Emergency Medicine Reports

The Practical Journal for Emergency Physicians

Volume 31, Number 7 / March 15, 2010

www.emreports.com

Authors:

Creagh T. Boulger, MD, Clinical Instructor, Emergency Medicine, The Ohio State University, Columbus.

Howard A. Werman, MD, FACEP, Professor of Emergency Medicine, The Ohio State University, Columbus.

Peer Reviewer:

Jeremy T. Cushman, MD, MS, EMT-P, FACEP, Assistant Professor of Emergency Medicine, University of Rochester, NY; Medical Director, Monroe-Livingston EMS System.

Statement of Financial Disclosure

To reveal any potential bias in this publication, and in accordance with Accreditation Council for Continuing Medical Education guidelines, we disclose that Dr. Schneider (editor) serves on the editorial board for Logical Images. Dr. Farel (CME question reviewer) owns stock in Johnson & Johnson. Dr. Stapczynski (editor), Dr. Werman (author), Dr. Boulger (author), Dr. Cushman (peer reviewer), Mr. Underwood (associate publisher), and Ms. Mark (specialty editor) report no relationships with companies related to the field of study covered by this CME activity.

AHC Media LLC

Controversies in Emergency Medical Services

Emergency medical services (EMS) is the broad term for medical care and related services provided in the out-of-hospital environment. These services have been in existence in some form since the time of Napoleon and originally were created during times of war in an effort to treat, triage, and transfer wounded soldiers. The first civilian hospital-based ambulance system in the United States was created in 1865 in Cincinnati, OH. The ambulance was staffed by an intern in a horse-drawn carriage and carried items such as splints, brandy, morphine, and a stomach pump. Modern-day EMS has evolved significantly since that time and has paralleled the growth in emergency medicine.

The expansion in care provided in the out-of-hospital setting is based primarily on the extrapolation of therapies provided in the hospital (and, in particular, emergency department) setting. Limitations to performing high-quality research in the field include variability in EMS provider skill level, variability of EMS protocols, limitations in funding, restricted access to equipment, practice location (rural vs. urban), ability obtain patient consent, and difficulty in obtaining patient follow-up. Given these hurdles, prehospital research typically carries acknowledged limitations; in other cases, one is left to extrapolate findings from in-hospital care to the out-of-hospital environment.

This article will highlight a few of the many areas of controversy that may be found in the current EMS literature, suggest where there are gaps in existing knowledge, and make some recommendations regarding clinical application of the research.

Prehospital Hypothermia

Approximately 300,000 people in the United States suffer from out-of-hospital cardiac arrest each year.[1] Despite many technical advances as well as the widespread availability of defibrillators, advanced life support medications, and trained medical personnel, many of these victims do not survive.[2-4] Of those who have return of spontaneous circulation (ROSC) in the field, fewer than half leave the hospital alive. The most common cause of death in these individuals is anoxic brain injury.[5]

Recent studies of early cooling in post-cardiac arrest patients[3,4] have shown clinical benefit, including reduced morbidity and mortality. Post-cardiac arrest hypothermia has produced benefit whether instituted in the ED or the ICU.[3,4] Both overall survival and better neurologic outcome were increased. Based largely on these studies, the "2005 AHA Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care" recommended that "unconscious adult patients with ROSC after out-of-hospital cardiac arrest should be cooled to 32°C to 34°C (89.6°F to 93.2°F) for 12-24 hours when the initial rhythm was VF (Class IIa)."

Many experts believe that induced hypothermia should become standard following cardiac arrest and should be instituted in the prehospital setting. This may be based, in part, on animal studies, which have shown that the

Executive Summary

The following methods can improve EMS operations and patient outcome:

- **Cardiac arrest with successful resuscitation:** Initiate prehospital therapeutic hypothermia on patients who remain comatose using an infusion of ice-cooled saline (4°C) at 60-100 mL/min.
- **Chest pain and STEMI:** Obtain a 12-lead ECG in the field and transport patients with a STEMI pattern to a designated facility with 24-hour PCI capability with advance notice.
- **Cardiac arrest with unsuccessful resuscitation:** Prehospital termination of resuscitation protocols require careful planning and community acceptance.
- **Airway management:** Prehospital intubation programs should be limited to highly trained providers who frequently use the technique.

benefits of post-arrest hypothermia are maximized when initiated early and that these effects may also be time-limited.[6,7]

The exact mechanisms for the neuroprotective effects of hypothermia remain elusive. It is known that for every 1 degree Celsius of cooling, brain metabolism is decreased by 6%.[8] It has been suggested that this leads to conservation of limited oxygen and substrate stores within neurons. It is also conjectured that part of the benefit of hypothermia comes from suppression of chemical reactions under hypoxic conditions that cause free radical release, electrolyte shifts, and amino acid release. Under normothermic conditions, these reactions ultimately lead to mitochondrial damage and cell death.[9-12]

Many methods of cooling have been studied. These vary greatly in equipment costs and convenience as well as in ease and speed of temperature control. One of these methods is the use of cooling blankets that cool the body with air or water that flows through the blanket. This method is limited by the size restrictions of such devices for use in the prehospital environment. Another method investigated is the use of cooled intravenous saline. This method may be more feasible in the prehospital setting. Studies have used cooled saline (4°C) with infusion rates of 60-100 mL/min.[9,12-15] In these studies, the patient can be cooled between 1 and 2 degrees Celsius in the first hour of infusion. Kampmeyer et al.[16] proposed an economical solution to the potential problem of keeping cooled fluids immediately available in the field. The authors concluded that at ambient temperature, a cooler with six-sided insulation and reusable ice packs is practical and can maintain a temperature of 4°C in two 1-L bags of normal saline for more than 24 hours.

One additional method[17] evaluated the use of an adhesive cooling device. These devices are applied over the torso of the patient and provide cooling comparable to rates achieved using cooled saline. The average cooling achieved with the adhesive cooling pads was 3.3°C, compared to 1.4-1.7°C with cooled saline in most studies.[13-15] The adhesive cooling pads provided a seamless transition to in-hospital cooling.

Most studies suggest cooling for at least 24 hours to an ideal temperature of 32-34°C.[18,19] Temperature monitoring is a key component to successful use of therapeutic hypothermia. This may be challenging in the prehospital setting, especially in the post-arrest patient. In addition, the majority of studies suggest that once cooling is initiated, the patient should not be rewarmed for at least 12-24 hours. Prehospital hypothermia requires collaboration between the EMS and the accepting facility, which must have proper equipment and expertise to continue the cooling process. This may explain why few prehospital systems have adopted a prehospital hypothermia protocol.[20]

Several barriers exist to the implementation of therapeutic hypothermia protocols in the prehospital environment, including equipment challenges as well as difficulties in controlling the rate of temperature decline and ability to achieve the goal temperature. Cady et al.[9] have specifically addressed some potential drawbacks of prehospital cooling. They mention that hypothermia may be burdensome, both in execution and time, on one- or two-person EMS crews. They further note that after completing the primary survey, there may not be much time to initiate cooling prior to arrival. In addition, they emphasize the risk of early rewarming if post-arrest cooling initiated by EMS is not sustained by the accepting hospital. Kamarainen et al.[14] reviewed the literature on prehospital hypothermia and confirmed many of these findings, noting the well-described benefit.

Cooling in itself is not a benign procedure. Therapeutic hypothermia increases the risk of arrhythmias, infection, hyperglycemia, and coagulopathy. Most of the previous studies acknowledge these risks; however, such complications were rarely encountered. Additionally, cooling induces shivering, which produces heat and is therefore counterproductive to the cooling process.

Gaps in Knowledge. There is clear benefit to the use of hypothermia in survivors of ventricular fibrillation. There are limited data to support the use of hypothermia with other underlying rhythms and non-cardiac causes of cardiopulmonary arrest; however, the few studies on patients with other initial rhythms do appear to support the use of hypothermia. It remains unclear whether there is benefit to initiating post-cardiac arrest hypothermia in the field.

Recommendations. The authors support implementation of a prehospital cooling protocol in coordination with local hospitals, as such treatment may provide increased benefit to patients suffering from out-of-hospital cardiac arrest. Currently, infusion of cooled saline may be the most convenient and cost-effective method. Those being cooled should be placed on a monitor, as they are at increased risk for arrhythmias; this may limit the use of the procedure in systems without trained paramedics. In addition, while measurement of core temperature is ideal, constant core temperature monitoring is not without its limitations in terms of both cost and convenience.

