Withholding and termination of resuscitation of adult cardiopulmonary arrest secondary to trauma: Resource document to the joint NAEMSP-ACSCOT position statements

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ABSTRACT: In the setting of traumatic cardiopulmonary arrest, protocols that direct emergency medical service (EMS) providers to withhold or terminate resuscitation, when clinically indicated, have the potential to decrease unnecessary use of warning lights and sirens and save valuable public health resources. Protocols to withhold resuscitation should be based on the determination that there are no obvious signs of life, the injuries are obviously incompatible with life, there is evidence of prolonged arrest, and there is a lack of organized electrocardiographic activity. Termination of resuscitation is indicated when there are no signs of life and no return of spontaneous circulation despite appropriate field EMS treatment that includes minimally interrupted cardiopulmonary resuscitation. Further research is needed to determine the appropriate duration of cardiopulmonary resuscitation before termination of resuscitation and the proper role of direct medical oversight in termination of resuscitation protocols. This article is the resource document to the position statements, jointly endorsed by the National Association of EMS Physicians and the American College of Surgeons' Committee on Trauma, on withholding and termination of resuscitation in traumatic cardiopulmonary arrest. (*J Trauma Acute Care Surg*. 2013;75: 459–467. Copyright © 2013 by Lippincott Williams & Wilkins)

KEY WORDS: Termination; withholding treatment; trauma; cardiopulmonary arrest; EMS.

In 2003, the National Association of EMS Physicians (NAEMSP) and the American College of Surgeons' Committee on Trauma (ACSCOT) published a joint position article for withholding or termination of resuscitation (TOR) of patients in cardiopulmonary arrest caused by trauma[1] (Table 1). This resource document supports two new positions (Tables 2 and 3) jointly endorsed by NAEMSP and ACSCOT on withholding resuscitation and TOR in traumatic cardiopulmonary arrest.[2,3] It should be noted that while the previous position considered the concepts of "withholding" and "termination" collectively, the new positions refer to these concepts separately. Furthermore, while there have been no changes to the withholding position, resulting in a reaffirmation of this position, evolution of the science has resulted in revisions to the TOR position.

Although the unbundling of these two positions may seem to be mere semantics, there are scientific and regulatory reasons to separate these two positions. The withholding position includes notation regarding a lack of "…organized electrocadiographic activity." The determination that a patient does not have electrocardiographic activity requires checking for a pulse and placing a monitor on the patient. In some emergency medical service (EMS) systems, it may be possible to perform this action and then withhold resuscitation. However, in some systems, this activity may be considered a part of patient assessment, which defines the initiation of patient care and thus defines that resuscitation has already begun. Therefore, in these systems, it may be more appropriate to use a TOR protocol than a withholding protocol except in cases when the patient is clearly dead such as decapitation or hemicorporectomy.

Regardless, the purpose of this article is to present the scientific evidence supporting these two new positions. Of note, these positions pertain to the care of the trauma patient before and are not meant to guide care after arrival at an acute care facility. Comprehensive discussion on the utility of certain ED procedures, therefore, is not relevant to this article. The science discussed in this article is purely focused on the patient that has no identified signs of life and has limited chances of survival, regardless of the care provided to the patient after arrival to an acute care facility, such that the risks of resuscitation and transport outweigh any potential benefit.

PATIENTS AND METHODS

The development of the updated TOR protocol and this resource document began with a structured review of the literature regarding the topic of resuscitation in traumatic cardiopulmonary arrest, focusing on articles that pertain to the constituents that determine the outcome of the arrest.

We began with a review of the literature that was used to support the 2003 position article. We then initiated PubMed and EMBASE searches of the English-language literature using the key words: *cardiopulmonary arrest in trauma*, *termination of resuscitation*, *timing of arrest*, *rhythm analysis*, *vital sign assessment*, and *emergency department thoracotomy.* All articles deemed to be relevant to the topic were reviewed, and a draft position, based on the supporting literature review, was formulated. This position was then sent for review and further refinement by the board of directors of NAEMSP and the EMS subcommittee of the ACSCOT. Thus, the levels of the evidence of these positions are a combination of an analysis of the best available evidence and the consensus of these two professional associations. This resource document, with included tables, discusses all the articles reviewed in the development of these positions relevant to out-of-hospital termination or resuscitation of traumatic cardiopulmonary arrest and outlines the key findings of this literature.

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TABLE 1. 2003 Position on Withholding and TOR in Traumatic Cardiopulmonary Arrest

Resuscitative efforts may be withheld in blunt trauma if the patient is apneic, pulseless, and without organized electrocardiographic activity.
Patients of penetrating trauma found apneic and pulseless should be assessed for the presence of other signs of life such as papillary reflexes, spontaneous movement, or organized ECG activity. If any of these findings are present, the patient should be resuscitated and transported to the nearest ED or trauma center. If these findings are absent, resuscitative efforts may be withheld.
Resuscitative efforts should be withheld in patients of penetrating or blunt trauma with injuries obviously incompatible with life, such as decapitation or hemicorporectomy.
Resuscitative efforts should be withheld in patients of penetrating or blunt trauma with evidence of significant time lapse since pulselessness, including dependent lividity, rigor mortis, and decomposition.
Cardiopulmonary arrest patients in whom the mechanism of injury does not correlate with clinical condition, suggesting a nontraumatic cause of the arrest, should have standard resuscitation initiated.
Termination or resuscitation efforts should be considered in trauma patients with EMS witnessed cardiopulmonary arrest and 15 min of unsuccessful resuscitation and CPR.
Traumatic cardiopulmonary arrest patients with a transport time to an ED or trauma center of more than 15 min after the arrest is identified may be considered nonsalvageable, and TOR should be considered.
Guidelines and protocols should be individualized for each EMS system. Consideration should be given to factors such as the average transport time within the system, the scope of practice of the EMS providers in the system, and the definitive care capabilities with the system. Airway management and intravenous line placement should be accomplished during transport when possible.
Special consideration must be given to patients of drowning and lightning strike and in situations where significant hypothermia may alter the prognosis.
EMS providers should be familiar with the guidelines and protocols affecting the decision to withhold or terminate resuscitative efforts.
All termination protocols should be developed and implemented under the guidance of the system EMS medical director. Online medical control may be necessary to determine the appropriateness of TOR.
Policies and protocols for TOR efforts must include notification of the appropriate law enforcement agencies and notification of the medical examiner or coroner for final disposition of the body.
Families of the deceased should have access to resources, including clergy, social workers, and other counseling personnel, as needed.
Adherence to policies and protocols governing TOR should be monitored through a quality review system.

