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# Withholding or Termination of Resuscitation in Pediatric Out-of-Hospital Traumatic Cardiopulmonary Arrest

AMERICAN COLLEGE OF SURGEONS Committee on Trauma, AMERICAN COLLEGE OF EMERGENCY PHYSICIANS Pediatric Emergency Medicine Committee, NATIONAL ASSOCIATION OF EMS PHYSICIANS and AMERICAN ACADEMY OF PEDIATRICS Committee on Pediatric Emergency Medicine

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POLICY STATEMENT

# Withholding or Termination of Resuscitation in Pediatric Out-of-Hospital Traumatic Cardiopulmonary Arrest

## abstract

FREE

This multiorganizational literature review was undertaken to provide an evidence base for determining whether recommendations for out-of-hospital termination of resuscitation could be made for children who are victims of traumatic cardiopulmonary arrest. Although there is increasing acceptance of out-of-hospital termination of resuscitation for adult traumatic cardiopulmonary arrest when there is no expectation of a good outcome, children are routinely excluded from state termination-of-resuscitation protocols. The decision to withhold resuscitative efforts in a child under specific circumstances (decapitation or dependent lividity, rigor mortis, etc) is reasonable. If there is any doubt as to the circumstances or timing of the traumatic cardiopulmonary arrest, under the current status of limiting termination of resuscitation in the field to persons older than 18 years in most states, resuscitation should be initiated and continued until arrival to the appropriate facility. If the patient has arrested, resuscitation has already exceeded 30 minutes, and the nearest facility is more than 30 minutes away, involvement of parents and family of these children in the decision-making process with assistance and guidance from medical professionals should be considered as part of an emphasis on family-centered care because the evidence suggests that either death or a poor outcome is inevitable. *Pediatrics* 2014;133:e1104–e1116

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**KEY WORDS**

traumatic cardiopulmonary arrest, blunt trauma, cardiorespiratory arrest, resuscitative thoracotomy, out-of-hospital cardiac arrest, out-of-hospital termination of resuscitation, cardiopulmonary resuscitation, emergency medical services, advanced life support, basic life support, outcome, survival, children, adolescent

**ABBREVIATIONS**

CPR—cardiopulmonary resuscitation
ED—emergency department
EMS—emergency medical services
PCPC—pediatric cerebral performance category
ROSC—return of spontaneous circulation



*(Continued on last page)*

## INTRODUCTION

In 2003, the National Association of EMS Physicians and the Committee on Trauma of the American College of Surgeons published guidelines for out-of-hospital withholding or termination of resuscitation for adult victims of traumatic cardiopulmonary arrest who met specific criteria.[1] Clinical criteria included absent pulse, unorganized electrocardiogram rhythm, fixed pupils (all at the scene), and cardiopulmonary resuscitation (CPR) greater than 15 minutes. The recommendations did not extend to the pediatric population. Although many of the studies on which the recommendations were based included children, the vast majority of the involved subjects were adults. Studies published to that time that addressed the pediatric population in particular[2,3] and evaluated survival and functional outcome of pediatric blunt trauma victims with either full traumatic cardiopulmonary

arrest or severe hypotension suggested that the prognosis for pediatric traumatic cardiopulmonary arrest victims is similar to that for adults. Given the emotional demands of withholding resuscitation from a child in the field, it was believed by both the leadership in pediatric trauma care and emergency medical services (EMS) that additional studies were warranted before including children in any termination-of-resuscitation protocol. This literature review in pediatrics was undertaken to provide an evidence base for determining whether recommendations for out-of-hospital termination of resuscitation could be made. The project aims were to (1) identify whether specific criteria exist that would support out-of-hospital withholding or termination of resuscitation for traumatic cardiopulmonary arrest victims and (2) identify a specific time frame for any subset of pediatric trauma patients beyond which further resuscitative efforts are futile.

## METHODS

Organizational participants included the Committee on Trauma, Subcommittee on Emergency Services—Prehospital, and Pediatric Surgical Specialty Group of the American College of Surgeons; Committee on Pediatric Emergency Medicine of the American Academy of Pediatrics; National Association of EMS Physicians; and Pediatric Committee of the American College of Emergency Physicians. The initial review was completed in September 2008, and additional literature through 2011 was added to provide currency to the review. General guidelines for evaluation included the following:

1. Distinguish between blunt and penetrating trauma victims.
2. Define "pediatric patient" as 18 years of age or younger.
3. Determine location of arrest (out-of-hospital or emergency department [ED]).