Prehospital Electrocardiograms

The American Heart Association estimates that every year 1,200,000 Americans suffer an acute myocardial infarction (AMI). ST-elevation myocardial infarction (STEMI) accounts for approximately 500,000 AMIs and carries a substantial risk of death. Early revascularization of patients with STEMI has been shown to improve mortality and functional outcome.

Strategies for revascularization include early administration of fibrinolytic agents (door-to-drug time) or mechanical measures (door-to-balloon time). Obtaining a prehospital ECG in patients with STEMI has been demonstrated to be a key element of reducing revascularization times[21] and is currently a Class I recommendation of the American Heart Association.[22] However, the best method of implementing this strategy remains to be defined.

A study by Eckstein et al.[23] demonstrated that in Los Angeles County, obtaining 12-lead ECGs in the field resulted in 90% of the patients receiving percutaneous intervention (PCI) under the goal time of 90 minutes or less. In this study, the initial read of a STEMI was based on either a computer-generated interpretation of "acute MI" or by identification of > 1 mm of ST elevation in 2 contiguous leads upon presentation to the emergency department. The full benefits of this system were limited by the fact that only 31% of the study patients were transferred by EMS directly to a center with PCI capabilities. Swor et al.[24] evaluated the impact of prehospital ECG acquisition on the reduction in door-to-balloon time in their prehospital system. Here again, the ECG was interpreted by the EMS providers with assistance from the computer algorithm; however, EMS providers were able to activate the catheterization lab from the field. These authors found that door-to-balloon time was less than 90 minutes in 85.2% of cases. Here again, the authors were only able to demonstrate a successful strategy of prehospital activation of the cardiac catheterization laboratory in 31 of 164 STEMI patients (18.9%) transported during the study period. A recent study by Schull et al.[25] surveying EMS providers in five provinces in Canada demonstrated that only 47% of paramedics were trained in 12-lead ECG acquisition, and 40% were trained in ECG interpretation. Since ECG acquisition and interpretation or transmission is the essential first step in activating a STEMI alert, this clearly points to a weak link in optimizing STEMI care. Finally, Brainard et al.[26] conducted a meta-analysis on all studies evaluating the reduction in door-to-reperfusion time. This study identified only four studies of appropriate quality, all of which were conducted prior to the AHA's Class 1 recommendation on prehospital ECG. Nonetheless, these authors found a 22-minute reduction in door-to-reperfusion time in the patients who had a prehospital ECG. Due to the publication dates of the four studies included in this analysis (prior to 1995), it is likely that most of these patients received pharmaceutical reperfusion but not other strategies, such as pre-arrival catheterization team activation, that would take full advantage of the use of prehospital ECG.

Several possible methods are available to initiate STEMI activation using the prehospital ECG. The simplest method is an activation based on the formal interpretation of the computer algorithm built into most commercially available ECG machines. These algorithms have been shown to have a high sensitivity for detection of significant ST elevations in patients later proven to have STEMI.[28] When this strategy was employed by Brown et al.,[29] there was a demonstrated reduction in the door-to-balloon time (73 minutes vs. 130 minutes for non-field STEMI), an improved ejection fraction, and a lower mortality rate. The false negative activation of the cardiac catheterization laboratory was 20% in this study.

Another strategy is to train paramedics in the interpretation of the ECG independent of the computer interpretation. This approach was evaluated by Trivedi et al.,[30] who evaluated 103 trained paramedics on 5 separate clinical scenarios with ECG findings of both STEMI and non-STEMI. Four months after receiving a one-hour training program, the sensitivity for diagnosing STEMI was 92.6% and the specificity was 85.4%. This confirms the findings of earlier studies.[31,32] However, Vaught et al.[33] evaluated the impact of paramedic interpretation on door-to-balloon time in a system with paramedic interpretation. They found that there was no improvement in door-to-balloon time.

More recently, transmission of the images to the emergency physician or cardiologist has been shown to be an effective strategy. Adams et al.[36] examined the impact of transmission of the ECG image to a cardiologist's hand-held device on door-to-balloon time. Patients who received prehospital transmission of the ECG to the cardiologist demonstrated a 28-minute decrease in average door-to-balloon time when compared to those patients who presented directly to the emergency department during the study period. Similarly, Dhruva et al.[37] demonstrated that using wireless technology to transmit the ECG from the scene directly to the cardiologist resulted in a 66-minute improvement in door-to-intervention time when compared to their historical control group. Finally, Sejersten et al.[38] showed that the average door-to-balloon time was 74 minutes, 63 minutes shorter than historical controls.

Perhaps the most important question for patients identified in the prehospital setting is destination, particularly in urban and suburban centers with many receiving hospital options. Given the fact that early treatment of STEMI patients has demonstrated better functional recovery and improved mortality, it would seem intuitive that transport to a PCI-capable center would be most appropriate. Eckstein et al.[39] showed that implementing a formal network of STEMI receiving centers within an organized EMS system produced a door-to-balloon time of less than 90 minutes in 89% of cases and an EMS contact-to-balloon time of less than 90 minutes in 62.5% of cases. The impact of an organized system was recently examined by Sivagangabalan et al.,[40] who demonstrated that a direct field-to-catheterization-lab strategy based on ED interpretation of the transmitted ECG improved both functional outcome (systolic ejection fraction) and 30-day mortality when compared to patients transported to the emergency department of the interventional center or those who were first transported to a community setting. These authors also found that any delay from symptom onset to reperfusion resulted in an additional mortality risk of 0.3% per minute of delay. These findings have confirmed results from earlier studies.[41-43] (*See Table 1.*)

Gaps in Knowledge. Prehospital 12-lead ECGs appear to be a major strategy to reduce door-to-balloon time and thus expedite transfer to definitive care for patients suffering from STEMI. However, the best strategy for obtaining an ECG and placing the data into the hands of the decision-makers remains unclear. In addition, the question of who is most appropriate to activate the catheterization lab (EMS personnel, ED physician, or cardiologist), what are appropriate under-triage and over-triage rates, and a cost/benefit analysis of STEMI systems have yet to be determined. A cost/benefit analysis must be conducted to determine the true benefits to fully implementing a regional STEMI system.

Recommendations. There is a clear benefit to obtaining a prehospital ECG and placing that information into the hands of decision-makers. Barriers, including costs of equipment, training of paramedics, and geographical disparities in the availability of advanced prehospital providers (paramedics vs. EMT-basics or intermediates) and access to PCI centers, must be addressed.

Prehospital Termination of Resuscitation

National statistics suggest that only about 5% of patients who experience out-of-hospital cardiac arrest survive to hospital discharge.[45,46] In particular, those patients who do not regain a pulse in the out-of-hospital setting have a particularly dismal prognosis.[47] Kellerman et al. showed that of 758 patients who did not have return of spontaneous circulation in the out-of-hospital setting, only 3 survived to hospital discharge; all had neurologic impairment.[48]

Many authors have suggested that criteria be developed that predict those patients with expected poor outcomes with out-of-hospital arrest. Factors including an initial rhythm of asystole or PEA (pulseless electrical activity) and no return of spontaneous circulation (ROSC) in the field have been associated with a poorer prognosis.[49,50] This has led to some discussion about extending the ability of prehospital providers to terminate resuscitation efforts in the field beyond the declaration of futility in those with obvious signs of death (dependent lividity, decapitation, rigor mortis, etc.).

Termination of resuscitation (TOR) in the field for out-of-hospital cardiac arrest remains a controversial issue. Several areas must be considered when discussing this topic, including: which patients should be eligible for field termination; who is qualified to declare TOR; what are the costs and benefits to instituting such a policy in the field; if TOR is initiated in the field, who then becomes responsible for disposition the body, for supporting the family, and completion of the death certificate?

Much of the literature on terminating field resuscitation seeks to tease out the circumstances and characteristics shared by those who survive, identify those with better neurological outcomes, and integrate these characteristics into their decision-making rules. This may prove helpful, as there is a significant cost, time burden, and safety concern for the EMS providers and emergency department staff involved in the care of these patients.