Contextual Factors Influencing Resuscitation Decisions

Ambulance Crashes While Running Lights and Sirens

In 2011, NAEMSP published a position statement on TOR for nontraumatic cardiopulmonary arrest.[4] The accompanying resource document by Millin et al.[5] reviewed the literature on the science of ambulance crashes while running warning lights and sirens.

Most importantly, it is clear that running emergency vehicles with warning lights and sirens increases the risk of ambulance crashes, injury to EMS providers, and injury to a member of the public who is not involved in the incident.[6–15] Furthermore, the literature on resuscitation demonstrates that the quality of cardiopulmonary resuscitation (CPR) significantly deteriorates when chest compressions are performed in a moving ambulance.[16,17] As such, a TOR protocol reduces the risk of ambulance crashes and increases chances of successful resuscitation by focusing on high-quality, minimally interrupted chest compressions before transport to an acute care facility.[18–20] However, it should be noted that there is complexity in this issue with traumatic cardiopulmonary arrest in that definitive treatment to correct major internal blood loss may be best achieved at a trauma center and the quality of chest compressions may be less relevant.

TABLE 2. 2012 Position on Withholding Resuscitation in Traumatic Cardiopulmonary Arrest

It is appropriate to withhold resuscitative efforts for certain trauma patients for whom death is the predictable outcome.
Resuscitative efforts should be withheld for trauma patients with injuries that are obviously incompatible with life, such as decapitation or hemicorporectomy.
Resuscitative efforts should be withheld for patients of either blunt or penetrating trauma when there is evidence of prolonged cardiac arrest, including rigor mortis or dependent lividity.
Resuscitative efforts may be withheld for a blunt trauma patient who, on the arrival of EMS personnel, is found to be apneic, pulseless, and without organized electrocardiographic activity.
Resuscitative efforts may be withheld for a penetrating trauma patient who, on arrival of EMS personnel, is found to be pulseless and apneic and there are no other signs of life, including spontaneous movement, electrocardiographic activity, and papillary response.
When the mechanism of injury does not correlate with the clinical condition, suggesting a nontraumatic cause of cardiac arrest, standard resuscitative measures should be followed.

Cost

Another consideration in the development of TOR protocols is the cost of resuscitation for a patient in cardiopulmonary arrest. Perhaps more important than the high cost of resuscitation per individual patient[21,22] is the effect on the EMS system of transporting a patient that has minimal to no chances of survival because this diverts resources from living patients that

TABLE 3. 2012 Position on TOR of Traumatic Cardiopulmonary Arrest

A principle focus of EMS treatment of trauma patients is efficient evacuation to definitive care, where major blood loss can be corrected. Resuscitative efforts should not prolong on-scene time.
EMS systems should have protocols that allow EMS providers to terminate resuscitative efforts for certain adult patients in traumatic cardiopulmonary arrest.
TOR may be considered when there are no signs of life and there is no ROSC despite appropriate field EMS treatment that includes minimally interrupted CPR.
Protocols should require a specific interval of CPR that accompanies other resuscitative interventions. Past guidance has indicated that up to 15 min of CPR should be provided before resuscitative efforts are terminated, but the science in this regard remains unclear.
TOR protocols should be accompanied by standard procedures to ensure appropriate management of the deceased patient in the field and adequate support services for the patient's family.
Implementation of TOR protocols mandates active physician oversight.
TOR protocols should include any locally specific clinical, environmental, or population-based situations for which the protocol is not applicable. TOR may be impractical after transport has been initiated.
Further research is appropriate to determine the optimal duration of CPR before terminating resuscitative efforts.

TABLE 4. Survival Point Estimates and Associated 95% CIs

Study	Total Survivors, n (%)	95% CI*
Shimazu and Shatney, 1983	7/267 (2.6)	1.2–5.4%
Aprahamian et al., 1985	3/95 (3.2)	0.07–9.3%
Wright et al., 1989	0/67 (0)	0–0.047%
Esposito et al., 1991	1/97 (1.0)	0.0003–0.056%
Rosemurgy et al., 1993	0/124 (0)	0–2.9%
Fulton et al., 1995	6/245 (2.4)	0.1–5.3%
Stratton et al., 1998	9/879 (1.0)	0.5–2.0%
Battistella et al., 1999	16/602 (2.7)	1.6–4.3%
Stockinger and McSwain, 2004	15/588 (2.6)	1.5–4.2%
Pickens et al., 2005	14/184 (7.6)	4.5–12.5%
Willis et al., 2006	4/1,327 (0.3)	0.01–0.59%
Moriwaki et al., 2010	13/477 (2.7)	1.6–4.7%
Tarmey et al., 2011	4/52 (7.7)	2.1–18.5%
Mollberg et al., 2011	1/294 (0.3)	0.1–1.88%

*95% CIs were calculated using the Agresti-Coull approximate binomial CI calculation method.

have other time critical diseases such as acute myocardial infarction, stroke, and multiorgan trauma with intact pulses.[23–25]

Mortality From Traumatic Arrest

Ultimately, the decision to terminate resuscitative efforts is influenced by the risk-to-benefit ratio of the resuscitation and the expectancy that the patient will survive with a favorable outcome. In general, survival rates from traumatic cardiopulmonary average approximately 2%.[21,26–38] To illustrate the wide range of findings, overall point estimates for survival and 95% confidence intervals (CIs) are listed in Table 4.

