred in 36 patients (26.5%) in the standard group compared to 58 patients (46.4%) in the DSED group and 51 patients (35.5%) in the VC group. Survival to discharge with a good neurologic outcome occurred in 15 patients (11.2%) in the standard group, 34 patients (27.4%) in the DSED group, and 23 patients (16.2%) in the VC group.

The study is limited by the fact that it was stopped early by the monitoring board because of issues related to the Covid-19 pandemic which complicated enrolling patients. In addition, the overall sample size was small which may overestimate the potential benefit of the treatment effect. Lastly, complete information about pre- or co-existing conditions, medication use, and hospital care was not available thus potential confounders could be present that affected the results.

This study demonstrates that survival to hospital discharge was more common in patients who received DSED or VC defibrillation than standard defibrillation. The outcomes favored DSED, however this type of defibrillation is often not provided in most EMS systems as two defibrillators are required. Since VC defibrillation also had a higher rate of survival than standard, it may be the better alternative.

2. **Outcomes of law enforcement officer administered naloxone.** Gooley B, Weston B, Colella MR, Farkas A. *Amer J Emerg Med* 2022;62:25–29.

The opioid crisis in the United States has escalated in recent years to the point of becoming a public health emergency. The narcotic antagonist naloxone (Narcan ^{tm}) has been used for decades to overcome and reverse the effects of opioids, both in the hospital and in the prehospital environment. With the increase in deadly overdoses, the need to have naloxone administered as soon as possible was recognized, even prior to the arrival of medical personnel. The development of a simple nasal administration device makes naloxone administration available to most first responders as well as civilians, often without the need for a prescription.

The authors conducted a retrospective study examining the efficacy of naloxone administration by Law Enforcement Officers (LEOs) in Milwaukee County Wisconsin for the period from January 2016 until August 2021. The officers were trained to administer 4 mg/0.1 mL intranasal naloxone for suspected opioid overdose. Officers were required to document any contacts where naloxone was administered either during the shift or after. Documentation included suspected substance, number of dosages administered, reversal results, refusal of transport, withdrawal symptoms, irritability/combativeness after administration and death.

A total of 597 cases were documented to have naloxone administered by LEOs prior to EMS arrival during the study period. Of the total, 438 patients had only one dose administered with 155 receiving two or more doses. The primary suspected substance thought to be responsible for the overdose was documented as heroin in sixty-nine percent (69%) of cases. Naloxone was thought to be effective by LEOs in sixty-two percent (62%) of administrations. Seventy-one (71) patients refused transport after reversal of symptoms. Resulting combativeness occurred in less than one percent (1%) of the cases post-reversal.

The authors note limitations of the study include the fact that formal chemical identification of involved substances was not possible and instead relied upon Leo's impression or information gathered at the scene to suspect the specific type of substance. An "I don't know" category was added to the documentation check sheet, so officers did not have to select a substance if it was in question or they were not sure. This study is also limited by the fact that all medical information was collected by police officers with no or limited medical background, thus potentially compromising the accuracy of reported data. Interestingly, heroin was the opioid most commonly suspected (58% of cases) and fentanyl was thought to be involved in only 4% of overdoses.

Opiate overdoses have been and continue to be a major public health issue in most areas of the United States. This study demonstrates that Law Enforcement Officers can effectively identify patients with signs and symptoms of overdose in need of reversal and successfully administer naloxone as required. This correlates with previous published studies. Combativeness resulting from acute narcotic withdrawal was extremely low, which has also been demonstrated in other prehospital studies. The authors note that further prospective studies will be needed as the shift from heroin to fentanyl or other synthetic narcotics evolves.

3. **Needle Cricothyroidotomy by Intensive Care Paramedics**. Bye R, St Clair T, Delorenzo A, Bowles KA, Smith K. *Prehosp Disaster Med* 2022;37:625 – 629. Full text available at: https://doi.org/10.1017/S1049023X22001157

Failed traditional airway management techniques ultimately requiring percutaneous or surgical cricothyroidotomy are rare occurrences in the prehospital environment. The inability to place a more traditional airway or maintain acceptable ventilation with a BVM can occur for various reasons including: failed rapid sequence intubation (RSI), thermal airway trauma, blunt neck trauma, anaphylaxis, and airway obstruction. In the face of these situations, paramedics and advanced prehospital providers may be left with only one alternative to effectively ventilate the patient, a cricothyroidotomy.

The authors conducted a retrospective review study look to evaluate the effectiveness of using a non-surgical and semi-surgical cricothyroidotomy approach to airway management. Located in Victoria, Australia with a population of 6.5 million and over 330K EMS patients per year, the EMS system utilizes a two-tiered ALS approach with ALS paramedics and Intensive Care Paramedics. During the study period only Intensive Care Paramedics were trained and authorized to perform cricothyroidotomies.