Most early studies on this topic have involved systems with paramedic units that were capable of interpreting underlying ECG rhythms and utilizing advanced life support measures. As an example, Mohr et al. noted that most physician medical directors were comfortable with cessation of resuscitation efforts if no response to ACLS measures was noted after 45 minutes of resuscitation.[52] The American Heart Association suggests that failure to respond to intensive resuscitation efforts of more than 10 minutes duration rarely results in a neurologically intact survivor.[53] The issue becomes blurred with recent evidence that advanced life support measures actually may worsen the prognosis,[54] or when the EMS provider is not able to determine the underlying rhythm and is only able to distinguish when a shockable rhythm is present.

Morrison et al. recently evaluated a prediction rule to be used by basic EMTs for terminating resuscitation

Table 1: Summary of Prehospital ECGs, Transmission, Interpretation, and Outcome

Article	Prospective or Retrospective	n	EMS Level	Transmission Method	Interpreter	Activation	Outcome
Eckstein et al[23]	Retrospective (compared EMS vs. self transport)	238	EMTP	Call in	EMTP/ED	ED	Reduced DTB (108 to 95 min)
Swor et al[24]	Prospective (compared field activation vs. all other STEMIs)	164	EMTP	Call in	EMTP	ED	Reduced DTB (96 to 70 min)
Curtis et al[27]	Retrospective review of national MI registry (comparing patients who received a prehospital ECG to those who did not)	55647	Varied	n/a	n/a	n/a	Reduced DTB (110 to 94 min)
Brown et al[29]	Prospective (field vs. non-field STEMI)	78	EMTP	n/a	Computer	EMTP	Reduced DTB (130 to 73 min)
Vaught et al[33]	Retrospective (compare EMS DTB before and after implementing field activation)	92	EMTP	Cellular transmission	EMTP	ED	DTB time did not meet 90 min standard
Adams et al[36]	Prospective (field activation vs. self transport vs. prior EMS vs. failed transmission)	24	EMTP	Wireless transmission	EMTP	Cardiology	Reduced DTB (101 to 50 min)
Dhruva et al[37]	Prospective (EMS field activation vs previous EMS)	80	Unclear	Wireless transmission	EMTP	ED/ Cardiology	Reduced DTB (145 to 80 min)
Sejersten et al[38]	Prospective (field activation vs. control)	565	EMTB and MD	Wireless transmission	Unclear	Cardiology	Reduced DTB (112 to 49 min)
Sivagangbalan et al[40]	Prospective (compared to self presentation or EMS without field activation)	1449	EMTP	Wireless transmission	ED/EMTP	ED	Reduced DTB (146/105 to 78 min)
LeMay et al[42]	Prospective (field activation vs. control)	333	EMTP	Call in	EMTP	EMTP/ Cardiology	Reduced DTB (125 to 63 min)
Key: DTB = Door-to-balloon time; EMTP = paramedic; EMTB = EMT basic; ED = emergency department physician							

efforts in the field.[46] This study evaluated patients at least 18 years old with non-traumatic cardiac arrest and prospectively evaluated the validity of the rule in 1999 cardiac arrest survivors and assessed neurologic outcome of survivors. In the study, 1999 cardiac arrest victims were identified; 41 of them survived to hospital discharge. The investigators prospectively applied the TOR rule to consecutive cardiac arrest cases by assigning each patient to the "terminate" group or "transport" group, while not acting on the rule. The TOR prediction rule included the following criteria: no ROSC, no shocks administered, and the arrest is not witnessed by EMS personnel. When the TOR prediction rule was applied, 772 of these patients would have met criteria for field termination and, of the 772, 4 survived to hospital discharge. This resulted in a 0.53% false-negative rate.

Ong et al.[55] reported on the use of field termination rules in a BLS system with automated external defibrillators. These authors evaluated several TOR rules that differed in criteria, such as the return of spontaneous rhythm, the advice of the AED to deliver a shock, various time intervals, and the presence of other complicating factors such as drugs, hypothermia, or drowning. The sensitivity for each of the decision rules was greater than 99%, but only the rule that included termination of resuscitation for patients with unwitnessed cardiac arrests where no shock was advised and did not have a return of spontaneous rhythm had a specificity over 50%. It should be noted, however, that three patients in whom termination of resuscitation would have been advised were discharged alive in this retrospective study. The study concluded that the rule developed by Morrison and Verbeek et al.[56,57] had the largest impact on limiting transport.

The results of Morrison et al.[46] have been validated by several other authors such as Richman et al.,[58] Ruygrok et al.,[59] and Sasson et al.[60] Ruygrok et al.[59] compared three TOR criteria: BLS criteria, ALS criteria, and neurologic TOR criteria. (*See Figure 1.*) The authors made the assumption that if all of the criteria were met, resuscitation efforts would have been stopped. These three rules were then applied to a large registry of cardiac arrest patients. Each rule was analyzed with regard to patient outcomes, including survival to hospital discharge as well as neurologic function based on the Cerebral Performance Categories Scale. The authors determined that all three criteria were able to identify patients requiring continued resuscitation. Of the three rules, the BLS was the best at predicting patient survival with good neurologic outcome. The BLS criteria were also more accurate at predicting death and poor neurologic outcome. Sasson et al.[60] analyzed the sensitivity and specificity of the BLS and ALS TOR rules and found the BLS rule to be 50.6% sensitive and 98.7% specific. This compared with the ALS TOR rule, which was found to be 23.3% sensitive and 100% specific.

Morrison et al.[46] also commented on the cost of futile resuscitation and noted that transport and in-hospital health care costs for victims of cardiac arrest are nearly $5.1 billion annually in the United States. There was the potential to reduce hospital transport of cardiac arrest victims by about 30%.

What is highly controversial is the false-positive rate for each rule. In each of these studies, at least one patient whose resuscitation efforts would have been terminated in the field according to the prediction rule survived to discharge, many with good neurologic outcomes. This raises ethical and legal considerations in applying TOR prediction rules.

One additional concern is the issue of responsibility for the after care of the patient and the family. Delbridge et al.[61] conducted a prospective study in which they interviewed family members present at the scene of unsuccessful resuscitation efforts. In this study, 96% of those interviewed were satisfied with the decision to terminate in the field. Seventeen of the 53 patients were transferred to the emergency department. Seventy-six percent of the families of these 17 patients said they would have accepted field termination. The overall conclusion of this study was that families, in general, were receptive to field termination and happy with the care provided by paramedics surrounding their family member's death. Schmidt et al.[62] performed a similar study by interviewing surviving family of out-of-hospital cardiac arrest victims who were terminated in the field. Their study also found that family members thought that the EMTs were both professional and supportive.