Conditions for TOR

Signs of Life and Initial Electrocardiographic Rhythm

Within the context of withholding and termination of resuscitation protocols, any patient that has spontaneous respirations, pulse or measurable blood pressure, or spontaneous movement should be resuscitated and transported to the closest appropriate acute emergency facility. In addition, pulseless patients with organized electrical activity identified by electrocardiogram (ECG) also warrant at least the initiation of resuscitation.

With regard to electrocardiographic rhythms, the majority of available evidence suggests that an initial rhythm of asystole is associated with a very low probability of survival for both blunt and penetrating traumatic cardiopulmonary arrest. In 1985, Aprahamian et al.[27] published a study of 95 trauma patients who were in cardiopulmonary arrest on paramedic arrival. Of the 51 patients (54%) who were in asystole at the time of paramedic arrival, there were no survivors to hospital discharge. A study by Esposito et al.[29] in 2004 showed similar results with no survivors in the group of patients in asystole at the time of hospital arrival. Stratton et al.[31] showed that all 4 (0.8%) of 497 survivors of arrest from penetrating trauma who had a functionally intact outcome had either pulseless electrical activity (PEA) with a sinus-based rhythm at a normal rate or PEA with sinus tachycardia; no patients with asystole survived.

Seamon et al.[39] showed that for survivors of penetrating trauma who had ED thoracotomy (EDT), sinus tachycardia was an independent predictor of survival (odds ratio [OR], 5.17; 95% CI, 1.04–25.60, $p = 0.044$). These results were reaffirmed in a 2008 follow-up study of EDT penetrating trauma patients.[40] Survivors in this study more often had signs of life in the field, sinus tachycardia (nonsurvivors, 10.2% vs. survivors, 43.5%; $p < 0.001$) and normal sinus rhythm (nonsurvivors, 4.5% vs. survivors, 17.4%, $p = 0.037$). Three of the 23 survivors (1.8% of the study population) in this study had asystole recorded as the initial cardiac rhythm.[40] In a 2004 study by Powell et al.,[41] 6 of 26 patients that had prehospital CPR had asystole at the time of EDT. Of the five survivors, one had a severe neurologic deficit, three had mild deficits, and two had no neurologic deficits. All survivors in asystole had pericardial tamponade.

More recently, Tarmey et al.[37] studied 52 patients in a military setting with traumatic cardiopulmonary arrest. All 29 patients with asystole died, and 3 of the 4 survivors had a sinus-based rhythm with a rate of greater than 40.

In addition to asystole, PEA with a rate less than 40 per minute has also been shown to be correlated with extremely low odds of survival in traumatic cardiopulmonary arrest. In one study, the mean (SD) duration of CPR for five patients who had an initial rate less than 40 per minute and were admitted to the intensive care unit was 19.8 (4.2) minutes, but none of these patients survived.[32] No patient with an initial rate less than 40 per minute survived, and no patients with an initial rhythm of asystole survived. Similarly, in Pickens et al.,[34] stepwise regression of all clinical assessment covariates found an ECG rate of more than 40 per minute to be a strong independent predictor of survival (OR, 6.7; 95% CI, 1.7–27, $p = 0.008$).

Further examining the effect of heart rate on survival, Siram et al.[42] attempted to devise a prediction score to determine outcomes for EDT and found a rate greater than 100 per minute to be associated with a 60% survival rate; no survival data were described for bradycardic or normocardic patient in this study.

Therefore, analysis of the existing literature demonstrates that patients in an asystolic rhythm have extremely low odds of survival (<1%). Furthermore, the literature suggests that patients in narrow complex PEA with a normal or tachycardic rhythm are more likely to survive and patients in PEA with a wide complex bradycardic rhythm are less likely to survive. An overview of the studies that examine the relationship between asystolic arrest and survival is presented in Table 5. Survival from asystolic arrest in these studies averages at less than 1%.

EDT and Resuscitation Duration

Although discussion of the merits of EDT is beyond the scope of this article, there is some relevance in that it is important to identify patients in the out-of-hospital environment in traumatic cardiopulmonary arrest that might benefit from this procedure. The ACSCOT recommends that EDT is best applied to patients with penetrating cardiac injuries who arrive to the ED after a short transport time with witnessed signs of

TABLE 5. Asystole as a Predictor for Outcome of Resuscitation

Study	Study Population	Patients in Asystole, n (% of Total Patients)	Patients in Asystole Who Lived With Good Outcome, n (% of Total Patients)
Aprahamian et al., 1985	95 patients in traumatic arrest	51 (53.7)	0 (0)
Esposito et al., 1991	112 EDT patients	16 (14.3)	0 (0)
Stratton et al., 1998	497 patients in traumatic arrest	Data not provided	0 (0)
Battistella et al., 1999	604 patients in traumatic arrest	212 (35.1)	0 (0)
Powell et al., 2004	959 EDT patients	6 (0.62)	5 (0.52)
Seamon et al., 2008	180 EDT patients for penetrating injury	62 (34.4)	3 (1.8)
Moriwaki et al., 2010	477 patients in arrest from blunt trauma	313 (65.6)	0 (0)
Moore et al., 2011	56 patients that survived EDT (total patients that had EDT not provided)	7 (12.5)	3 (5.4)
Tarmey et al., 2011	52 patients in traumatic arrest	29 (56)	0 (0)

Good outcome is defined as mild or no neurologic deficit.

life.[43] The injury that is likely to be the most amenable to EDT is pericardial tamponade—an injury easily diagnosed with a bedside ultrasound examination.[44–46] The ACSCOT not only recommends EDT for other penetrating injuries but also states that these patients have a very low survival rate. The ACSCOT recommends EDT for blunt trauma patients only when the arrest was witnessed by the ED staff.[43]

