

How far is too far? A review of the evidence for Prehospital Termination of Resuscitation after Cardiac Arrest

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Out-of-hospital cardiac arrest (OHCA), whether traumatic or nontraumatic, has a very low rate of survival to discharge. Termination of resuscitation (TOR) by EMS has thus been a highly discussed topic over the recent years. Some argue that everything must be done for patients with OHCA, while others disagree, taking into consideration the inherent risk of EMS personnel during transport and the futile use of resources which cost millions of dollars. In our local ems system, the medical care protocol for resuscitation of cardiopulmonary arrest requires that all patients found in cardiopulmonary arrest by EMS personnel receive CPR per AHA standards. Exceptions to this rule are if the patient has a Florida Pre-Hospital DNR order or if the patient is “obviously dead,” meaning they are pulseless, apneic, unresponsive and at least one of the following: absence of cardiac activity in 2 or more leads, rigor mortis/cyanosis, decomposition of body tissue, decapitation, or destruction of the brain or heart. Also if CPR has been initiated by a bystander prior to EMS arrival, and the patient is determined dead, EMS does not have to continue resuscitation. Prior to this review in our local EMS system, if resuscitation was initiated by EMS personnel, it could not be discontinued without physician input via online medical control.

Given that TOR protocols differ greatly throughout the country, various organizations have become involved in this debate. They have created guidelines for EMS to use in cases for which termination of resuscitation may be considered. The American Heart Association has outlined BLS and ALS termination or resuscitation criteria. For BLS responders, the criteria are as follows: (1) arrest unwitnessed by EMS; (2) no defibrillation delivered; (3) no return of spontaneous circulation achieved. For ALS responders, the criteria are as follows: (1) arrest unwitnessed by EMS or bystanders; (2) no bystander CPR initiated; (3) no defibrillation delivered; (4) no return of spontaneous circulation after full ALS care. These criteria were developed to be used only if they are present on scene, prior to the initiation of transport to the hospital. These guidelines do not account for a traumatic arrest, and thus the NAEMSP/ACS-COT developed more detailed criteria for patients in the presence of trauma. A copy of these criteria can be found on the NAEMSP website: <http://www.naemsp.org> by searching for termination of resuscitation guidelines in trauma.

After extensive review of the literature, it is evident that the majority of studies are in favor of a protocol for prehospital termination of resuscitation for traumatic and nontraumatic cardiac arrest. The data shows that applying the BLS criteria has resulted in a high specificity and PPV for determining those with poor or no survival, a decrease in EMS transport rate, and a significant saving in costs. However, individual ethical principles and finding an acceptable “miss rate” are issues that stir up further debate.

The goal of this review is to evaluate the evidence available on the different approaches to the concept of prehospital termination of resuscitation by EMS personnel. Ideally in our own system we plan to provide a medical care protocol to guide them in these difficult decisions. Literature published within the last 5 years was used in this review in an effort to keep the information as up to date and as relevant as possible. The majority of the studies found in the search were retrospective cohort studies or systematic reviews of the evidence. It would be ideal to evaluate evidence from randomized-controlled trials, however it is possible that ethical dilemmas and difficulty obtaining consent have prevented these types of studies from being performed. Therefore this review is limited to studies that do not provide the strongest evidence. We felt it essential that this review include both traumatic and nontraumatic cardiac arrest, as well as adult and pediatric patients because it best represents the population in which EMS personnel serve.