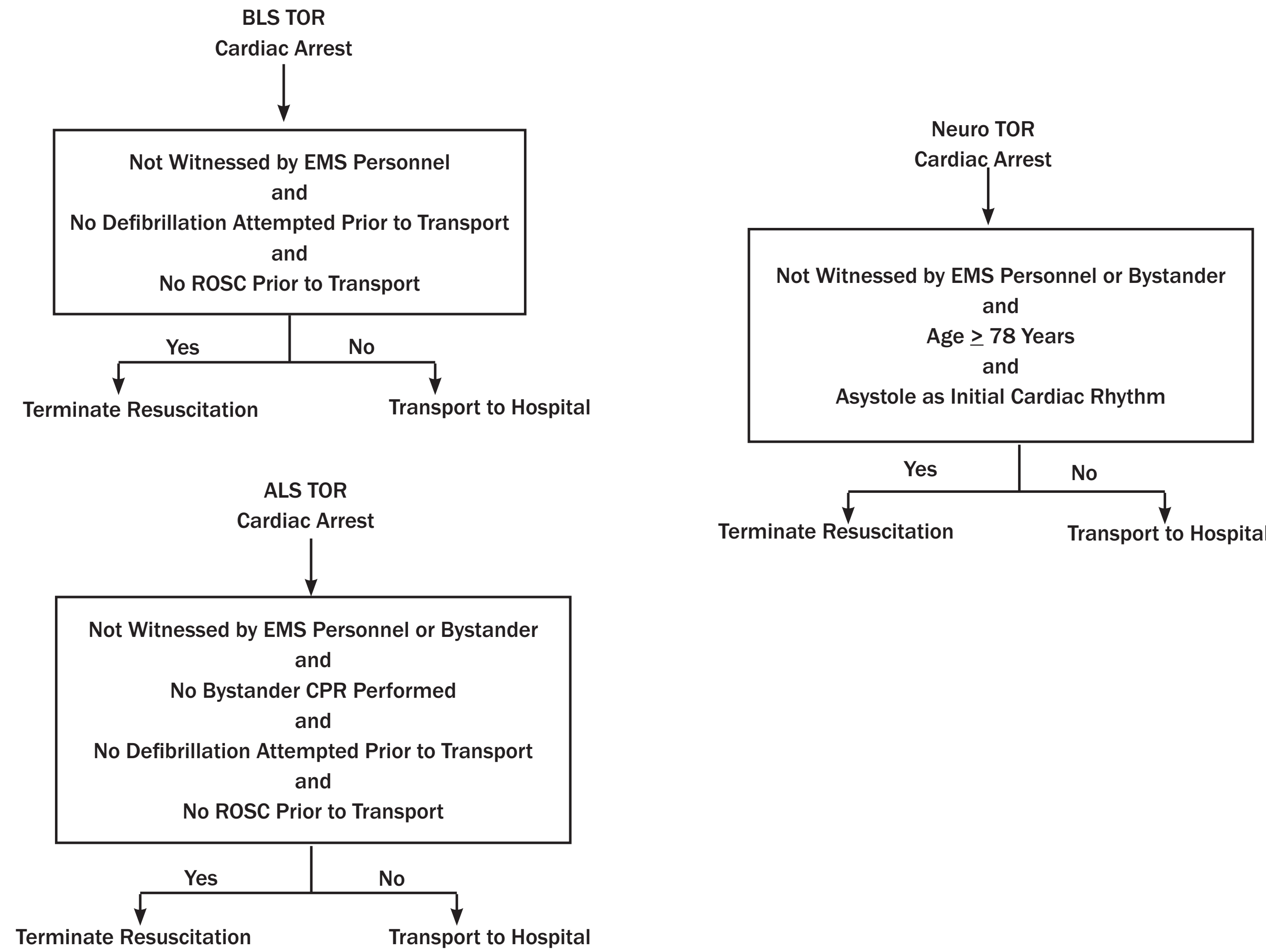
Gaps in Knowledge. Issues that need to be considered in instituting a TOR policy include emotional support for the family, disposition of the body, and certification of death. Several systems that have implemented a TOR policy have EMS providers inform the family of the death and stay with the patient until a local coroner or public safety officer arrives to assume care of the body. This clearly does not address all of the concerns mentioned. Further clarity is needed on issues including family resistance to TOR, unsafe scenes, EMS comfort with TOR policies, and consistent training on field termination and notification of death. Such matters remain under discussion at the national level. Sasson et al.[63] described the collaboration of several influential national organizations that will be able to work collaboratively to minimize these barriers so that prehospital TOR may be more widely implemented. Finally, ethical issues surrounding the implementation of TOR policies, including a threshold for false-positive terminations, must be resolved.

Recommendations. Simple TOR prediction rules have a very high sensitivity and specificity when applied to patients with out-of-hospital cardiac arrest. Some rules require information that is available even to basic emergency care providers. When applied in a prospective manner, TOR would significantly reduce health care costs associated with unnecessary transportation of cardiac arrest victims and prolonged yet futile ALS care, as well as reducing the physical burden on hospital staff. However, as mentioned, no acceptable miss rate has been established. Until these ethical and legal issues are resolved, public acceptance and global implementation of these rules are unlikely.

Prehospital Intubation

Airway remains the first priority in patient care. It has always been assumed that securing a definitive airway early leads to better patient outcomes, especially if a compromised airway is identified in the prehospital phase of care. Early studies demonstrated that paramedics could reliably be taught to perform intubation in the out-of-hospital

Figure 1: Schematic Representations of the 3 Termination of Resuscitation (TOR) Criteria



Possible exceptions to each include (1) age < 18 years; (2) trauma; (3) hypothermia or cold-water submersion; (4) overdose; or (5) do-not-resuscitate orders or obvious death, defined by rigor mortis, dependent lividity, or decomposition. *ROSC*, Return of spontaneous circulation.

Figure reprinted with permission from: Ruygrok ML, Byyny RL, Haukoos JS. Validation of 3 termination of resuscitation criteria for good neurologic survival after out-of-hospital cardiac arrest. *Ann Emerg Med* 2009;54:239-247.

setting. Airway management recently has emerged, however, as an area of controversy in the prehospital arena. The controversy has arisen because, while a secure airway is important, intubation is not a benign procedure. Concerns have been raised regarding skill proficiency, complication rate, and impact on patient outcome.

A primary area of concern is the high failure rates of prehospital intubation. Studies cite failure rates from 15-50% by paramedics in the prehospital setting.[66-70] Prehospital failure rates are primarily derived from reviews of out-of-hospital intubations by ground paramedics, which are compared to failure rates between 3-6% in intubations done by physicians.[67]

A major contributing factor appears to be the low incidence of use of this complex skill by individual EMTs.[71] Recent studies discuss the issue of training and experience in intubation, noting that UK paramedics average about 1 intubation per paramedic per year.[68,70] Other studies note that prehospital intubation rates might increase if paramedics could have more experience and training in endotracheal intubation.[73,74] Using a large statewide database, Wang et al. found that two-thirds of paramedics had two or fewer intubations during a one-year period, and 39% had no attempted intubations.[75]

Part of the low success rate of prehospital intubation recently has been elucidated by Garaza et al.[74] These authors identified many distracting factors, such as location of intubation, bystanders, weather, unsafe scene, suboptimal lighting, and patient position. The discussion that ensued encouraged paramedics to optimize their intubation conditions by increasing available space, improving lighting, preparing the equipment, and training personnel.

As with any medical procedure,

one must weigh the risk vs. benefit when evaluating the applicability of any procedure in the field of medicine. Several studies tout the benefits of early intubation,[76-79] which include safety during transport, ability to oxygenate and ventilate, and the prevention of aspiration. Only recently have the true risks of performing an intubation been more clearly delineated. These risks include airway trauma following multiple failed attempts, hematoma formation, aspiration, hypoxemia, laryngospasm, and esophageal trauma/intubation.[81-85]

Several tools exist to help mitigate risks associated with the procedure, especially missed esophageal intubation. More objective means of confirming an endotracheal intubation are available. Capnometry, capnography, color change end-tidal CO_2 detectors, and esophageal detector devices (EDD) all act as secondary confirmatory devices. Each of these methods has drawbacks and advantages, depending on the clinical situation. For example, color-change $ETCO_2$ detectors have a higher incidence of false-negative readings (color change consistent with esophageal intubation when the tube is actually in the trachea) in patients with poor perfusion or cardiac arrest.[80] Esophageal detector devices may appear to demonstrate proper tracheal placement during prolonged bag-valve-mask ventilation when the tube is actually in the esophagus.[80] The American Heart Association (AHA) Guidelines propose the following algorithm for $ETCO_2$ device use in endotracheal tube confirmation:

"If a pulse is present, rely on the colorimetric, qualitative CO_2 techniques.

"If a pulse is absent, use the colorimetric CO_2 device. But if the device shows no color change, add the test of the EDD. No air rush with positive suction indicates that the tracheal tube is in the esophagus — therefore reintubate. Air rush with no suction indicates that the tube is in the trachea — therefore secure the tube."[80]

The colorimetric device and EDD are relatively cost effective, with the color-change devices costing between \$10 and \$20 on average, and the esophageal detection device averaging around \$5. In addition to their affordability, these devices are relatively low tech, user-friendly, and very portable, which makes them very feasible for EMS use.

Tan et al. reported that an increase in the number of attempts was associated with a delay in transport to definitive care, also resulting in an increase in complications including hypoxia, cardiac arrhythmia, airway injury, bleeding, and edema.[70] The authors concluded that limiting field intubation to two attempts would decrease complications and likely reduce associated morbidity and mortality.

In addition to their conclusions regarding intubation success and complication, Cobas et al.,[64] Eckstein et al.,[88] and Cudnik et al.[89] noted an increased mortality in patients who received prehospital intubation. This is perhaps the most important issue, as it relates specifically to prehospital intubation and is consistent with earlier work from Davis et al.[90] and Wang et al.[91] demonstrating a detrimental effect of prehospital intubation on patient outcome. In fact, the relative risk of death and poor outcome was 1.6 in the Davis study and 4.0 in the Wang study. Cobas et al. found no improved survival with intubation as compared to bag-valve-mask ventilation (BVM).[64] Some limitations to these studies include the fact that they are focused on trauma patients who are at increased risk for having a difficult airway, compromised by blood, foreign bodies, emesis, or injury. These results were recently refuted by Bulger et al.,[92] who retrospectively studied moderate to severe head-injured patients who received paralytic agents and found no difference in mortality.