The recommendations from the ACSCOT differ from the Western Trauma Association (WTA), which recommend EDT for patients with no signs of life and less than 10 minutes of CPR for blunt traumatic arrest and less than 15 minutes of CPR for arrest secondary to penetrating trauma.[47] As referenced in the WTA practice guideline, Cothren et al.[48] summarized the available literature on survival following EDT in adults. Consistent with the ACSCOT recommendations, survival rates for patients arriving to the ED with no signs of life were highest for isolated cardiac injuries with 4 (3%) of 126 patients from the reported studies surviving. Rhee et al.[49] also present a review of the literature showing a survival rate of 1.2% for all patients who arrive with no signs of life in the field. As discussed later, two other references in the WTA practice guideline further present data on the effect of resuscitation time on overall survival rates.[41,50]

Specifically examining the effect of CPR time on the rate of successful resuscitation, the 2003 NAEMSP/ACSCOT guideline on TOR in traumatic cardiopulmonary arrest endorsed 15 minutes of CPR before TOR. The authors of the 2003 guideline felt that at the time, the collective data supported the assertion that any patient with traumatic cardiopulmonary arrest and more than 15 minutes of transport time would not survive.[1] In a further analysis of the studies that were reviewed for development of the 2003 guideline and in review of studies published since the 2003 guideline, it is unclear as to the appropriate duration that EMS providers should resuscitate a patient, with minimally interrupted CPR, before TOR.

Looking at studies that were published before the 2003 guideline, in 1982, Mattox and Feliciano[51] published the results of 100 patients with traumatic cardiopulmonary arrest and greater than 3 minutes of CPR. All patients in this study died before discharge from the hospital. In 1984, Copass et al.[52] reviewed 3 years of data of 131 blunt (n = 107) and penetrating (n = 24) traumatic cardiopulmonary arrest patients in Seattle, Washington. Survivors (n = 29) had an average of 12 minutes of CPR versus 28 minutes of CPR in nonsurvivors ($p < 0.01$). Based on these results, the authors of both of these studies recommended a "scoop and run" system. Furthermore, these studies show that longer resuscitation are associated with poor chances of survival.

In 1991, Esposito et al.[29] reviewed 112 patients who had EDT for traumatic cardiopulmonary arrest. There were two survivors overall, with one survivor who arrested in the ED having good neurologic outcome. The other survivor had 15 minutes of CPR that was initiated during transport and had poor neurologic outcome. Overall, the average CPR time for survivors was 7.5 minutes, and the CPR time for nonsurvivors averaged at 33 minutes. In 1992, Durham et al.[53] also looked at outcomes of EDT. Of 389 patients, 207 arrived to the ED with CPR in progress. In this study, there were no survivors with blunt trauma. Average CPR time for survivors of penetrating trauma from stab wounds was 5.1 minutes compared with 9.1 minutes for nonsurvivors and 5.2 minutes for survivors of gunshot wounds compared with 9.4 minutes for nonsurvivors of gunshot wounds.

There are two other studies worth noting that were available for analysis of the effect of duration of CPR on resuscitation outcomes at the time of the 2003 guideline. In 1995, Fulton et al.[30] described the results of 245 patients with traumatic cardiopulmonary arrest that were resuscitated at the University of Louisville Hospital. In this study, there were six total survivors, with only three of the survivors having a good neurologic outcome. The duration of CPR for each of the six survivors was less than 10 minutes. The difference in the duration of CPR between the survivors with good neurologic outcome compared with the survivors without good neurologic outcome was not described. In 1996, Pasquale et al.[22] studied the utility of a predefined criteria to determine that a patient presenting to an ED in traumatic cardiopulmonary arrest could be considered dead on arrival and, therefore, not require ED resuscitation. Of note, this criterion arbitrarily included 15 minutes of CPR without (ROSC). In this study of 106 patients, there were 3 survivors with a mean duration of CPR of 2.33 minutes compared with a mean duration of CPR of the nonsurvivors of 23.64 minutes.

Since the publication of the 2003 guideline, there have been six articles published, which have specifically examined the relationship between time of CPR and the ability to achieve meaningful outcomes. Powell et al.,[41] as referenced by the WTA guideline on EDT, examined 959 patients with EDT with 26 of 62 survivors requiring prehospital CPR. In this study, all of the survivors had 10 minutes or less of CPR with the exception of 5 survivors who had a range between 11 minutes and 15 minutes of CPR. Four of these five had only mild or no neurologic deficits (0.42% of the entire study population). Pickens et al.[34] examined 173 patients with prehospital CPR for traumatic arrest with 3 of 14 survivors with greater than 10 minutes of CPR ranging between 11 minutes and 17 minutes and good neurologic outcome (1.7% of the study population). All survivors with a discharge Glasgow Coma Scale (GCS) score greater than 10 had pulses restored before ED arrival. Furthermore, the authors also found that survivors had significantly shorter length of CPR compared with nonsurvivors ($p = 0.014$).

Moriwaki et al.[36] report on 477 patients with traumatic cardiopulmonary arrest from blunt trauma. In this study, a cluster of 12 survivors achieved ROSC in less than 10 minutes, and there was only 1 survivor achieving ROSC after 17 minutes of CPR. No information is provided for the one outlier in this study, and the initial rhythm, vital signs, and mechanism of injury were not described.[54] Furthermore, it is not clear if the single isolated survivor had a good neurologic outcome.

Moore et al.,[50] also referenced by the WTA guideline on EDT, report on 56 survivors of EDT, with 19 patients receiving prehospital CPR. All patients had CPR for 10 minutes or less, except one with a gunshot wound to the chest with 15 minutes of CPR and a moderate neurologic deficit. Mollberg et al.[38] also report outcomes from EDT. In their study of 120 patients who had EDT for penetrating thoracic trauma, patients were analyzed in two groups: Group 1, those who had witnessed arrest with signs of life in the field and less than 15 minutes of CPR; Group 2, those who had witnessed arrest without signs of life in the field or witnessed arrest with signs of life in the field and greater than 15 minutes of CPR. Of the 120 total patients in the study, 78 required prehospital CPR (Group 1, 34; Group 2, 44). Mean CPR time for Group 1 was 13.3 minutes, and mean CPR time for Group 2 was 20.7 minutes. There were six survivors in the first group and no survivors in the second group. The duration of CPR for the six survivors, beyond less than 15 minutes, is not reported.