Specific characteristics of the arrest were determined, if possible, as follows:

1. Distinguish between respiratory and cardiopulmonary arrest (from any cause).
2. Determine duration of witnessed arrest.
3. Determine duration of resuscitation to successful return of spontaneous circulation (ROSC).
4. Determine outcome of children who had successful ROSC: did they survive to reach the hospital, survive to hospital discharge, and have long-term neurologic function?
5. Determine duration of resuscitation efforts in nonsurvivors.
6. Determine effects of epinephrine administration.
7. Determine outcome of thoracotomy when used.
8. Exclude special circumstances: drowning (warm or cold water), hypothermia, burns, electrocution (lightning, electric fence).
9. Determine any caveats with regard to survival to be an organ donor.

Methodology for the evidence evaluation was based on the 2000 Eastern Association for the Surgery of Trauma guideline "Utilizing Evidence-Based Outcome Measures to Develop Practice Management Guidelines: A Primer."[4] Class I evidence is derived from prospective, randomized, controlled trials; class II evidence represents clinical studies in which data were collected prospectively or retrospective analyses that were based on clearly reliable data; and class III evidence is based on retrospectively collected data. A validity scale for class I was detailed by Jadad et al in 1996.[5] Recommendations were classified as level 1, 2, or 3 according to the following definitions:

1. Level 1: The recommendation is convincingly justifiable based on the available scientific information alone. This recommendation is usually based on class I data; however, strong class II evidence may form the basis for a level 1 recommendation, especially if the issue does not lend itself to testing in a randomized format. Conversely, low-quality or contradictory class I data may not be able to support a level 1 recommendation.
2. Level 2: The recommendation is reasonably justifiable by available scientific evidence and strongly supported by expert opinion. This recommendation is usually supported by class II data or a preponderance of class III evidence.
3. Level 3: The recommendation is supported by available data, but adequate scientific evidence is lacking. This recommendation is generally supported by class III data. This type of recommendation is useful for educational purposes and in guiding future clinical research.

Each article was assigned at least 2 reviewers. The assignments were known only to the project director. All articles were also reviewed by the project director, and evidence class was reconciled as needed.

## LITERATURE REVIEW

MedLine and PubMed were searched for the initial review through Ovid from 1980 to 2006. Subsequently, the review was updated with literature as recent as 2011. Search terms included traumatic cardiopulmonary arrest, blunt trauma, cardiorespiratory arrest, resuscitative thoracotomy, out-of-hospital cardiac arrest, out-of-hospital termination of resuscitation, cardiopulmonary resuscitation, EMS, advanced life support, basic life support, outcome, survival, children, and adolescent. Article

bibliographies were hand-searched for additional references. New citations were added and assigned as appropriate. Abstracts were included only if a companion manuscript was identified. Editorials, letters to the editor, and studies that included only adults were eliminated. Published articles that included only victims of drowning were ultimately eliminated after review because the special circumstance of hypothermia and/or cold water drowning may alter resuscitation. Studies that included both adults and children were used if the children were evaluated separately or if data relevant only to children could be abstracted from the text. Studies that mixed traumatic arrests and arrests from other causes were used only if the trauma cohort was described independently. Only trauma patients who suffered a cardiopulmonary arrest rather than isolated respiratory arrest were included. Individual patients were included for review only if they could be tracked through the published article such that some outcome (ie, at least survival to hospital discharge) could be determined. The arrest interval or time to resuscitation was defined, in a witnessed arrest, as the time between the occurrence of arrest and the time that CPR was instituted, whether by a bystander or professional. Resuscitation time was defined as the duration of CPR until either ROSC or death was declared.

## RESULTS

Fifty-four articles were retrieved for the initial review.[2,3,6–57] Of these, 35 were eliminated for the reasons described previously,[6–40] leaving 19 articles with potentially useful information.[2,3,41–57] An additional 23 articles were screened for the secondary review,[58–81] with 9 articles appropriate for inclusion.[58,64–69,72,81] There were 2 sets of patients included in 2 articles each, and data were used only once.[53,72,74,80] There were 5 class II studies and 22 class III studies. From the 27 articles, there were 1114 patients who suffered an out-of-hospital traumatic cardiopulmonary arrest, with 60 surviving to hospital discharge (5.4%). Outcome data were available in 23 articles for 51 of these patients (Table 1): 29 suffered neurologic devastation and were either severely disabled or in a vegetative state,[2,6,41,44,53,64,66,68] 3 patients had moderate disability,[3,42,66] and 19 survived with a "good" or full neurologic recovery.[3,42,66,68,69] A separate evidentiary table provides data for cases of out-of-hospital traumatic cardiopulmonary arrest in children for which outcome was not reported (Table 2).[56,59,72,81]