Interestingly, the success rates for intubation as well as outcomes are improved in patients intubated by air medical crews. This was noted by Davis et al.,[90] Wang et al.,[91] and Cudnik et al.,[89] who found improvement in survival in these subsets of patients. Germann et al.[93] evaluated the intubation skills of air medical personnel and found that they had an out-of-hospital success rate of 92%. This may be up to 30% better than ground EMS success rates. The authors suggest that this is likely due to the strict skill performance requirements, ongoing training, and more frequent exposure to intubation that air medical crews experience. This conclusion was supported by Fakhry et al.,[94] who found a 96.6% success rate for scene RSI performed by air transport paramedics. Intubation in their hands was associated with low complication rates and proper ventilation as measured by arterial pCO_2. They attribute the success of their program to training, regular experience, and close monitoring of a limited group of providers, which maximizes their exposure and experience with this procedure.

Gaps in Knowledge. Most of the data on the dangers of endotracheal intubation come from large EMS systems or statewide databases. It is also known that air medical transport programs appear to have both procedural success and outcomes similar to those of physicians. The specific factors that result in high intubation success, low complications, and improved mortality require further study. The role of strict adherence to the use of secondary confirmation devices following intubation as a means of reducing esophageal intubation requires better analysis. Finally, the role of alternative airway devices in maintaining proper ventilation and oxygenation in the prehospital setting, which is not discussed here, deserves further consideration

Recommendations. Intubation is a very helpful and sometimes life-saving procedure that can be performed by paramedics. However, it should be used selectively with a full understanding of the limitations and risks associated with the procedure. Operator experience is key, and the number of previous intubations and the comfort level of the operator have an impact on the success of intubation. Thus, providers should have a system in place to train and regularly refresh their intubation skills. Systems that provide a concentrated experience in intubation with strong medical oversight appear to have the best results. The environment is an important element in success or failure of field intubations; whenever possible, one should try to minimize distractions and maximize space in addition to ensuring that all equipment is readily available. Where appropriate experience cannot be achieved, EMS should be encouraged to assist with bag-valve-mask ventilation or consider the use of alternative airway devices, which may be a safe and effective way to support ventilation and oxygenation in a patient in whom intubation would otherwise be considered.

Summary

Prehospital care is an inexact science, combining studies conducted in an uncontrolled environment along with extrapolations of in-hospital therapies and procedures. Areas such as initiation of hypothermia in the survivors of cardiac arrest, termination of futile resuscitation efforts, the role of prehospital ECG in emerging STEMI systems, and the optimal role of prehospital intubation in patient care remain controversial and will require further elucidation in the emerging EMS and emergency medicine literature.

References

1. Becker LB, Smith DW, Rhodes KV. Incidence of cardiac arrest: A neglected factor in evaluating survival rates. *Ann Emerg Med* 1993; 22:86-91.
2. Eisenberg MS, Horwood BT, Cummins RO, et al. Cardiac arrest and resuscitation: a tale of 29 cities. *Ann Emerg Med* 1990; 19:179-186.
3. Zeiner A, Holzer M, Sterz F, et al. Mild resuscitative hypothermia to improve neurological outcome after cardiac arrest: A clinical feasibility trial. Hypothermia after Cardiac Arrest (HACA) Study Group. *Stroke* 2000;31:86-94.
4. Laurent I, Adrie A, Vinsonneau C, et al. High-volume hemofiltration after out-of-hospital cardiac arrest. *J Am Coll Cardiol* 2005;46:432-437.
5. Brauner ME, Sayre MR. Emedicine. Therapeutic hypothermia updated: Dec 22, 2008, Accessed 10/20/09.
6. Kuboyama K, Safar P, Radovsky A, et al. Delay in cooling negates the beneficial effect of mild resuscitative cerebral hypothermia after cardiac arrest in dogs: A prospective, randomized study. *Crit Care Med* 1993;21:1348-1358.
7. Nozari A, Safar P, Stezoski SW, et al. Critical time window for intra-arrest cooling with cold saline flush in a dog model of cardiopulmonary resuscitation. *Circulation* 2006;113:2690-2696.
8. International Advisory Committee on Resuscitation (ILCOR). Therapeutic hypothermia after cardiac arrest. *Circulation* 2003;108:118-121.
9. Cady C, Andrews S. Prehospital resuscitated cardiac arrest patients: Role for induced hypothermia. *Prehosp Emerg Care* 2009;13:402-405.
10. Colbourne F, Sutherland G, Corbett D. Postischemic hypothermia: A critical appraisal with implications for clinical treatment. *Mol Neurobiol* 1997;14:171-201.
11. Ginsberg MD, Sternau LL, Globus MY, et al. Therapeutic modulation of brain temperature: Relevance to ischemic brain injury. *Cerebrovasc Brain Metab Rev* 1992;4:189-225.
12. Safar PJ, Kochanek PM. Therapeutic hypothermia after cardiac arrest. *N Engl J Med* 2002;346:612-613.
13. Kim F, Olsufka M, Longstreth WT Jr, et al. Pilot randomized clinical trial of prehospital induction of mild hypothermia in out of hospitalcardiac arrest patients with a rapid infusion of 4 degrees C normal saline. *Circulation* 2007;115:3064-3070.
14. Kamarainen A, Virkkunen I, Tenhunen J,et al. Prehospital therapeutic hypothermia for comatose survivors of cardiac arrest: A randomized clinical trial. *Acta Anathesiol Scand* 2009;53:900-907
15. Hammer L, Vitra F, Savry D, et al. Immediate prehospital hypothermia Protocol in comatose survivors of out-of-hospital arrest. *Am J Emerg Med* 2009;27:570-573.
16. Kampmeyer M, Callaway C. Method of cold saline storage for prehospital hypothermia. *Prehosp Emerg Care* 2009;13:81-84.
17. Uray, T, Malzer R. Vienna Hypothermia After Cardiac Arrest Study Group. Out-of–hospital surface cooling to induce mild hypothermia in human cardiac arrest: A feasibility trial. *Resuscitation* 2008;77:331-338.
18. Bernard SA, Gray TW, Buist MD, et al. Tratmen of comatose survivors of out-of-hospital cardiac arrest with induced hypothermia. *N Engl J Med* 2002;346:557-563.
19. Hypothermia after Cardiac Arrest Study Group. Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest. *N Engl J Med* 2002;346:549-556.
20. Suffoletto BP, Salcido DD, Menegazzi JJ. Use of prehospital induced hypothermia after out-of-hospital cardiac arrest: A survey of the National Association of EMS Physicians. *Prehosp Emerg Care* 2008;12:52-56.
21. Bradley EH, Herrin J, Wang Y, et al. Strategies for reducing the door-to-balloon time in acute myocardial infarction. *N Engl J Med* 2006;355:2308-2320.
22. 2005 American Heart Association Guidelines for Cardiopulmonary Resusciation and Emergency Cardiovascular Care: Part 8: Stabilization of the Patient With Acute Coronary Syndromes. *Circulation* 2005;112:IV-89-IV-110.
23. Eckstein M, Cooper E, Nguyen T, et al. Impact of paramedic transport with prehospital 12-lead electrocardiography on door-to-ballon times for patients with ST-segment elevation myocardial infarction. *Prehosp Emerg Care* 2009;13:203-206.
24. Swor R, Hegerberg S, McHugh-McNally A, et al. Prehospital 12-lead ECG: Efficacy or effectiveness? *Prehosp Emerg Care* 2006;10:374-377.
25. Schull MJ, Vaillancourt S, Donovan L, et al; Canadian Cardiovascular Outcomes Research Team. Underuse of prehospital strategies to reduce time to reperfusion for ST-elevation myocardial infarction patients in 5 Canadian provinces. *CJEM* 2009;11:473-480.
26. Brainard AH, Raynovich W, Tandberg D, et al. The prehospital 12-lead electrocardiogram effect on time to initiation of reperfusion therapy: A systemic review and meta-analysis of existing literature. *Am J Emerg Med* 2005;23:351-356.
27. Curtis JP, Portnay EL, Wang Y, et al. National Registry of Myocardial Infarction-4. The prehospital electrocardiogram and time to reperfusion in patients with acute myocardial infarction, 2000-2002: Findings from the National Registry of Myocardial Infarction-4. *J Am Coll Cardiol* 2006;47:154401552.
28. Kudenchuk PJ, Ho MT, Weaver WD, et al. Accuracy of computer-interpreted electrocardiography in selecting patients for thrombolytic therapy. MITI Project Investigators. *J Am Coll Cardiol* 1991;17:1486-1491.
29. Brown JP, Mahmud E, Dunford JV, et al. Effect of prehospital 12-lead electrocardiogram on activation of the cardiac catheterization laboratory and door-to-balloon time in ST-segment elevation acute myocardial infarction. *Am J Cardiol* 2008;101:158-161.
30. Trivedi K, Schuur JD, Cone DC. Can paramedics read ST-segment elevation myocardial infarction on prehospital 12-lead electrocardiogram? *Prehosp Emerg Care* 2009;13:207-214.
31. Whitbread M, LeahV, Bell T, et al. Recognition of ST elevation by paramedics. *Emerg Med J* 2002;19:66-67.
32. Feldman JA, Brinsfield K, Bernard S, et al. Real-time paramedic compared with blinded physician identification of ST-segment elevation myocardial infarction: results of an observational study. *Am J Emerg Med* 2005;23:443-448.