Finally, Tarmey et al.[37] report outcomes of traumatic cardiopulmonary arrest in a military population presenting to a field hospital in Afghanistan. Of the 52 patients in the study, there were four survivors each with a good neurologic outcome. All patients that arrested in the field died, and the survivors arrested either during transport or at the hospital. The median CPR time for survivors was 8 minutes. One survivor had a prolonged CPR of 24 minutes with 21 minutes of CPR during transport. The survivor with a prolonged down time had aggressive resuscitation during transport including administration of blood products and hemorrhage control.

Collectively, the studies that allow for analysis of the effect of duration of CPR on survival show that survivors of traumatic cardiopulmonary arrest have significantly shorter CPR time compared with that of nonsurvivors. The 2003 guideline promoted 15 minutes of CPR before TOR based on the dead-on-arrival criteria in the article by Pasquale et al., despite the fact that in that study, survivors had a significantly an average CPR time shorter than 15 minutes.

Analysis of the studies available at the time of the development of the 2003 guideline and the studies that have been published since the 2003 guideline demonstrates the potential for a lower threshold than 15 minutes because 10 minutes of resuscitation seems to capture the overwhelming majority of patients who are likely to survive the arrest. However, owing to the heterogeneity of the studies, it is difficult to analyze these results in a collective manner, and as such, it is unclear as to the appropriate duration that EMS providers should perform CPR before TOR. In addition, most of these studies are retrospective, and all are limited by the prehospital CPR time documented by the providers. The accuracy of these times may be limited because they are often estimated after the resuscitation has ended. Regardless, for those studies that allow for analysis of a percentage of patients that have successful resuscitation, only 9 (0.75%) of 1,200 patients, including those that had EDT, survived to hospital discharge neurologically intact after more than 10 minutes of CPR. With a specific look at EDT studies, there were 4 (2.8%) of 142 survivors with a favorable neurologic outcome and more than 10 minutes of CPR. Analysis of time as a determinate for TOR is shown is Table 6.

EMS Procedures

Regarding the performance of procedures by EMS providers before arrival to the hospital, it should be noted that this has shown mixed results. Copass et al.[52] showed that survival from traumatic arrest was associated with endotracheal intubation and placement of intravenous lines by EMS providers. However, subsequent studies have questioned the role of airway management by EMS providers in the critically ill trauma patient.[55–57] Specifically examining trauma patients that had EDT, Seamon et al.[39] showed that patients were 2.63 times less likely to survive for every additional procedure performed by EMS providers (OR, 0.38; 95% CI, 0.18–0.79, $p = 0.0096$).

The findings in the study of Seamon et al. are contrasted by a study by Warner et al.,[58] which suggests that there may be a role for needle thoracostomy in selected patients with 3 (25%) of 12 patients in PEA from traumatic cardiopulmonary arrest achieving ROSC with prehospital needle thoracostomy. Hospital discharge information for the three patients was not reported in this study. Therefore, while it may seem logical for EMS providers to perform certain procedures on a patient in traumatic arrest (e.g., airway management or needle thoracostomy), the literature is not clear whether the performance of these procedures by EMS providers will add benefit to the care of the patient. This does not, however, preclude the development of protocols that ensure proper overall management of the trauma patient by addressing easily reversible causes of the arrest with adequate oxygenation/ventilation and hemorrhage control with direct pressure or tourniquets.

Exclusions to TOR Protocols

In developing TOR protocols, EMS medical directors may consider exclusions under certain situations. Since the

TABLE 6. Time as a Predictor for Outcome of Resuscitation

Study	Study Population	Patients Who Survived to Discharge, n (%)	Effect of Time on Survival With Good Neurologic Outcome (% of Total Patients)
Mattox et al., 1982	100 patients with chest trauma and > 3 min of prehospital CPR	0 (0)	No survivors after 3 min of CPR
Copass et al., 1984	131 patients with prehospital CPR for traumatic arrest	30 (22.9)	Mean CPR time: survivors, 12 min; nonsurvivors, 28 min
Esposito et al., 1991	112 patients with EDT for traumatic arrest with 97/112 requiring CPR before the hospital	1/97 (1.0)	Overall average CPR time for survivors 7.5 min; 1 survivor with prehospital CPR for 15 min but with poor neurologic outcome
Durham et al., 1992	387 trauma patients with EDT	32 (8.2); 17/32 (53.1) required prehospital CPR	Mean CPR time: gunshot wound survivors, 5.2 min; nonsurvivors, 9.4 min. Stab survivors, 5.1 min; nonsurvivors, 9.1 min. Blunt, no survivors
Fulton et al., 1995	245 patients with prehospital CPR for traumatic arrest	6 (2.4)	No survivors with >10 min CPR
Pasquale et al., 1996	106 patients with prehospital CPR for traumatic arrest	3 (1.9)	Mean CPR time: survivors, 2.33 min; nonsurvivors, 23.64 min
Powell et al., 2004	959 patients with EDT	62 (6.5); 26/62 (41.9) required prehospital CPR	Mean CPR time for survivors, 6.77 min; 21 survivors with < 10 min of CPR; 4 (0.42) survivors with good neurologic outcome and 11–15 min of CPR
Pickens et al., 2005	184 patients with prehospital CPR for traumatic arrest	14 (7.6)	3 (1.6) survivors with good neurologic outcome and 11–17 min of CPR; survivors had significantly shorter length of CPR time ($p = 0.014$)
Moriwaki et al., 2010	477 patients with prehospital CPR for blunt trauma	13 (2.7)	12 survivors with <10 min CPR; 1 (0.21) survivor with 17 min CPR; neurologic outcome of survivor with >10 min CPR not reported
Moore et al., 2011	56 survivors of EDT	19 (34) required prehospital CPR	average CPR time, 5.77 min; 18 survivors with <10 min CPR; 1 (1.7) survivor with 15 min CPR but with poor neurologic outcome
Mollberg et al., 2011	120 patients with EDT; 78/120 with prehospital CPR	6/120 (5)	0 (0) survivors with >15 min of CPR
Tarmey et al., 2011	52 patients in traumatic arrest	4/52 (7.7)	Median CPR time for survivors, 8 min