A uniform system of describing disability was not used by all authors, although the most popular system was the pediatric cerebral performance category (PCPC; Table 3).[82] Thirty-six patients suffered an out-of-hospital traumatic cardiopulmonary arrest from penetrating injuries, and at least 9 of them had a resuscitative thoracotomy in an ED; all of these patients died regardless of whether thoracotomy was performed.[3,50–52,68] Resuscitative thoracotomy was performed at the scene, in the ED, or in the operating room, for 30 patients (combined blunt and penetrating trauma victims) who suffered an out-of-hospital traumatic cardiopulmonary arrest, and there were no survivors.[3,50–52] A few published articles mentioned children who were declared dead in the field, implying that the state or country has a do-not-resuscitate protocol for a subset of arrest victims.[3,47,48,78,79]

Cause of death, interval of arrest to CPR, and total resuscitation time for survivors were reported in a few articles. Specific anatomic causes of death were only rarely mentioned in published articles and included blunt trauma to the brain and spinal cord[43] and penetrating injuries to the head/brain, liver, spleen, heart, and aorta.[50] In a recent report, 78% of nonsurvivors had a traumatic brain injury.[66] It was difficult to abstract time to initiation of resuscitation and total resuscitation times for trauma patients from most articles. Information for arrests of all causes was available in a few. For example, interval to CPR was 2.3 minutes for survivors and 6.5 minutes for nonsurvivors in a Canadian study of 41 patients who had an unexpected cardiac arrest,[48] and median interval to initiation of CPR in a prospective study from California that included arrests from all causes was 3 minutes (range, 0–5 minutes) among survivors and 13 minutes (range, 4–64 minutes) among nonsurvivors.[53] Reported survivor mean ED resuscitation time in 1 article, exclusive of field resuscitation, was 11.4 minutes,[42] and survivor median resuscitation time in another report was 14 $\pm$ 2.5 minutes (in the ED).[45] One article further described 5 survivors with a mean resuscitation time in the ED of 57.8 (SD, 25.5 minutes), and all had either severe disability or a vegetative state at discharge.[41] An outlier survivor in terms of resuscitation time had a good outcome with a combined 42 minutes of out-of-hospital and ED resuscitation.[45] In a study describing 56 pediatric patients with out-of-hospital traumatic cardiopulmonary arrest, 20 of the 56 trauma patients were revived by initial in-hospital CPR (ROSC, $\geq$20 minutes), but only 1 patient whose outcome was not disclosed was eventually discharged from the hospital alive.[58] In 2010, a retrospective review of pediatric out-of-hospital traumatic cardiopulmonary arrest documented 6 survivors of a patient cohort of 30 patients.[66] CPR greater than 15 minutes and fixed pupils distinguished nonsurvivors from survivors, and adult criteria based on those of Hopson et al[1] correctly predicted 100% of those who died when all of the criteria were met. The mean duration of CPR was 42

**TABLE 1** Evidentiary Table for Out-of-Hospital Traumatic Cardiopulmonary Arrest in Children Where Outcome Was Reported