33. Vaught C, Young D, Bell S, et al. The failure of years of experience with electrocardiographic transmission from paramedics to the hospital emergency department to reduce the delay from door to primary coronary intervention below the 90-minute threshold during acute myocardial infarction. *J Electrocardiol* 2006;39:136-141.

34. Sejersten M, Young D, Clemmensen P, et al. Comparison of the ability of paramedics with that of cardiologists in diagnosing ST segment elevation acute myocardial infarction in patients with acute chest pain. *Am J Cardiol* 2002;90:995-998.

35. Davis DP, Graydon C, Stein R, et al. The positive predictive value of paramedic versus emergency physician interpretation of the prehospital 12-lead electrocardiogram. *Prehosp Emerg Care* 2007;11:399-402.

36. Adams GL, Campbell P, Adams JM, et al. Effectiveness of prehospital wireless transmission of cardiograms to a cardiologist via handheld device for patients with acute myocardial infarction (from the Timely Intervention in Myocardial Emergency, NorthEast Experience [TIME-NE]). *Am J Cardiol* 2006;98:1160-1164.

37. Dhruva V, Abdelhadi S, Anis A, et al. ST-segment analysis using wireless technology in acute myocardial infarction (STAT-MI) trial. *J Am Coll Cardiol* 2007;50:509-513.

38. Sejersten M, Sillesen M, Hansen PR, et al. Effect on treatment delay of prehospital teletransmission of 12-lead electrocardiogram to a cardiologist for immediate triage and direct referral of patients with ST-segment elevation acute myocardial infarction to primary percutaneous coronary intervention. *Am J Cardiol* 2008;101:941-946.

39. Eckstein M, Koenig W, Kaji A, et al. Implementation of specialty centers for patients with ST-segment elevation myocardial infarction. *Prehosp Emerg Care* 2009;13:215-222.

40. Sivagangabalan G, Ong ATL, Narayun A, et al. Effect of prehospital triage on revascularization times, left ventricular function, and survival in patients with ST-elevation myocardial infarction. *Am J Cardiol* 2009;103:907-912.

41. Garvey JL, MacLeod BA, Sopko G, et al. Pre-hospital 12-lead electrocardiography programs: A call for implementation by emergency medical services systems providing advanced life support — National Heart Attack Alert Program (NHAAP) Coordinating Committee; National Heart, Lung, and Blood Institute (NHLBI); National Institutes of Health. *J Am Coll Cardiol* 2006;47:485-491.

42. Le May MR, Davies RF, Dionne R, et al. Comparison of early mortality of paramedic-diagnosed ST-segment elevation myocardial infarction with immediate transport to a designated primary percutaneous coronary intervention center to that of similar patients transported to the nearest hospital. *Am J Cardiol* 2006;98:1329-1333.

43. Carstensen S, Nelson GC, Hansen PS, et al. Field triage to primary angioplasty combined with emergency department bypass reduces treatment delays and is associated with improved outcome. *Eur Heart J* 2007;28:2313-2319.

44. Cummins RO, Ornato JP, Thies WH, et al. Improving survival from sudden cardiac arrest: The "chain of survival" concept. *Circulation* 1991;83:1832-1847.

45. Bonnin MJ, Swor RA. Outcomes in unsuccessful field resuscitation attempts. *Ann Emerg Med* 1989;18:507-512.

46. Morrison LJ, Visentin LM, Kiss A, et al. Validation of a rule for termination of resuscitation in out-of hospital cardiac arrest. *N Engl J Med* 2006;478-487.

47. Stiell IG, Wells GA, Spaite DW, et al. The Ontario Prehospital Advanced Life Support (OPALS) study part II: Rationale and methodology for trauma and respiratory distress patients. *Ann Emerg Med* 1999;34:256-262.

48. Kellermann AL, Hackman BB, Somes G. Predicting the outcome of unsuccessful advanced cardiac life support. *JAMA* 1993;270:1433-1436.

49. Eisenberg MS, Mengerrt TJ. Cardiac resuscitation. *N Engl J Med* 2001;344:1304-1313.

50. Kellerman AL, Staves DR, Hackman BB. In hospital resuscitation following unsuccessful prehospital advanced cardiac life support. *Ann Emerg Med* 1998;17:589-594.

51. Pepe PE, Swor RA, Ornato JP, et al; Turtle Creek Conference II. Resuscitation in the out-of-hospital setting: Medical futility criteria for on-scene pronouncement of death. *Prehosp Emerg Care* 2001;5:79-87.

52. Mohr M, Bahr J, Schmid J, et al. The decision to terminate resuscitative efforts: Results of a questionnaire. *Resuscitation* 1997;34:51-55.

53. Ethical issues. *Circulation* 2005;112(24 Supp):IV-6-IV-11.

54. Olasveengen TM, Sunde K. Brunborg C, et al. Intravenous drug administration during out-of-hospital cardiac arrest: A randomized trial. *JAMA* 2009;302:2222-2229.

55. Ong ME, Jaffey J, Stiell I, et al. OPALS Study Group.Comparison of termination-of-resuscitation guidelines for basic life support defibrillator providers in out of hospital cardiac arrest. *Ann Emerg Med* 2006;47:337-343.

56. Verbeek PR, Vermeulen MJ, Ali FH, et al. Derivation of a termination-of–resuscitation guideline for emergency medical technicians using automated external defibrillators. *Acad Emerg Med* 2002;9:671-678.

57. Morrison LJ, Kiss A, Vermeulen M, et al. Derivation and evaluation of a termination of resuscitation clinical prediction rule for advanced life support providers. *Resuscitation* 2007;74:266-275.

58. Richman PB, Vadeboncocur TF, Chikani V, et al. Independent evaluation of an out-of-hospital termination of resuscitation (TOR) clinical decision rule. *Acad Emerg Med* 2008;15:517-520.

59. Ruygrok ML, Byyny RL, Haukoos JS, Colorado Cardiac Arrest & Resuscitation Collaborative Study Group and the Denver Metro EMS Medical Directors. Validation of 3 termination of resuscitation criteria for good neurologic survival after out-of-hospital cardiac arrest. *Ann Emerg Med* 2009;54:239-247.

60. Sasson C, Hegg AJ, Macy M, et al. Prehospital termination of resuscitation in cases of refractory out-of-hospital cardiac arrest. *JAMA* 2008;300:1432-1438.

61. Delbridge TR, Fosnocht DE, Garrison HG, et al. Field termination of unsuccessful out-of-hospital cardiac arrest resuscitation: Acceptance by family members. *Ann Emerg Med* 1996;27:649-654.

62. Schmidt TA, Harrahill MA. Family response to out-of-hospital death. *Acad Emerg Med* 1995;2:513-518.

63. Sasson C, Forman J, Krass D, et al. A qualitative study to identify barriers to local implementation of prehospital termination of resuscitation protocols. *Circ Cardiovasc Qual Outcomes* 2009;2:361-368. Epub 2009 Jun 30.