During the study period (May 1, 2015 to September 15, 2020) there were 29 cases in which an Intensive Care Paramedic (ICP) performed a cricothyroidotomy. All cases involved patients over the age of 18 years. The commercially available QuickTrach II (QTII) was the device chosen by the service for use during the study period. Two patients were excluded from the study, one due to a preexisting tracheostomy and a second due to being placed by a non-affiliated provider. A nearly equal distribution of patients between medical and trauma were noted in the study cohort, 51.9% vs. 48.1%. Seventeen crics were performed because of failure of intubation and 10 were done as the primary airway method. The average success rate during the study period, confirmed by waveform capnography or colorimetric capnometry, was seventy-four (74) percent, however there was a change in operational placement technique of the device during the study. During the first twenty-seven (27) months of the study eight

procedures were performed using the manufacture's recommended procedure. This produced a success rate of fifty (50) percent. In the remainder of the study period a revised protocol using a small surgical incision through the skin was adopted, with the penetration of the cricoid membrane completed with the QTII device. This semi-surgical approach yielded an eighty-two (82) percent success rate. It should be noted that this difference however was not statistically significant due to the low number of patients enrolled in the cohort. Two complications involving the development of cervical subcutaneous emphysema resulted from failed attempts at needle placement.

This study is limited by the small number of patients involved and the fact that it is a retrospective review and not linked to patient outcomes. In addition, no information is provided about the decision or reason for choosing cricothyroidotomy as the initial method of airway management.

Securing an airway is a fundamental skills required at all levels of EMS providers. The authors of this study demonstrate, similar to other studies, that paramedics with advanced training can perform a cricothyroidotomy in the prehospital setting. However, this is a high acuity, low occurrence procedure with the potential for significant complications. While studies such as this are designed to provide data on the prehospital care provider's ability to perform a particular procedure, ultimately patient outcome and survival is the predominate goal. In this study nearly fifty-seven (57) percent of the patients who had cricothyroidotomy attempted were in cardiac arrest which begs the question of the projected low survival rate in this subset of patients to begin with. Future studies, although difficult to perform given the low occurrence of patients with indications for cricothyroidotomy, should be aimed at evaluating outcome and survivability of those patients who have received cricothyroidotomy in the prehospital setting.

4. **Prolonged tactical tourniquet application for extremity combat injuries during war against terrorism in the Sahelian strip.** Sabate-Ferris, APfister G, Boddaert G, et al. *Europ J Trauma Emerg Surg 2022:48:3847–3854*

The American military experience with tourniquet use in combat situations revolutionized the use of tourniquets for life-threatening hemorrhage from limb trauma, not only on the battlefield but also in the civilian trauma setting. Given the rapid evacuation of casualties in Iraq and Afghanistan, the median duration of tourniquet application time was reported to be 60 minutes with no resulting loss of limb.

This was a retrospective study performed by the French Military Health Service in a forward medical treatment facility in Gao, Mali between 2015 and 2020. This study looked to determine whether there were complications from extended tourniquet application in patients with combat injuries. In the Sahel, the French Military Health Service faced significant logistical challenges with operations covering five countries and a five million kilometer area. While their standard of care called for reassessing patients for conversion of tourniquets to pressure dressings within two hours after application, operational constraints often led to applications exceeding that time limit.

Included in the study were all patients with extremity injuries and the application of at least one tourniquet for a minimum of three hours. Data collected included injury patterns, associated shock, tourniquet location; duration of application, subsequent complications, and surgical procedures. The tourniquet used in all cases was the Combat Application Tourniquet (C.A.T.)

Eleven patients (39% of all patients that had tourniquets applied in the field) met inclusion criteria. The eleven patients had 14 injuries. Seven patients presented with hemorrhagic shock and five patients required two tourniquets to stop the bleeding. Four (4) patients sustained injuries as a result of improvised explosive devices (IEDs) and the remaining seven (7) had one or more high-velocity gunshot wounds. The mean tourniquet application time was 268 minutes with a range of 180 to 360 minutes. All patients developed rhabdomyolysis. Compartment syndrome occurred in 10 of the 14 limbs injured

and four amputations were performed. The three most severe cases suffered persistent severe rhabdomyolysis with acute renal failure requiring dialysis.

This study is limited by the fact it has an extremely small number of patients with prolonged tourniquet times. However all did develop rhabdomyolysis. The combat setting limited the ability of medics to convert the tourniquet to other means of hemorrhage control. The manuscript is not clear on whether the amputations performed were because of the degree of muscle damage from the prolonged tourniquet application or if they were due to the extent of the injury to the limb.

Tourniquets continue to save lives on the battlefield but tourniquets left in place for extended periods can lead to serious complications. The French experience in Sahel was different than the military findings from Iraq and Afghanistan because of the long evacuation times. The authors stated that "extended and proximal tourniquet applications led to significant morbidity related to compartment syndrome and rhabdomyolysis. Hemorrhagic shock, mass casualty incident, and tactical constraints often precluded revising the temporary tourniquet applied under fire." While tourniquets indeed saved lives, they must be revised as soon as possible if bleeding can be controlled by other means within 2 hours of application. They also advised that tourniquets be placed as distally as possible and that direct pressure should be used for wounds below the knee and elbow whenever the situation allows. Still, they cautioned that no patient should bleed to death because of the reluctance to use a tourniquet. While this was a military study, it has implications for civilian rural EMS with prolonged evacuation and transport times. Their reminders about tourniquet conversion apply to the civilian setting as well as the final caution that no one should die from uncontrolled hemorrhage because of reluctance to use a tourniquet