There were two studies in the literature search that presented drawbacks to the implementation of a protocol for prehospital termination of resuscitation. The first was a retrospective review of 89 trauma patients who suffered from either blunt or penetrating trauma, received CPR in the field, and were taken to the hospital for further management. Four patients survived to discharge with 2 of which were secondary to blunt trauma. One of the blunt trauma patients likely arrested from electrocution and the other from hypoxia. Thus, it was concluded that CPR in the field in trauma patients is not always futile, being there were 4 survivors. The authors recommended treating patients on a case-by-case basis, especially in cardiac arrests in which other factors such as electrocution and hypoxia may have been involved in the cause of the arrest. This study did have several limitations including : a small study sample size, it was a retrospective study, and the data collected depended on EMS and hospital documentation (so there were several unknown factors such as transport time and duration of arrest).³ Another retrospective cohort analysis evaluated the three BLS TOR criteria. Out of 2810 patients in the study, 1160 met the three BLS TOR criteria, and only one survived to hospital discharge. Thus, it was concluded that the BLS TOR criteria can accurately predict those cardiac arrest patients who will not survive to hospital discharge.⁴ However, this study brings up the issue of finding an acceptable miss rate. In this study, one patient with a good neurological outcome at the time of discharge would have been missed if the BLS TOR criteria had been implemented. Is it ok to miss one person? How do you put a value on the life of one person? This issue contributes to the fact that protocols regarding termination of resuscitation differ throughout the country.

Only one retrospective study was found that analyzed traumatic arrest in the pediatric population. This study evaluated the following data: duration of CPR, ECG rhythm, presence or absence of a pulse, pupil response, transport times, and other demographic data. They found that CPR greater than 15 minutes and fixed pupils were significant variables to distinguish between survivors and nonsurvivors. They found that if these two criteria plus ECG rhythm and absent pulse are applied as a protocol for termination of resuscitation, they would correctly identify all nonsurvivors. Of course, given the rarity of pediatric traumatic cardiac arrests, this study only analyzed 30 patients in the span of 10 years, which is one of the limitations in the study.⁵

The remaining studies in this review found that protocols were beneficial in determining termination of resuscitation. Many of the studies confirmed that the BLS TOR criteria are superior. One study compared the BLS TOR criteria, ALS TOR criteria, and Neuro TOR criteria to evaluate rate of survival with good neurological functioning. The Neuro TOR criteria are as follows: (1) cardiac arrest unwitnessed by EMS or bystanders; (2) age >78 years; and (3) asystole. This rule performed poorly in determining appropriate patients for termination of resuscitation.⁸ Multiple studies in this literature search found that the BLS TOR rule, the ALS TOR rule, and the criteria developed by the NAEMSP/ACS-COT had a high PPV for death, and use of these rules would significantly decrease EMS transport and overall costs. A more recent study demonstrated that patients found in asystole without field ROSC have a negligible chance of survival to hospital discharge, suggesting that only patients with a shockable rhythm or those with field ROSC should be transported by EMS to a medical facility. This again supports criteria from the BLS-TOR guidelines.¹⁰

Overall, only the BLS-TOR rule has been rigorously validated and can be considered in all EMS systems. Further studies, especially prospective randomized-controlled trials, would most definitely aid in gaining widespread acceptance of this rule. The problem with establishing a rule for termination of resuscitation is that some people may feel that missing even one person who could have been potentially saved is unacceptable, no matter the savings in costs and risks to EMS personnel. Also the definition of medical futility should be revisited, and there should be a cost-benefit analysis within individual EMS systems to evaluate whether this rule, or any TOR rule, is appropriate for implementation.

Prior to implementation of any protocol, it is important to get the EMS personnel and physicians to agree with the protocol. The EMS providers should feel comfortable with terminating or withholding resuscitation, although this becomes difficult seeing they are trained to intervene and save lives. The NAEMSP/ACS-COT guidelines formed as an agreement between EMS physicians and trauma surgeons are well accepted and can be adapted to fit individual systems. Perhaps the TOR criteria can be modified. Further research should be aimed at the identification the circumstances present in the rare survivors, so we can always do what is best for our patients and our community. Some exclusion criteria that could be added to the current guidelines include: an age range, temperature range, or exposure to drugs, electrocution or drowning. Also perhaps a limit on scene time + transport time should be incorporated as well. Further research would need to be performed to confirm whether these additions would be appropriate.