| Authors | No. of Trauma Victims | Survivors | Outcome | Special Circumstances | Class |
|---|---|---|---|---|---|
| Hazinski et al 1994[2] | 38 | 1 | Severe disability (9.5-y-old functioning as nonambulatory 1-y-old) | Out-of-hospital intubation did not influence likelihood of reanimation | II |
| Suominen et al 1998[3] | 28 | 1 | Moderate disability | Run over by train, airway obstructed, spontaneous circulation within 17 min of the accident and after 5 min of resuscitation | III |
| Pitetti et al 2002[41] | 53 | 1 | Severely disabled (PCPC 4; see Table 3) | Survivors likely to be in sinus rhythm on arrival in ED, to have received fewer doses of epinephrine in ED | III |
| Kuisma et al 1995[42] | 10 | 1 | Partial disability, capable of self-care (Bloom III; see Table 2) | Mean resuscitation times for survivors and nonsurvivors was 11.4 and 30.6 min; bystander initiated related to favorable outcome, survivor had ROSC in 17 min | III |
| Calkins et al 2002[43] | 16 | 0 | | | III |
| Ronco et al 1995[44] | 26 | 1 | Severely disabled (examined by a neurologist, no scoring system) | Median ED resuscitation time for both survivors and nonsurvivors was 30 min; only intact survivor was resuscitated before ED arrival | III |
| O'Rourke, 1986[45] | 10 | 2 | Vegetative state | | III |
| Thompson et al 1990[46] | 28 | 2 | Severely disabled | | III |
| Tsai and Kalisen, 1987[47] | 6 | 0 | | | III |
| Friesen et al 1982[48] | 13 | 0 | | Interval between arrest and institution of active CPR was 2.3 min in survivors and 6.5 min in nonsurvivors | II |
| Sirbaugh et al 1999[49] | 44 | 0 | | | II |
| Sheikh and Culbertson 1993[50] | 13 | 0 | | All had ED thoracotomy within 5 min of ED arrival | III |
| Beaver et al 1987[51] | 17 | 0 | | All had ED thoracotomy after a mean of 22 min of conventional resuscitation | III |
| Powell et al 1988[52] | 9 | 0 | | All had ED thoracotomy; all scene arrest patients died | III |
| Young et al 2004[53](same as Brindis et al 2011[80]) | 118 | 6 | All severe disability or vegetative state (PCPC 4 or 5) | No survivor who had ED CPR >31 min had a good neurologic outcome | II |
| Patterson et al 2005[54] | 59 | 0 | | No long-term trauma survivors with use of either standard or high-dose epinephrine | II |
| Martin et al 2002[55] | 7 | 0 | | All patients in study had pulseless electrical activity at scene | III |
| Broides et al 2000[57] | 7 | 0 | | | III |
| Widdel et al 2010[69] | 30 | 1 | Good neurologic outcome | Survivor had 2 min of out-of-hospital CPR; aggressive resuscitation is rarely successful | III |
| Horisberger et al 2002[65] | 16 | 0 | | | III |
| Capizzani et al 2010[66] | 30 | 6 | 2 with good neurologic outcome, 1 fair, 3 poor | CPR >15 min and fixed pupils were predictive of death or poor outcome | III |
| Fisher and Worthen 1999[64] | 65 | 1 | 1 survivor in persistent vegetative state | | III |
| Murphy et al 2010[68] | 169 | 28 | 55% survived intact but one-third of these required no airway support | 66 patients transferred from another hospital; no children survived if CPR was ongoing at ED arrival | III |
| Total | 812 | 51 (6.3%) | | 29 (57%) severe disability; 3 (6%) moderate disability; 19 (37%) normal | |

minutes (SD, 28 minutes) for nonsurvivors and 7 minutes (SD, 3 minutes) for survivors. Three patients were discharged from the hospital with orders for outpatient rehabilitation services, and 3 patients required extensive rehabilitation and require 24-hour assistance with activities of daily living. A recently published multicenter cohort study of out-of-hospital pediatric cardiac arrest included 15 children with traumatic cardiopulmonary arrest (total, 138 patients), and 3 survived.[67] Although PCPC scores were used for survivors, it was not possible to determine outcomes for these 3 children. However, survivors from all causes had a median duration and interquartile range of CPR of 18.5 minutes (3.5–28.5 minutes) versus 41 minutes (24–54 minutes) for nonsurvivors.

**TABLE 2** Evidentiary Table for Out-of-Hospital Traumatic Cardiopulmonary Arrest in Children for Whom Outcome Was Not Reported

| Authors | No. of Trauma Victims | Survivors | Outcome | Special Circumstances | Class |
|---|---|---|---|---|---|
| Lin et al 2007[58] | 56 | 1 | Outcome not reported | 20/56 patients revived in ED with ROSC all ≥20 min | III |
| Li et al 1999[56] | 182 | 2 | Unable to determine | National Pediatric Trauma Registry data, <2% of patients who were asystolic on admission were discharged alive | III |
| Moler et al 2011[72] (same as Moler et al 2009[74]) | 15 | 3 | Unable to determine | Median duration and interquartile range of CPR of 18.5 (3.5–28.5) min | III |
| Stockinger et al 2004[81] | 49 | 3 | Unable to determine | | III |
| Total | 302 | 9 (3%) | | | |