Good outcome is defined as mild or no neurologic deficit.

literature supporting inclusion or exclusion of these situations in TOR protocols is lacking, medical directors should consider system-specific factors with regard to these situations: pediatric patients, pregnant and hypothermic patients, patients struck by lightning, and environmental conditions deemed unsafe for EMS providers. Patients with a minor traumatic mechanism and a presumed medical cause for cardiopulmonary arrest should also be not included in these guidelines and rather managed based on nontraumatic cardiopulmonary arrest guidelines.[4]

Direct Medical Oversight

The previous NAEMSP/ACSCOT TOR position on traumatic arrest included the statement that "...online medical control may be necessary to determine the appropriateness of termination of resuscitation."[1] To date, there is no scientific literature to support or refute the need for direct medical oversight in the application of TOR protocols. Since standardized written protocols are more likely to be consistently applied in a systematic manner and the requirement for medical consult has the potential to increase scene time and pull providers away from patient care, there may be benefit to not requiring direct medical oversight in the application of TOR protocols. Further research is needed to fully understand the proper role of direct medical oversight in the application of TOR protocols.

From Position Statement to Protocol Development

There is no doubt that anecdotal case reports will continue to be published demonstrating the rare case of a patient surviving traumatic cardiopulmonary arrest after prolonged asystole. However, in the development of protocols for withholding and TOR, it is important to consider the balance between providing the greatest amount of care possible to an individual patient and doing the greatest good for the population. The criteria for withholding and termination as outlined in this article and in Tables 2 and 3 takes into account the importance of caring for the individual and the recognition that pursuing futile care in the out-of-hospital environment has the potential to cause significant harm to the EMS system and to the greater populace.

Despite the scientific evidence, there are operational challenges that may make it difficult to use these positions for the development of functional EMS system protocols. Perhaps, the greatest challenge is the recommendation for TOR after a period of unsuccessful resuscitative efforts. System medical directors need to consider the potential advantage to quickly loading a patient into a transport unit and moving toward a trauma center and how this will impact a TOR protocol. The use of a time determinant in a TOR protocol is complicated by a need for a process to terminate while in transit and consideration of what should be done with a patient once the resuscitation has been terminated. A decision should be made if the EMS providers should continue with transport to the trauma center without lights and sirens, stop at the side of the road and wait for the medical examiner, or continue with transport directly to the medical examiner or identified morgue[59] or if there is another method to handle this situation. Geographic location of the arrest and other factors in the state regulatory environment may affect these decisions. Of note, the State of Maryland recently implemented a new protocol to direct EMS providers to pronounce the patient dead in the field and then transfer the care of the patient to local law enforcement and the coroner.[60]

As there are operational challenges that are to be expected in the development of protocols for withholding and TOR, it is important to note that the purpose of this article is to present the best available evidence. It is up to the system medical director to determine the best method to create these protocols accounting for the system specific factors and balancing the best available evidence.

CONCLUSION

In the setting of cardiopulmonary arrest secondary to trauma from both blunt and penetrating mechanisms, an evidence-guided protocol for withholding resuscitation includes clear evidence that the patient is dead, and a protocol for TOR should include the following elements: no evidence of signs of life including no pulse, no respirations, no blood pressure; and no ROSC after initiation of resuscitation by the EMS providers, which should include minimally interrupted chest compressions.

AUTHORSHIP

M.G.M. contributed in the primary study design, overall leadership for development of the manuscript, literature review, data analysis, writing, editing, review, and refinement with NAEMSP. S.M.G. contributed in the literature review, statistical analysis, data analysis, writing, and editing. S.R.K. contributed in the literature review, writing, and editing. A.M. contributed in the literature review, writing, and editing. E.M.B. contributed in the writing, editing, review, and refinement with ACSCOT.

DISCLOSURE

The authors declare no conflicts of interest.