More recent studies are also evaluating the role of end-tidal CO₂ and the use of cardiac echo to aid in the decision to terminate resuscitation. Another recently published study noted blood ammonia and lactate levels to be independent predictors of favorable outcomes for patients with nontraumatic OHCA.¹¹ All of these additional findings need further evaluation prior to including them in formal TOR criteria.

After this review our system decided to implement guidelines which allowed EMS personnel to

discontinue resuscitation in the field without medical control contact if all of the following criteria are present: patient found in asystole and remained in asystole, ETCO₂ <10mmhg, 20 minutes of ACLS has been performed, and no other signs of life present (no respiratory effort, pupils fixed and dilated). Though it would be convenient to have a common rule for TOR across the nation, it is difficult given the ethical dilemma and differing patient populations across the country. All too often futile resuscitations are performed in the emergency department (ED) because resuscitation was performed in the field. These resuscitations consume a significant amount of resources including time from the ED staff, which consequently affects patient throughput. Furthermore, the patients who do have return of spontaneous circulation are admitted to the ICU, which decreases ICU bed availability, and many of these patients do not survive to hospital discharge. Due to severe hypoxia many of the patients that do survive to discharge are neurologically devastated and are a burden to their families or are sent to a skilled nursing facility. However, it is difficult to ignore how amazing it is when a patient survives neurologically intact and is able to thank you for your help. We cannot diminish the value of that one person.

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STUDY	DESIGN	FINDINGS	LIMITATIONS	CONCLUSIONS
Sherbino et al. 2010	Systematic review of 6 validation studies evaluating clinical decision rules for predicting no probability of survival were found in a PubMed search.	The BLS-TOR rule for pts with OHCA has a PPV of 99.5% and decreases the transportation of all patients by 62.6%.	Few number of studies reviewed	PRO: The BLS-TOR rule is a simple rule that identifies patients who will not survive OHCA.
Mollberg et al. 2011	Retrospective review of level I trauma center's database from 2003-2010. 294 patients with traumatic cardiopulmonary arrest reviewed who met criteria for withholding or terminating resuscitation efforts.	1/294 patients survived to be discharged with GCS 6. Total costs incurred by these 294 patients was more than \$3.5 million.	Design of study was retrospective review; guidelines followed by EMS discretion	PRO: data support the current NAEMSP/ ACS-COT guidelines regarding the withholding or termination of resuscitation of patients in prehospital TCPA
Willis et al. 2006	Retrospective review of patients from 2001 to 2004 who sustained major blunt or penetrating trauma, received CPR in the field, and were taken to the hospital.	1327 traumatic cardiac arrest cases, of which 89 received field CPR. 4 patients survived to discharge, and 2 of these were blunt trauma, one who likely arrested from electrocution and the other from hypoxia.	Unknown duration of arrest, length of resuscitation; transport time; guidelines followed by EMS discretion; majority of patients in study suffered blunt trauma	CON: CPR in the field is not always futile; case-by-case evaluation is warranted

Sasson et al. 2008	Retrospective cohort study using data in CARES between 2005 and 2008 to validate the AHA guidelines on BLS and ALS termination of resuscitation	5505 patients. Of 2592 who met BLS TOR criteria, 5 survived to discharge. 1192 met ALS criteria, none survived. BLS specificity and PPV were 0.987 and 0.998. ALS specificity and PPV were both 1.000 for predicting lack of survival.	AHA rules only apply to nontraumatic cardiac arrest; data was collected from 8 cities, but half of cases were from Atlanta, GA and thus may not be generalizable.	PRO: Both BLS and ALS rules have a high specificity and PPV in determining out-of-hospital cardiac arrest patients who have little or no chance of survival
Morrison et al. 2009	Prospective cohort of prehospital cardiac arrest patients to determine if either the BLS or ALS rule could be used universally for termination of resuscitation. From 2006-2007.	2415 patients with prehospital cardiac arrest. Per ALS rule, TOR recommended for 743 patients, no survivors. Per BLS rule, TOR recommended for 1302 patients, no survivors. For both, 100% specificity for recommending transport of potential survivors. 100% PPV of death.	Low sensitivity of rules; study conducted in Canada (questionable applicability)	PRO: Use of the BLS rule universally for termination of resuscitation would result in a lower overall transport rate without missing any potential survivors. The rule would be implemented when there was no ROSC prior to transport, no shock was given, and the arrest was not witnessed by EMS.