**TABLE 3** Disability Scoring Systems

| PCPC[57] | |
|---|---|
| 1 | Normal |
| 2 | Mild disability |
| 3 | Moderate disability |
| 4 | Severe disability |
| 5 | Coma or vegetative state |
| 6 | Brain dead |
| **Bloom Classification[92]** | |
| I | No disability, active life |
| II | Mild disability, active life |
| III | Partial disability, but capable of self-care |
| IV | Total disability, incapable of self-care |

A few articles addressed the use of epinephrine in out-of-hospital cardiopulmonary arrest in terms of survival, with some noting that survivors often needed no epinephrine. At least 3 authors associated more than 2 or 3 doses of standard dose epinephrine with death, although not necessarily among trauma victims, and 1 had survivors who had received up to 4 doses.[35,41,53,67]

The mean attempted resuscitation time in many studies averaged 30 minutes. Most child survivors of out-of-hospital traumatic cardiopulmonary arrest undergoing resuscitative efforts of this duration were neurologically devastated. The 3 patients who had moderate disability had ROSC after approximately 17 minutes of CPR.[3,42,66] Normal outcome was seen more often in trauma victims who had a perceived rapid ROSC, although an exact time in minutes was difficult to extract from the article with the majority of survivors who had a normal neurologic status.[68]

A few articles made specific reference to organ donation, mentioning that sustained ROSC may serve as a bridge to possible organ donation and is necessary to prevent organ failure before harvesting.[58] However, it was noted by another group that it is ethically inappropriate to proceed with resuscitation solely to preserve organs because the physician may be more committed to the potential well-being of an unknown recipient rather than the patient at hand or his or her family members. Traditionally, cadaveric organ transplantation operates under the "dead donor rule," and organ recovery must not be the direct cause of the donor's death, a concept that is justified by the prohibition against the direct killing of innocent persons. Furthermore, the added expense associated with organ preservation, until such time as decoupling has occurred and the family can be approached about donation, is generally the responsibility of the donor family. If the family decides to donate, future expenses will be born by the organ procurement organization on behalf of the recipient.[83] If the family declines the opportunity to donate, this added expense and burden is not offset by a perceived benefit to the family.[44]

## DISCUSSION

Each year in the United States, 16 000 children suffer cardiopulmonary arrest.[59] Inpatient results are improving, but the outcome for pediatric traumatic out-of-hospital arrests remains poor, although newer evidence suggests that children and adolescents with out-of-hospital arrest from other causes are more likely to survive than adults.[41,53,59–62,78,84] Pediatric out-of-hospital deaths represent nearly one-third of pediatric deaths in the United States,[85] and in 1 urban study, 2% of pediatric EMS calls were attributed to pediatric out-of-hospital arrests.[63] Some of the more current studies of out-of-hospital arrest exclude trauma. Trauma is the leading cause of death from 1 through 21 years of age, and homicide or child abuse is the leading cause of trauma in children younger than 1 year[86]; therefore, the optimal management of pediatric out-of-hospital traumatic cardiopulmonary arrest deserves special attention and will be the primary focus of the recommendations based on this review. Because many of the articles used for this review include pediatric arrests with multiple etiologies, making a few general observations about pediatric cardiopulmonary arrest is pertinent.

In a large 3-year prospective study of out-of-hospital arrests attributable to all causes in children younger than 12 years,[53] 8.6% of the children survived, one-third of whom had a good neurologic outcome. No patient who received more than 3 doses of epinephrine or more than 31 minutes of resuscitation in the ED survived. In

a more recent review of the literature and science of pediatric resuscitation, Topjian et al reported that 5% to 10% of pediatric out-of-hospital arrest victims survive to hospital discharge, with 0% to 12% having good neurologic outcomes.[59] Indicators of potential for successful outcomes in pediatric out-of-hospital arrest include a witnessed arrest, the occurrence of early bystander CPR, an initial shockable rhythm, and ROSC within 20 minutes.[84] In the absence of these characteristics, a good outcome is extraordinarily unlikely. However, anecdotal reports of children who survive after a prolonged resuscitation exist and lend unease to including them in generalized protocols. Although the outcome of pediatric inpatient cardiac arrests, generally associated with primary cardiac disease, is better than for adults, the outcome for pediatric out-of-hospital resuscitation is substantially worse because out-of-hospital arrests in children are more commonly caused by severe trauma, prolonged respiratory arrest, or septic shock rather than a primary cardiac etiology.[59] These etiologies imply a longer period of hypoxia before the actual arrest, with resulting brain and other organ damage. As noted previously, the mean resuscitation time in most pediatric studies was an average of 30 minutes. Most children with out-of-hospital traumatic cardiopulmonary arrest who received this duration of resuscitation and survived were irreversibly neurologically devastated.[2,6,41,44,53,64,66,68] Two of the 3 patients who suffered only moderate disability had ROSC after approximately 17 minutes of CPR.[3,42] Documentation of ROSC for the 19 children who had return to baseline or near-baseline status was reported for only 3 of the children as 2 minutes and less than 15 minutes.[66,69] In the series that quoted the largest number of intact survivors ($n$ = 16), the authors acknowledged that one-third of survivors presented with a stable airway and did not require intubation for respiratory support. There was also a uniform distribution across all injury severity score groups for survivors, with more than half of those survivors having an injury severity score greater than 16. These findings caused the authors to reflect that almost half of the survivors had either an exceedingly rapid response to out-of-hospital CPR or out-of-hospital findings that may not have warranted CPR intervention at all.[68] In fact, it has been recognized that some children who undergo CPR in the out-of-hospital setting are unlikely to have been pulseless because of the difficulty of recognizing pulselessness in children.[60,86]