REFERENCES

1. Hopson LR, Hirsh E, Delgado J, Domeier RM, McSwain NE Jr, Krohmer J. Guidelines for withholding or termination of resuscitation in prehospital traumatic cardiopulmonary arrest: a joint position paper from the National Association of EMS Physicians Standards and Clinical Practice Committee and the American College of Surgeons Committee on Trauma. *Prehosp Emerg Care*. 2003;7:141–146.
2. National Association of EMS Physicians and the American College of Surgeons Committee on Trauma. Termination of resuscitation for adult traumatic cardiopulmonary arrest. *Prehosp Emerg Care*. 2012;16:571.
3. National Association of EMS Physicians and the American College of Surgeons Committee on Trauma. Withholding of resuscitation for adult traumatic cardiopulmonary arrest. *Prehosp Emerg Care*. 2013;17:291.
4. National Association of EMS Physicians. Termination of resuscitation in nontraumatic cardiopulmonary arrest. *Prehosp Emerg Care*. 2011;15:542.
5. Millin MG, Khandker SR, Malki A. Termination of resuscitation of nontraumatic cardiopulmonary arrest: resource document for the National Association of EMS Physicians position statement. *Prehosp Emerg Care*. 2011;15:547–554.
6. Kahn CA, Pirrallo RG, Kuhn EM. Characteristics of fatal ambulance crashes in the United States: an 11-year retrospective analysis. *Prehosp Emerg Care*. 2001;5:261–269.
7. Saunders CE, Heye CJ. Ambulance collisions in an urban environment. *Prehosp Disaster Med*. 1994;9:118–124.
8. Slattery DE, Silver A. The hazards of providing care in emergency vehicles: an opportunity for reform. *Prehosp Emerg Care*. 2009;13:388–397.
9. Becker LR. Ambulance crashes: protect yourself and your patients. *JEMS*. 2003;28:24–26.
10. Ray AF, Kupas DF. Comparison of crashes involving ambulances with those of similar-sized vehicles. *Prehosp Emerg Care*. 2005;9:412–415.
11. Ray AM, Kupas DF. Comparison of rural and urban ambulance crashes in Pennsylvania. *Prehosp Emerg Care*. 2007;11:416–420.
12. Marques-Baptista A, Ohman-Strickland P, Baldino KT, Prasto M, Merlin MA. Utilization of warning lights and siren based on hospital time-critical interventions. *Prehosp Disaster Med*. 2010;25:335–339.
13. Brown LH, Whitney CL, Hunt RC, Addario M, Hogue T. Do warning lights and sirens reduce ambulance response times? *Prehosp Emerg Care*. 2000;4:70–74.
14. Hunt RC, Brown LH, Cabinum ES, Whitley TW, Prasad NH, Owens CF Jr, Mayo CE Jr. Is ambulance transport time with lights and siren faster than that without? *Ann Emerg Med*. 1995;25:507–511.
15. Hunt RC, Brown LH, Whitley TW, Prasad NH, Owens CF Jr. Emergency warning lights and sirens. *Ann Emerg Med*. 1999;34:114–115.
16. Russi CS, Kolb LJ, Myers LA. A comparison of chest compression quality delivered during on-scene and transport cardiopulmonary resuscitation (abstract). *Prehosp Emerg Care*. 2011;15:106.
17. Hinchey PR, Myers JB, Lewis R, De Maio VJ, Reyer E, Licatese D, Zalkin J, Snyder G. Improved out-of-hospital cardiac arrest survival after the sequential implementation of 2005 AHA guidelines for compressions, ventilations, and induced hypothermia: the Wake County experience. *Ann Emerg Med*. 2010;56:348–357.
18. Morrison LJ, Kierzek G, Diekema DS, Sayre MR, Silvers SM, Idris AH, Mancini ME. Part 3: ethics: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2010;122:S665–S675.
19. Vanden Hoek TL, Morrison LJ, Shuster M, Donnino M, Sinz E, Lavonas EJ, Jeejeebhoy FM, Gabrielli A. Part 12: cardiac arrest in special situations: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2010;122:S829–S861.
20. Bobrow BJ, Clark LL, Ewy GA, Chikani V, Sanders AB, Berg RA, Richman PB, Kern KB. Minimally interrupted cardiac resuscitation by emergency medical services for out-of-hospital cardiac arrest. *JAMA*. 2008;299:1158–1165.
21. Rosemurgy AS, Norris PA, Olson SM, Hurst JM, Albrink MH. Prehospital traumatic cardiac arrest: the cost of futility. *J Trauma*. 1993;35:468–473; discussion 473–474.
22. Pasquale MD, Rhodes M, Cipolle MD, Hanley T, Wasser T. Defining "dead on arrival": impact on a level I trauma center. *J Trauma*. 1996;41:726–730.
23. National Association of State EMS Officials. Regionalization of care: position statement of the National Association of State EMS Officials. *Prehosp Emerg Care*. 2010;14:403.
24. Glickman SW, Lytle BL, Ou FS, Mears G, O'Brien S, Cairns CB, Garvey JL, Bohle DJ, Peterson ED, Jollis JG, et al. Care processes associated with quicker door-in-door-out times for patients with ST-elevation-myocardial infarction requiring transfer: results from a statewide regionalization program. *Circ Cardiovasc Qual Outcomes*. 2011;4:382–388.
25. Braithwaite SA, Millin MG. Emergency medical services and emergency department thoracotomy. *J Trauma*. 2011;71:269–270.