64. Cobas MA, De la Pena MA, Manning R, et al. Prehospital intubations and mortality: A Level 1 trauma center perspective. *Crit Care Trauma* 2009;109:489-493.

65. Denver Metro Airway Study Group. A prospective multicenter evaluation of prehospital airway management performance in a large metropolitan area. *Prehosp Emerg Care* 2009;13:304-310.

66. Deakin CD, Peters R, Tomlinson P, et al. Securing the pre-hospital airway: A comparison of laryngeal mask insertion and tracheal intubation by UK paramedics. *Emerg Med J* 2005;22:64-67.

67. Ochs M, Davis D, Hoyt D. Paramedic performed rapid sequence intubation of patients with severe head injuries. *Ann Emerg Med* 2002;40:159-167.

68. Fullerton JN, Roberts KJ, Wyse M. Can experienced paramedics perform tracheal intubation at cardiac arrests? Five years experience of a regional air ambulance service in the UK**.** *Resuscitation* 2009 Sep 3 (epub ahead of print).

69. Stewart RD, Paris PM, Winter PM, et al. Field endotracheal intubation by paramedical personnel: Success rates and complications. *Chest* 1984;85:341-345.

70. Tam RK, Maloney J, Garboury I, et al. Review of endotracheal intubation by Ottawa advanced care paramedics in Canada. *Prehosp Emerg Care* 2009;13:311-315.

71. Johnston BD, Seitz SR, Wang HE. Limited opportunities for paramedic student endotracheal intubation training in the operating room. *Acad Emerg Med* 2006;13:1051-1055.

72. Davis DP. Should invasive airway management be done in the field? *CMAJ* 2008;178:1171-1173.

73. Heff H, Wenzel V, Lockery D. Prehospital intubation: The right tools in the right hands at the right time. *Anesth Analg* 2009;109:303-305.

74. Garza AG, Gratton Mc, McElroy J, et al. Environmental factors encountered during out-of-hospital intubation attempts. *Prehosp Emerg Care* 2009;13:286-290.

75. Wang HE, Kupas DF, Hostler D, et al. Procedural experience with out-of-hospital endotracheal intubation. *Crit Care Med* 2005:33:1718-1721.

76. Bushby N, Fitzgerald M, Cameron P, et al. Prehospital intubation and chest decompression is associated with unexpected survival in major thoracic blunt trauma. *Emerg Med Australas* 2005;17:443-449.

77. Davis D, Fisher R. Is there added benefit to prehospital intubation over noninvasive airway maneuvers? *Acad Emerg Med* 2005;12:163.

78. Arbabi S, Jurkovich GJ, Wahl WL, et al. A comparison of prehospital and hospital data in trauma patients. *J Trauma* 2004;56:1029-1032.

79. Winchell RJ, Hoyt DB. Endotracheal intubation in the field improves survival in patients with severe head injury. *Arch Surg* 1997;132:592-597.

80. Cummins RO, Hazinski MF. New guidelines on tracheal tube confirmation and prevention of dislodgement. *Circulation* 2000;102(suppl 2):I-380-384.

81 Murray JA, Demetriades D, Berne TV, et al. Prehospital intubation in patients with severe head injury. *J Trauma* 2000;49:1065-1070.

82. Gausche M, Lewis RJ, Stratton SJ, et al. Effect of out of hospital pediatric endotracheal intubation on survival and neurological outcome. *JAMA* 2000;283:783-790.

83. Cooper A, DiScala C, Foltin G, et al. Prehospital endotracheal intubation for severe head injury in children: A reappraisal. *Semin Pediatr Med* 2001;10:3-6.

84. Timmermann A, Russo SG, Eich C, et al. The out-of-hospital esophageal and endobronchial intubations performed by emergency physicians. *Anesth Analg* 2007;104:619-623.

85. Calkins TR, Miller K, Langdorf MI. Success and complication rates with prehospital placement of an esophageal-tracheal combitube as a rescue airway. *Prehosp Disaster Med* 2006;21:97-100.

86. Vezine MC, Trepanier CA, Nicole PC, et al. Complications associated with esophageal tracheal combitube in the prehospital setting. *Can J Anaesth* 2007;54:124-128.

87. Wirtz DD, Ortiz C, Newman DH, et al. Unrecognized misplacement of endotracheal tubes by ground prehospital providers. *Prehosp Emerg Care* 2007;11:213-218.

88. Eckstein M, Chan L, Schneir A, et al. Effect of prehospital advanced life support on outcomes of major trauma patients. *J Trauma* 2000;48:643-648.

89. Cudnik MT, Newgard CD, Wang H, et al. Distance impacts mortality in trauma patients with an intubation attempt. *Prehosp Emerg Care* 2008;12:459-466.

90. Davis DP, Hoyt DB, Ochs M, et al. The effect of paramedic rapid sequence intubation on outcome in patients with severe traumatic brain injury. *J Trauma* 2003;54:444-453.

91. Wang HE, Peitzman AB, Cassidy LD, et al. Out-of-hospital endotracheal intubation and outcome after traumatic brain injury. *Ann Emerg Med* 2004;44:439-450.

92. Bulger EM, Copass MK, Sabath DR, et al. The use of neuromuscular blocking agents to facilitate prehospital intubation does not impair outcome after traumatic brain injury. *J Trauma* 2005;58:718-723.

93. Germann CA, Baumann MR, Kendall KM, et al. Performance of endotracheal intubation and rescue techniques by emergency services personnel in an air medical service. *Prehosp Emerg Care* 2009;13:44-49.

94. Fakhry SM, Scanlon JM, Robinson L, et al. Prehospital rapid sequence intubation for head trauma: Conditions for a successful program. *J Trauma* 2006;60:997-1001.

Physician CME Questions

61. What is the leading cause of in-hospital death in patients who survive out-of-hospital cardiac arrest?
    A. multiple system organ failure
    B. fatal dysrhythmia
    C. anoxic brain injury
    D. cardiogenic shock

62. The American Heart Association has determined that the use of hypothermia following successful PEA arrest is a Class IIb recommendation.
    A. true
    B. false

63. Which of the following are suggested benefits to prehospital cooling following successful resuscitation from cardiac arrest?
    A. reduction in oxygen free radicals
    B. slowing of basal metabolic rate
    C. conservation of brain oxygen and substrate
    D. all of the above

64. What has been the greatest barrier to implementation of prehospital hypothermia protocols for survivors of cardiac arrest?
    A. coordination of care with receiving hospitals
    B. high cost of all prehospital cooling measures
    C. patient consent issues
    D. lack of demonstrated efficacy of hypothermia in cardiac arrest

65. Obtaining a prehospital ECG is a Class I recommendation of the American Heart Association.
    A. true
    B. false

66. Which of the following are proven methods of identifying a prehospital STEMI?
    A. transmission of ECG to emergency physician or cardiologist
    B. paramedic interpretation of the prehospital ECG
    C. use of ECG algorithm on the monitor/defibrillator
    D. all of the above

67. Which of the following statements is true?
    A. National survival for out-of-hospital cardiac arrest is 10-20%.
    B. Termination protocols using information available to basic providers can predict a dismal likelihood of successful resuscitation.
    C. Providers must be able to demonstrate a failure to respond to ACLS medications prior to field pronouncement of death.
    D. There are prehospital termination of resuscitation protocols that can predict with absolute certainty failure to gain ROSC in the field.

68. What is the potential reduction in prehospital transport of out-of-hospital cardiac arrest victims according to Morrison?
    A. 10%
    B. 20%
    C. 30%
    D. 40%

69. What is the single most important factor in failure to recognize prehospital esophageal intubations?
    A. failure to use confirmatory methods such as end-tidal CO_2 detectors
    B. poor assessment skills by prehospital providers
    C. difficulty with poor lighting in the prehospital environment
    D. common occurrence of tube dislodgement in moving patient to emergency department gurney

70. Which of the following statements regarding prehospital intubation is true?
    A. The success rate of out-of-hospital intubations has been uniformly dismal.
    B. One study found that multiple intubation attempts did not delay transport to definitive care.
    C. The high cost of end-tidal CO_2 detectors has been a barrier to their implementation.
    D. The success rates were improved in patients intubated by air medical crews.