ED crowding in the United States is an emerging threat to patient safety and public health, particularly in safety-net hospitals.[88–90] Although the effects of ED crowding on patient care and outcome are complex, transport of a nonviable patient from the field to the ED has the secondary effect of making the resources of the EMS personnel unavailable for those who might benefit from crucial immediate attention. A series of articles by Morrison et al validating the termination of resuscitation rule estimated that the frequency of out-of-hospital adult cardiac arrest transports to the ED could be reduced from 100% to 37.4% of calls, with no loss of viable patients, thus resulting in valuable resource and cost savings.[91–93] In addition to the cost concerns, the "lights and siren" run is associated with significant potential for injury to EMS personnel and the public.[94–97] Finally, the costs of supplies (often including precious blood products) and the emotional toll on ED providers who would not otherwise be exposed to the death, including the risk of posttraumatic stress disorder, are all important considerations that should not be ignored when choosing whether to transport a patient who is already dead or who will inevitably die (unpublished survey data; in process to submit for publication).

It is for these reasons that there is increasing acceptance of termination of resuscitation for adults when there is no hope for a good outcome.[1,76,91,92,98–101] Although the same justifications apply to children, especially in light of worse out-of-hospital resuscitation outcomes, children are routinely excluded from termination-of-resuscitation protocols, at least in the United States.[1] Approximately half of states have formalized termination of resuscitation in statute or protocol, but only a few apply them to children. In a recent Melbourne, Australian, study of out-of-hospital arrest, 29 patients had attempts at resuscitation discontinued in the field. Including the 7% of patients who had no attempts at resuscitation, this represented 20.6% who were declared dead at the scene by paramedics.[79]

Beyond the resource-saving benefits associated with termination of resuscitation, 2 small studies indicate that families of adult patients who die in the out-of-hospital setting may actually adapt better to their losses when there is cessation of futile resuscitative efforts in the field.[102,103] Many states have EMS protocols or statutes that allow do-not-resuscitate orders or a declaration of death in the field for adult victims with obvious signs of death, including decapitation, hemicorporectomy, lividity, rigor mortis, and decomposition, although even these states may exclude children from such protocols and procedures. The Resuscitation Outcomes Consortium reported that no EMS resuscitation was performed in 19% of children, and the

Australian reported that no EMS resuscitation was performed in 7%.

There remains a profound reluctance to stop futile resuscitative efforts when the patient is a child.[98] On the basis of the literature to date, the reluctance stems from provider and public ignorance of out-of-hospital arrest outcomes,[26–27,29,103–105] fear related to inadequate preparation for communication with acutely grieving family members,[26,106] perceived determinants of family adaptation to loss, and concerns regarding legal liability for providers. The issue of whether families benefit from futile resuscitative measures in the field and ED has not been studied. The Institute of Medicine study "Emergency Care for Children: Growing Pains"[90] corroborates that the provision of even routine emergency care for children provokes stress and anxiety for EMS providers because of lack of knowledge, training, and pediatric-specific experience.[107,108] Increased training and information is desired by EMS providers[109] and seems to mitigate the discomfort in some settings.[26,29,109,110]

There are no US studies of the needs of families of children at the scene of the death, although it is the time of the most tremendous shock and the time when EMS providers have the unique opportunity to positively affect the lives of the survivors forever. Most existing advice regarding the needs of families affected by the sudden, unexpected death of a child is based on extrapolations from the hospital setting or on anecdotal evidence. These recommendations are remarkably similar to recommendations regarding the care of families bereaved in other settings, particularly when the deceased is a child.[46,47]