Capizzani et al. 2010	<p>Retrospective study of 30 pediatric patients from 0 to 19 yrs old with prehospital traumatic cardiac arrest in 2000 to 2009. The following data were assessed:</p> <ul style="list-style-type: none"> CPR greater than 15 minutes and fixed pupils were significant variables to distinguish between survivors and nonsurvivors, ECG rhythm, presence or absence of a pulse, pupil response, transport times, and other demographic data. 	<p>CPR greater than 15 minutes and fixed pupils were significant variables to distinguish between survivors and nonsurvivors, whereas ECG rhythm and absent pulse did not. The mean (SD) duration of CPR was 42+-28 min for nonsurvivors and 7+-3 min for survivors.</p>	<p>Not all criteria documented; limited number of cases given how rare pediatric traumas are; functional outcome of survivors not assessed</p>	<p>PRO: If all 4 criteria are met, there were no survivors indicating that these criteria may aid in developing a rule for pediatric traumatic cardiac arrests</p>
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Ruygrok et al. 2008	Retrospective study of adult nontraumatic cardiac arrest patients from 2003 to 2004 in the Denver Cardiac Arrest Registry with a goal to evaluate the BLS, ALS and neurologic TOR criteria.	715 patients studied. 223 had ROSC, 175 survived to hospital admission, 58 survived to hospital discharge, and 42 survived to hospital discharge with good neurologic function. 100% of those with good neurologic function were correctly identified for continued resuscitation by the 3 criteria. The BLS-TOR criteria identified 36% of patients with poor neurologic survival or no survival, compared with 25% by the ALS-TOR criteria and 6% by the neurologic TOR criteria.	Median age was 65 yrs, which is important when assessing the generalizability of the results. Also, paramedics used own discretion for TOR, not any guidelines. Other factors, such as temperature, have a role in determining good neurologic outcome.	PRO: All 3 termination of resuscitation criteria had equally high abilities to identify patients requiring continued resuscitation. The BLS termination of resuscitation criteria, however, had the best combined ability to predict good neurologic survival and poor neurologic survival or death.
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Richman et al. 2008	Retrospective cohort analysis in Arizona. Consecutive adult, OHCA were evaluated, 2004-2006. A statewide OHCA database from 30 different EMS systems was used. Data were abstracted from EMS first care reports and hospital discharge records.	2180 patients; 2047 patients had cardiac arrest unwitnessed by EMS; 1,653 had an unwitnessed arrest and no ROSC. 1,160 of 2,180 (53.2%) patients met all three BLS TOR criteria; only one survived to hospital discharge.	Retrospective instead of prospective; all levels of EMS providers were included; mean age was 64 which affects generalizability of study; the study with TOR criteria missed one survivor with good neurological outcome, so what is the acceptable miss rate?	PRO/CON: The BLS TOR criteria can accurately predict those cardiac arrest patients who will not survive to hospital discharge, however a miss rate of 1 patient with a good neurological outcome may not be acceptable
Stratton et al. 2008	Prospective cohort study of adult nontraumatic cardiac arrest patients; variables studied were if the patients had an unwitnessed collapse and/or if no bystander CPR was performed; study done over a 6-month period in which 541 patients were analyzed and functional neurological survival was the outcome of interest	No neurologically functional survivors at hospital discharge among the 180 victims in the unwitnessed, no-bystander CPR subgroup. Functional neurological survival for witnessed collapse, bystander CPR was 6.0%. For witnessed collapse, no-bystander CPR it was 3.8%. For unwitnessed collapse with bystander CPR it was 1.3%.	Low study population; location of study in an urban-suburban area may not be generalizable	PRO: For patients with unwitnessed collapse and lack of bystander CPR, TOR should be considered.