CME Answer Key

61. C; 62. B; 63. D; 64. A; 65. A; 66. D; 67. B; 68. C; 69. A; 70. D

Emergency Medicine Reports™ (ISSN 0746-2506) is published biweekly by AHC Media LLC, 3525 Piedmont Road, N.E., Six Piedmont Center, Suite 400, Atlanta, GA 30305. Telephone: (800) 688-2421 or (404) 262-7436.

Associate Publisher: Russ Underwood

Specialty Editor: Shelly Morrow Mark

Director of Marketing: Schandale Kornegay

GST Registration No.: R128870672

Periodicals Postage Paid at Atlanta, GA 30304 and at additional mailing offices.

POSTMASTER: Send address changes to Emergency Medicine Reports, P.O. Box 740059, Atlanta, GA 30374.

Back issues: $31. Missing issues will be fulfilled by customer service free of charge when contacted within one month of the missing issue's date.

Multiple copy prices: One to nine additional copies, $359 each; 10 to 20 additional copies, $319 each.

Subscriber Information

Customer Service: 1-800-688-2421

Customer Service E-Mail:
customerservice@ahcmedia.com

Editorial E-Mail:
shelly.mark@ahcmedia.com

World Wide Web page:
http://www.ahcmedia.com

Subscription Prices

1 year *with* 60 ACEP/60 AMA/60 AAFP Category 1/Prescribed credits: $544

1 year *without* credit: $399
Add $17.95 for shipping & handling

Resident's rate $199

Discounts are available for group subscriptions, multiple copies, site-licenses or electronic distribution. For pricing information, call
Tria Kreutzer at 404-262-5482.

All prices U.S. only.
U.S. possessions and Canada, add $30 plus applicable GST. Other international orders, add $30.

Accreditation

AHC Media LLC is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.

AHC Media LLC designates this educational activity for a maximum of 60 *AMA PRA Category 1 Credits™*. Each issue has been designated for a maximum of 2.30 *AMA PRA Category 1 Credits™*. Physicians should only claim credit commensurate with the extent of their participation in the activity.

Approved by the American College of Emergency Physicians for 60 hours of ACEP Category 1 credit.

Emergency Medicine Reports has been reviewed and is acceptable for up to 39 Prescribed credits by the American Academy of Family Physicians. AAFP accreditation begins 01/01/10. Term of approval is for one year from this date. Each issue is approved for 1.50 Prescribed credits. Credit may be claimed for 1 year from the date of each issue. The AAFP invites comments on any activity that has been approved for AAFP CME credit. Please forward your comments on the quality of this activity to cmecomment@aafp.org.

This is an educational publication designed to present scientific information and opinion to health professionals, to stimulate thought, and further investigation. It does not provide advice regarding medical diagnosis or treatment for any individual case. It is not intended for use by the layman. Opinions expressed are not necessarily those of this publication. Mention of products or services does not constitute endorsement. Clinical, legal, tax, and other comments are offered for general guidance only; professional counsel should be sought for specific situations.

This CME activity is intended for emergency and family physicians. It is in effect for 24 months from the date of the publication.

AHC Media LLC

Emergency Medicine Reports
The Practical Journal for Emergency Physicians

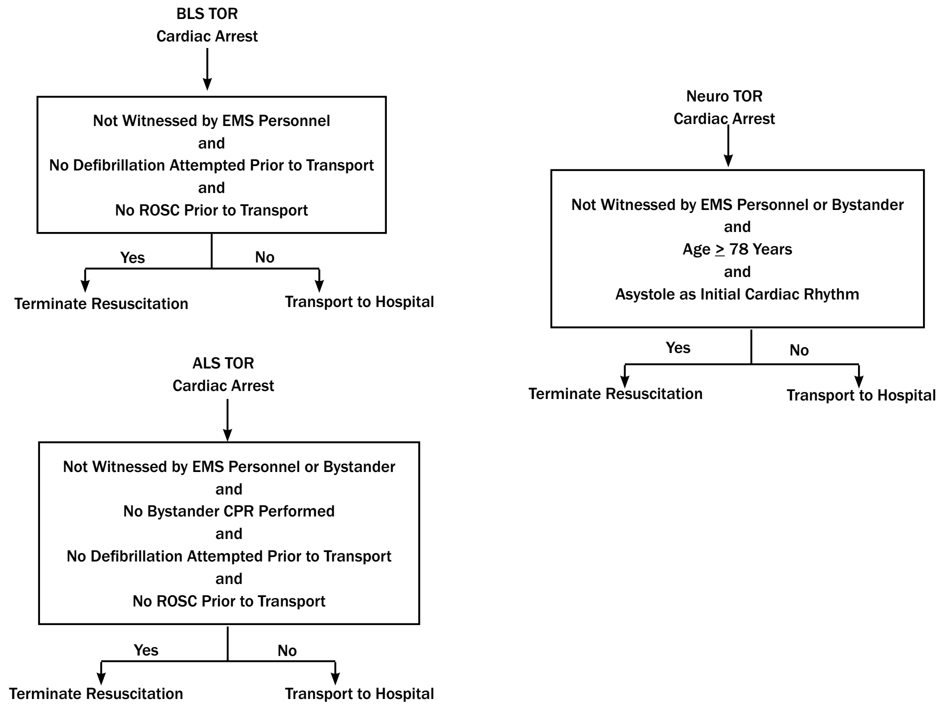
Controversies in Emergency Medical Services

Summary of Prehospital ECGs, Transmission, Interpretation, and Outcome

Article	Prospective or Retrospective	n	EMS Level	Transmission Method	Interpreter	Activation	Outcome
Eckstein et al[23]	Retrospective (compared EMS vs. self transport)	238	EMTP	Call in	EMTP/ED	ED	Reduced DTB (108 to 95 min)
Swor et al[24]	Prospective (compared field activation vs. all other STEMIs)	164	EMTP	Call in	EMTP	ED	Reduced DTB (96 to 70 min)
Curtis et al[27]	Retrospective review of national MI registry (comparing patients who received a prehospital ECG to those who did not)	55647	Varied	n/a	n/a	n/a	Reduced DTB (110 to 94 min)
Brown et al[29]	Prospective (field vs. non-field STEMI)	78	EMTP	n/a	Computer	EMTP	Reduced DTB (130 to 73 min)
Vaught et al[33]	Retrospective (compare EMS DTB before and after implementing field activation)	92	EMTP	Cellular transmission	EMTP	ED	DTB time did not meet 90 min standard
Adams et al[36]	Prospective (field activation vs. self transport vs. prior EMS vs. failed transmission)	24	EMTP	Wireless transmission	EMTP	Cardiology	Reduced DTB (101 to 50 min)
Dhruva et al[37]	Prospective (EMS field activation vs previous EMS)	80	Unclear	Wireless transmission	EMTP	ED/ Cardiology	Reduced DTB (145 to 80 min)
Sejersten et al[38]	Prospective (field activation vs. control)	565	EMTB and MD	Wireless transmission	Unclear	Cardiology	Reduced DTB (112 to 49 min)
Sivagangbalan et al[40]	Prospective (compared to self presentation or EMS without field activation)	1449	EMTP	Wireless transmission	ED/EMTP	ED	Reduced DTB (146/105 to 78 min)
LeMay et al[42]	Prospective (field activation vs. control)	333	EMTP	Call in	EMTP	EMTP/ Cardiology	Reduced DTB (125 to 63 min)

Key: DTB = Door-to-balloon time; EMTP = paramedic; EMTB = EMT basic; ED = emergency department physician

Schematic Representations of the 3 Termination of Resuscitation (TOR) Criteria



Possible exceptions to each include (1) age < 18 years; (2) trauma; (3) hypothermia or cold-water submersion; (4) overdose; or (5) do-not-resuscitate orders or obvious death, defined by rigor mortis, dependent lividity, or decomposition. *ROSC*, Return of spontaneous circulation.

Figure reprinted with permission from: Ruygrok ML, Byyny RL, Haukoos JS. Validation of 3 termination of resuscitation criteria for good neurologic survival after out-of-hospital cardiac arrest. *Ann Emerg Med* 2009.

Supplement to *Emergency Medicine Reports*, March 15, 2010: "Controversies in Emergency Medical Services." *Authors:* **Creagh T. Boulger, MD**, Clinical Instructor, Emergency Medicine, The Ohio State University, Columbus; and **Howard A. Werman, MD, FACEP**, Professor of Emergency Medicine, The Ohio State University, Columbus.