Ethical concerns regarding the implementation of a termination-of-resuscitation policy deserve mention. Minority populations experience traumatic injuries disproportionately, including traumatic death. Any termination of resuscitation policy may therefore be viewed with distrust, particularly among minority populations. There are situations in which a family is remote from the scene of the arrest, and transport of the child to a hospital may allow family members more resources for grief counseling. EMS providers may be concerned about child abuse and prefer to transport.[86] New technologies for resuscitation after cardiopulmonary arrest from various causes are being considered and used at some hospitals, including extracorporeal membrane oxygenation.[111,112] This technology is expensive and may or may not lead to improved neurologic outcomes in trauma patients.[113] The ability of lay parents to grasp the risks and benefits of this extraordinary treatment option, providing informed consent when they are faced with an emergency life-or-death decision for their child, may be significantly compromised by the urgency of the process. The use of hypothermia as a treatment strategy after traumatic brain injury has also been attempted without a demonstrated survival advantage.[114] Preservation of circulation with the specific intent of organ preservation for transplantation is controversial. A specific area of debate that applies to this discussion includes the use of invasive procedures that are nonbeneficial to the donor. Health professionals should remain informed of advances in resuscitation that will allow a balanced discussion with those who will have decision-making authority for a given child.

This literature review and analysis has several limitations. The articles available for review are heterogeneous with respect to etiology of arrest, type of arrest (cardiopulmonary versus respiratory arrest), and location (out-of-hospital or ED), and final outcome data are often lacking. One study used registry data that may repeat reports of some children previously mentioned in the other studies. There is now an effort to try to standardize data for out-of-hospital arrests that will be helpful going forward, but this information cannot be applied to this review.[115] One of the more recent reviews that applied this template excluded trauma patients.[78] Some of the references in the discussion that detail out-of-hospital cardiac arrest transports to the ED in adults may not necessarily translate to children. The original Hopson study has been reconfirmed, and 1 of the pediatric studies used the same criteria with consistent results,[66,81] but another group had several survivors when applying the same criteria to an urban population.[72] As mentioned, some children who undergo CPR in the out-of-hospital setting are unlikely to have been pulseless because of the difficulty of recognizing pulselessness in children.[60,86] Nevertheless, results of the current review suggest that survival for children suffering an out-of-hospital traumatic cardiopulmonary arrest attributable to blunt or penetrating trauma is poor and that many survivors live with devastating neurologic disability. Despite its limitations, the following conclusions can be proposed on the basis of the results of this review: (1) the retrospective analysis revealed a reported overall traumatic cardiopulmonary arrest survival rate of 5.4%; (2) more recent publications corroborate that a short (<20 minutes) ROSC is associated with improved survival but not necessarily a good outcome; (3) virtually all survivors who require resuscitation for >20 minutes are neurologically devastated, but a few children resuscitated under more favorable circumstances have returned

to baseline; and (4) there are some clear markers that will help identify the rare child who might have a chance at a good outcome. In particular, survivors are likely to have a short interval of arrest to CPR (<5 minutes), to have ROSC in the field within minutes of beginning CPR, and to have sinus rhythm on arrival in the ED. There is little evidence that epinephrine makes a difference in the outcome of trauma patients. Most children with out-of-hospital traumatic cardiopulmonary arrest who receive more than 20 minutes of resuscitation and survive are neurologically devastated. Those who do better receive resuscitation for only a few minutes.

Although most of the recommendations in this statement are at a level 2 or 3 based on the evidence, the decision to withhold resuscitative efforts in a child under specific circumstances (decapitation or dependent lividity, rigor mortis, etc) is reasonable. However, in other circumstances, because of the potential for ambiguity and miscommunication, if there is any doubt as to the circumstances or timing of the traumatic cardiopulmonary arrest, under the current status of limiting termination of resuscitation in the field to persons older than 18 years in most states, resuscitation should be initiated and continued until arrival to the appropriate facility. The decision in these instances should not be left to EMS providers with different levels and variety of training, expertise, experience, and communication skills (even with remote input from the medical director, who is not on-site) to ensure a consistent message is delivered to parents and families of these children. If the patient has arrested and resuscitation has already exceeded 30 minutes and the distance to the nearest facility is more than 30 minutes away, involvement of parents and family of these children in the decision-making process with assistance and guidance from medical professionals should be considered as part of an emphasis on family-centered care because evidence suggests that either death or a poor outcome is inevitable.