26. Shimazu S, Shatney CH. Outcomes of trauma patients with no vital signs on hospital admission. *J Trauma*. 1983;23:213–216.
27. Aprahamian C, Darin JC, Thompson BM, Mateer JR, Tucker JF. Traumatic cardiac arrest: scope of paramedic services. *Ann Emerg Med*. 1985;14: 583–586.
28. Wright SW, Dronen SC, Combs TJ, Storer D. Aeromedical transport of patients with post-traumatic cardiac arrest. *Ann Emerg Med*. 1989;18: 721–726.
29. Esposito TJ, Jurkovich GJ, Rice CL, Maier RV, Copass MK, Ashbaugh DG. Reappraisal of emergency room thoracotomy in a changing environment. *J Trauma*. 1991;31:881–885; discussion 885–887.
30. Fulton RL, Voigt WJ, Hilakos AS. Confusion surrounding the treatment of traumatic cardiac arrest. *J Am Coll Surg*. 1995;181:209–214.
31. Stratton SJ, Brickett K, Crammer T. Prehospital pulseless, unconscious penetrating trauma victims: field assessments associated with survival. *J Trauma*. 1998;45:96–100.
32. Battistella FD, Nugent W, Owings JT, Anderson JT. Field triage of the pulseless trauma patient. *Arch Surg*. 1999;134:742–745; discussion 745–746.
33. Stockinger ZT, McSwain NE Jr. Additional evidence in support of withholding or terminating cardiopulmonary resuscitation for trauma patients in the field. *J Am Coll Surg*. 2004;198:227–231.
34. Pickens JJ, Copass MK, Bulger EM. Trauma patients receiving CPR: predictors of survival. *J Trauma*. 2005;58:951–958.
35. Willis CD, Cameron PA, Bernard SA, Fitzgerald M. Cardiopulmonary resuscitation after traumatic cardiac arrest is not always futile. *Injury.* 2006;37:448–454.
36. Moriwaki Y, Sugiyama M, Yamamoto T, Tahara Y, Toyoda H, Kosuge T, Harunari N, Iwashita M, Arata S, Suzuki N. Outcomes from prehospital cardiac arrest in blunt trauma patients. *World J Surg*. 2011;35:34–42.
37. Tarmey NT, Park CL, Bartels OJ, Konig TC, Mahoney PF, Mellor AJ. Outcomes following military traumatic cardiorespiratory arrest: a prospective observational study. *Resuscitation*. 2011;82:1194–1197.
38. Mollberg NM, Glenn C, John J, Wise SR, Sullivan R, Vafa A, Snow NJ, Massad MG. Appropriate use of emergency department thoracotomy: implications for the thoracic surgeon. *Ann Thorac Surg*. 2011;92:455–461.
39. Seamon MJ, Fisher CA, Gaughan J, Lloyd M, Bradley KM, Santora TA, Pathak AS, Goldberg AJ. Prehospital procedures before emergency department thoracotomy: "scoop and run" saves lives. *J Trauma*. 2007;63:113–120.
40. Seamon MJ, Fisher CA, Gaughan JP, Kulp H, Dempsey DT, Goldberg AJ. Emergency department thoracotomy: survival of the least expected. *World J Surg*. 2008;32:604–612.
41. Powell DW, Moore EE, Cothren CC, Ciesla DJ, Burch JM, Moore JB, Johnson JL. Is emergency department resuscitative thoracotomy futile care for the critically injured patient requiring prehospital cardiopulmonary resuscitation? *J Am Coll Surg*. 2004;199:211–215.
42. Siram S, Oyetunji T, Johnson SM, Khoury AL, White PM, Chang DC, Greene WR, Frederick WA. Predictors for survival of penetrating trauma using emergency department thoracotomy in an urban trauma center: the Cardiac Instability Score. *J Natl Med Assoc*. 2010;102:126–130.
43. Working Group, Ad Hoc Subcommittee on Outcomes, American College of Surgeons Committee on Trauma. Practice management guidelines for emergency department thoracotomy. Working Group, Ad Hoc Subcommittee on Outcomes, American College of Surgeons-Committee on Trauma. *J Am Coll Surg*. 2001;193:303–309.
44. Eckstein M. Termination of resuscitative efforts: medical futility for the trauma patient. *Curr Opin Crit Care*. 2001;7:450–454.
45. Kavolius J, Golocovsky M, Champion HR. Predictors of outcome in patients who have sustained trauma and who undergo emergency thoracotomy. *Arch Surg*. 1993;128:1158–1162.
46. Speight J, Sanders M. Pericardial tamponade with a positive abdominal FAST scan in blunt chest trauma. *J Trauma*. 2006;61:743–745; discussion 745.
47. Burlew CC, Moore EE, Moore FA, Coimbra R, McIntyre RC Jr, Davis JW, Sperry J, Biffl WL. Western Trauma Association critical decisions in trauma: resuscitative thoracotomy. *J Trauma Acute Care Surg*. 2012;73: 1359–1363; discussion 1363–1364.
48. Cothren CC, Moore EE. Emergency department thoracotomy for the critically injured patient: objectives, indications, and outcomes. *World J Emerg Surg*. 2006;1:4.
49. Rhee PM, Acosta J, Bridgeman A, Wang D, Jordan M, Rich N. Survival after emergency department thoracotomy: review of published data from the past 25 years. *J Am Coll Surg*. 2000;190:288–298.
50. Moore EE, Knudson MM, Burlew CC, Inaba K, Dicker RA, Biffl WL, Malhotra AK, Schreiber MA, Browder TD, Coimbra R, et al. Defining the limits of resuscitative emergency department thoracotomy: a contemporary Western Trauma Association perspective. *J Trauma*. 2011;70:334–339.
51. Mattox KL, Feliciano DV. Role of external cardiac compression in truncal trauma. *J Trauma*. 1982;22:934–936.
52. Copass MK, Oreskovich MR, Bladergroen MR, Carrico CJ. Prehospital cardiopulmonary resuscitation of the critically injured patient. *Am J Surg*. 1984;148:20–26.
53. Durham LA 3rd, Richardson RJ, Wall MJ Jr, Pepe PE, Mattox KL. Emergency center thoracotomy: impact of prehospital resuscitation. *J Trauma*. 1992;32:775–779.
54. Millin MG, Galvagno SM. A population-based time determinant for termination of resuscitation. *World J Surg*. 2010;35:1152.
55. Dunford JV, Davis DP, Ochs M, Doney M, Hoyt DB. Incidence of transient hypoxia and pulse rate reactivity during paramedic rapid sequence intubation. *Ann Emerg Med*. 2003;42:721–728.
56. Carr BG, Brachet T, David G, Duseja R, Branas CC. The time cost of prehospital intubation and intravenous access in trauma patients. *Prehosp Emerg Care*. 2008;12:327–332.
57. Davis DP, Koprowicz KM, Newgard CD, Daya M, Bulger EM, Stiell I, Nichol G, Stephens S, Dreyer J, Minei J, et al. The relationship between out-of-hospital airway management and outcome among trauma patients with Glasgow Coma Scale Scores of 8 or less. *Prehosp Emerg Care*. 2011; 15:184–192.
58. Warner KJ, Copass MK, Bulger EM. Paramedic use of needle thoracostomy in the prehospital environment. *Prehosp Emerg Care*. 2008;12:162–168.
59. Brywczynski J, McKinney J, Pepe PE, Eckstein M, Myers JB, Fowler RL, Slovis CM. Emergency medical services transport decisions in posttraumatic circulatory arrest: are national practices congruent? *J Trauma*. 2010;69: 1154–1159; discussion 1160.
60. EMS Provider Protocols. Maryland Institute for Emergency Medical Services Systems. Available at: www.miemss.org/home/EMSProviders/EMSProviderProtocols/tabid/106/Default.aspx. Accessed March 6, 2013.