## TREATMENT CONCLUSIONS BASED ON EVIDENCE

1. The withholding of resuscitative efforts should be considered in pediatric victims of penetrating or blunt trauma with injuries obviously incompatible with life, such as decapitation or hemicorporectomy (Level 2).
2. The withholding of resuscitative efforts should be considered in pediatric victims of penetrating or blunt trauma with evidence of a significant time lapse after pulselessness, including dependent lividity, rigor mortis, and decomposition (Level 2).
3. Initiation of standard resuscitation should be considered for cardiopulmonary arrest patients in whom the mechanism of injury does not correlate with a traumatic cause of arrest unless (1) or (2) above applies (Level 2).
4. Initiation of standard resuscitation should be considered in cardiopulmonary arrest victims of lightning strike or drowning in whom there is significant hypothermia unless (1) or (2) applies (Level 2).
5. Immediate transportation to an ED should be considered for children who exhibit witnessed signs of life before traumatic CPR and have CPR ongoing or initiated within 5 minutes in the field, with resuscitation maneuvers including airway management and intravenous or intraosseous line placement planned during transport (Level 2).
6. After blunt and penetrating trauma in victims in whom there is an unwitnessed traumatic cardiopulmonary arrest, a longer period of hypoxia may be presumed to have occurred, and an acceptable duration of CPR (including bystander CPR) of less than 30 minutes may be considered with medical director input (Level 3).
7. If there is any doubt as to the circumstances or timing of the traumatic cardiopulmonary arrest, under the current status of limiting termination of resuscitation in the field to persons older than 18 years in most states, resuscitation should be initiated and continued until arrival to the appropriate facility (Level 3).
8. The inclusion of children in state termination-of-resuscitation protocols should be considered, including children who are victims of blunt and penetrating trauma who have or in whom there is EMS-witnessed cardiopulmonary arrest and at least 30 minutes of unsuccessful resuscitative efforts, including CPR (Level 2).

### FUTURE POLICY AND PROTOCOL GUIDANCE

1. Termination-of-resuscitation protocols for children based on the evidence should be developed and implemented under the guidance of the EMS system or state EMS medical director. Online medical control may be needed to determine the appropriateness of termination of resuscitation in individual children.
2. Policies and procedures for termination-of-resuscitation protocols must include notification of the appropriate law enforcement agencies and notification

of the medical examiner or coroner for final disposition of the body.

3. EMS providers should receive education regarding communication with families and assistance with how to direct families to community and grief resources. EMS providers should have immediate access to resources for their own debriefing and counseling. Families of the deceased should have immediate access to culturally and linguistically appropriate care, counseling, and resources, including access to clergy, social workers, and other counseling personnel.
4. EMS, medical control, and ED providers should have access to resources for their own debriefing and counseling after the death of a child.
5. Adherence to policies and protocols governing termination of resuscitation should be monitored through a quality review system.
6. A more formal study evaluating out-of-hospital traumatic cardiopulmonary arrest that includes long-term neurologic and functional outcome should be performed to clarify expectations for intact survival in children and legitimatize the inclusion of children in termination-of-resuscitation protocols.
7. Research is vitally needed regarding the acceptance of termination-of-resuscitation protocols by families of children sustaining out-of-hospital traumatic cardiopulmonary arrest to determine the potential emotional effects of both termination of resuscitation and failure to initiate resuscitative efforts when futility of such efforts is apparent.
8. There is a need for more research and study of infants, children, and adolescents from diverse racial, ethnic, cultural, and socioeconomic populations to determine whether disparities in resuscitative care or outcomes exist.
9. Engagement of, partnership with, and collaboration with local communities and advocacy groups, perhaps through a community-based participatory research concept, may prove helpful in developing protocols and providing community health education programs about this subject.


### LEAD AUTHOR

Mary E. Fallat, MD

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**Withholding or Termination of Resuscitation in Pediatric Out-of-Hospital Traumatic Cardiopulmonary Arrest**

AMERICAN COLLEGE OF SURGEONS Committee on Trauma, AMERICAN COLLEGE OF EMERGENCY PHYSICIANS Pediatric Emergency Medicine Committee, NATIONAL ASSOCIATION OF EMS PHYSICIANS and AMERICAN ACADEMY OF PEDIATRICS Committee on Pediatric Emergency Medicine

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